STATE OF THE FISHERIES REPORT 2005/06

Government of Western Australia

Department of
Fisheries

Fish for the future

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Overview from the **Chief Executive Officer**

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

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

This year's report continues to support the Department's ecologically sustainable development (ESD) approach to the management of the state's fisheries and their aquatic environments. The structure of the report also deals with fisheries and fishing-related activities on a bioregional basis, enabling ecosystem-based fisheries management to be more efficiently considered. Furthermore, outlines of the management processes undertaken by the Department to manage the broader impacts of fishing on the aquatic environment, such as habitats, precede the fishery reports in each bioregion.

These bioregional reports indicate that the majority of Western Australia's significant fisheries stocks continue to be in a healthy condition and that fishing presents few risks to the stocks or the aquatic ecosystems underpinning them. However, the stocks of the state's larger sharks, particularly the longer-lived species, continue to be under excessive pressure, especially from international vessels operating illegally in our northern waters. Thus, while the management of the state's fisheries targeting these vulnerable stocks has been extensively reviewed, significant attention remains focused on reducing the level of illegal activities.

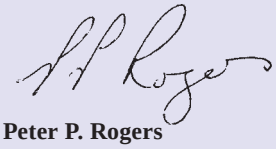
Further analyses are being undertaken to determine the level of recovery in offshore Shark Bay snapper stocks. There is increasing concern about the status of crustacean fisheries within Cockburn Sound, possibly as a result of environmental changes, and more work will be done within during the coming year to clarify this situation.

Last year saw a very large catch of scallops within the Abrolhos Islands fishery which generated a significant boost to the total landed value of seafood for the state. The western rock lobster fishery maintained its landed value despite a slightly lower catch. There is, however, growing concern about the economic returns from many fisheries as a result of relatively static beach prices, exchange rates and substantial increases in costs, particularly for fuel.

While demonstrating that the state's fish stocks are generally in good shape, the report also shows that new management initiatives continue to be taken on many fronts. Such adjustments to fisheries management arrangements are frequently required to accommodate natural fluctuations in stock abundance and continuing improvements to fishing efficiency through the application of new technology by both the commercial and recreational sectors. As an example, the revised management package for the commercial rock lobster fishery implemented during 2005/06 was developed in collaboration with fishers to minimise the economic impacts and optimise the social benefits of the new arrangements.

This highlights the increasing complexity and challenges facing those involved in fisheries and marine management, and especially the need for ongoing scientific monitoring and stakeholder support. Such elements are proving vital to the implementation of the Government's Integrated Fisheries Management (IFM) initiative, which will in turn be essential for the long-term sustainability of the state's fisheries and aquatic environments. The IFM process, which began in 2004, is now beginning to make recommendations on the explicit catch shares for each sector. Once finalised, this will probably require realignment of the way fisheries are managed and monitored.

I would like to take this opportunity to express my appreciation to all Departmental staff who have contributed to this important annual performance review of our fish stocks. Similarly, fishers throughout the state are to be commended for their positive support for the Department's research and management programs, without which sustainability would not be achieved. Finally, special mention must be made of the previous editor, Dr Jim Penn, who during the past 12 years oversaw the production of the *State of the Fisheries Report* from its inception, through many refinements, to its current, highly effective format, which has been adopted by many other jurisdictions.



Peter P. Rogers
Chief Executive Officer

Editor's **Introduction**

The *State of the Fisheries Report 2005/06* continues to follow the fully bioregional format which reflects the Department's ongoing commitment to ecosystem-based management of the state's aquatic resources. This bioregional structure for fishing activities parallels the Department's major Integrated Fisheries Management initiative, which is designed to ensure that the aggregate catch harvested from each stock is both sustainable and shared equitably between fishing sectors. This structure should enable readers to more easily assess the interrelationships between fisheries and their cumulative effect within each bioregion of the state. In this context, individual fish stocks can be regarded as general indicators of the health of the aquatic environment.

Each of the individual fishery status reports is currently based upon the well-established ESD reporting approach that has enabled all of the state's significant commercial fisheries to undergo assessment and achieve environmental certification under the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The status reports are grouped by sector so that stakeholders can go to discrete sections relevant to their particular interests. It is anticipated, however, that once IFM processes are fully operational, this structure may need to be reviewed. The stakeholder focus does reflect the important and critical role that many fishers play in recording their data on fish catches and the environment, which are necessary to both manage and monitor the state's fish stocks.

I am pleased to report that in 2005/06, commercial and recreational fishers have continued to support the Department's research and management effort through a variety of voluntary logbook and Voluntary Fisheries Liaison Officer programs. Similarly, the long-standing involvement of commercial skippers in specific research projects now extends into the recreational sector, including a significant number who have assisted in the completion of a tagging program on samson fish and those who have started to participate in the new Research Angler Program. The active collaboration between aquaculturists and the Department's research teams has also enhanced the R&D projects necessary to expand production from these small but important regional industries.

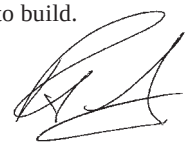
The Department's new Fisheries and Marine Research Laboratories at Hillarys, commissioned last year, are being well utilised. The Naturaliste Marine Discovery Centre within the Hillarys complex, which is close to being operational, will provide the public and school groups with a unique opportunity to understand and appreciate the state's marine resources and the science that underpins their sustainable management.

As part of the Department's more comprehensive approach to the management of the marine ecosystem, the Research Division has established a dedicated Biodiversity Branch. This group will be the focus for research on ecological and protected species interactions arising from fishing activities and for the provision of information needed for regional marine planning, including marine parks. The group will also be pivotal in the additional research currently being developed through the Government's new WA Marine Science Institution (WAMSI) initiative to enable comprehensive monitoring of the state's marine systems at a bioregional level. One of the primary areas for this work will be the Abrolhos Islands, where the Government has recently invested a significant level of resources. This includes the construction of the Saville Kent research facility on Rat Island and, more recently, the Separation Point facility in Geraldton, which together make up the Abrolhos Islands Research Institute. This infrastructure provides the platform for a variety of research activities within this unique fisheries and marine environment and is therefore expected to attract a significant level of national and international scientific interest.

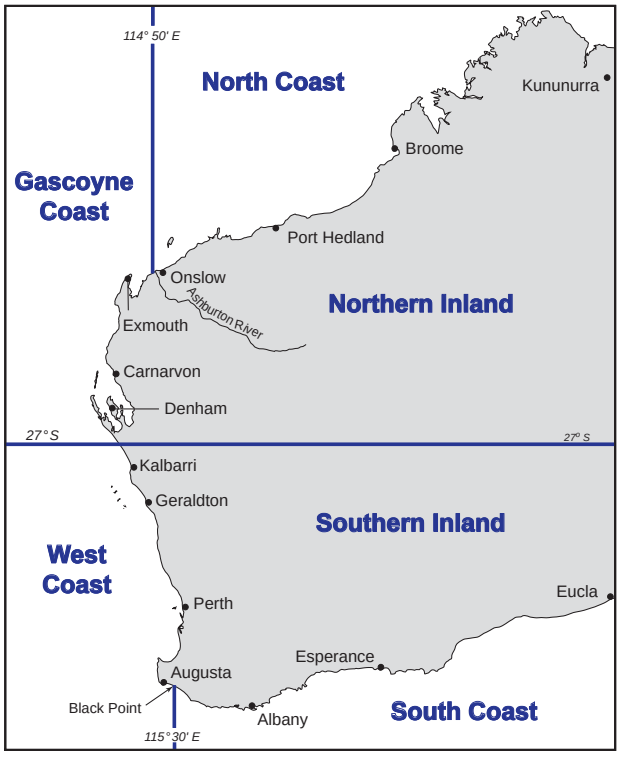
While the *State of the Fisheries Report* provides the general public and interested fishers with a ready reference source, it is also designed to support the Department's various reporting requirements, including those to the Australian Government under the EPBC Act. The report is directly accessible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

Finally, I would like to thank all of my Departmental colleagues who have assisted in the production of this volume and its many status reports. Particular thanks are due to Ms Fran Head, who continues to ensure that the standard of the text throughout this complex document remains at

an exceptionally high level. Mrs Sandy Clarke has again contributed her significant publishing expertise to convert the text into a high-quality printed volume. Finally, I endorse the acknowledgement given by the CEO for the significant contribution made by the previous editor, Dr Jim Penn, to the formation and development of this important document over many years. It represents a fine legacy upon which we intend to build.



Dr Rick Fletcher
Director – Fisheries Research



INTRODUCTION FIGURE 1

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

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 also appears in the Department's Annual Report to Parliament). Many of these terms and headings follow the national ESD reporting structure (Fletcher et al. 2002). In addition to the explanations provided below, acronyms are expanded at their first occurrence in the text, and are 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 (Introduction Figure 1). A 'bioregion' refers to a region defined by common oceanographic characteristics in the marine environment and climate/rainfall characteristics in the inland river systems. The marine bioregional boundaries used here are broadly consistent with those of the *Interim Marine and Coastal Regionalisation for Australia* report (IMCRA Technical Group 1997), except for the inclusion of the Gascoyne coast as a separate region, reflecting its nature as a permanent transition zone between tropical and temperate waters. The precise boundaries of the bioregions reflect specific grid reference points used in fisheries management plans and data recording systems. Each individual bioregion has been provided with a general introduction outlining its aquatic environment, major commercial and recreational fisheries and aquaculture industries.

Breeding stock status

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

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

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

Non-retained species

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

Ecosystem effects

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

Target catch (or effort) range

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

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

Where annual catch or effort falls outside of this range, 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 2004/05 or the calendar year 2005, whichever is more appropriate. Similarly, the statistics on compliance and educational activities are also for 2004/05, following 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 2006.

Performance measures

As noted above, almost all the state's significant export fisheries have now undergone assessment and achieved environmental certification under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999*. Consequently, the *State of the Fisheries Report* also reports the performance of the relevant fisheries against the specific performance measures developed during the EPBC assessment process. Within the individual fishery status reports, each of these performance measures is shown in a highlighted box to assist the reader. The results are also summarised in Appendix 6.

Common fish names

It should be noted that the common names of a small number of fish species have changed in this volume. (Where this has occurred, a reference is included to the common name formerly used for the same species.) This 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 down the continental shelf. Under the Interim Marine and Coastal Regionalisation for Australia (IMCRA) scheme, published in 1998 by the Australian and New Zealand Environment and Conservation Council, the bioregion has been divided into three meso-scale regions: the Abrolhos Islands, the Central West Coast and Leeuwin–Naturaliste.

The fish stocks of the region are typically temperate, in keeping with the coastal water temperatures which range from 18°C to about 24°C. The current is also responsible for the existence of the unusual Abrolhos Islands coral reefs at latitude 29° S and the extended southward distribution of many tropical species along the west and south coasts. This 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 which flows northward from Cape Leeuwin as far as Shark Bay, occur during summer and influence the distribution of many of the coastal finfish species.

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

The west coast is characterised by exposed sandy beaches and a limestone reef system which creates surface reef lines often about 5 km off the coast. Sea floors further offshore on the continental shelf are typically 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 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 four significant estuarine systems, the Swan/Canning, Peel/Harvey and Leschenault estuaries and Hardy Inlet (Blackwood estuary), all of which are permanently open to the sea and form an extension of the marine environment except when freshwater runoff displaces the oceanic water for a short period in winter and spring.

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

The bioregion is also home to an active wetline fishery, for which specific management arrangements are currently being developed. Demersal line fishers take a range of species including dhufish, snapper, baldchin groper and emperors from boats operating purely as wetliners (i.e. no form of access other than the fishing boat licence) as well as from boats operating in other managed fisheries. There is also

an important take of fish by beach seining and near-shore gillnetting using hand-hauled nets, for species including whitebait, mullet and whiting.

In this region more than any other in the state, population growth poses specific challenges for fisheries management. Increased recreational fishing pressure, and the setting of catch shares for commercial and recreational users, remains a major focus of the Department's management activity.

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

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

The principal aquaculture development activities in the west coast bioregion are the production of blue mussels and marine algae 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.

ENVIRONMENTAL MANAGEMENT

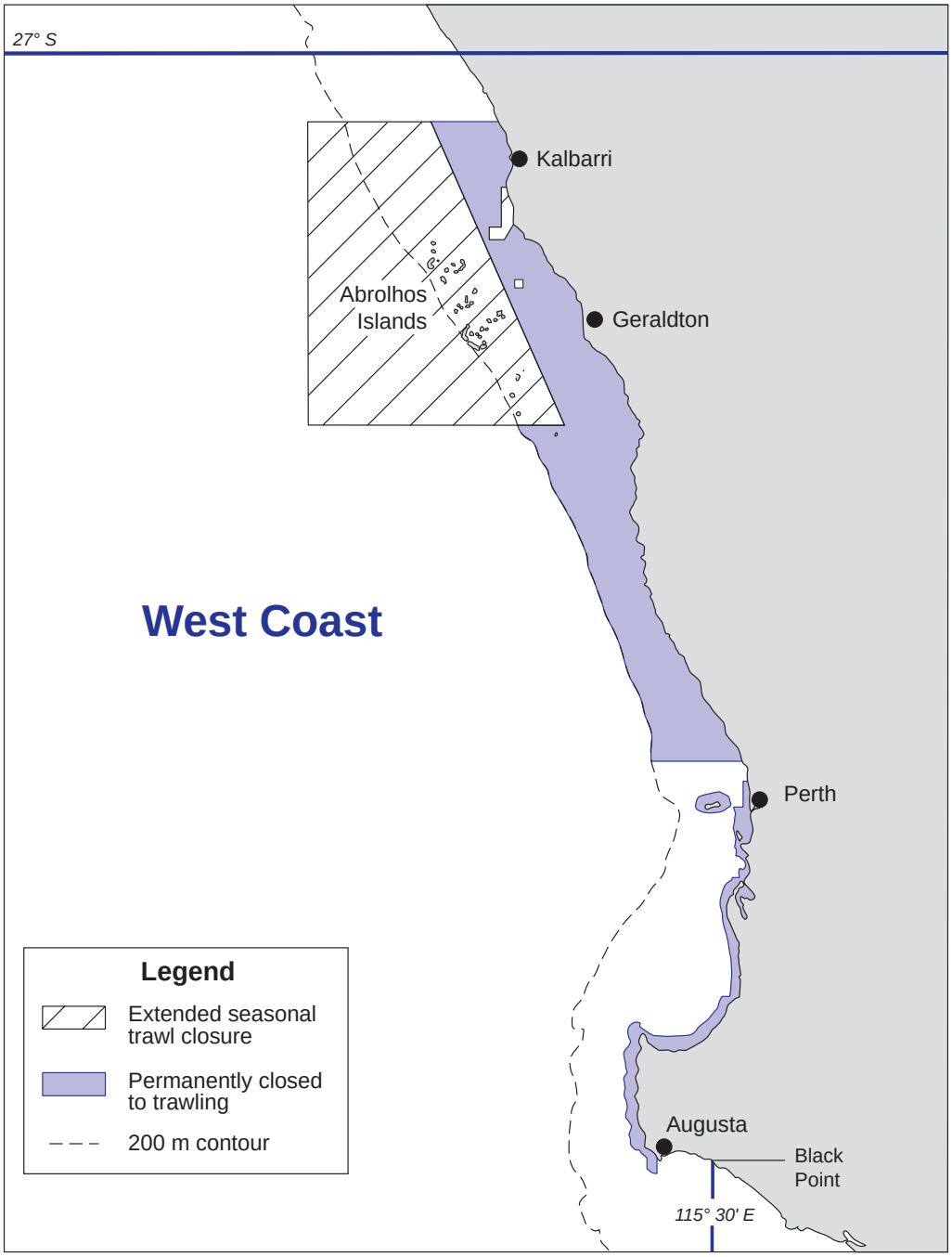
Regional Overview

On the west coast, marine habitats are largely protected from any physical impact of commercial fishing by extensive closures to trawling, the only permitted fishing method that can significantly affect marine habitats. These closures, introduced in the 1970s and 1980s, protect essentially all seagrass and reef habitats, with trawling limited to sand areas inhabited by target species such as scallops (West Coast Habitat Protection Figure 1). In addition, habitat and biodiversity protection is provided by specific Fish Habitat Protection Areas, Reef Observation Areas and marine parks in sensitive areas (West Coast Habitat Protection Figure 2). These protective management measures have contributed to maintaining the marine habitat and biodiversity in generally good condition. However, biodiversity and fish habitats in the west coast bioregion now face major threats from coastal development and environmental degradation through terrestrial runoff impacting estuaries and some protected near-shore waters.

During 2005/06, the Department of Fisheries gazetted orders under the *Fish Resources Management Act 1994* to modify fisheries activities in accordance with the management plan for the Jurien Bay Marine Park. Additional technical advice was also provided in relation to the proposed marine park between Cape Leeuwin and Cape Naturaliste. The management plan for the proposed Capes Marine Park is now out for public review.

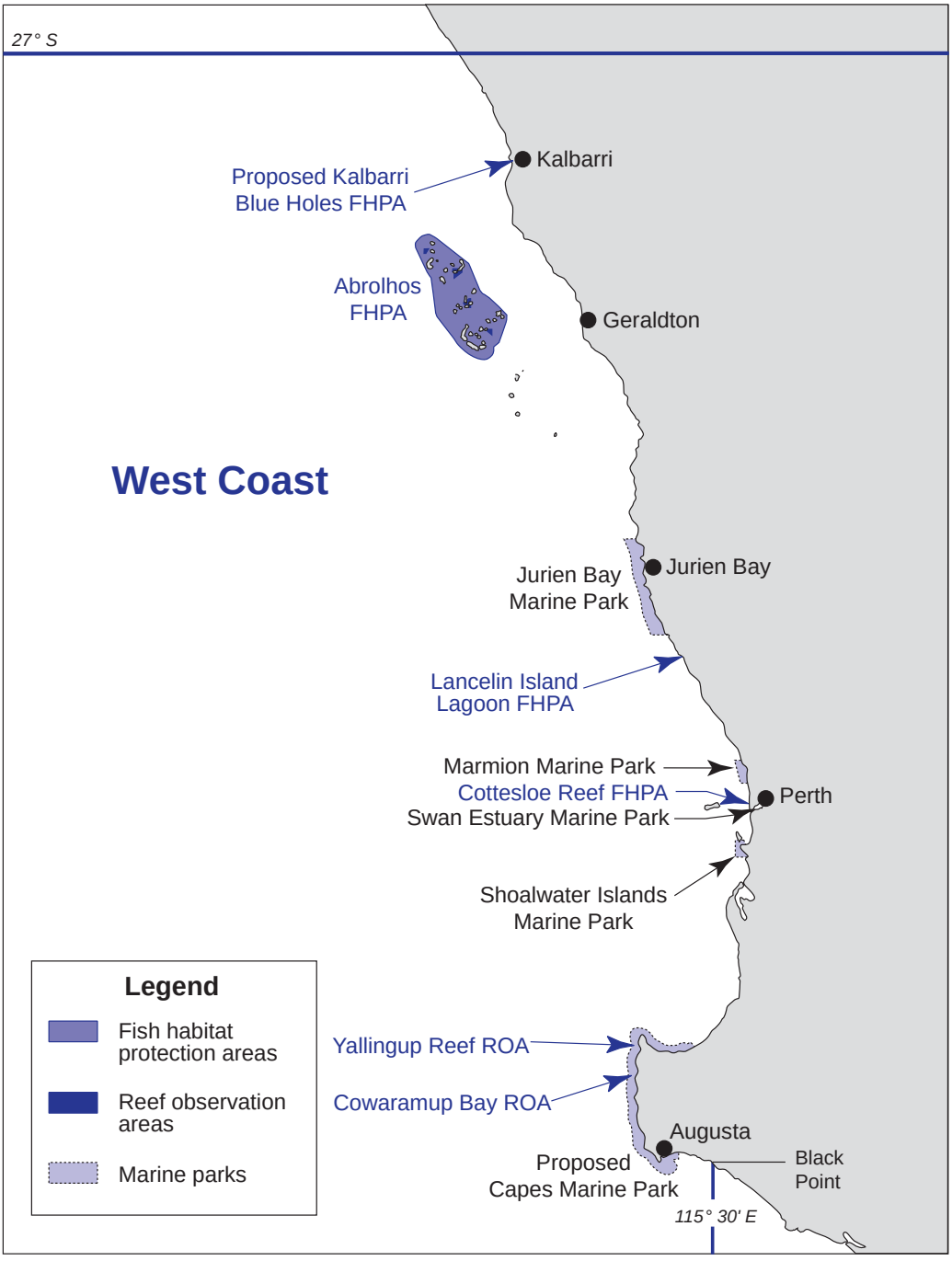
A final plan of management for the proposed Kalbarri Blue Holes Fish Habitat Protection Area is in preparation.

Recommendations for the development of a land-based tourism facility at the Abrolhos Islands, contained in Fisheries Management Paper no.146 (the sustainable tourism plan for the islands), continued to be implemented during 2005/06. Humfrey Land Developments worked with a Departmental working group to develop a proposal, which was subsequently submitted to the Environmental Protection Authority for environmental approval. The Authority set the level of assessment at 'Public Environmental Review' (PER). The PER documentation will be released for public comment in 2006/07.



WEST COAST HABITAT PROTECTION FIGURE 1

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



WEST COAST HABITAT PROTECTION FIGURE 2

Map showing current and proposed areas of protected fish habitat in the west coast bioregion.

COMMERCIAL FISHERIES

West Coast Rock Lobster Managed Fishery Status Report

S. de Lestang and R. Melville-Smith
Management input from T. Bray

FISHERY DESCRIPTION

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

Governing legislation/fishing authority

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)

Consultation processes

Rock Lobster Industry Advisory Committee (RLIAC) and subcommittees
Annual RLIAC coastal tour
Department–industry meetings

Boundaries

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 three 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.

Management arrangements

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, and since 1993/94 a usage rate of 82% has operated to keep the TAE at a sustainable level.

Further effort reductions introduced during 2005/06 are discussed in detail in the 'New management initiatives' section.

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

The management arrangements also include the protection of females in breeding condition, minimum carapace lengths and maximum female carapace lengths. Gear controls, including escape gaps and a limit on the size of pots, also play a significant role in controlling exploitation rates. The season is open from 15 November to 30 June annually, with the Abrolhos Islands zone operating from 15 March to 30 June.

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.

Research summary

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

An environmental management strategy was developed for use in the assessment of the broader ecosystem impacts of rock lobster fishing in the context of ESD and MSC certification. This strategy includes research to reduce the interaction of sea lion pups with pots and an investigation into the ecosystem effects of rock lobster fishing in deep water.

Research into appropriate 'sea lion exclusion devices' (SLEDs) has examined a number of options, eventually focusing on a design consisting of a cup-head bolt. Video trials indicated that this SLED was efficient in limiting the entry of juvenile sea lions into rock lobster pots. Industry concerns over the SLED design resulted in further commercial trials in 2005/06. Results from this work show that, for participants who set their cup-head type SLED according to instructions, there is no discernible reduction in catch rate of legal-size lobsters due to the SLED.

An FRDC-funded project to examine the effects of western rock lobster fishing on the deep-water ecosystem off the west

coast of Western Australia began in 2004/05. In 2005/06 tethered tow cameras, sediment grabs and commercial divers were employed to determine the relationship between habitat characteristics and the abundance of lobsters and to collect samples for dietary analysis. This work is ongoing.

A second FRDC-funded lobster project, completed in 2005/06, assessed the potential for on-growing wild-caught puerulus (post-larvae). Outcomes of this project highlighted the high survival and growth rates that can be obtained in aquaculture systems at acceptable stocking densities, indicating that puerulus on-growing may be one possibility for expanding lobster production in the future. An article resulting from this work has been accepted for publication.

A third FRDC project, which is to be completed in 2006/07, is investigating reproductive biology issues relevant to managing the western rock lobster broodstock. Preliminary results have shown that:

- the quality or fitness of larvae seems not to be influenced by the size of the female or spawning location;
- the size at which both sexes mature has been decreasing over time and is now over 10 mm smaller than 30 years ago; and
- a large number of males all contribute to mating at any one location – there does not appear to be any dominance by a small number of large individuals.

Two articles resulting from this work have recently been accepted for publication.

RETAINED SPECIES

Commercial production (season 2004/05): 12,138 tonnes

Landings

Trends in the annual catches from the West Coast Rock Lobster Managed Fishery are shown in West Coast Rock Lobster Figure 1. The 2004/05 catch in the WCRLF was forecast from puerulus settlement 3–4 years previously to be 12,650–12,850 t. The actual catch from the WCRLF for the 2004/05 season was 12,138 t, 9.9% greater than the long-term average catch (1980/81 to 2003/04) of 11,046 t and 10.5% lower than the previous season's 13,564 t. In 2004/05, the catches in A Zone, B Zone and C Zone were 2,191, 3,244 and 6,704 t respectively, with A Zone 16.3% higher, B Zone 7.8% lower and C Zone 17.9% lower than the previous season.

The total catch of western rock lobster from this fishery (commercial and recreational) was approximately 12,517 t, 10.5 % lower than the previous season's catch of 13,992 t.

Octopus may also be caught in rock lobster pots, generally in shallow water (0–20 fathoms or 0–37 m), and a catch rate of 0.029 octopus per pot lift was recorded in the 2004/05 voluntary research log book data. This was 24.3% 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 182,794 octopus caught in the shallow waters of the fishery during 2004/05. Octopus catches in B Zone (99,975) were 40% greater than in C Zone (71,163). A Zone recorded an estimated octopus catch of 11,655.

The catch rate of octopus (incidental landings) is a performance indicator for this fishery, and at 0.029 octopus per pot lift achieved the performance measure of being within 10% of the historical range. The historical range (± 10%) is 0.0129–0.033 octopus per pot lift.

Fishing effort/access level

The 82% pot usage rate maintained since 1993/94 has had the secondary effect of 'encouraging' a reduction in fleet size as vessels purchased additional pot entitlements to improve their economic efficiency. In 2004/05 the numbers of vessels fishing for lobster were 136 in A Zone, 130 in B Zone and 270 in C Zone. Thus, in comparison to the 549 active boats in 2003/04, a fleet of 536 vessels fished in 2004/05.

The nominal fishing effort was 9.7 million pot lifts, 4.7% lower than the 10.1 million pot lifts for 2003/04 and the lowest level since the 1970s (West Coast Rock Lobster Figure 1). The 2004/05 nominal effort for A, B and C Zones was 1.21, 3.43 and 5.08 million pot lifts respectively, which was 2.5% more, 4.6% less and 5.5% less than the previous season's pot lifts.

Catch rate

The catch per unit of effort (CPUE) achieved annually by the fishery (West Coast Rock Lobster Figure 2) provides a broad indicator of variations in the abundance of the legally catchable stock. The downward trend from the 1950s to the 1980s reflects the increasing effort during this period (West Coast Rock Lobster Figure 1), which automatically leads to lower CPUE. This trend was reversed in the early 1990s through a substantial management-induced reduction in effort (i.e. pot usage was reduced to 82% of the unit holding).

Shorter-term fluctuations in abundance (West Coast Rock Lobster Figure 2) represent the cyclical nature of puerulus settlement, which is reflected in the legal-sized abundance (CPUE) three to four years later.

The decrease in CPUE to 1.25 kg/pot lift in 2004/05 (around 6.9% less than the previous year) relates directly to the levels of puerulus settlement recorded previously.

It should be noted that the catch rate does not directly reflect the overall abundance of lobsters, as legal catches are generally around 10–20% of the overall biomass due to the large biomass of under-size animals and breeding females, which are fully protected.

Recreational component: 3%

On the basis of the 2004/05 mail survey adjusted to the phone/diary survey estimates, an estimated 3% of the total rock lobster catches were taken recreationally. (See Recreational Western Rock Lobster Fishery Status Report, pp. 64-67.)

STOCK ASSESSMENT

Assessment complete: **Yes**

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

The stock remains close to maximum sustainable yield and under the current management arrangements introduced in 1993/94, which included an 82% pot usage rate, the overall breeding stock also remains at or above the target levels of the late 1970s and early 1980s (West Coast Rock Lobster Figures 3 and 4).

Depletion analysis indicates that over the last 10 years the harvest rate in A Zone has decreased slightly, while a significant increase has occurred in the coastal fishery, particularly in B Zone (West Coast Rock Lobster Figure 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 lobsters at the end of the year.

Post-larval (puerulus) recruitment to the fishery is monitored monthly and relates to fluctuations in environmental conditions such as strength of the Leeuwin Current and the frequency and intensity of low-pressure systems generating westerly winds. Annual indices of puerulus settlement for 2004/05 were below average at all sampling sites (West Coast Rock Lobster Figure 7). These results reflect the neutral Southern Oscillation Index (an indicator of El Niño conditions which affects the strength of the Leeuwin Current), which commenced in 2004 and has continued well into 2005. These low 2004/05 settlements will first impact on catches during the 'reds' of 2007/08 and then as a poor 'whites' throughout the fishery in 2008/09.

Breeding stock levels: **Adequate**

A three-year moving average (smoothing) is used to show the underlying trends in the trajectory of the breeding stock indices rather than highlighting individual data points which can vary significantly due to environmental effects on the catchability of lobsters.

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

A performance measure for the fishery is that the breeding stock index remains above that estimated to be the 1980 level (22% of virgin biomass). The breeding stock levels in 2004/05 for A and C Zones were clearly above this reference point, although B Zone is close to the trigger point (West Coast Rock Lobster Figures 3 and 4). The fishery has therefore met its performance measure, but management action is planned for Zone B in 2005/06 to ensure this zone remains above the 1980 level.

Projected catch next season (2005/06): **10,050–10,450 tonnes**

Total catch predictions for the WCRLF are made by summing the regional catch predictions from puerulus settlement at the Abrolhos Islands (A Zone), Seven Mile Beach (B Zone) and Alkimos (C Zone) (West Coast Rock Lobster Figure 7). Catch estimates for C Zone are also forecast from combined puerulus settlement figures from a number of C Zone puerulus collection sites. Seasons 2005/06 and 2006/07 are expected to produce commercial catches of around 10,250 t and 9,650 t respectively, resulting from average puerulus settlement in 2001/02 and below-average puerulus settlement in 2002/03 (West Coast Rock Lobster Figure 7). Catches during the 2007/08 season are expected to remain similar to those in 2006/07 (10,000 t).

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Fishery-independent monitoring on commercial vessels indicates that the impact of rock lobster fishing on the bycatch of fish and invertebrates, other than octopus (see 'Retained species'), is minimal.

Protected species interaction: **Low–moderate**

The WCRLF interacts with the Australian sea lion, *Neophoca cinerea*, with the accidental drowning of an estimated small number of sea lion pups in rock lobster pots as the pups attempt to rob the traps of either bait or rock lobsters. Incidents appear to be restricted to shallow waters (< 20 m) and to areas within 30 km of the mainland breeding colonies on the mid-west coast. In the formal ecological risk assessment conducted as part of the MSC certification and Department of Environment and Heritage (DEH) assessment processes, the interaction between the WCRLF and the Australian sea lion population on the west coast was assessed as being a moderate risk due to the small population size and discrete population structure of the sea lion.

Management actions being proposed to eliminate the incidental mortality of sea lions include modifying existing pots with some form of sea lion exclusion device which will have minimal impact on fishing operations. Further collaborative trials with industry are being conducted to estimate the impact of the preferred SLED on western rock lobster catches. A scientific reference group including independent experts advises on all the issues associated with seal research.

A performance measure for this fishery is that no increase in the rate of capture of sea lions occurs. During the 2004/05 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 six turtle species that occur in the waters of the western rock lobster fishery, only the

entanglement of leatherback turtles (*Dermochelys coriacea*) was identified as a moderate risk by the risk assessment.

A performance measure for the fishery is that there is no increase in interactions with turtles. In 2004/05 three leatherback turtles were reported to have been entangled in lobster fishing gear. This incident rate is within the historical range of between 2 and 5 entanglements per season over the preceding four seasons. The fishery has therefore met this performance measure.

There are occasional reports of a whale 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–August. Because of the fishery's closed season, there is a limited period for interaction; however, with the increasing population of whales, more interactions are likely in the future. Interactions are reported by industry to the Department of Environment and Conservation (DEC) and a specialist team operates to disentangle the animal, with a very high success rate. The industry has developed a code of practice to minimise the interaction with whales in conjunction with DEC and SeaNet.

The environmental management strategy adopted for the WCRLF requires monitoring of, and attempts to minimise, accidental interaction with these species wherever practicable.

A performance measure for the fishery is that there is no increase in the rate of interactions with whales and dolphins (entanglements). Over the recorded history (1989–2003), commercial lobster fishing has resulted in 0–4 whale/dolphin interactions per season. Since only two whale entanglements were attributed to the 2004/05 lobster season, the fishery has met its performance measure.

ECOSYSTEM EFFECTS

Food chain effects: Moderate

The fishery is unlikely to cause significant trophic ('food web') cascade effects, as the protected sub-legal-sized lobsters and breeding stock components form a relatively constant significant proportion of the biomass (> 80%) 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. A moderate risk was assigned to this fishery during the ecological risk assessment. Research funded by FRDC is underway to determine if variations in lobster abundance have any detectable influence on the ecology of deep-water reefs inhabited by lobsters.

Habitat effects: Low

The legislated design of rock lobster pots, the materials they are made from and the strict control of replacement pots prevents 'ghost fishing' problems arising. A study of human impacts on the marine environments of the Abrolhos Islands estimated that potting might impact on less than 0.3% of the surface area of fragile habitat (corals) at the Abrolhos, where fishing is only allowed for three and a half months of the year. Generally, throughout the coastal fishery, rock lobster fishing occurs on sand areas around robust limestone reef habitats covered with coralline and macro-algae such as kelp (*Ecklonia* spp.). This type of high-energy coastal habitat is regularly subjected to swell and winter storms and so is considered highly resistant to damage from rock lobster potting.

SOCIAL EFFECTS

The western rock lobster fishery is an important sector of Western Australia's economy, with the catch from the current reporting season valued ex-vessel at $259 million. Employment is seasonal, the fishing season covering seven and a half months from 15 November to 30 June. A total of 536 vessels and 1,491 people were engaged directly in fishing for rock lobsters in 2004/05. This equates to one skipper and an average of about 1.78 deckhands per vessel, which is very similar to that recorded during the 2003/04 season. During the year, 7 processing establishments, located in the Perth metropolitan area (3), Dongara (1) and Geraldton (3), serviced practically every location where fishing occurred.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2004/05: $259 million

The price fishermen received for the western rock lobster in 2004/05 was an estimated average of $21.5/kg in all zones of the fishery. This was a 13.2% increase on the $19/kg paid in 2003/04, and is mainly attributable to the smaller catch in 2004/05. Thus, despite the increase in price per kilogram, the overall value of the fishery did not change significantly from the previous season's value of $257 million. The bulk of the product was exported to Japan, Taiwan, Hong Kong/China and the United States.

FISHERY GOVERNANCE

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

Between 1974/75 and 2003/04 commercial catches have averaged 10,907 ± 574 t (95% confidence intervals of the mean) and ranged from 8,166 t in 1985/86 to 14,523 t in 1999/2000. Variation of these catches results primarily from variable levels of recruitment, which are driven by the environmental conditions experienced by western rock lobster larvae and post-larvae, and levels of fishing effort. With fishing effort having been reduced, catches are still expected to fall within the above range.

New management initiatives (2005/06)

Significant changes to the management system came into effect at the commencement of the 2005/06 season, with the aim of addressing in the short to medium term (one to three years) sustainability concerns regarding the level of breeding stock, mainly in the northern coastal region of the fishery.

Two separate sustainability packages were produced, one for Zones A and B (northern) and one for Zone C (southern), as the sustainability risks in these areas differed. Specifically, the Department advised industry that the equivalent of a 15% effort reduction was required in the northern region of the fishery, while in the south a 5% effort reduction would be sufficient. The final composition of the two management packages was determined by industry on the basis of advice provided by the Department. The packages introduced are expected to reduce effort by the desired amounts and provide economic savings and social benefits within the industry.

In the northern coastal region the management package comprised:

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

In the southern region the management package comprised:

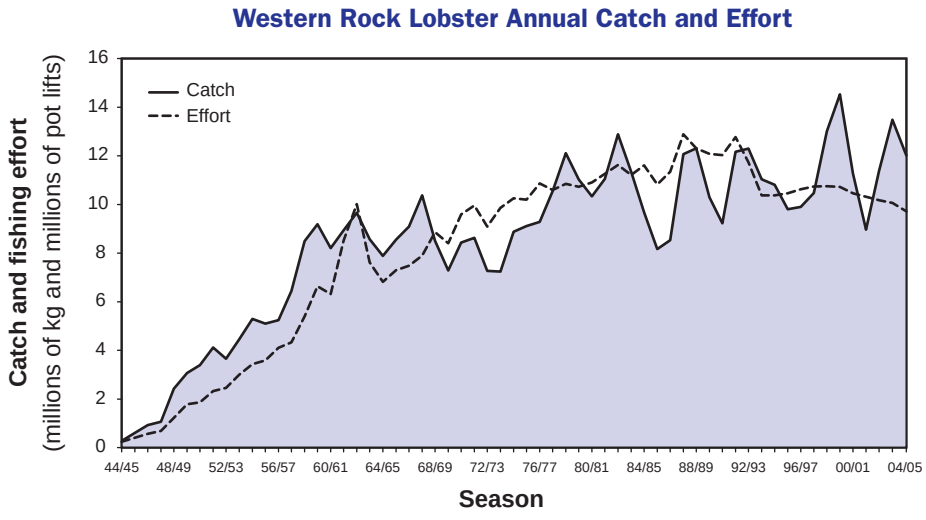
- 10-day November closure (15 November – 24 November);
- 3-day moon closures from 1 February to 30 June (one day prior to the full moon, the day of the full moon and the day after the full moon); and
- time off – fishery closed for Christmas Day and New Year's Day.

A review of the fishery's long-term management options is currently being undertaken to determine whether catch quota management (output controls) should be installed to replace effort management (input controls, the current management system).

The introduction of sea lion exclusion devices to the fishery is expected to take effect in the 2006/07 season.

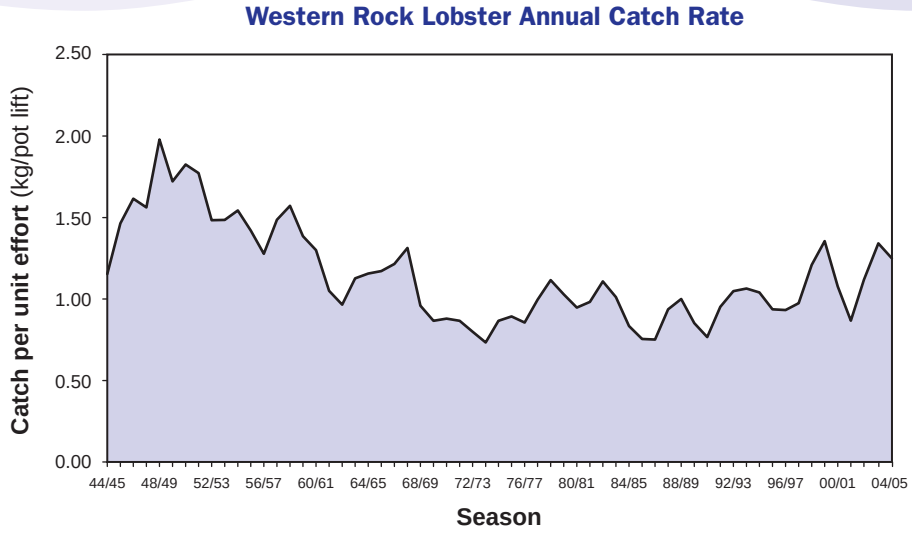
EXTERNAL FACTORS

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



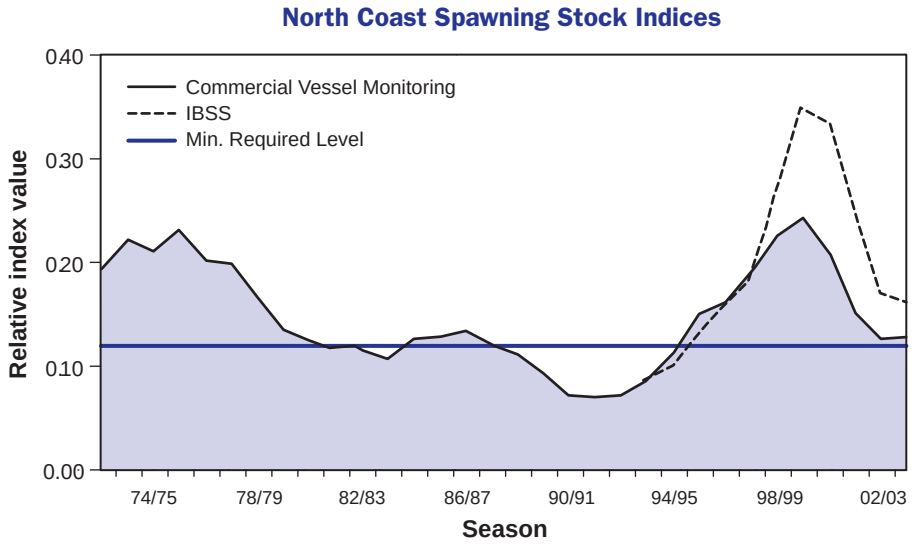
WEST COAST ROCK LOBSTER FIGURE 1

Annual catch and nominal fishing effort from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2004/05.



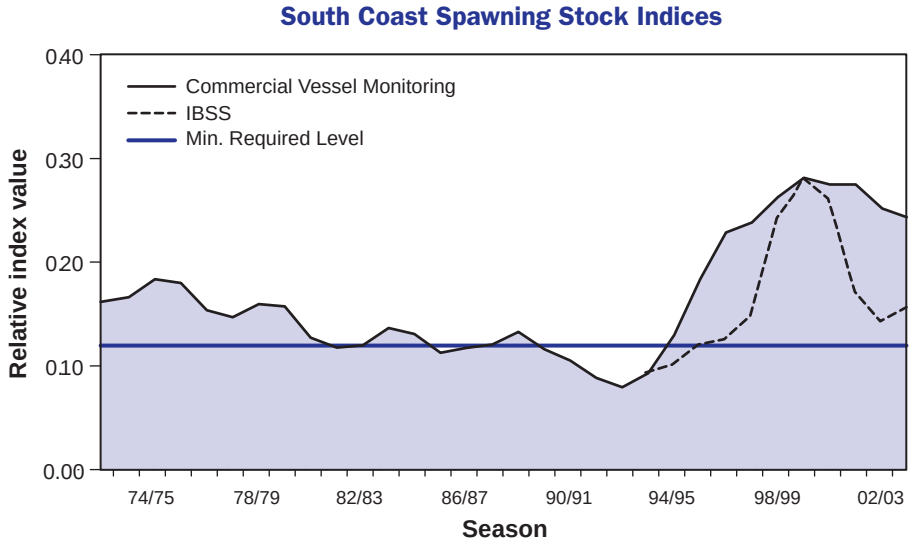
WEST COAST ROCK LOBSTER FIGURE 2

Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2004/05.



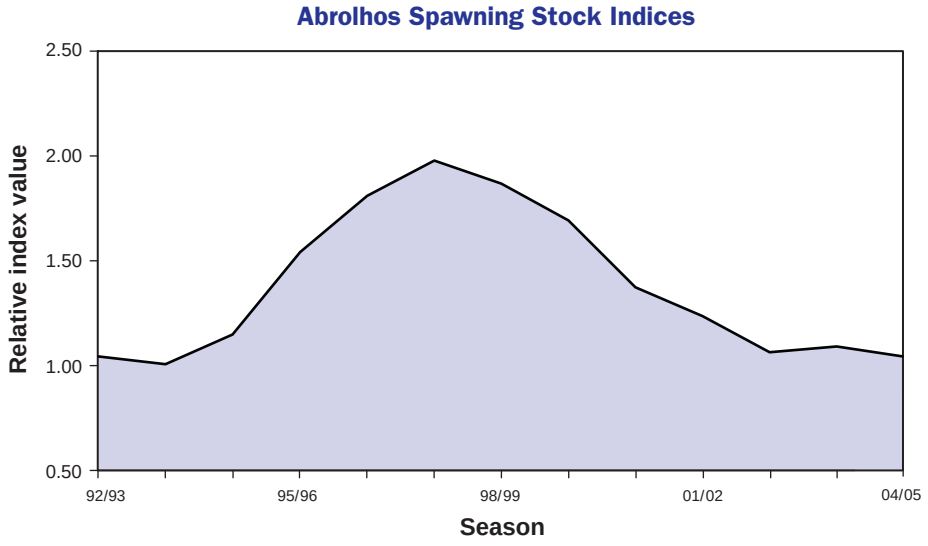
WEST COAST ROCK LOBSTER FIGURE 3

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



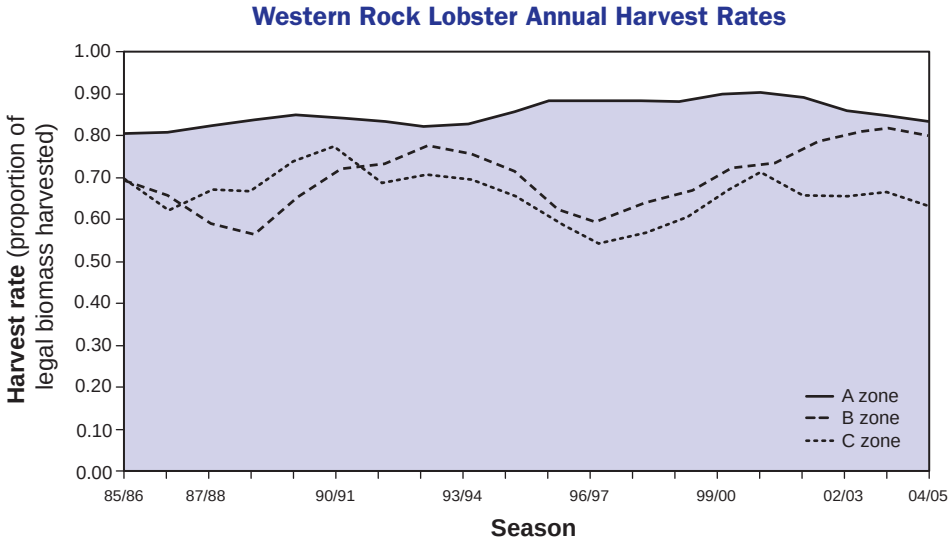
WEST COAST ROCK LOBSTER FIGURE 4

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



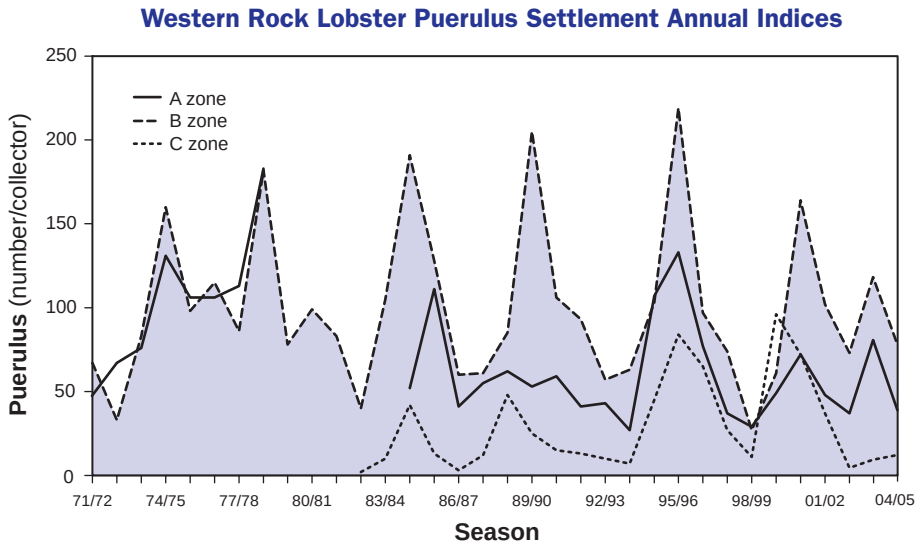
WEST COAST ROCK LOBSTER FIGURE 5

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



WEST COAST ROCK LOBSTER FIGURE 6

Annual harvest rates of western rock lobster in Zones A, B and C.



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).

Roe's Abalone Managed Fishery Status Report

A. Hart and F. Fabris
Management input from J. Kennedy

FISHERY DESCRIPTION

The Western Australian commercial Roe's abalone fishery is a dive fishery operating in shallow coastal waters along WA's western and southern coasts. The principal harvest method is a single diver working off 'hookah' (surface supplied breathing apparatus) using an abalone 'iron' to prise abalone off rocks. Abalone divers operate from small fishery vessels (generally < 9 m). Roe's abalone (*Haliotis roei*) are found in commercial quantities from the South Australian border to Shark Bay, although they are not uniformly distributed throughout this range.

Governing legislation/fishing authority

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

Consultation process

Abalone Management Advisory Committee
Department–industry meetings

Boundaries

The Abalone Management Plan covers all Western Australian coastal waters, which are divided into eight management areas. The Roe's abalone stock, however, is only abundant and subject to regular fishing south of Shark Bay. Commercial fishing for Roe's abalone is managed in six separate areas (Roe's Abalone Figure 1).

Management arrangements

The commercial Roe's 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 area and allocated to licence holders as individual transferable quotas (ITQs). The overall TACC for 2005 was 112.7 t whole weight (note this small species is always landed in the whole condition). The TACC is administered through 25,180 ITQ units, with a minimum unit holding of 800 units generally applying, although some Roe's abalone licences are permitted to operate below this minimum in recognition of historical fishing practices. The licensing period runs from 1 April to 31 March of the following year.

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

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

Research summary

Abalone divers are required to provide daily catch information on the total weight of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. These data are used to assist in research, compliance and management matters. Current research is focused on stock assessment using catch and effort statistics and research surveys of stocks in the metropolitan area. The FRDC project entitled 'Digital video techniques for assessing population size structure and habitat of greenlip and Roe's abalone', which was designed to test the possibility of underwater video for monitoring density and size structure of abalone stocks, was successfully completed in 2005. Roe's industry divers collected size-frequency and abundance information *in situ*, and resolved to scale up the program to make it an annual process, with a target of 30–35 video survey sites for 2006.

RETAINED SPECIES

Commercial production (season 2005): 96.5 tonnes whole weight

Landings

The TACC for the 2005 quota year was 112.7 t whole weight for Roe's abalone. The catch of 96.5 t whole weight for the 2005 season (Roe's Abalone Table 1) was 10% lower than in 2004 and 16.2 t lower than the TACC. The reason for not taking the entire quota is that poor weather conditions restricted access to the remote regions of the fishery in Area 1 (no catch taken) and Area 8 (72% of quota caught).

Fishing effort/access level

Total effort for dedicated Roe's abalone divers in 2005 was 665 diver days, which was below the fishery governance range of 679–914 days expected for taking the entire quota. This low level is consistent with stocks being in good shape.

Catch rate

The catch rate for dedicated Roe's abalone divers in 2005 was 131 kg/day, which was 4% higher than the 2004 catch rate of 126 kg/day and the highest catch rate since 2000.

Recreational component: 23–31%

The statewide recreational catch estimate for Roe's abalone in 2004 from the telephone diary survey was between 33 t and 48 t. Recreational fishing therefore represented about 23–31% of the total (commercial and recreational) Roe's abalone catch across the state in 2004. As no telephone diary surveys were undertaken in 2005, these estimates will be updated in the 2006 recreational season. They are expected to be slightly smaller due to a lower catch for the 2005 Perth metropolitan fishery.

For details of survey methods see the Licensed Recreational Abalone Fishery Status Report (pp. 67–72).

STOCK ASSESSMENT

Assessment complete: **Yes**

The catch, effort and catch rate statistics indicate that, overall, Roe's abalone stocks are in an acceptable state and at higher than historically average levels in Area 7 and Area 2. In Area 2, a 10% increase in TACC has been allocated. In Area 7, a 10% increase has been recommended, but not allocated due to Integrated Fisheries Management (IFM) issues. The overall TACC was not caught principally because of poor weather in Area 8 and Area 1 of the fishery (Roe's Abalone Figure 1), where approximately 14 t of quota was foregone.

Annual research stock surveys of the metropolitan stocks are reported in the Licensed Recreational Abalone Fishery Status Report, pp. 67–72.

Breeding stock levels: **Adequate**

Research has shown that the size at sexual maturity (50% of animals mature) of Roe's abalone in the Perth metropolitan area is approximately 40 mm (2–3 years of age). Preliminary growth data for these same metropolitan Roe's abalone indicate that they have a minimum of one 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, especially since the commercial fishery's legal minimum size in Area 7 (the metropolitan area) is 70 mm, 10 mm larger than that used by the recreational sector. In Area 1, the commercial fishery's legal minimum length is 75 mm.

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

In 2005, catches in all areas fished were within the agreed ranges, indicating that breeding stock levels were adequate (Roe's Abalone Table 2). No fishing took place in the remote Area 1 due to adverse weather conditions.

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 pod 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 are drift algae feeders, their removal is unlikely to result in any changes to the algal growth cover in areas fished.

SOCIAL EFFECTS

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

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: **$3.1 million**

The estimated average price for Roe's abalone in 2005 was $33/kg, the same as in 2004. On the basis of the average price the fishery was worth approximately $3.1 million, a decrease from the 2004 value of $3.5 million, but higher than the 2003 value of $2.6 million. Overall, the price of Roe's abalone has dropped by around 40% since 2000, when it was $55/kg whole weight.

FISHERY GOVERNANCE

Target effort range: **679–914 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 (679–914 diver days) recorded over the five-year period 1994–1998. This range reflects the acceptable variation in catch rates due to weather and recruitment cycles. The effort value of 665 diver days in 2005 falls just below the lower end of the expected effort range, but for a catch of only 96 t out of a quota of 112.7 t. Overall, this indicates that the fishery as a whole is performing above average.

A recommendation has been made that the TACC for 2006 should increase slightly from 112.7 t to 116.3 t, due to increases in Area 2 and Area 7 as a result of good stock levels.

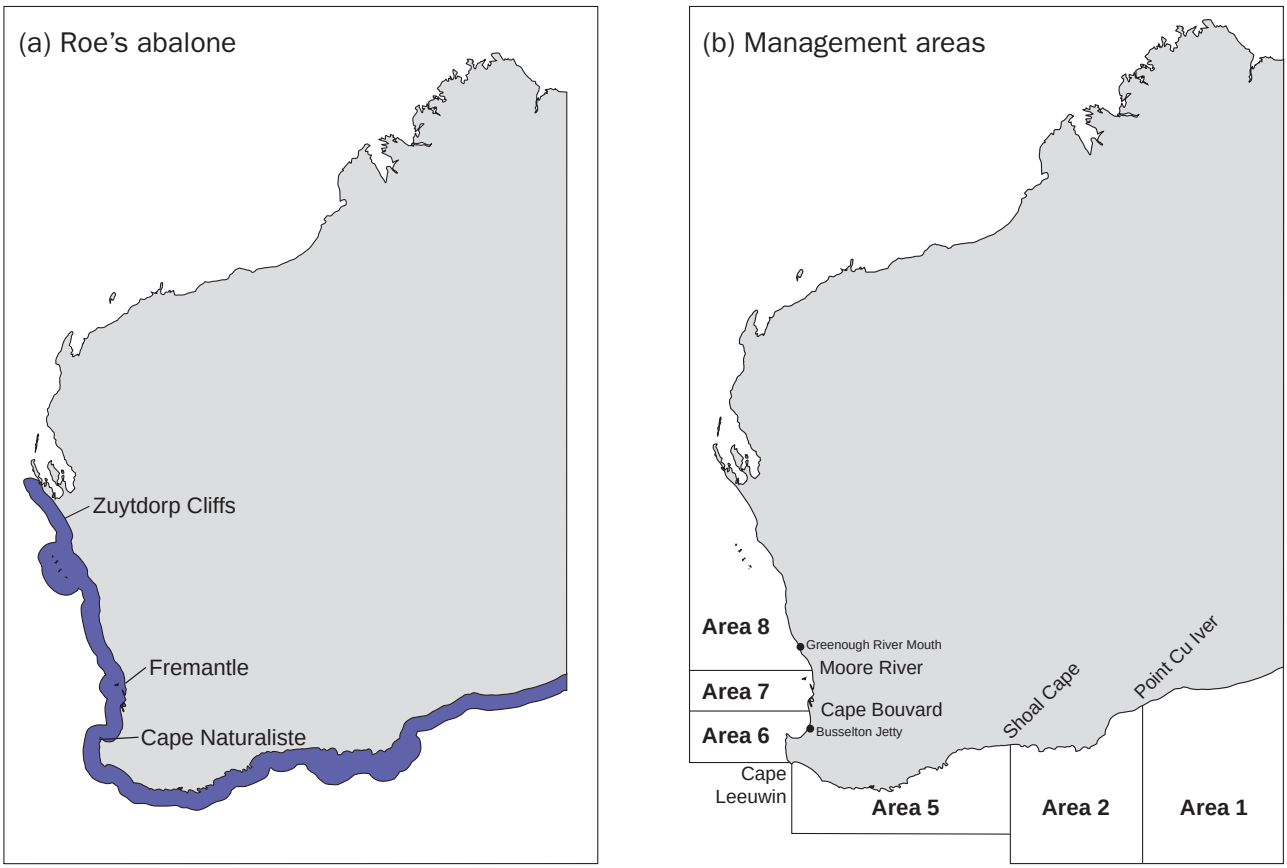
New management initiatives (2005/06)

There were no new management initiatives introduced in 2005/06, though consultation took place with industry on relatively minor operational changes to the *Abalone Management Plan 1992*. These matters are currently being progressed.

The Roe's abalone fishery has been given priority under the current Integrated Fisheries Management process. There may be a need to implement management changes in the coming years to give effect to the outcomes of this process.

EXTERNAL FACTORS

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



ROE'S ABALONE 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 TABLE 1

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

QUOTA PERIOD[2]	*ROE'S TACC kg whole weight*[3]	*ROE'S CAUGHT kg whole weight*	*DIVER DAYS*[4] *(Roe's divers only)*	*KG WHOLE WT per diver day (Roe's divers only)*
1990	105,000	116,447	936	112
1991	101,000	109,489	832	118
1992	105,000	111,341	735	134
1993	128,000	115,281	832	123
1994	125,960	117,835	908	113
1995	125,960	114,501	1,047	98
1996	125,960	118,715	1,004	106
1997	126,790	118,738	855	120
1998	93,960[5]	86,425	695	108
1999	119,900[6]	112,949	659	149
2000	115,900[6]	107,735	647	144
2001	107,900[6]	99,174	687	126
2002	107,900	100,471	700	125
2003	110,900	96,005	723	118
2004	110,900	107,593	740	126
2005	112,700	96,496	665	131

Notes

1. Data source: quota returns.
2. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar year.
3. Standard conversion factors for meat weight to whole weight for Roe's abalone were 2.5 prior to 2000 and 3.0 from 2000.
4. Effort (diver days) for dedicated Roe's divers only. This year, database improvements allowed a better estimate, and consequently, figures vary from last year. A standardisation multiplier (2.3) was applied to 1999–2002 diver days estimates from Area 7, to account for the increase in catch rates arising from the lifting of the daily catch limit of 100 kg.
5. Reduced quota for a six-month season.
6. Industry-instigated voluntary 6 t reduction in quota for 1999 and voluntary 4 t reduction in 2000 and a 2 t reduction in 2001 in response to concerns over the low abundance of legal-sized abalone in Area 8.
7. Prior to 2000, effort estimates (diver days) extracted from days when catch was processed; from 2000 onwards, effort estimates extracted from daily catch and disposal record counts.

ROE'S ABALONE TABLE 2
Assessment against agreed performance measures for 2005.

PERFORMANCE INDICATOR	PERFORMANCE MEASURE[1]	2005 VALUES	ASSESSMENT/COMMENTS
Area 1			
Total catch (TACC)	9,900 kg	0	Exploratory quota only – not caught due to poor weather
Total effort (diver days)	14–43	0	See above
Area 2			
Total catch (TACC)	19,800 kg	19,038	Met – 96% of quota caught
Total effort (diver days)	80–106	98	Met – within agreed level
Area 5			
Total catch (TACC)	20,000 kg	19,045	Met – 95% of quota caught
Total effort (diver days)	100–140	115	Met – within agreed level
Area 6			
Total catch (TACC)	12,000 kg	12,266	Met – 98% of quota caught
Total effort (diver days)	80–127	115	Met – within agreed level
Area 7			
Total catch (TACC)	36,000 kg	35, 405	Met – 98% of quota caught
Total effort (diver days)	175–215	175	Met – within agreed level
Area 8			
Total catch (TACC)	15,000 kg	10,742	Not met – 72% of quota caught, due to poor weather
Total effort (diver days)	140–200	162	Met – within agreed level

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

Abrolhos Islands and Mid West Trawl Managed Fishery

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

FISHERY DESCRIPTION

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

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* (Wildlife Trade Operation)

Consultation process

Department–industry meetings

Boundaries

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

Management arrangements

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

The fishing gear (net size) in this fishery is unitised, with one headrope unit being equivalent to 4 fathoms (7.32 m). For the 2005 season, 17 boats operated in the fishery. However, 45.5 units (out of the entire net entitlement of 46 headrope units) were utilised by the 16 boats that are licensed to operate in the fishery. One additional boat fished under Ministerial exemption using a try net (5 m net headrope opening) as the maximum net entitlement.

In 2005, the scallop season opened on 28 April and closed on 28 July. The Port Gregory prawn trawl area of the fishery also opened on 28 April but closed on 28 June.

During the season licensees requested that an area adjacent to the eastern boundary of the fishery be opened to scallop fishing. This area was the same as that opened in the 2003 season when scallop recruitment settlement was widespread. This area was opened for seven days commencing at noon on 12 July. All boats operated in this area and fishing ceased at 10 a.m. on 18 July after six days. The catch from this area was 450 t whole weight. The meat weight on average was 25 to 30 pieces to the pound, which was larger than the meat size taken on the main trawl grounds prior to this opening. This area is now part of the standard scallop survey, particularly in high recruitment years.

The majority of the fleet ceased fishing by 19 July with all boats having left by 22 July, before the official closure date.

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

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

Research summary

Research monitoring of the scallop stocks in the fishery is undertaken utilising fishers' monthly returns data. All boats also complete detailed research log books validated by processor returns, which together with an annual pre-season survey, provide the information required for assessing the fishery. Advice on the status of stocks and appropriate season opening and closing dates is provided to industry.

RETAINED SPECIES

Commercial production (season 2005): 6,470 tonnes whole weight

Landings

The total landings for the 2005 season were 6,470 t whole weight (1,294 t meat weight) of scallops (Abrolhos Islands Scallop Figure 1). The predicted catch range for the 2005 season, based on a pre-season survey, indicated a high catch of scallops between 2,900 and 4,350 t whole weight. The total landings were above the predicted catch range but are acceptable because very high concentrations of scallops were found in some locations not sampled during the survey.

Only limited fishing by one boat took place in the Port Gregory area and catches were minimal.

Fishing effort/access level

A total of 7,669 trawl hours (nominal effort) were recorded for the 2005 season, equivalent to 6,376 standardised trawl hours (standardised to 14 fathoms headrope length). Despite being lower than the 10,382 trawl hours nominal effort recorded in 2003 (the last good recruitment season), total landings were higher in 2005 because of the higher concentrations of scallops (Abrolhos Islands Scallop Figure 1). The effort level represents a fishing season of 85 days' duration in 2005, compared to 97 days in 2003.

Catch rate

The catch rate in 2005 was 946 kg/hr (whole weight, standardised effort), compared with approximately 640 kg/hr for 2003. This reflected the high abundance of scallops located within a smaller area in 2005 compared to 2003.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

This fishery is highly variable, being dependent on sporadic recruitment, which appears to be strongly influenced by environmental conditions, e.g. the Leeuwin Current. A pre-season recruitment survey is undertaken annually. A relationship between catch rates during surveys and subsequent catch is evident. Due to the patchy spatial distribution of recruits it is not possible for pre-season surveys to cover all potential settlement areas, particularly in high abundance years. Therefore the catch projection is for the areas covered by the survey only. In years when recruitment settlement is widespread the prediction is likely to be conservative.

Breeding stock levels: Adequate

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

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

The main performance measure for the fishery relates to maintaining breeding stocks of scallops by setting season length according to the residual stock index. The 2005 fishing season was set at three months, consistent with the high yield predicted from the survey in November 2004. Hence the breeding stock indicator was met.

Projected catch next season (2006): 250–500 tonnes whole weight

For 2006, the catch prediction is determined using all survey data except one trawl shot from the southern Zeewijk Channel, which has very high numbers of scallops over a small area and will not contribute significantly to the catch. The catch prediction for the 2006 Abrolhos season is therefore expected to be in the range 250–500 t whole weight.

Additional catches may be achieved in areas not covered by the survey.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The trawl fleet operates over a small portion of the licensed fishing area, focusing on scallop aggregations on the relatively bare sand habitat associated with this species. In 2005, the total area of the fishery that was fished by scallop boats was 4%, the same as in 2004. Owing to the focused nature of this fishery, the confined area coverage in 2005 and the large mesh size (100 mm), little bycatch was taken during the fishing season.

Protected species interaction: **Low**

While turtles do occur in the Abrolhos Islands, these species are towards the southern extent of their range, and do not breed in the Abrolhos Islands area because water temperatures are too low. Consequently, interactions with turtles were always minimal, and now that grids are compulsory in the fishery their capture should be eliminated. No records of turtle captures were made in 2005. Few other protected species occur in this area.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

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

Habitat effects: **Low**

The fishers generally operate over a very small proportion (approximately 4% on average) of the licensed area and therefore the total area impacted by trawling is small. Trawling was not extensive during 2005 and was confined to trawl grounds where high scallop abundance occurred, rather than fishing throughout the fishery. The same small area outside the fishery boundary fished in 2003 was also fished this season.

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

SOCIAL EFFECTS

This scallop fishery utilises large crews of up to 13 per vessel (except for the one boat using a try net) to carry out on-board processing during the short period of fishing in the season. The estimated employment for the year 2005 was 180 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $22 million

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

FISHERY GOVERNANCE

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

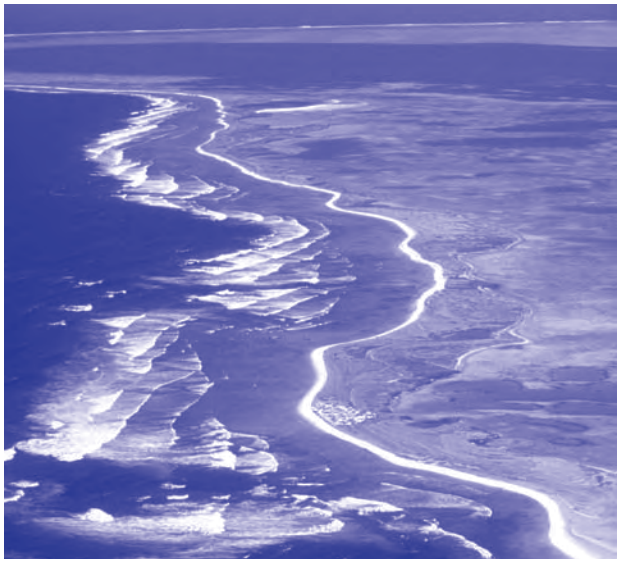
Apart from the exceptional catches of the mid-1990s and 2003, which were due to unusual environmental conditions increasing the success of recruitment, the historic catch range for this fishery is 95–1,830 tonnes whole weight. The catch in 2005 was predicted to exceed this range due to the observed survey data showing good pre-season recruitment.

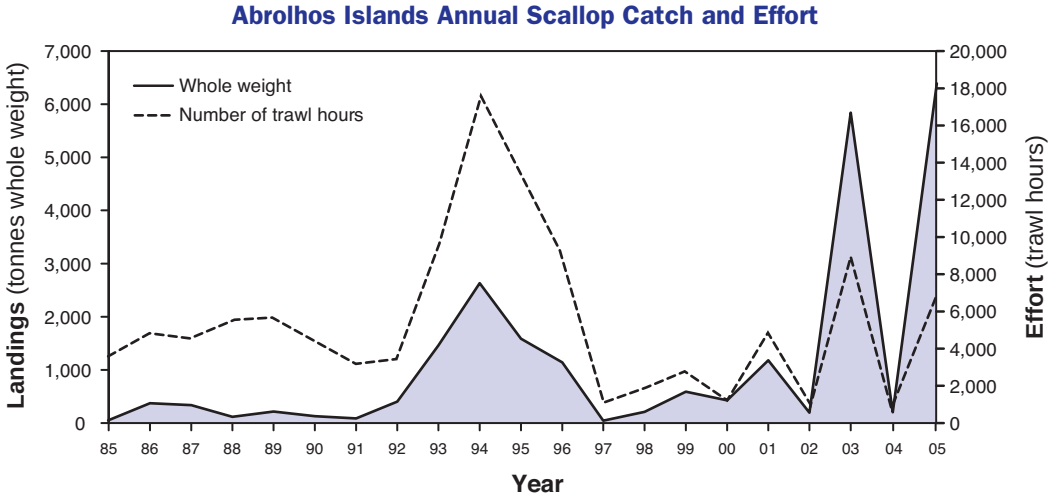
New management initiatives (2005/06)

Discussions are continuing between the scallop and rock lobster industries to further delineate sensitive or rock lobster habitats to be avoided by scallop trawlers while fishing. There has also been increased use of spatial closures when small scallops were detected during fishing. From 2006, a catch rate threshold cut-off level is to be implemented as a trigger to cease fishing in this fishery when the average fleet catch falls below 250 kg per 24 hour period over two consecutive days.

EXTERNAL FACTORS

The high level of recruitment seen in late 2002 and 2004, following very low catch seasons, highlights the dependence of recruitment success upon environmental conditions such as the Leeuwin Current rather than spawning stock levels. It also illustrates the extreme level of annual variability in recruitment. As more years of pre-season survey and fishing season catch and effort data become available, the relationship between environmental factors and recruitment success can be further evaluated, providing a better understanding of the scallop fishery.





ABROLHOS ISLANDS SCALLOP FIGURE 1

Annual scallop landings for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985–2005.

South West Trawl Managed Fishery Status Report

M. Kangas

Management input from S.O'Donoghue

FISHERY DESCRIPTION

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

Governing legislation/fishing authority

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

Consultation

Department–industry meetings

Boundaries

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

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

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

Management arrangements

The fishery is managed under an input control system limiting boat numbers, gear sizes and fishing areas. A total of 14 boats are licensed to operate in this fishery, some in more than one zone. Zone A and B boats may fish between 1 January and 15 November and Zone D boats can fish all year round. Access to Zone C ceased following a Fishery Adjustment Scheme in which all four authorisations were removed prior to the 2003 season. The management plan also includes large closures to protect sensitive coastal habitats (including seagrass beds) and fish nursery areas such as Cockburn Sound, Warnbro Sound and inshore Geographe Bay.

Research summary

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

RETAINED SPECIES

Commercial production (season 2005):
Prawns 14 tonnes
Scallops < 1 tonne whole weight

Landings

The total landings for the season were 14 t of western king prawns and less than 1 t whole weight of scallops. The catch of king prawns was 17% up on the catch of 2004, while the scallop catch was much lower. The fishery also lands a mixture of by-product species, of which the most abundant species recorded was 2 t of blue swimmer crabs (*Portunus pelagicus*). All other landings of by-product species were less than 1 t each.

Fishing effort/access level

A total of 188 days were recorded as being fished by 3 boats in 2005, compared to 268 days by 6 boats in 2004 and 428 days by 6 boats in 2003.

Catch rate

Not available.

Recreational component: **Nil**

STOCK ASSESSMENT

Assessment complete: **Not assessed**

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

NON-RETAINED SPECIES

Bycatch species impact: **Low**

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

Protected species interaction: **Negligible**

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

ECOSYSTEM EFFECTS

Food chain effects: **Low**

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

Habitat effects: **Low**

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

SOCIAL EFFECTS

The estimated employment for the year 2005 was 9 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005:
Prawns $176,000
Scallops $2,000

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

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

FISHERY GOVERNANCE

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

New management initiatives (2005/06)

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

EXTERNAL FACTORS

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

West Coast Blue Swimmer Crab Fishery Status Report

L. Bellchambers, K.D. Smith, D. Johnston and D. Harris
Management input from R. Gould

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 intertidal zone to at least 50 m in depth. However, the majority of commercially fished stocks are concentrated in the coastal embayments between Bunbury in the south and Port Hedland in the north. Historically, the major fishing areas were along the lower west coast, so the fishery has until now been reported within the west coast bioregion. With the increasing catches in the Gascoyne and Pilbara, a separate report covering these bioregions may be needed in future.

Blue swimmer crabs comprise the bulk of the state's commercial inshore crab catches, with more than three-quarters of the annual catch coming from Shark Bay and Cockburn Sound. They are targeted using a variety of fishing gear. Traditionally, commercial crab fishers in WA used set (gill) nets or drop nets, but most have now converted to purpose-designed crab traps. The state's prawn and scallop trawl fisheries also retain crabs as a by-product.

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

Governing legislation/fishing authority

Cockburn Sound (Crab) Management Plan 1995
Warnbro Sound (Crab) Management Plan 1995
Exceptions to the Fish Traps Prohibition Notice 1990 and Fish Traps Restrictions Notice 1994
Exemptions under Section 7 of the *Fish Resources Management Act 1994*
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation – Shark Bay and Northern Developmental crab fisheries)

Consultation process

Department–industry meetings

Boundaries

The key commercial fisheries for blue swimmer crabs in Western Australia are located in the west coast, Gascoyne and Pilbara regions. Each of the commercial fisheries within these regions is managed as a separate entity, with its own specific boundaries and management arrangements.

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

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

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

One licence operates in Comet Bay, off Mandurah.

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

The former Geographe Bay fishery covered the waters south of a line drawn from the north-west tip of Cape Natuarliste to McKenna Point lighthouse in Bunbury. This commercial fishery, though still open at the start of the season being reported here, was officially closed on 21 January 2005 due to escalating conflicts between the recreational and commercial sectors.

Gascoyne: During the fishing season being reported here (2004/05), separate licence conditions described specific areas of operation for the commercial crab fishers working in Shark Bay. One Shark Bay beach seine fisher and one Cockburn Sound crab fisher, both with long-standing histories of targeting crabs in these waters, were permitted to use traps in the waters of Shark Bay south of Koks Island. The Carnarvon Experimental Crab Trap Fishery covered the waters from Quobba Point in the north, to Bernier and Dorre Islands in the west, and south to Cape Peron. On 1 December 2005, these arrangements were replaced by the Shark Bay Crab Fishery (Interim) Management Plan (see 'New management initiatives').

Two exemptions have been issued to fish the waters of Exmouth Gulf south of a line drawn between the northernmost point of North West Cape and Locker Point.

Pilbara: Exemptions were issued in 2001 for two fishers to target blue swimmer crabs in the waters off the Pilbara coast in the north-west of Western Australia. (One of these fishers has two licences, making a total of three licences in the fishery.) Both exemptions allow for fishing from the high water mark to the 200 m isobath, one between longitudes 115° E and 120° E (roughly Onslow to Port Hedland) and the other between longitudes 117° E and 120° E (roughly Point Samson to Port Hedland).

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*. Each individual fishery is 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 (Blue Swimmer Crab Table 1).

The principal management tool employed to ensure adequate breeding stock in the commercial crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. Except for males at Shark Bay which mature at 115 mm carapace width (CW), blue swimmer crabs become sexually mature below 100 mm CW. The legal minimum sizes range from 127 mm CW to 135 mm CW in different fisheries, and maintaining the legal minimum size above the size at sexual maturity should ensure adequate egg production for each of the blue swimmer crab stocks under typical environmental conditions.

A comprehensive ESD assessment of the Shark Bay 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 crabs. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Data for the assessment of blue swimmer crab stocks on the west coast are obtained from fishers' compulsory catch and effort returns, voluntary daily log books and on-board catch monitoring conducted by Fisheries Research staff. Additional information on the biology and ecology of blue swimmer crabs has been provided by a number of FRDC-funded projects conducted by the Department of Fisheries and Murdoch University. An FRDC project completed in 2005 developed a catch prediction model for the Cockburn Sound blue swimmer crab fishery that forecasts future commercial catches within the Sound, as well as undertaking a stock assessment of the Shark Bay blue swimmer crab fishery.

RETAINED SPECIES

Commercial production (season 2004/05): 1,033 tonnes

Landings

The total commercial catch of blue swimmer crabs taken in Western Australian waters during 2004/05 was a record 1,033 t. This represents a 14% increase from 2003/04 (909 t), primarily due to a large increase in landings in the Shark Bay fishery.

Shark Bay recorded a 37% increase to achieve its highest catch ever (726 t compared to 529 t in 2003/04), with the Carnarvon Experimental Crab Trap Fishery continuing as the largest of the state's crab fisheries. Dedicated crab trap fishermen accounted for 560 t (a 40% increase over 2003/04), with the Shark Bay trawl fleet contributing the remaining 166 t (a 30% increase). Shark Bay prawn trawlers tend to retain more crabs in years when prawn catches are lower.

The commercial catch for the 2004/05 season from dedicated trap fishers in Cockburn Sound was 84 t, representing a 47% decrease from 2003/04 and again falling below the target annual catch range of 200–350 t (Blue Swimmer Crab Figure 1). Large fluctuations in blue swimmer catches from Cockburn Sound are common, and are primarily dependent on favourable environmental conditions during the period between spawning and recruitment of juvenile crabs to the fishery. Analyses are currently underway to identify correlations between commercial catches of blue swimmer crabs in Cockburn Sound and inter-annual variations in environmental variables such as wind, rainfall and temperature.

The commercial catch from Area 2 of the West Coast Estuarine Fishery (the Peel/Harvey Inlet) for 2004/05 was 79 t, an increase of some 31% from the 60 t taken in 2003/04 (Blue Swimmer Crab Figure 1).

Experimental fishing continued in the Pilbara region during 2004/05, with dedicated crab trap fishers operating intermittently throughout the year. Total blue swimmer crab landings decreased from the 62 t taken in 2003/04. The small retained catch of blue swimmer crabs from trawlers remained constant, while the trap catch declined.

A further 109 t of blue swimmer crabs were caught in the remaining areas of the state during 2004/05. Of this catch, 55 t was caught using crab traps, 20 t using gill (set) nets, 32 t by otter trawlers and 2 t using drop nets, with the remaining 0.1 t taken by haul nets or fish traps.

Fishing effort/access level

The commercial crab catch in Western Australia is predominantly taken using a specifically designed crab trap, which accounted for 78% of the commercial catch in 2004/05 (similar to the 80% in 2003/04). The remainder was taken primarily by trawling (19%), where crabs are a by-product species, with a small component caught in gillnets. The overall state fishing effort during 2004/05 increased by 1% for traps, up from 634,861 trap lifts in 2003/04 to 642,015 trap lifts for 2004/05.

Effort in Shark Bay increased significantly during 2004/05. The five dedicated Shark Bay crab trap fishermen made 347,940 trap lifts over 1,178 days, up from 290,860 trap lifts over 1,047 fishing days during 2003/04 (Blue Swimmer Crab Figure 2).

In Cockburn Sound during 2004/05, 153,365 trap lifts were reported from 1,097 fishing days, down from 190,136 trap lifts over 1,394 fishing days during 2003/04 (Blue Swimmer Crab Figure 3).

Effort levels from fishers using crab traps in Area 2 of the West Coast Estuarine Fishery (the Peel/Harvey Inlet) increased by 37%, from 43,755 trap lifts in 2003/04 to 59,762, trap lifts in 2004/05 (Blue Swimmer Crab Figure 4).

Fishing effort by commercial blue swimmer crab fishers in the developmental Pilbara fishery decreased substantially in 2004/05 due to logistical problems with one of the vessels.

Catch rate

Catch rates from each fishery provide an index of abundance which can be used to assess fishery performance from year to year. Comparative annual rates are presented here for the four areas that contributed the majority of the blue swimmer crab catch for the past year. All four fisheries use dedicated crab traps.

For Shark Bay in 2004/05 the catch rate was 1.61 kg/trap lift, which is within the range seen since 1999/2000 when significant fishing out of Carnarvon began.

The trap catch rate in Cockburn Sound for 2004/05 was 0.54 kg/trap lift, down from 0.83 kg/trap lift for the 2003/04 season (Blue Swimmer Crab Figure 3) and below the typical CPUE of about 0.9 kg/trap lift observed since the fishery adopted traps in 1994/95. This reduced CPUE is considered to reflect poor recruitment over the past two years (2003/04 and 2004/05).

In the Peel/Harvey Inlet the catch rate of 1.32 kg/trap lift for 2004/05 was similar to the 1.37 kg/trap lift recorded in 2003/04 (Blue Swimmer Crab Figure 4).

The CPUE in the Pilbara fishery increased by 65%, from 1.03 kg/trap lift in 2003/04 to 1.7 kg/trap lift in 2004/05, but effort was much lower.

Recreational component: West coast 40% (approx.)

Most of the recreational blue swimmer crab fishing in Western Australia occurs in the west coast bioregion. Departmental surveys have estimated recreational catches of blue swimmer crabs in this bioregion to be about 40% of the total catch. The recreational take was dominated by catch from the Peel/Harvey Estuary where surveys in 1998/99 estimated the catch made by the recreational sector to be 289 t. Recent surveys produced recreational catch estimates for Cockburn Sound of 18 t, 23 t and 18 t for the 2002, 2003 and 2004 calendar years respectively. The Cockburn Sound recreational fishing surveys have shown that catch share agreements were initially successful in increasing the proportional share of total blue swimmer crab catches taken by the recreational sector, from 8% between September 1996 and August 1997 to 15% between September 2001 and August 2002. However, the estimated proportion taken by the recreational sector declined to 9% in 2003 and was 12% in 2004.

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

A creel survey monitoring recreational crabbing in the Gascoyne region was carried out during 1998/99. The survey provided a recreational blue swimmer catch estimate of 968 kg, representing less than 1% of the total catch. Most of the catch was taken in inner Shark Bay.

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, as commercial operations targeting blue swimmer crabs in the area did not begin until the following year.

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

STOCK ASSESSMENT

Assessment complete: Preliminary

Length-frequency data gathered from ongoing monitoring programs in the Shark Bay and Pilbara crab fisheries suggest that management controls currently in place are adequate in maintaining a sustainable level of catch and effort. However, this may not be the case for Cockburn Sound (see below).

Commercial catches from the various blue swimmer crab fisheries sampled since 1998 have returned consistent size distributions both between fisheries, and between years within a fishery. The development of appropriate mesh sizes for use on commercial crab traps has eliminated the catch of juvenile crabs (< 80 mm CW) and significantly reduced the catch of crabs < 120 mm CW, without impacting on legal catches. Improved work practices have reduced the mortality of returned under-size and berried crabs caught in commercial traps to negligible levels.

A preliminary assessment has been made using trap catch rates for each of the major blue swimmer crab fisheries in the state.

Shark Bay: Trap catches in Shark Bay (Blue Swimmer Crab Figure 2) showed an almost five-fold increase from the commencement of the Carnarvon Experimental Crab Trap Fishery in 1998 until 2002/03, while effort and catch per unit effort increased just three and 0.5 times respectively within that period. These increases in catch and CPUE reflect the more efficient fishing of blue swimmer stocks in Shark Bay, as the commercial operators' knowledge of the stocks has increased over time.

Cockburn Sound: The catches achieved in Cockburn Sound are closely related to the effort applied to the stocks and the level of recruitment. Historically the catch ranged between 100 t and 200 t, until the conversion to trap fishing in the mid-1990s when catches in excess of 300 t were achieved with higher effort levels. Although subsequent adjustments to effort through a reduction in traps per vessel and licence buy-backs resulted in both catch and effort returning to the ranges of the early 1990s, there has been a successive decline in catch in this fishery in the last two seasons. Furthermore, catches have been below the minimum acceptable catch range of 200–350 t for the last four seasons. The current low stock levels, as indicated by declining CPUE and research trawls, warrant further research and management attention, and the target catch range also needs to be reassessed. This is especially important given future industrial developments that are planned for the Sound, such as the Desalination Plant, the Fremantle Ports Outer Harbour Facility and the

Power Plant. Although the catch prediction model estimated a commercial blue swimmer crab catch of 101 t for the 2005/06 season in Cockburn Sound, preliminary analysis suggests that catches will be significantly lower.

West Coast Estuarine Fishery Area 2: The commercial catch from the Peel/Harvey estuarine system is relatively small compared to the recreational catch, but provides a useful tool to monitor the status of the stocks. The commercial catch achieved since the introduction of traps has been relatively stable in the range of 50–60 t, with effort in the order of 50,000 trap lifts. CPUE is more variable, reflecting annual changes in recruitment to the estuarine system.

Pilbara: A preliminary assessment of developing crab fisheries within the Pilbara region showed that these fisheries appear productive with steady catch rates. The results are, however, preliminary and highlight the need for ongoing research and management.

Breeding stock levels: Adequate

As the legal size at first capture (127–135 mm CW), which is reached within the first 12–18 months of age, is well above the size at maturity (85–115 mm CW for males and females) in all sectors of the fishery, the breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas under normal environmental conditions. The industry voluntarily applies a higher minimum size for marketing purposes, further increasing the level of spawning prior to capture. However, reduced catches in Cockburn Sound over the past couple of seasons have led to concerns about breeding stock levels and recruitment in this fishery. Breeding stock and recruitment levels will be reviewed in the future to assess possible causes and target catch ranges potentially modified.

The performance measure for the export of crabs from the Shark Bay fishery requires that the breeding stocks are maintained, as demonstrated by adult crab abundance (catch per unit effort). In 2004/05 the CPUE in the main northern Shark Bay fishery, at 1.61 kg/trap lift, remained well above the historical minimum CPUE of approximately 1 kg/trap lift, which has proved adequate to support recruitment to the fishery.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

The shift from using gillnets to traps in most areas has resulted in a substantial reduction in bycatch from dedicated crab fishing. Pots are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled. Small numbers of fish are infrequently captured in crab pots, but the fishers are not permitted to retain them. The low number of fish caught and returned by crab fishers is considered to pose a negligible risk to these breeding stocks. Discarded bycatch from trawl fisheries taking crabs as a by-product is dealt with in those specific reports.

Protected species interaction: Negligible

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

ECOSYSTEM EFFECTS

Food chain effects: Low

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

Habitat effects: Negligible

Fishing with traps results in limited habitat disturbance, with only minor dragging of traps on the bottom during trap retrieval. Sand and associated biota do not get brought to the surface in commercial blue swimmer crab traps as the mesh used on traps is sufficiently large to allow the escape of any sand-dwelling macrobenthos. Although seagrasses are occasionally brought to the surface with the trap, the infrequent nature of this occurrence, and the small amount of living seagrass removed, results in minimal habitat damage.

SOCIAL EFFECTS

During 2004/05, approximately 54 people were employed as skippers and crew on vessels fishing for blue swimmer crabs at various locations along the west coast. Additional employment is also being created in the Gascoyne and Pilbara regions, where development of post-harvest processing of the crab catch is occurring.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2004/05: $4.6 million

The state blue swimmer crab catch for the 2004/05 season was valued at approximately $4.6 million, representing an 18% increase on the $3.9 million generated in 2003/04. Beach prices varied between $4/kg and $6/kg live weight, with the average price for the year being $4.25, the same as in 2003/04. While the majority of the product was sold through local and interstate markets, several Shark Bay fishers have been exploring markets in south-east Asia and value-adding of product on the domestic market.

FISHERY GOVERNANCE

Target catch range: 200–350 tonnes (Cockburn Sound only)

For the managed fishery in Cockburn Sound, the commercial target range for the current management regime is

approximately 200–350 t. This range is based on catches in the five-year period from 1995/96 to 1999/2000, after the fishing effort was converted to trapping. As the fishery has subsequently undergone further effort reductions since 1999/2000, the current target range will be reviewed.

Catches from new and expanding fisheries (such as Shark Bay and Peel/Harvey) have already taken the statewide catch for the species in excess of 1,000 t. A review of these blue swimmer crab fisheries will be undertaken and target catch ranges set.

New management initiatives (2005/06)

On 1 December 2005, an interim management plan came into effect to govern the administration of the Shark Bay crab fishery. The plan, which supersedes the varied management arrangements previously in place, is intended to allow for the further development of the fishery while maintaining a sustainable level of fishing effort and providing greater tenure and security for operators.

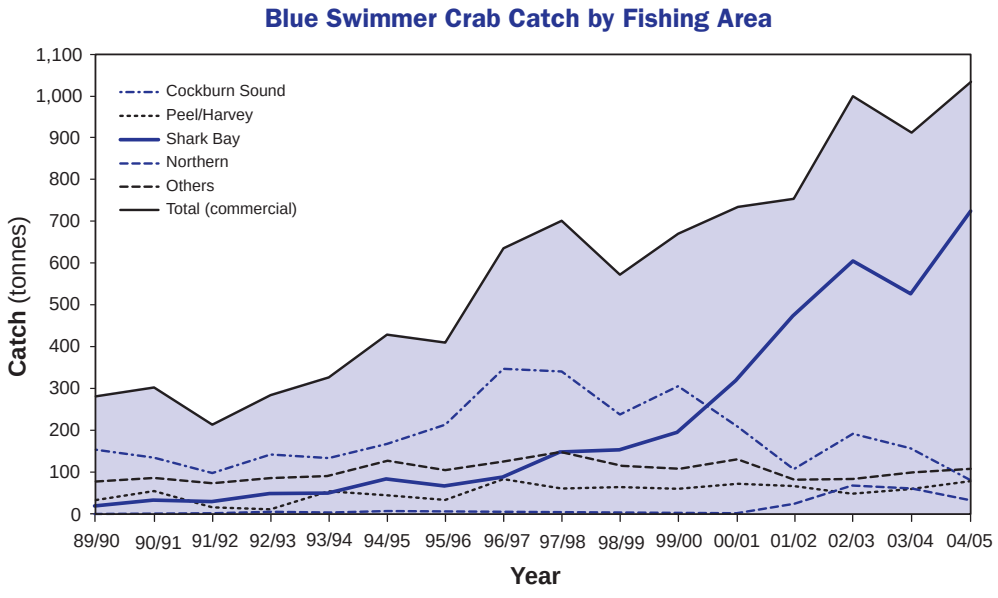
In February 2006, the Australian Government Department of Environment and Heritage declared the Northern Developmental Blue Swimmer Crab Fishery a Wildlife Trade Operation under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a number of conditions, this certification allows product from the fishery to be exported from Australia for a period of three years before reassessment.

EXTERNAL FACTORS

Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of this variation are not fully understood, it is considered most likely due to environmental influences on larval survival.

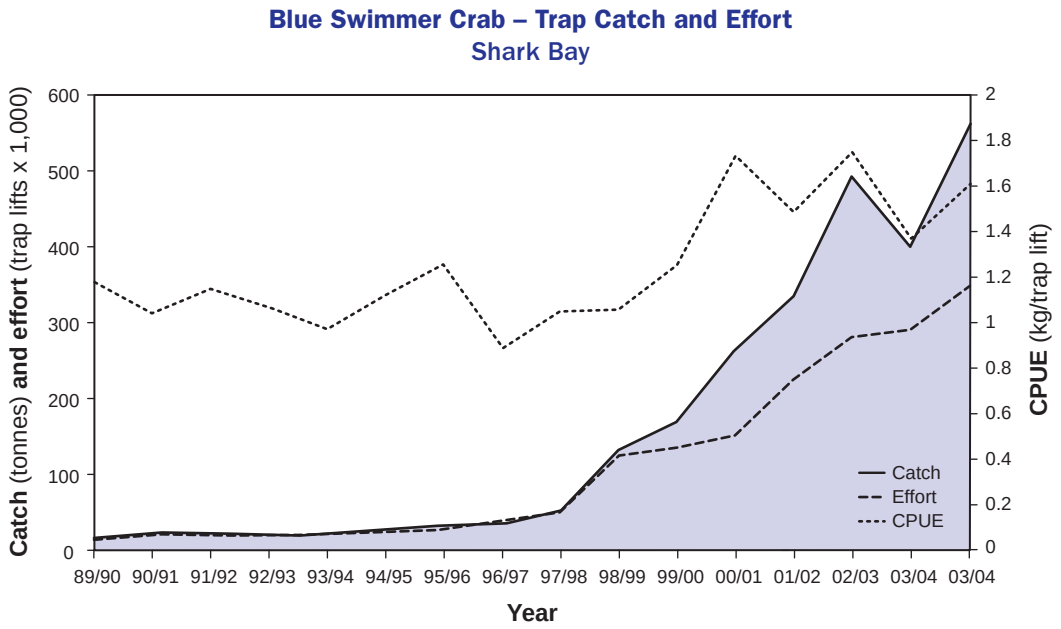
Currents and water movement play a significant role in determining recruitment success, as a specific window of time is available during the megalopal larval stage of the blue swimmer crab to reach and/or select a suitable settlement site. Both temperature and salinity influence the spawning behaviour, distribution, activity and movement of blue swimmer crabs, while juvenile growth is also markedly influenced by the availability of food. The potential impacts of pollutants and habitat degradation in Cockburn Sound need to be investigated.

Surveys measuring the strength of recruitment to the Cockburn Sound crab fishery as part of a three-year FRDC project are now complete. A catch-prediction model capable of forecasting the commercial catch for the following season has been constructed. The relationship between environmental factors, recruitment and catch will be further evaluated as data become available.



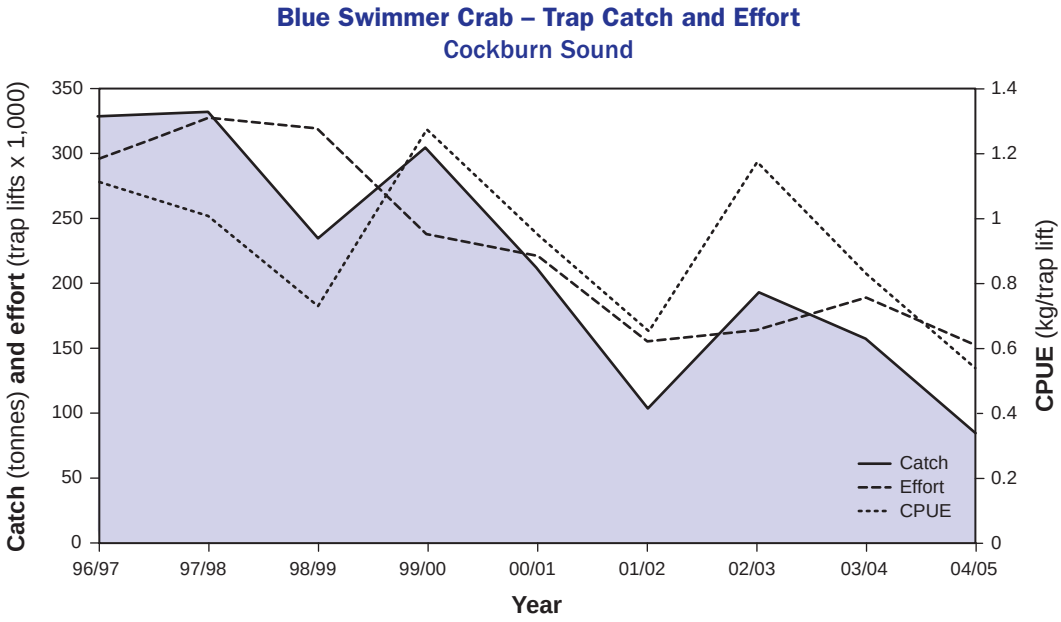
BLUE SWIMMER CRAB FIGURE 1

Commercial catch history for the blue swimmer crab (*Portunus pelagicus*) in Western Australia between 1989/90 and 2004/05, indicating main regions of commercial catches.



BLUE SWIMMER CRAB FIGURE 2

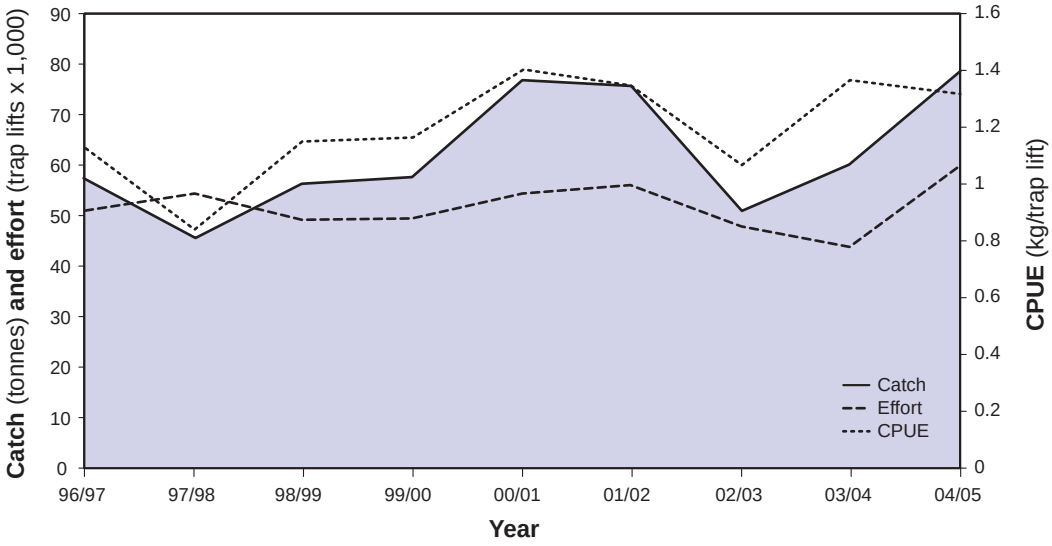
Blue swimmer crab catch (t), effort (trap lifts x 1000) and catch per unit effort (kg/trap lift) in Shark Bay during the period 1989/90 to 2004/05 using traps.



BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (t), effort (trap lifts x 1000) and catch per unit effort (kg/trap lift) in Cockburn Sound during the period 1996/97 to 2004/05 using traps.

Blue Swimmer Crab – Trap Catch and Effort
Peel/Harvey



BLUE SWIMMER CRAB FIGURE 4

Blue swimmer crab catch (t), effort (trap lifts x 1000) and catch per unit effort (kg/trap lift) in the Peel/Harvey Estuary (Area 2 of the West Coast Estuarine Fishery) during the period 1996/97 to 2004/05 using traps.

BLUE SWIMMER CRAB TABLE 1

Management arrangements for the Western Australian blue swimmer crab fisheries during the 2004/05 season.

BIOREGION	FISHERY		NO. OF LICENCES IN FISHERY	NO. OF LICENCES ACTIVE IN 2004/05	GEAR TYPE	TOTAL TRAP/ NET ALLOCATION	NO. OF TRAPS/NET FISHED IN 2004/05	MINIMUM COMMERCIAL SIZE LIMIT (mm CW)	SPATIAL AND TEMPORAL CLOSURES
WEST COAST	Cockburn Sound		11	6	Hour glass traps	780	775	130	A variety of spatial and temporal closures have been implemented in Western Australia's blue swimmer crab fisheries, tailored to the specific circumstances of each fishery. The closures primarily aim to: • protect blue swimmer crab spawning stocks, along with the spawning grounds of neighbouring fish species; and • manage the interaction between commercial and recreational crabbing sectors. Refer to individual fishery management plans for specific details.
	Warnbro Sound		1	1	Hour glass traps	100	100	130	
	West Coast Estuarine	Area 1 (Swan/ Canning River)	4	4	Haul/set nets	2000 m haul net* 2000 m set net* (mesh <127mm) 4000 m set net (mesh >127mm)	820 m set net	127	
		Area 2 (Peel/ Harvey Inlet)	9	9	Hour glass traps	378	378	127	
	Comet Bay		1	1	Hour glass traps	80	80	127	
	Mandurah–Bunbury		4	4	Hour glass traps	Northern – 160 Southern – 240	Northern – 160 Southern – 240	128	
	Geographe Bay *(closed 21 January 2005)*		8	8	Hour glass traps	320	320	128	
GASCOYNE	Carnarvon Experimental Crab Trap		3	3	Hour glass traps	900	900	135	
	Shark Bay		2	2	Hour glass traps	500	500	135	
	Exmouth Gulf		2	1	Hour glass traps	400	200	135	
PILBARA	Northern Crab		3	3	Hour glass traps	600	600	135	

* nets not used to target blue swimmer crabs

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

R. Melville-Smith
Management input from R. Gould

FISHERY DESCRIPTION

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

Governing legislation/fishing authority

West Coast Deep Sea Crab Fishery (Interim) Management Plan 2003

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Department–industry meetings

Boundaries

The West Coast Deep Sea Crab Fishery, which during the season being reported (2005) was in an interim management phase, operates between Cape Leeuwin and the Northern Territory border and is divided into five areas. Vessels are only permitted to fish outside the 150 m depth contour.

Management arrangements

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

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

There are currently five full-time permits and two part-time permits to operate in the fishery. The interim management plan is due to expire in December 2006 and the fishery will move to become fully managed at that stage. It is also proposed that the fully managed fishery will use a quota management system initially with equal individual transferable quota for each existing permit holder. Consultation with industry regarding the new management plan has been finalised and the Minister for Fisheries has approved drafting of legislation to move the fishery to a quota-managed regime.

A comprehensive ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of deep sea crabs. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Research for this fishery has involved assessing the current status of the west coast deep sea crab stocks based on commercial catch returns, log book information and at-sea research monitoring of the catch. Funding was granted in 1999 by the FRDC to develop an understanding of the biology and fishery of champagne crabs. Further funding was made available in 2001 for similar research to be undertaken on crystal crabs. The Murdoch University component of this work has become available (September 2004) and the Department of Fisheries component will be available in late 2006.

RETAINED SPECIES

Commercial production (season 2005): 207 tonnes

Landings

A catch of 207 t of crystal crabs was taken in the fishery in 2005, a decrease of 11% on the catch taken in the 2004 season (233 t) (Deep Sea Crab Figure 1). There were no catches of champagne or giant crabs in this fishery during the 2005 season.

Fishing effort/access level

Effort decreased by 19% from an estimated 135,500 pot lifts in the 2004 season to 109,500 pot lifts in the 2005 season. The effort estimate in this fishery is based on detailed catch and effort log book returns which are required to be completed by fishers in this fishery during its developmental status.

Catch rate

The standardised catch per unit of fishing effort for crystal crabs increased by 13%, from 1.51 kg/pot lift in 2004 to 1.71 kg/pot lift in 2005, but remained lower than the peak of 2.5 kg/pot lift in 2000.

Recreational component: Nil

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

STOCK ASSESSMENT

Assessment complete: Preliminary

The total catch for 2005 decreased, but catch rates have, as in 2004, continued to improve (Deep Sea Crab Figure 1). There are several possibilities that could explain this result. One is that there might have been good recruitment into the fishery in the last two years. This seems an unlikely explanation, because the species is known to be long-lived and slow-growing and therefore not likely to show large fluctuations in recruitment. A more likely explanation is that the staged withdrawal of some catch restrictions that commercial fishers have imposed on themselves, such as a larger minimum size than the legal minimum size limit, has opened up a previously

unfished portion of the stock, leading to increased catch rates. This, combined with efficiency increases resulting from fishers becoming more adept at positioning their lines where the best catch rates will be achieved, could explain the trend that has been recorded in the last couple of years.

If a 5% efficiency increase for the fishery is assumed since 1998, then the catch rates since 2002 are steady and those of 2004 and 2005 are less optimistic. The question remains whether a 5% efficiency increase in the last five years is a reasonable assumption, given that fishers are gaining in experience every year. The western rock lobster fishery continues to have efficiency increments of 1–3% per year due to technology improvements, even after 50 years of fishing.

Breeding stock levels: **Adequate**

In crystal, champagne and giant crab species, the males grow considerably larger than the females. The legal minimum sizes of 92 mm carapace length for champagne crabs and 140 mm carapace length for giant crabs, together with the voluntarily agreed minimum of 120 mm carapace width for crystal crabs, offer significant protection for the female portion of the populations. Furthermore, preliminary evidence shows that sizes at maturity for males and females of both crystal and champagne crabs are well below the minimum sizes in both. Therefore, the broodstock is well protected.

A greater level of research has been undertaken on the state of the breeding stock levels of giant crabs than for crystal and champagne crabs. Estimates made by Andrew Levings of Deakin University (unpub. data) suggest that the 140 mm carapace length minimum size is expected to protect at least 40% of pristine egg production in the Western Australian portion of Australia's giant crab population.

The performance measure for this fishery uses catch level as an indicator of breeding stock. In the case of champagne crabs, the catch is required to stay below 50 t, and for crystal crabs, to remain within the range 100–300 t. For both species, these criteria were met (see 'Landings' section).

NON-RETAINED SPECIES

Bycatch species impact: **Low**

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

Protected species interaction: **Negligible**

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

ECOSYSTEM EFFECTS

Food chain effects: **Negligible**

Catches of the three 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 in depths between 500 and 800 m. An estimate of the amount of ground between 500 and 1,000 m over the distributional range of crystal crabs is about 50,600 km^2. Assuming that all the ground is equally productive, this means that about 4 kg of crabs are being removed each year per km^2 of ground.

Habitat effects: **Low**

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

SOCIAL EFFECTS

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

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005:
$2.7 million

The beach value of the fishery was about $2.9 million in 2005, based on an average beach price of $13/kg for crystal crabs. The majority of the catch is exported live to south-east Asia.

FISHERY GOVERNANCE

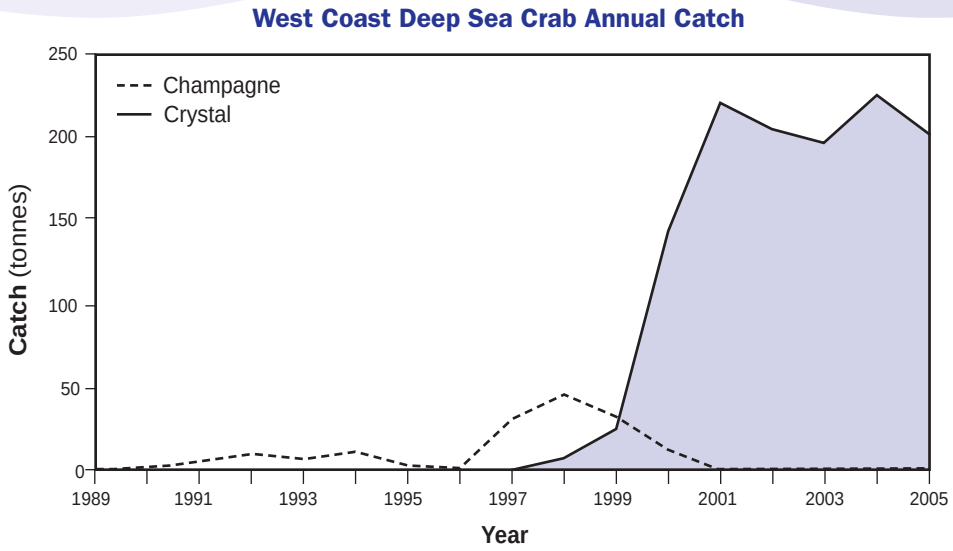
Target catch range:
Current 100–300 tonnes (crystal crabs)
Future 100–250 tonnes (crystal crabs)

The effort in this interim managed fishery during 2005 was restricted to five full-time and two part-time fishers spread throughout the range of the fishery. Not all these permits are being utilised.

The target catch range was originally set based on observations during the early developmental years of the fishery. However, given that the fishery has probably been fully exploited since about 2000, at current levels of fishing the catch expected in the next few years would be in the range of 100–250 t.

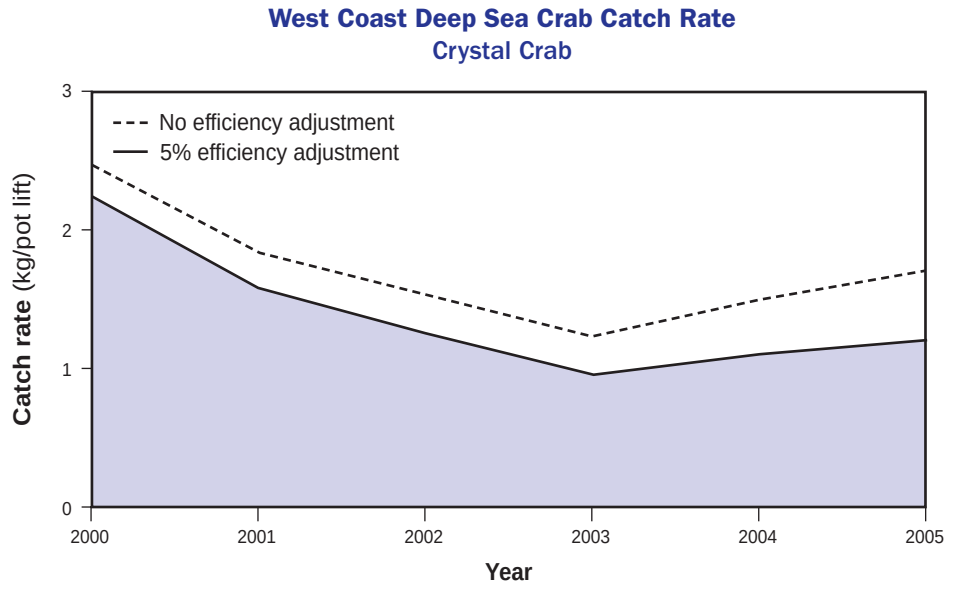
New management initiatives (2005/06)

It is expected that the fishery will move to a new unitised, quota-based interim management plan in January 2007. It is intended that the new interim plan will run for a further five years and will provide for 7,000 individual transferable units (1,000 per permit holder). In conjunction with the new interim plan it is proposed to develop Ministerial Policy Guidelines that will provide for the means to set an annual total allowable quota and set trigger points to address restrictions on bycatch from the fishery (noting that the fishery currently has virtually no bycatch).



WEST COAST DEEP SEA CRAB FIGURE 1

Annual catches of crystal and champagne crabs from 1989 to 2005. Annual giant crab catches have always been small, and they have therefore been excluded.



WEST COAST DEEP SEA CRAB FIGURE 2

Catch per unit effort for 2000–2005 for crystal crabs, with and without adjustment to take into account likely efficiency increases.

West Coast Estuarine Fisheries Status Report

K. Smith and J. Brown
Management input from A. Salas

FISHERY DESCRIPTION

The West Coast Estuarine Managed Fishery (WCEF), which operates in the Swan/Canning and Peel/Harvey Estuaries, is a multi-species fishery targeting many finfish species. The Hardy Inlet fishery, although not included in the WCEF interim management plan implemented during 2003, is also reported here as it shares the characteristics of the other west coast estuaries.

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

Governing legislation/fishing authority

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

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

Consultation process

Department–industry meetings

Boundaries

Swan/Canning and Peel/Harvey Estuaries: The management plan encompasses all estuaries on the west coast between 27º S and 33º11´ S. However, the plan incorporates a broad range of closures, so that in general terms (but with some exceptions) the only areas open to fishing are:

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

Note: The closures in both the Swan/Canning and Peel/Harvey fisheries are complex, so the management plan, the related legislation and regulations should be referred to for details.

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

Management arrangements

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

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

Research summary

Historically, monitoring of fisheries and fish stocks in the west coast estuaries has been based on monthly catch and effort statistics (CAES) provided by commercial fishers. This valuable data set has provided consistent, long-term information for monitoring estuarine fish, including recreationally important stocks where they are harvested by both sectors. CAES data are interpreted using the extensive scientific knowledge of the fish stocks in estuaries derived from research by Department of Fisheries and Murdoch University scientists since the 1970s.

In recent years, reduced levels of commercial fishing activity have occurred as a result of voluntary fishery adjustment schemes (i.e. licence buy-backs). As a result, commercial catch and effort data are no longer providing adequate information to assess the status of certain estuarine stocks. Additional monitoring strategies to enable the recreational sector and/or independent surveys to contribute data to assessments of our important estuarine fish and crustaceans are required. The Research Angler Program and annual research surveys of juvenile fish recruitment are among the strategies now being employed by the Department to meet this need. At the same time, even greater co-operation from the remaining commercial fishers is required to provide fine-scale catch and effort data that can be used to derive a CPUE-based index of abundance for target species. A new commercial fishing daily log book to record fine-scale data is being developed in consultation with estuary fishers.

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 production (season 2005): 261 tonnes

Landings

In 2005 the total catch from west coast estuaries was 261 t, including the following catches of key target species:

Blue swimmer crabs	*Portunus pelagicus*	87.8 t
Sea mullet	*Mugil cephalus*	66.4 t
Western sand whiting	*Sillago schomburgkii*	36.8 t
Yellow-eye mullet	*Aldrichetta forsteri*	34.1 t
Perth herring	*Nematalosa vlaminghi*	9.8 t
Australian herring	*Arripis georgianus*	9.4 t
Black bream	*Acanthopagrus butcheri*	4.9 t
Cobbler	*Cnidoglanis macrocephalus*	3.3 t
King George whiting	*Sillaginodes punctata*	2.4 t
Tailor	*Pomatomus saltatrix*	1.8 t
Other species		4.0 t

Swan/Canning: The total fishery catch in the Swan/Canning Estuary in 2005 was slightly lower than in 2004 (actual figure not available owing to the small number of operators). Total annual catch has essentially been stable since 2000, after following a declining trend throughout the 1990s. The decline in catch was largely driven by a decline in fishing effort, from about 25 active vessels during the 1970s to about 3 in 2005. The catch during 2005 was composed primarily of blue swimmer crab, Perth herring and sea mullet, with small quantities of black bream and yellow-eye mullet.

Peel/Harvey: Reported catches in the Peel/Harvey Estuary since 1980 are shown in West Coast Estuarine Figure 1. From the mid-1970s until 1990, total annual landings declined markedly, mainly due to declines in annual catches of yellow-eye mullet, sea mullet and cobbler. From 1990 to 1998, annual catches were stable and averaged 313 t. Annual catches declined from 329 t in 1998 to 188 t in 2000 but were then relatively stable from 2000 to 2005.

As in the Swan/Canning Estuary, the catch trend in the Peel/Harvey Estuary after 1990 closely followed the decline in fishing effort. In both estuaries, declines in total annual landings were due to declines in finfish landings. Unlike finfish landings, annual crab landings in these estuaries have gradually increased since 1980 despite declining effort levels. In 2005, approximately 36% of the total Peel/Harvey catch consisted of blue swimmer crabs, with sea mullet, yellow-eye mullet and western sand whiting making up 84% of the finfish catch.

Hardy Inlet: The 2005 catch was similar to the 2004 level (actual figure not available owing to the small number of operators). The catch level trend has been stable since 1996. The majority of the 2005 catch was composed of western sand whiting, with small quantities of black bream, sea mullet and other finfish. There was a small catch of blue swimmer crabs in 2005.

Key species

The following species have been historically important in west coast estuarine fisheries. However, recent changes in fishing activity, market forces and environmental impacts in estuaries have altered the species composition of the catch. The importance to the fishery of species such as cobbler and King George whiting has decreased, while the importance of other species such as yellow-finned whiting and sea mullet has increased. The suite of species presently used as indicators of fishery status is under review.

Blue swimmer crabs: See West Coast Blue Swimmer Crab Fishery Status Report (pp. 31–38).

Black bream: Catches of black bream were reported from the Swan/Canning Estuary and the Hardy Inlet in 2005. In each estuary, the catches in 2005 were slightly higher than in 2004.

Cobbler: Minor catches of cobbler were reported from the Swan/Canning Estuary, Peel/Harvey Estuary and Hardy Inlet in 2005. The annual catch of cobbler in the Swan/Canning Estuary declined dramatically after 1988, when 10.4 t was reported. Since 1998, annual catches have not exceeded 170 kg. Recent catches of cobbler in the Peel/Harvey Estuary were also low relative to historic levels. The 2005 catch in the Peel/Harvey Estuary was 2.9 t, slightly up from the 1.3 t caught in 2004. From 2000 to 2005, the annual catch in the Peel/Harvey estuary has averaged 2.3 t, which is significantly less than the average annual catch of 57 t in the previous 25 years (1976–1999).

King George whiting: In 2005, King George whiting catches were reported only from the Peel/Harvey Estuary (2.4 t). Recent catches 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. The catch then declined to pre-1996 levels and averaged 2.8 t from 2001 to 2005.

Fishing effort/access level

Swan/Canning:	level of access – 3 licensees
Peel/Harvey:	level of access – 11 licensees
Leschenault:	level of access – no commercial access
Hardy Inlet:	level of access – 1 licensee

The levels of access listed above are as at March 2005. Licence holders in the west coast estuaries that are open to commercial fishing are endorsed to fish a single estuary system only.

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

Fishing effort in the other estuaries will continue to be reported as the average number of boats fishing per month.

This measure of effort provides a general indication of effort changes over time. In these fisheries, the licence buy-back scheme applied to commercial fishing licences has resulted in a decline in effort and hence lower catches.

Swan/Canning: Fishing effort has steadily declined over recent decades. The mean number of active fishing units per month fell from about 25 in the mid-1970s to about 3 in 2005.

Peel/Harvey: During the 1980s, fishing effort (number of method days fished) averaged 5,372 days per year, but this included a period of rapid decline between 1988 and 1990. Effort then stabilised and averaged 3,463 days per year from 1990 to 2000. After another pronounced decline between 1998 and 2000, effort again stabilised with an average of 1,980 days fished per year between 2000 and 2005 (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 2005.

Catch rate

Swan/Canning: The total annual CPUE (including finfish and crab catches) since 1990 has been relatively stable, suggesting that the total abundance of species that make up the catch may have remained fairly constant. However, the proportion of estuarine-dependent species in the catch (particularly finfish that depend strongly on the estuary for spawning or nursery habitats) has decreased in recent years. Annual finfish CPUE in the Swan/Canning Estuary exhibited a declining trend during the 1990s, while crab CPUE increased over the same period. Catch trends were relatively stable from 2000 to 2005.

Peel/Harvey: The total annual CPUE (kg per method day fished) declined during the 1980s, and has since remained fairly constant. While compulsory CAES monthly returns do not allow targeted fishing effort to be determined for individual stocks, the general stability of the total fishery CPUE suggests the abundance of the suite of species that make up the catch has remained fairly constant since 1990, though apparently at a significantly lower level than in earlier years. As in the Swan/Canning Estuary, the CPUEs of finfish and crabs in the Peel/Harvey Estuary have decreased and increased, respectively, since 1980.

Hardy Inlet: Since the early 1990s the trend in CPUE has generally followed fluctuations in the catch. The catch trend over the past 10 years (1996–2005) has been stable.

Recreational component: 30–75%

In 2000/01, the National Recreational and Indigenous Fishing Survey collected data on all target species. From this survey, the recreational finfish catch 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 three times the commercial finfish catch in the Hardy Inlet/Blackwood River.

With the cessation of commercial fishing in Leschenault Inlet in 2002, the recreational sector now takes all of the catch.

STOCK ASSESSMENT

Assessment complete: Not assessed

The status of the fishery in each west coast estuary is reviewed annually.

Basic assessments have been undertaken previously for select indicator species (black bream, cobbler and King George whiting). Annual monitoring of stock status is undertaken using catch and effort indicators. It must be acknowledged that 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 have been steadily increasing since the mid-1990s in the Hardy Inlet and increased markedly after 1990 in the Swan/Canning Estuary. These trends suggest recent increases in bream stock abundance in these estuaries. However, the Swan/Canning stock is dominated by relatively young fish, suggesting that annual recruitment is adequate but that the stock is subject to a relatively high rate of mortality. Environmental factors and fishing are both likely to be significant sources of mortality. Stock status in the Peel/Harvey system is unclear due to limited data but is probably similar to the Swan/Canning stock.

Cobbler: Cobbler populations are genetically unique within each west coast estuary. In 2005, catches of cobbler in the Swan/Canning and Peel/Harvey Estuaries remained very low relative to historic levels, despite continued market demand for this species. The decline in catch and stock abundance of this once important species appears to be the result of both fishery and fishery-independent factors, including loss of breeding habitats.

King George whiting: King George whiting spend the early part of their life (1–3 years) in estuaries before migrating at about age 4 to offshore reef areas where they grow to maturity and breed. They are most vulnerable to capture while residing in estuaries. The high catches of King George whiting in the late 1990s were due to an unusually abundant cohort of juvenile fish that recruited into the estuaries at this time. This cohort eventually matured and moved offshore. Relatively low recruitment (and therefore lower catches) have occurred since 2000.

Breeding stock levels: Not assessed

Black bream: Recreational and commercial catch rates of black bream in the Swan Estuary have been increasing over the past decade. Increasing catch rates and strong recent recruitment by black bream in the Swan Estuary are encouraging signs for the breeding stock in that system.

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 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 the breeding stock. However, the continuing very low catches in the three west coast estuaries are likely to be due to a combination of environmental factors (e.g. loss of breeding habitat) and the biological characteristics of this species (e.g. low fecundity, aggregating behaviour), and make the species inherently vulnerable to ongoing depletion.

King George whiting: King George whiting breed in the open ocean at age 4+, and juveniles use estuaries and coastal waters as nursery habitats for the first few years of their life. 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 LML 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 unsustainable level in the future.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

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

Protected species interaction: **Negligible**

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

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Low**

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

SOCIAL EFFECTS

In 2005, there was an average of 17 fishers operating each month in the west coast estuarine fisheries, largely supplying fresh fish to meet demand for locally caught product.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: **$1.1 million**

FISHERY GOVERNANCE

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

Under the current management regime, the target range for total catch in the Peel/Harvey fishery is 75–220 t. The current catch is well within this range. This range was derived by a statistical quality control chart using catch data from 1978 to 2002. Catch ranges are designed to allow catch levels to fluctuate in response to normal fluctuations in stock abundance. If annual catches fall outside acceptable ranges, an investigation into the cause will be triggered which, if required, may lead to changes in the management arrangements.

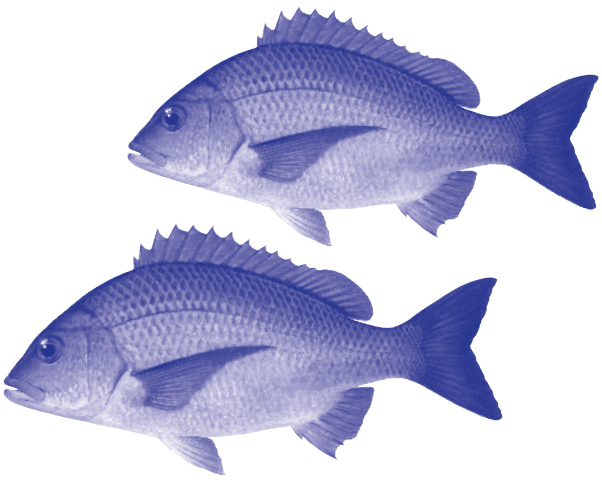
Acceptable catch ranges for the Swan/Canning and Hardy Inlet fisheries cannot be derived at this time given the recent decreases in the number of commercial fishers operating in these estuaries and the low amount of data now available from each estuary.

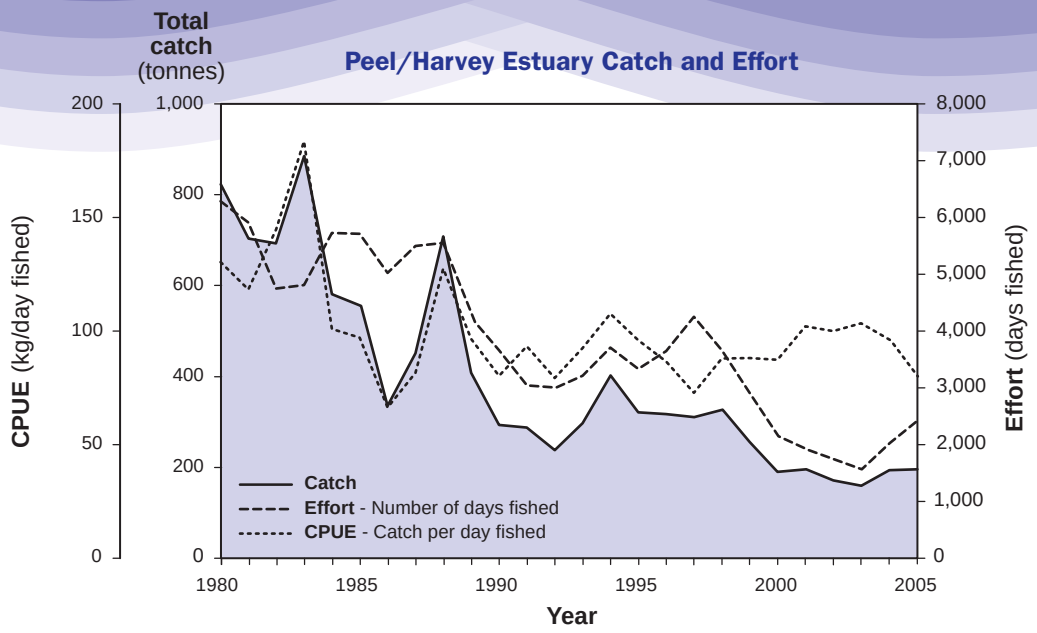
New management initiatives (2005/06)

Arrangements are underway to incorporate the management of the Hardy Inlet commercial fishery into a formal management plan.

EXTERNAL FACTORS

West coast estuaries are highly modified, and often degraded, environments. In these estuaries, the impacts of environmental factors on stock abundances are likely to be at least as important as fishing pressure. Hence, the sustainable management of the fish communities in west coast estuaries requires a collaborative effort between fishery and habitat managers. Anecdotal reports suggest that habitat and climatic changes have altered the composition and abundance of fish communities in west coast estuaries, although lack of historical monitoring makes many of these changes difficult to quantify. In the Swan/Canning Estuary, however, abundant fishery data provides evidence of marked declines in fish abundance since 1990 or earlier (Smith 2006). Declines are most pronounced among 'estuarine-dependent' species, i.e. those that rely on estuarine habitats for spawning, feeding and/or nursery areas.





WEST COAST ESTUARINE FIGURE 1

The annual catch, effort and catch per unit effort (CPUE) for the total fishery of the Peel/Harvey Estuary over the period 1980–2005.

Cockburn Sound Finfish Fisheries Status Report

J. Brown, K. Smith and E. Lai
Management input from A. Salas

FISHERY DESCRIPTION

There are three managed commercial fisheries that operate wholly and two managed commercial fisheries that operate partly within Cockburn Sound. The Cockburn Sound (Fish Net), Cockburn Sound (Line and Pot) and Cockburn Sound (Crab) Managed Fisheries operate entirely within Cockburn Sound, while the West Coast Beach Bait and the West Coast Purse Seine Managed Fisheries operate partly within Cockburn Sound.

The catches reported here are for finfish only and are mainly from the Cockburn Sound (Line and Pot) and the Cockburn Sound (Fish Net) Managed Fisheries.

Separate status reports are given elsewhere in this volume for the West Coast Beach Bait, West Coast Purse Seine and crab fisheries (see pp. 50–52, 52–55 and 31–38 respectively).

Cockburn Sound (Line and Pot) Managed Fishery: The fishing methods employed include handline, longline and squid jigging; the pots used are unbaited octopus pots.

Cockburn Sound (Fish Net) Managed Fishery: Fish are taken in this fishery by gillnet and haul net, with the main targeted species being southern sea garfish (*Hyporhamphus melanochir*) and Australian herring (*Arripis georgianus*).

Other fish species, including shark, whiting (Sillaginidae) and mullet (Mugilidae), are taken opportunistically.

Many of the species taken by these commercial fisheries are also targeted by recreational fishers, e.g. Australian herring, garfish, squid and pink snapper (*Pagrus auratus*).

Governing legislation/fishing authority

Cockburn Sound (Fish Net) Management Plan 1995
Cockburn Sound (Line and Pot) Management Plan 1995
Subsidiary legislation under the *Fish Resources Management Act 1994*

Consultation process

Department – industry meeting

Boundaries

The Cockburn Sound (Fish Net) and Cockburn Sound (Line and Pot) Managed Fisheries operate in *'the waters of the Indian Ocean bounded by a line commencing at a point on the high water mark at the western extremity of the South Mole at the entrance to Fremantle Harbour and extending westerly to the southern most rock of the Straggler Rocks; thence south easterly to the high water mark on the northern most point of Mewstone; thence generally southerly along the high water mark on the eastern shore of Mewstone to its southern most point; thence southerly to the high water mark on the northern most point of Carnac Island; thence generally southerly along the high water mark on the eastern shore of that island to its southern most point; thence southerly to the high water mark at Entrance Point*

on Garden Island; thence generally southerly along the high water mark on the eastern shore of that island to the south west point; thence southerly to the high water mark at John Point on the mainland; thence along the high water mark to the commencing point.'

Management arrangements

The Cockburn Sound (Line and Pot) and Cockburn Sound (Fish Net) fisheries are managed primarily through input controls in the form of limited entry, gear restrictions and closed areas. Over the past 10 years, as a result of Voluntary Fishery Adjustment Schemes, the number of licences in the two fisheries has been reduced significantly, from 42 to 13 line and pot licences and one fish net licence.

Research summary

Catch and effort data provided by commercial fishers, together with general biological information, have historically been used to assess the status of key finfish stocks in both the commercial and recreational fisheries in Cockburn Sound. However, declining levels of commercial fishing effort have rendered the data from this sector progressively less useful and stock assessments are increasingly reliant on data from the recreational sector and/or independent surveys. The Research Angler Program and annual research surveys of juvenile fish recruitment are among the strategies now being employed by the Department to meet this need. Also, even greater co-operation from the remaining commercial fishers will be required in future to provide fine-scale catch and effort data that can be used to derive a CPUE-based index of abundance for target species. A new commercial net fishing daily log book to record fine-scale data is currently being developed.

Australian herring is one of the main finfish species caught in Cockburn Sound. A re-assessment of the status of the Australian herring stock is currently underway (see Australian Herring Fishery Status Report, pp. 206–209).

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

Several research projects are currently underway that will provide additional data about key fishery species in Cockburn Sound. A 12-month creel survey of boat-based recreational fishing in the west coast bioregion commenced in July 2005 and will yield estimates of the annual catches by this sector. The recreational angler daily log book program commenced in 2004 and catch rates will provide an ongoing index of abundance for many stocks on the south and west coasts, in addition to that provided by commercial catch rates. Plankton samples taken in coastal waters off Perth in 2005 are currently being analysed to determine the distribution of larvae of herring, garfish and other finfish in this region.

RETAINED SPECIES

Commercial production (season 2005): 40 tonnes

Landings

The total catch from Cockburn Sound reported here excludes baitfish (whitebait, pilchard, scaly mackerel, anchovy and blue sprat), molluscs and crustaceans. The reported catch 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 species mentioned above) recorded from the West Coast Beach Bait and the West Coast Purse Seine Managed Fisheries, which conduct part of their respective operations within Cockburn Sound.

The total annual finfish catch in Cockburn Sound has shown a declining trend since peaking at 165 t in 1992. In 2005, the finfish catch was 40.4 t, which was the lowest catch recorded since the 1970s (Cockburn Sound Figure 1). The composition of the 2005 total finfish catch included about 13 teleost and elasmobranch species. Approximately 88% of the catch consisted of Australian herring and southern sea garfish, which are caught primarily by netting.

After 1980, annual landings of Australian herring in Cockburn Sound increased steadily to reach a peak of approximately 50 t in 1994. Since 1994, the catches of herring have been lower and relatively stable, fluctuating between 15 t and 30 t per year. In 2005, the herring catch was slightly higher than in the previous year (actual figures cannot be reported as there are fewer than five operators catching this species) and was only slightly below the 10-year average for the period 1995–2004.

The annual landings of sea garfish in Cockburn Sound increased gradually after 1980 to reach levels of approximately 20–30 t per year during the late 1990s. Subsequent annual landings of garfish have been slightly lower and relatively stable, fluctuating between 15 t and 20 t per year. The 2005 catch was slightly lower than the previous year (actual figures cannot be reported as there are fewer than five operators catching this species).

Fishing effort/access level

As of May 2005 there was one licensee in the Cockburn Sound (Fish Net) fishery and 13 licensees in the Cockburn Sound (Line and Pot) fishery.

Fishing effort is measured 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, as well as days fished in the West Coast Beach Bait and the West Coast Purse Seine Managed Fisheries where non-bait-fish species were caught. This provides only an approximate measure of the overall effort in Cockburn Sound by the commercial sector, which is composed of a number of different fisheries and various fishing methods.

Annual commercial fishing effort 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 1). It declined to 835 boat days in 1997 before rising again to a record high of 1,468 boat days in 1999. After 1999, annual effort steadily declined and reached a record low of 353 boat days in 2005. Recent declines in commercial effort are attributable to a progressive reduction in the number of active fishers operating since 1990.

Catch rate

From 1977 to 2005, the combined annual CPUE for the different fisheries and the various fishing methods in Cockburn Sound fluctuated between 49 and 119 kg/boat day. The trend over this period was stable, with an average of 83 kg/boat day.

Most recently, from 2000 to 2005, the annual CPUE have been rapidly increasing while catch and effort levels have been rapidly decreasing (Cockburn Sound Figure 1).

The annual CPUE for Australian herring in Cockburn Sound progressively increased between the 1970s and the mid-1990s, to reach a level of 36 kg/boat day in 1993 and 1994. Annual herring CPUE then steadily declined to 13 kg/boat day in 2000. Between 2000 and 2005, the herring CPUE increased very rapidly and reached a record high of 59 kg/boat in 2005.

Recreational component: **56–80%**

The most recent information on Cockburn Sound recreational shore- and boat-based fishing is from the National Recreational Fishing Survey, conducted between May 2000 and April 2001, and from a creel survey conducted between September 2001 and August 2002. The catches and effort estimated from each survey are summarised in Cockburn Sound Table 1. Both surveys indicate that the finfish catch from Cockburn Sound is primarily caught by the recreational sector.

A 12-month creel survey of boat-based recreational fishing in the west coast bioregion commenced in July 2005 and will yield estimates of the annual catches by this sector in Cockburn Sound.

STOCK ASSESSMENT

Assessment complete: **Not assessed**

For an assessment of Australian herring stocks, see pp. 206–209.

Breeding stock levels: **Not assessed**

The catch and catch rate trends reported by the Cockburn Sound commercial net fishery do not provide a reliable measure of total Australian herring stock abundance, firstly because the quantities caught by this fishery are small relative to the total state catch, and secondly because the catches are taken over a small area relative to the total range of this species across south-western Australia.

For an assessment of Australian herring stocks more generally, see pp. 206–209.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

This small-scale, multi-species fishery uses line and mesh nets to target primarily surface species. Targeted species are the dominant component of the catch and minimal quantities of discarded bycatch are generated, as virtually all species taken are marketed.

Protected species interaction: **Not assessed**

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Low**

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

SOCIAL EFFECTS

During 2005, the average number of crew fishing for finfish in the Cockburn Sound (Line and Pot) Managed Fishery and Cockburn Sound (Fish Net) Managed Fishery was approximately 10. Landings from these fisheries supply restaurant and retail sectors in the metropolitan area.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: **$149,600**

While relatively limited in overall value, the production from the commercial fishery provides an important input to the metropolitan fresh fish market.

In the past, the estimated annual value of this fishery was determined from the average price paid for these fish species statewide. The value provided here is determined from Perth market prices, and therefore provides a truer estimate of the value to the Cockburn Sound fishers. In most instances the average fish prices have increased as a reflection of the greater demand for many of these species at the metropolitan fresh fish market. In particular, the average price paid for Australian herring on the local domestic market is significantly higher than the average statewide price, which is greatly influenced by the large take in the herring trap net fishery that is predominantly sold at a lower price as rock lobster bait.

FISHERY GOVERNANCE

Target catch range: **30–112 tonnes**

The target catch range for this fishery 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 and by assuming that the fishing effort remains between 2000 and 2002 levels. The 2005 catch of 40.4 t was

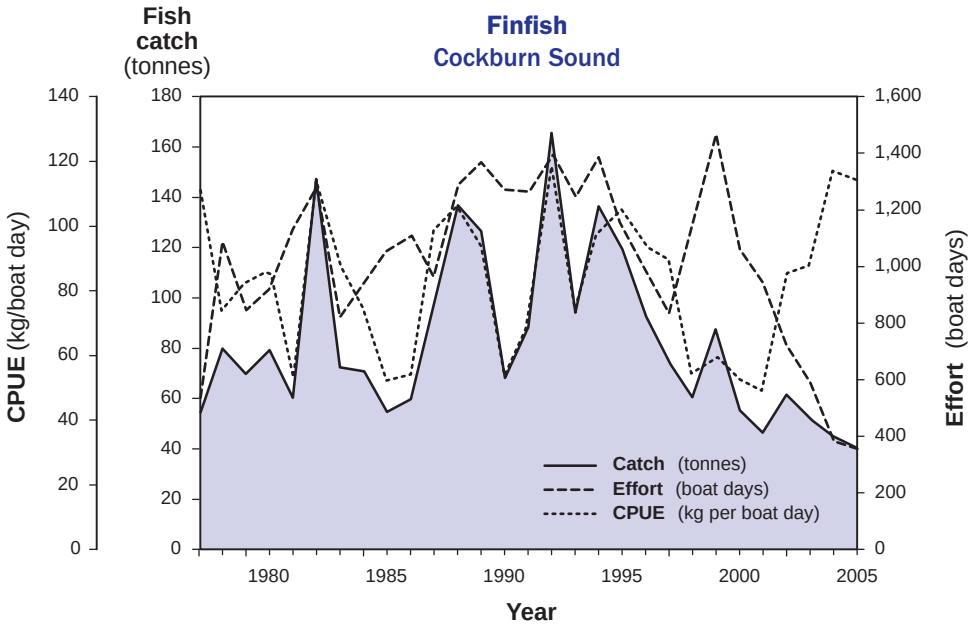
relatively low, but still within the target range. The relatively low effort levels in recent years are expected to continue and may necessitate a revision of the target catch range for the fishery in the future.

New management initiatives (2005/06)

The Department is planning a review of management arrangements for these fisheries in the future.

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 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.



COCKBURN SOUND FIGURE 1

The annual catch, effort and catch per unit effort (CPUE) for finfish (excluding bait fish) for the Cockburn Sound fisheries over the period 1977–2005.

COCKBURN SOUND TABLE 1

The catch, effort and the recreational catch as a percent of the total catch of key finfish recreational target species from surveys in Cockburn Sound during 2000–2001 and 2001–2002 (see the *State of the Fisheries Report 2003/4* for further explanation of this data).

	CREEL SURVEY (2001–2002) CATCH			*NATIONAL SURVEY (2000–2001) CATCH*		
SPECIES	*t*	*% shore*	*% boat*	*t*	*% shore*	*% boat*
A. herring	**31**	48	52	**62**	76	24
Whiting	**19**	21	79	**26**	20	80
Tailor	**5**	10	90	**17**	98	2
Pink snapper	**4**	0	100	**11**	0	100
Garfish	**4**	50	50	**18**	99	1
Skipjack	**3**	33	67	**27**	57	43
Silver bream	**2**	50	50	**nr***		
Dhufish	**nr***			**14**	0	100
	Effort			**Effort**		
Days fished – boat	85,000			66,700		
Days fished – shore	95,000			154,000		
	Recreational catch expressed as percentage of combined (recreational and commercial) catch					
All key species	56%			80%		

*nr - not reported

Note: These survey figures have been adjusted to fit the boundaries of the Cockburn Sound Managed Fisheries, which are slightly larger than the Cockburn Sound region as determined in these surveys.

West Coast Beach Bait Managed Fishery Status Report

T. Leary and D. Gaughan

FISHERY DESCRIPTION

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

Governing legislation/fishing authority

West Coast (Beach Bait Fish Net) Management Plan 1995
Subsidiary legislation under the *Fish Resources Management Act 1994*

Consultation process

Department–industry meetings

Boundaries

The West Coast Beach Bait Managed Fishery extends from the mouth of the Moore River, north of Perth, to Tim's Thicket in the south.

The south-west fishing activities occur from Tim's Thicket south to Point D'Entrecasteaux, with activity typically concentrated in Geographe Bay (Cape Naturaliste to Preston Beach).

Management arrangements

The West Coast Beach Bait Fishery is managed primarily through input controls (limited entry and gear restrictions). There are currently to 2 Class A licences and 1 Class B licence.

The future management arrangements for the south-west beach seine fishery have progressed through to the final stages of consultation. Currently, a discrete group of fishers are endorsed to operate in this area using similar methods to the managed beach bait fishers in the metropolitan and Mandurah areas. The Minister is due shortly to make a decision about the future management of this fishery.

Research summary

This fishery is not currently the subject of any active research program, although a significant research project on the biology and stock assessment of whitebait was completed in 1996. There is an ongoing research sampling program designed to predict recruitment of key inshore species, some of which contribute to this fishery. The annual catch of whitebait, obtained from the CAES system, is used as a de facto indicator of abundance to report on the performance of the fishery.

RETAINED SPECIES

Commercial production (season 2005):
All species 214 tonnes
Whitebait 158 tonnes

Landings

The main target species in this fishery is whitebait, of which 158 t were caught in the 2005 season (West Coast Beach Bait Figure 1). Catches of whitebait are discussed here according to the region in which they were landed. Metropolitan and Mandurah landings form part of the West Coast Beach Bait Managed Fishery, while Bunbury landings are from the 'south-west fishery'. Catches in each of the regions have varied significantly from the previous year; large interannual fluctuations in catch of whitebait are typical of this fishery (see 'Breeding stock levels').

Metropolitan: Slightly more than 1 t of whitebait was caught in the metropolitan region during 2005, continuing to reflect the low effort now applied in this area. There was no catch of whitebait for the metropolitan region during the previous year while the catch for 2003 was only 1.6 t.

Mandurah: The whitebait catch at Mandurah during 2005 was negligible, again reflecting the minimal effort. The catch for this region in 2004 was 3.4 t.

Bunbury: The Bunbury whitebait catch of 157 t is a reduction from last year's catch of 208 t, but matches the average of the previous five years' catches for this region.

The total catch of all other species in all regions in this fishery was 56 t, which was dominated by sea mullet and blue sprat (West Coast Beach Bait Table 1). The catch of sea mullet increased to 25 t from the 9 t landed in 2004. Catches of other species were similar to last year. Small quantities of pilchards (*Sardinops sagax*) and Australian herring (*Arripis georgianus*), sometimes caught in the beach seine fishery, are included in the catches reported for the West Coast Purse Seine Managed Fishery (pp. 52–55) and the Australian Herring Fishery (pp. 206–209) respectively.

Fishing effort/access level

Overall, for the two fisheries, 20 boats participated during 2005, with 18 reporting catches of whitebait. This is slightly less than the previous year's tally of 21 boats landing whitebait.

Catch rate

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

Recreational component: Nil

There is no recreational fishery for whitebait.

Recreational catches of some non-whitebait species (e.g. western sand whiting, trevally) landed by the West Coast Beach Bait Managed Fishery and south-west beach

seine fishery are currently being estimated. Catches by recreational fishers in the west coast bioregion are likely to be significantly larger than the commercial beach seine catches of these species.

STOCK ASSESSMENT

Assessment complete: **Yes**

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

The combined fishery catch of 158 t sits in the mid-range of the anticipated and acceptable catch.

Breeding stock levels: **Adequate**

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

NON-RETAINED SPECIES

Bycatch species impact: **Low**

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

Protected species interaction: **Negligible**

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

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The highly variable recruitment cycle of whitebait, apparently related to oceanographic effects, means that predatory birds and fish cannot rely solely on the availability of whitebait as a major food source in all years. Furthermore, the constraints of the beach seine gear and fishing method largely limit fishing to within 80 m of the shore in accessible areas. Stocks of whitebait are however more widely distributed, suggesting that natural predators have greater access to the fish than does the fishery. If catches in the metropolitan and Mandurah sectors of the fishery (currently the 'managed' component of the fishery) were to increase there might be some localised resource conflict between some birds and fishers. However, under current licensing arrangements and effort levels this is not deemed a problem.

Habitat effects: **Negligible**

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

SOCIAL EFFECTS

In 2005 a total of 20 boats involving 44 crew participated in the beach bait fishery.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: **$506,400**

The majority of whitebait landed were smaller fish destined for the human consumption market, typically selling for $3.20/kg. A small amount of larger sized fish, from the managed fishery, was utilised for recreational bait.

FISHERY GOVERNANCE

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

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

New management initiatives (2005/06)

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

EXTERNAL FACTORS

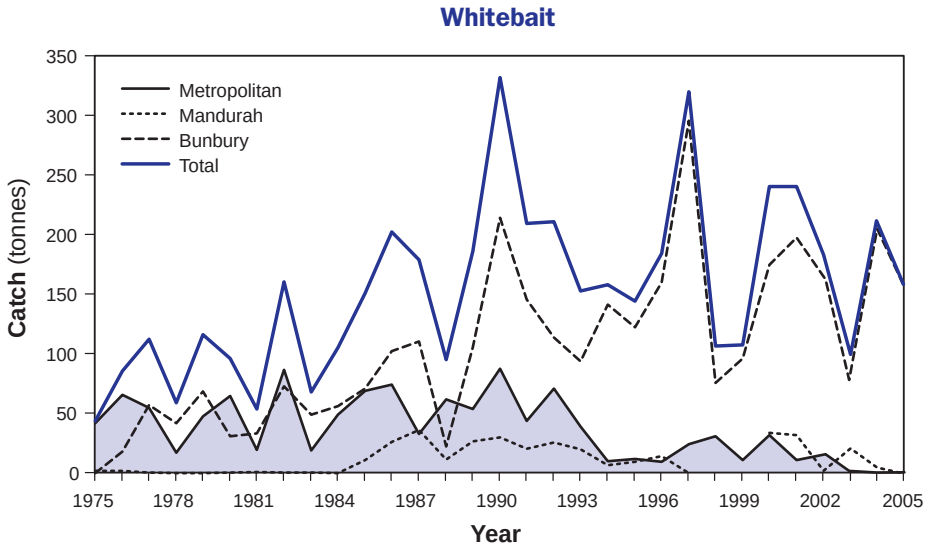
Annual catches in this fishery will most likely continue to exhibit large fluctuations under the influence of environmental factors. The fishery will therefore continue to be regulated through limited entry access and gear restrictions.

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

WEST COAST BEACH BAIT TABLE 1

Catches in 2005 of retained species other than whitebait from the West Coast Beach Bait Managed Fishery and south-west beach seining sector.

SPECIES		CATCH (tonnes)
Sea mullet	*Mugil cephalus*	25
Blue sprat	*Spratelloides robustus*	18
Western sand whiting,	*Sillago schombergkii*	6
Sea garfish	*Hyporamphus melanochir*	3
Trevally	Carangidae	2
Yellow-eye mullet	*Aldrichetta forsteri*	1
Other fish varieties		1
Total		**56**



WEST COAST BEACH BAIT FIGURE 1

Total annual catch of whitebait for each sector from 1975 to 2005.

West Coast Purse Seine Managed Fishery Status Report

T. Leary and D. Gaughan

Management input from R. Gregor

FISHERY DESCRIPTION

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

Governing legislation/fishing authority

West Coast Purse Seine Management Plan 1989
West Coast Purse Seine Managed Fishery Licence
Fisheries Notice no. 312 – Purse Seine Prohibition
Fisheries Notice no. 571 – Pilchard Fishing Prohibition
Fisheries Notice no. 476 – Net Hauling Restrictions
Condition 176 on a Fishing Boat Licence
Condition 93 on a Fishing Boat Licence (specific area)
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Purse Seine Management Advisory Committee
Department–industry meetings

Boundaries

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

Management arrangements

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

Currently a combined total allowable catch (TAC), covering both the 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 tradeable, as individually transferable quota units would be. For the 2005/06 licensing period there was a TAC of 1,500 t for pilchards with another 1,500 t TAC allowed for the other small pelagic species permitted to be taken by licensees. The Northern Development Zone has a separate TAC.

Research summary

Catches landed at Fremantle are regularly monitored, with the emphasis on pilchards. An FRDC-funded project examining the recovery of pilchard stocks following the 1998/99 mass mortality across southern Australia continues, and in July 2004 included a spawning biomass estimate, using the daily egg production method, for the west coast pilchard stock. Some catch sampling is also carried out on sardinella, an important component of the Fremantle fishery. Monitoring of catches provides age-composition data, from which relative recruitment strengths can be inferred. Biomass surveys, age-composition data and analysis of catches together allow periodic review of pilchard stocks and compilation of the following annual status report. Catches of sardinella from the Northern Development Zone are routinely sampled on a yearly basis and log book data is collated.

RETAINED SPECIES

Commercial production (2005): 379 tonnes

Landings

The combined catch of pilchards, sardinella and other minor species for the metropolitan and Southern Development Zone fishery areas saw a further significant decline to 379 t, down from 763 t in 2004 and 1,164 t in 2003. Pilchards and sardinella made similar contributions to the total catch (44% and 40% respectively), with the balance comprising 57 t of mainly maray.

Fishing effort/access level

Fishing effort for the Fremantle fleet comprised 370 days, a decline of around 10% from the previous year's 419 days (see 'External Factors' below). It is not possible to estimate effort separately for the different species targeted.

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

Catch rate

The catch rate of 867 kg/day for the Fremantle zone is much less than the previous year's 1,821 kg/day; however, this reflection of lower overall catches is not necessarily a good indicator of relative abundance of fish. Processor requirements and additional time required for a smaller fleet to find fish are factors in the observed decline.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

Stock assessment is completed only for pilchards. The fishery-independent spawning biomass surveys conducted in 2002 and 2004 indicate that the pilchard stock has recovered strongly after the 1998/99 mass mortality event. The estimated spawning biomass in 2004 was ~20,000 t, which is similar to historical levels prior to the 1998/99 mass mortality. The average age of pilchards obtained from Fremantle catches in 2005 was slightly more than 3 years. Strong recruitment of 2-year-olds was again apparent. The small catches of sardinella, in the context of this species' predominantly tropical distribution, are not expected to constitute a threat to the overall spawning stock for this species. Furthermore, catch monitoring in the Fremantle region has yet to show regular or extensive spawning by sardinella.

Breeding stock levels: Adequate

As only sexually mature fish are taken by this fishery, for which both catch monitoring and occasional biomass surveys are conducted, the above stock assessment relates directly to breeding stock levels.

NON-RETAINED SPECIES

Bycatch species impact: Low

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

Protected species interaction: Low

Pilchards and other small pelagic fish are consumed by several species of seabirds, pinnipeds, cetaceans and protected sharks (white shark), but there is currently no evidence to indicate any major interactions between these and the purse seine industry in the west coast region.

ECOSYSTEM EFFECTS

Food chain effects: **Moderate**

Ecosystem structure and function is reliant on flows of energy within an interconnected 'web'. Small pelagic fish occupy a pivotal role as a conduit between primary (phytoplankton) and secondary (zooplankton) production and the higher trophic levels. The characteristics of small pelagics mean they are available as food for a number of populations of larger animals including predatory fish, pinnipeds, cetaceans and bird species. Catches of small pelagics on the west coast are carefully constrained so as to leave a large majority of the estimated biomass available to predators. The quota for pilchards and other small pelagic species is set at a maximum of 10% of the spawning biomass, leaving more than 90% of the total biomass available to natural predators.

Habitat effects: **Negligible**

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

SOCIAL EFFECTS

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

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: **$358,000**

Most small pelagic fish caught on the west coast were destined for human consumption ('Fremantle sardines') this year, with lesser amounts directed to recreational bait, tuna feed, commercial rock lobster and finfish trap bait. The price paid to the boats in 2005 amounted to an average price per kilogram of $1.10 for pilchards, $0.90 for sardinella and $0.70 for maray. The margin on recreational bait and thus willingness to supply has been adversely affected by the number of South Australian operators now entering the recreational bait market.

FISHERY GOVERNANCE

Target effort range: **Not available**

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

New management initiatives (2005/06)

A new management plan is being developed for this fishery. The new plan will include the Southern and Northern Development Zones. These two areas, along with the metropolitan fishery, will thus be managed as zones within a single West Coast Purse Seine Fishery, with all operators fishing under a managed fishery licence rather than under an endorsement on their fishing boat licence.

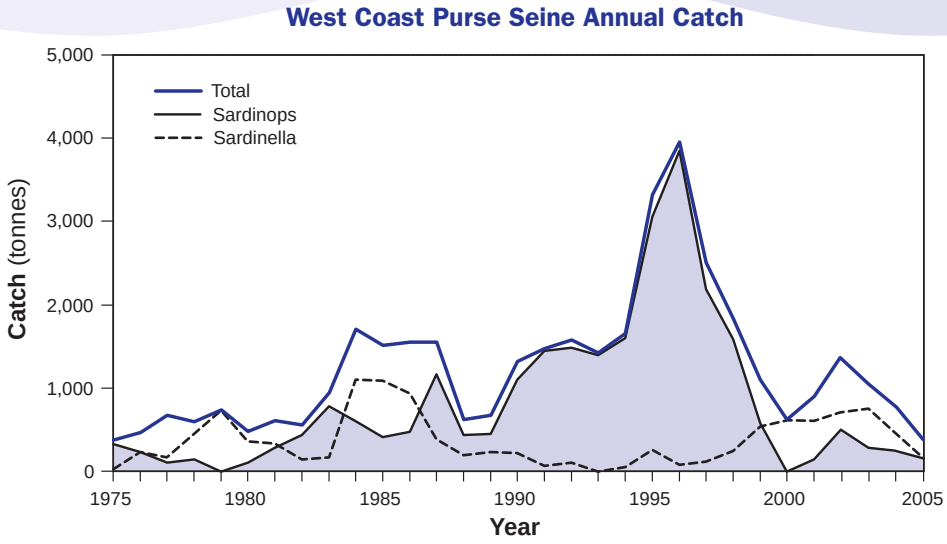
The implementation of a new management plan will change the fishery to a formal quota system with tradeable, individually transferable quota units and a TAC. The ITQ unit values will be reviewed annually and changed, as required, depending on stock levels.

In November 2005, the Australian Government Department of Environment and Heritage declared the West Coast Purse Seine Fishery a Wildlife Trade Operation under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a number of conditions, this certification allows product from the fishery to be exported from Australia for a period of three years before reassessment.

EXTERNAL FACTORS

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

The reduced effort applied in the fishery in recent years appears to have led to a loss of knowledge regarding behaviour of small pelagic fish. Thus, at those times when the fish are difficult to find, fishers have experienced difficulty in locating schools in 'new' locations. It remains uncertain whether there have been changes in either schooling behaviour of the key small pelagic species or their spatial dynamics following both the mass mortality event of 1998/99 and the major El Niño event that occurred shortly thereafter. It appears that the influence of oceanographic variation plays a role in determining the relative catchability of the pilchards and sardinella.



WEST COAST PURSE SEINE FIGURE 1

Annual catches of pilchards (*Sardinops*) and sardinella in the West Coast Purse Seine Fishery.

West Coast Demersal Scalefish Fishery Status Report

J. St John and J. King

Management input from K. Saville

FISHERY DESCRIPTION

The 'west coast demersal scalefish fishery' currently equates to the region's commercial wetline fishery, which has access to species or fishing methods not yet subject to a management plan. The wetline fleet comprises both 'wetline only' vessels and the 'wetline' activities of vessels with other managed fishery licences. Currently the wetline fishery is limited only by the overall ceiling on fishing boat licences. Handlines and droplines are the main fishing methods in this fishery.

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

Governing legislation/fishing authority

Fish Resources Management Regulations 1995
Fishing Boat Licence

Consultation process

Not applicable.

Boundaries

The west coast bioregion encompasses the waters of the Indian Ocean south of latitude 27° S and west of longitude 115°30´ E. However, as there is a proposal to extend the northern boundary of this fishery to latitude 26°30´ S when it is brought under formal management, the catches reported here include the catch of wetline boats in this half-block (27° S to 26°30´ S).

The fishery is reported in four zones: Kalbarri (26°30´ S to 28° S), mid-west (28° S to 31° S), metropolitan (31° S to 33° S) and south-west (33° S to 115°30´ E).

Management arrangements

Line fishing for west coast demersal scalefish is not yet subject to a formal management plan. The Wetline Review began in 2003 with the establishment of the Management Planning Panel (MPP) and the Commercial Access Panel (CAP). The MPP was appointed to develop specific management arrangements for these stocks in the west coast and Gascoyne bioregions. The CAP was appointed to devise a fair and equitable method of determining who will have ongoing access to the state's wetline stocks and their level of allocation. Both panels delivered their final recommendations to the Minister in December 2005. Following an additional round of public consultation in early 2006, the Minister is currently deliberating on the future management

arrangements for the fisheries. It is anticipated that new management arrangements will be implemented in 2007/08.

Currently, this fishery is managed primarily through size limits, some gear limits and closed seasons for some species (e.g. baldchin groper spawning closure at the Houtman Abrolhos Islands).

Research summary

Current research is examining aspects of the biology and harvest rates of the key fish species, and clarifying the catch levels of the different fishery sectors to provide more information for stock assessments and management. FRDC-funded studies of the regional variation in dhufish and snapper populations and the post-release mortality of demersal fish species are due for completion in 2006. A third FRDC-funded project studying spawning aggregations of samson fish and other west coast species will run until June 2007. A 12-month recreational creel survey and a telephone diary survey of boat fishing in the west coast bioregion will be completed in 2006, providing important information for use in the Integrated Fisheries Management arrangements for the demersal finfish stocks.

The two primary target species, dhufish and pink snapper, are used as the main indicator species for the fishery. The less abundant baldchin groper and breaksea cod (*Epinephelides armatus*) have been selected as additional indicator species for the IFM process, as they represent popular recreational species in the northern and southern sectors (respectively) of the west coast. Preliminary assessments of the latter two species will continue to be refined as the commercial data set is improved and additional biological information becomes available. In the interim, the fishery will continue to be monitored annually using CAES data.

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

RETAINED SPECIES

Commercial production (season 2004/05): 1,220 tonnes

Landings

In 2004/05 the total catch was 1,220 t, which is a decrease of 68 t from the previous year. The top 10 species landed during 2004/05 (West Coast Demersal Scalefish Table 1) included eight demersal finfish species/groups, one non-demersal finfish species and one shark species group that together comprised 84% of the total catch of all species. The remaining 16% of the catch included more than 72 other scalefish species and 18 species of sharks and rays, plus various squid and cuttlefish.

The three major targeted demersal species/groups (including the two main indicator species) comprised 60% of the total catch of all species caught by handline and dropline in the fishery. The landings of pink snapper were highest at 333 t. The second highest catch of 199 t comprised the two lethrinid species, *Lethrinus nebulosus* and *Lethrinus miniatus* (variously reported as spangled emperor, sweetlip emperor, large nor-west snapper and nor-west snapper) that were caught by 87 boats from the northern area. Dhufish ranked third with 196 t. Catches of the other two indicator species were 36 t of baldchin groper and 7 t of breaksea cod (West Coast Demersal Scalefish Table 1). This season, 43 boats caught 5 t of coral trout near the Houtman Abrolhos Islands.

Some of the species targeted by this wetline fishery are also caught in other fisheries. The West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery (WCDGDLF) landed 129 t of scalefish in 2004/05, and the Cockburn Sound finfish fishery lands small quantities of large mature pink snapper. The recreational charter boat sector, which also targets the demersal fish species in the west coast bioregion, is reported in detail on pp. 75–76.

The catches of three of the four demersal species used as indicator species for the fishery are examined in more detail below.

Dhufish: Although the reported dhufish catch in 2004/05 at 196 t (West Coast Demersal Scalefish Table 1) has declined 16% over the last two years from the 16-year peak catch taken in 2002/03, it remains above the 10-year average of 185 t. Within the bioregion, approximately half of the annual commercial catch of dhufish comes from the mid-west (West Coast Demersal Scalefish Figure 1). Of the remaining total catch, 20% comes from each of the south-west and metropolitan zones, while Kalbarri produces only 10% of the total catch. Catches in all four zones have shown a general upward trend over the last decade, with the pattern of annual catches varying most in the mid-west, and metropolitan catches following a similar pattern but at a lower level. Most of the reduction in catch in 2004/05 occurred in Kalbarri and the south-west (West Coast Demersal Scalefish Figure 1). Other commercial catches of dhufish include 17 t caught in the southern 'shark' fishery (WCDGDLF) during 2004/05, which is down 13% on last year.

Pink snapper: The total catch of pink snapper declined by 7 t from the previous year to 333 t in 2004/05. This catch, however, remained above the 10-year average of 254 t and still exceeds the previous peak in catch of 331 t in 1995/96 (West Coast Demersal Scalefish Figure 2). Within the west coast bioregion the majority of snapper are caught in the two most northerly zones. Catches in these zones follow a similar annual pattern but for the past 13 years the Kalbarri zone has had higher catches than the mid-west zone (West Coast Demersal Scalefish Figure 2). For the first time in four years catches in the Kalbarri zone have decreased, dropping from 186 t in 2003/04 to 162 t in 2004/05. Catches in the mid-west, however, have risen 5 t since last year to 106 t in 2004/05 and catches in the metropolitan and south-west zones continued to increase in 2004/05 to 38 t and 26 t respectively (West Coast Demersal Scalefish Figure 2). Other commercial catches of

snapper include 18 t caught in the southern shark fishery (WCDGDLF) during 2004/05, an increase of 5 t on last year.

Baldchin groper: The catch of baldchin groper in 2004/05 was 36 t, down by 2 t from last year but still above the 10-year average of 33.6 t (West Coast Demersal Scalefish Figure 3).

Fishing effort/access level

Annual fishing effort by the demersal wetline sector is estimated from the monthly CAES returns. These effort records are not broken down into time spent targeting or fishing for different species. Thus, effort days for each species can overlap due to the method of recording. If a species is captured during the month by a particular vessel, then effort days for the species are the maximum number of days on which the vessel utilised its wetline entitlement in that month. Effort days provide an indicator to allow a year-to-year comparison of wetline activity.

During 2004/05, 239 licensed fishing boats in the west coast bioregion line-fished for demersal finfish and 53 of these boats were 'wetline only'. Collectively, these vessels reported wetlining activities on a total of 11,561 days during 2004/05. Overall 220 boats reported catching dhufish, 219 boats caught pink snapper and 153 boats caught baldchin groper. The effort days relating to each of the key indicator species for 2004/05 are as follows.

Dhufish: The effort was 9,238 fishing days, a reduction of 7% since 2003/04. This level is high compared to the previous decade.

Pink snapper: The effort was 10,243 fishing days, which was very similar to 2003/04. This level has doubled in the last decade.

Baldchin groper: The effort was 5,319 fishing days, showing a slight decrease over 2003/04 when 5,755 days were recorded. In the last decade, however, the effort indicator for baldchin groper has doubled. The introduction of a specific closed area that restricts access to baldchin groper for three months of the year during their spawning season has only reduced the nominal effort on this species by 7% since its introduction two years ago.

Catch rate

Catch rates for the indicator species are calculated using the subsets of the fleet that target these species, to reflect the different temporal and spatial targeting practices among fishers and the frequent changes in boat ownership. Annual catch rates are, therefore, calculated using the top 10 boats by species, for each year in each zone. Average catch rates, and standard errors depicting variability of catch rates among the 10 boats, were calculated for dhufish and snapper in all four zones (Kalbarri, mid-west, metropolitan and south-west) and for baldchin groper in the bioregion as a whole (West Coast Demersal Scalefish Figures 3, 4 and 5). The nominal effort of each boat used to calculate CPUE was further adjusted upwards by 5% in 1992/93, 10% in 1993/94 and by 15% since 1994/95, to account for increases in fishing efficiency due to technological improvements such as colour sounders and GPS.

Dhufish: The catch and catch rate data for dhufish indicate that efficiency-adjusted CPUE in all zones except Kalbarri (West Coast Demersal Scalefish Figure 4) has been relatively stable over the past 16 years, fluctuating around 40 kg/fishing day. The only exception was a high catch rate of 66 kg/day in the metropolitan zone during 1997/98 (West Coast Demersal Scalefish Figure 4b). This appears to have been largely due to a relatively high abundance of dhufish that year, since high catch rates occurred in both the demersal gillnet fishery and the line fishery off Fremantle. In 2004/05 the catch rates of the metropolitan zone (51.2 kg/day) and the mid-west zone (48.7 kg/day) have risen, whereas catch rates in the south-west and Kalbarri have declined in the last three and four years respectively, following the catch trends (West Coast Demersal Scalefish Figure 4a and b). The 16-year average of dhufish catch rates in the Kalbarri zone is approximately half that of the other three zones (West Coast Demersal Scalefish Figure 4), reflecting the lower abundance of this temperate species at the northernmost limit of its distribution.

Pink snapper: Most of the pink snapper caught in this fishery come from the northern zones, with boats in the Kalbarri and mid-west zones dominating the annual trends in the total catch of snapper for the bioregion (West Coast Demersal Scalefish Figure 2). Although the catch rates of the Kalbarri zone are on average 55% higher than in the mid-west zone, catch rates of the two northern zones followed a similar pattern up to 1998/99 (West Coast Demersal Scalefish Figure 5). In 1999/2000 catch rates of the mid-west zone fell and remained relatively lower, averaging 37% of the Kalbarri zone despite the general increase in catch rates in both zones up to 2004/05. In contrast, the catch rates of snapper in the two southern zones are relatively low and stable. Since 1999/2000 average catch rates in the south-west have been similar to metropolitan catch rates at 23 kg/day. The variability of catch rates among the boats is highest in the Kalbarri zone and has increased over the last decade.

Except for the mid-west zone, catch rates have remained steady over the past two seasons, suggesting that recent high catches are related more to increased total fishing effort than fish abundance.

Baldchin groper: Catch rates of baldchin groper have remained relatively stable. Despite a slight downward trend over the past decade, the lowest catch rate in recent years (2001/02) is similar to the lowest catch rate a decade earlier in 1992/93 (West Coast Demersal Scalefish Figure 3).

Recreational component: > 30% (to be revised)

Recreational surveys of boat-based fishing will finish in June 2006 and results will be compared to the previous survey conducted in 1996/97 (see *State of the Fisheries Report 2000/01* for more details).

STOCK ASSESSMENT

Assessment complete: Preliminary

Dhufish: Research by Hesp et al. (2002) reported the overall age structure of the dhufish population, together with

preliminary estimates for natural mortality (M) of 0.1 and for fishing mortality (F) of at least 0.11. Given that F should be much less than M for long-lived fish such as dhufish, these estimates provide an indication that the dhufish stock may not be able to sustain current levels of catch. A current study on the age structure of populations of dhufish across three of the four zones (Kalbarri was not examined) suggests that the west coast population is dominated by year-classes from four years of high recruitment between 1994 and 1997. In the past decade the maximum age of dhufish has dropped 10 years, from 41 to 31 years old, and the proportion of older dhufish has decreased from 25% to 9% of the fished population (i.e. > 4 years old). These age data will be used in sophisticated age-based stock assessments to determine the status of the stocks more fully and this formal stock assessment will be available next year.

The overall trend of increasing commercial catch of dhufish and the maintenance of high catch rates demonstrates how strong year-classes can mask reductions in other age-classes in the population. Thus catch rates may only act as an index of abundance after large changes in population biomass have occurred.

Pink snapper: The age structure of pink snapper populations on the west coast has been determined for each of the four zones within the bioregion. As the age structure of snapper collected in Kalbarri during 2005 does not differ from the age structure of snapper in the Shark Bay Managed Fishery, the snapper population in the northern zone of the west coast bioregion and oceanic Shark Bay snapper are most likely to be the same stock.

Within the west coast bioregion the age structure of pink snapper varied within and among zones. Within the metropolitan zone the age structure of the population varied between offshore waters and Cockburn Sound due to the formation of large spawning aggregations within the Sound in summer (C. Wakefield unpub. data). In Cockburn Sound most (54%) of the snapper were 7 to 12 years old compared to only 5% of the population offshore (C. Wakefield unpub. data). Within the offshore areas of the bioregion, the proportion of snapper aged between 3 and 6 years inclusive differed between the two southern zones and the combined northern zones (73% south-west, 73% metropolitan (offshore) and 91% mid-west and Kalbarri combined).

The formal stock assessments will be available next year. Unlike dhufish, there is no previous age data to compare with the current data and therefore it is not yet possible to make comment about changes in the status of the stocks of pink snapper on the west coast.

As continuing high catches of pink snapper in the two northern zones may not necessarily reflect a greater abundance in stocks, these high catches may not be sustainable. Exacerbating concerns about the sustainability of snapper in the northern zones is the decline of the Shark Bay Managed Snapper Fishery, as the smaller spawning biomass off Shark Bay weakens its capacity to be a potential source of recruitment for snapper off Kalbarri.

Baldchin groper: In the absence of representative age structures for baldchin groper populations, the stock assessment is restricted to the use of catch rates to provide a relative measure of abundance. This relationship is affected by the increase in fishing efficiency of this fleet due to the technological improvements since the 1990s. Thus, standardised catch rates that are adjusted for fishing efficiency are used to assess trends in the catch and effort data of baldchin groper.

Catch and catch rates of baldchin groper are the least variable of the species examined in the west coast demersal scalefish fishery. Catch rates have dropped from the nine-year average of 15.1 kg/day (1991/92–1999/2000) to an average of 12.6 kg/day over the last five years (West Coast Demersal Scalefish Figure 3). This fall in catch rates coincides with the highest levels of effort recorded in 16 years. Although catches and effort remain high, the peak catch and effort in 2002/03 appears to have been reduced slightly by new management introduced in 2003. In that year, a specific closed area was implemented restricting access to this species during their summer spawning period (1 November to 31 January) within the Fish Habitat Protection Areas at the Houtman Abrolhos Islands. This reduction in effort will need to be taken into account in future assessments, and more detailed assessments of baldchin groper are required to ensure that over-exploitation does not occur.

Breeding stock levels: Not assessed

Comparisons of the age structures of dhufish populations show that the proportion of larger females in the population has fallen over the last decade. Larger females have higher fecundity (produce more eggs) because they have larger gonads (relative size of gonad compared to body weight is higher) and they spawn more frequently throughout the spawning season. Also, age structures of dhufish populations show that years of good recruitment can occur throughout the bioregion and appear to correlate with certain environmental conditions. This pattern needs to be investigated further to understand all the factors affecting replenishment of dhufish populations.

Although snapper are considered to spawn in small aggregations throughout the entire west coast bioregion, by far the largest spawning biomass identified in the bioregion is found in Cockburn Sound. Therefore, the importance of Cockburn Sound as a spawning and nursery ground for pink snapper on the lower west coast is paramount. Despite protection of the Cockburn Sound snapper from fishing by a partial spawning-season closure, the largest threat to this snapper spawning ground is environmental degradation in the area.

Efficiency-adjusted catch rates for baldchin groper indicate that spawning biomass may be in slight decline, however a species closure during the spawning season of this species at the Houtman Abrolhos Islands is assisting in dealing with this concern until formal management is in place.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

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

Protected species interaction: **Negligible**

Owing to the high selectivity of the fishing gear, commercial line fishing does not interact with protected species.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

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

SOCIAL EFFECTS

Employment in this fishery is difficult to assess because 78% (186) of the boats in the wetline fleet are associated with other licensed fisheries. Only 53 boats in the wetline fleet hold no other licences and thus are 'wetline only'. On average, the total fleet fished 48.4 days each, employing on average 2 crew to take demersal and other finfish during 2004/05.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2004/05: $7.8 million

The estimated value of the fishery in 2004/05 includes all species caught by handlines and droplines on the west coast of Western Australia. Nearly 100 species or taxa of seafood were recorded as catch and sold for an estimated $7.8 million. The highest-valued catch was dhufish at 34% of the total value, followed by pink snapper (23%), the lethrinids (14%), Bight redfish (*Centroberyx* sp.) (6%) and baldchin groper (5%), while grey-banded cod (4%) and hapuku (*Polyprion oxygeneios*) (2%) were the only other finfish species with a catch valued at more than $100,000. Prices used to calculate the value of the fishery in 2004/05 were dhufish $13.50/kg, pink snapper $5.24/kg and baldchin groper $10/kg. At $12.50/kg, coral trout commanded the second highest average price of all species in the fishery.

FISHERY GOVERNANCE

Target catch range: **558–798 tonnes**

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

For the fourth consecutive year, the catch of the entire fishery at 1,220 t is well above the proposed target range, reflecting the increasing mobilisation of the latent effort in the wetline fishery in the west coast bioregion. The target range was exceeded by 12% in 2000/01, 37% in 2001/02, 46% in 2002/03, 57% in 2003/04 and 53% in 2004/05. For the third consecutive year all three indicator species (dhufish at 196 t, pink snapper at 333 t and baldchin groper at 36 t) exceeded their target catch ranges.

New management initiatives (2005/06)

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

When management of the demersal wetline sector is introduced, the current target catch ranges will need to be reviewed and set to match long-term sustainable harvest levels and the commercial catch share agreed in the IFM process. This review will incorporate stock assessment information and the increased level of biological information on dhufish and other target species from the research program currently underway. In the interim, previous research has already indicated that the current catch is too high, suggesting that action to stabilise or reduce catches should be considered.

EXTERNAL FACTORS

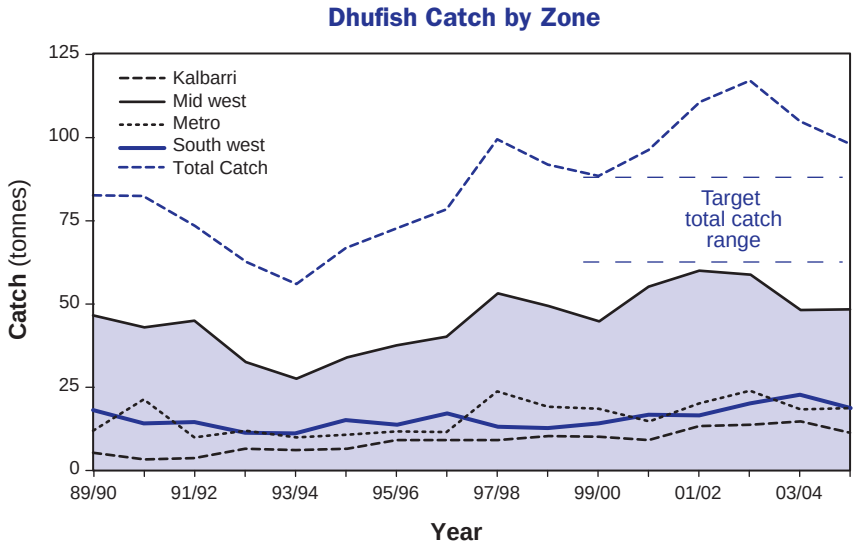
The productivity of the west coast demersal scalefish fishery relies on the maintenance of both the snapper and dhufish populations, which is most likely dependent on large and sporadic recruitment events. The relationship of such recruitment events to environmental factors is presently unknown, but is suspected to be strongly affected by changes in the strength and timing of the Leeuwin Current and the Capes Current. These relationships are currently being explored in more detail.

WEST COAST DEMERSAL SCALEFISH TABLE 1

Ranked catch (in tonnes) of the top species of finfish (grouped as demersal or other) and sharks taken in the fishery in 2004/2005. Major target or indicator species for the fishery are in **bold type**.

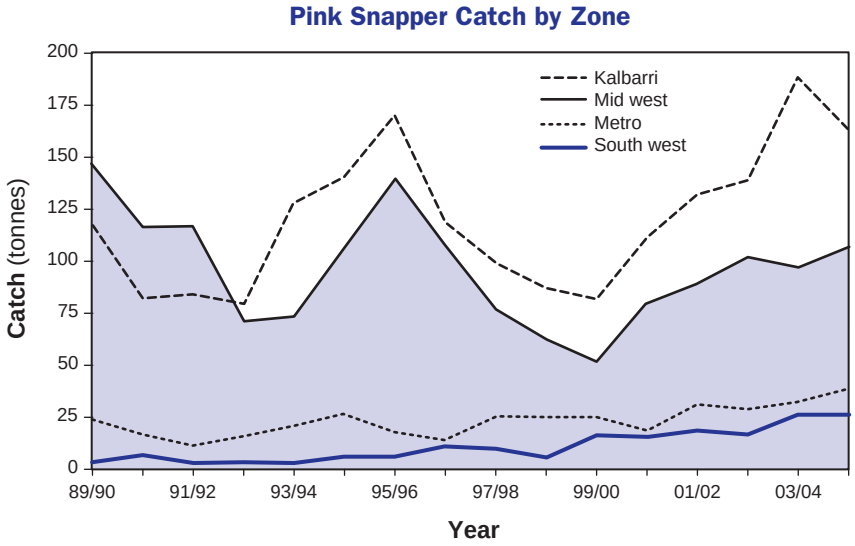
RANK	DEMERSAL FINFISH	NON-DEMERSAL FINFISH	SHARKS	SCIENTIFIC NAMES	LANDINGS (tonnes)
1	**Pink snapper**			*Pagrus auratus*	333
2	**Lethrinid species**			*Lethrinus nebulosus, L. miniatus*	199
3	**Dhufish**			*Glaucosoma hebraicum*	196
4	Redfish[1]			*Centroberyx* spp.	83
5		Samson fish		*Seriola hippos*	50
6			Wobbegong	Orectolobidae	42
7	Grey-banded cod			*Epinephelus octofasciatus*	41
8	**Baldchin groper**			*Choerodon rubescens*	36
9	Sweetlip			Haemulidae	24
10	Hapuku			*Polyprion oxygeneios*	22
11			Copper whaler	*Carcharhinus brachyurus*	20
12			Dusky whaler[2]	*Carcharhinus obscurus*	19
13	Deepsea trevella			*Hyperoglyphe antartica*	13
14			Other shark		10
15	**Breaksea cod**			*Epinephelides armatus*	7

1. Expected to be Bight redfish or Centroberyx gerrardi, a deep-water species.
2. Dusky whalers are often misreported as bronze whalers in the catch statistics.



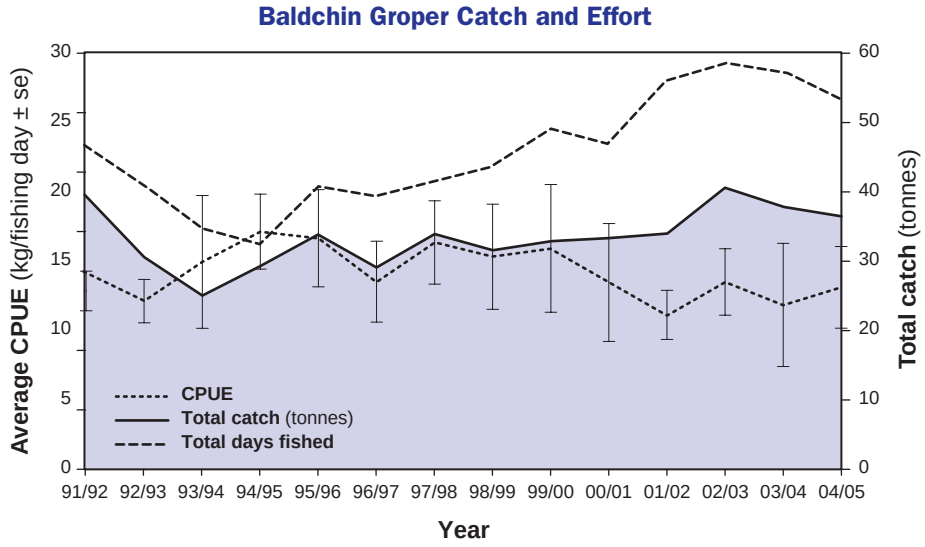
WEST COAST DEMERSAL SCALEFISH FIGURE 1

Annual catch of dhufish in the four zones and total annual catch of dhufish in the west coast demersal scalefish fishery from 1989/90 to 2004/05.



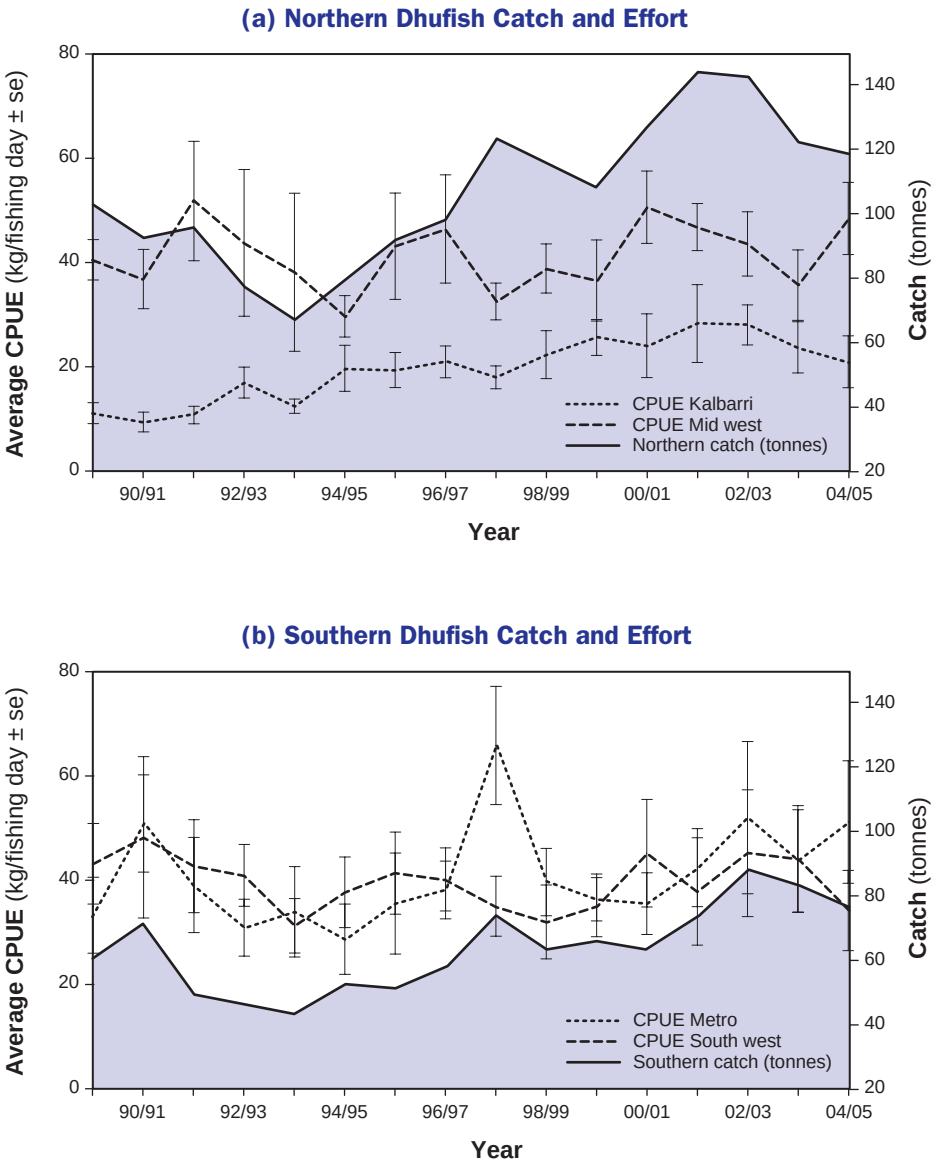
WEST COAST DEMERSAL SCALEFISH FIGURE 2

Annual catch of pink snapper in the four zones of the west coast demersal scalefish fishery from 1989/90 to 2004/05.



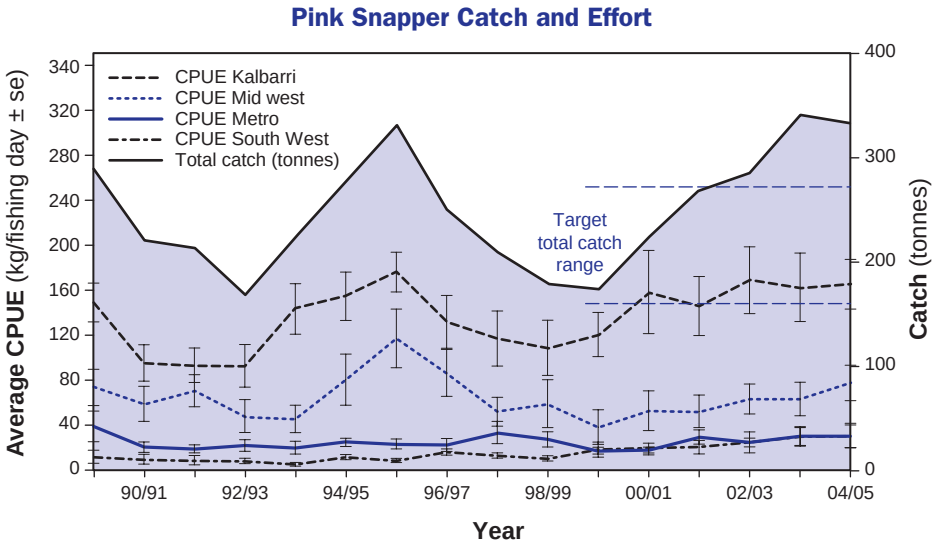
WEST COAST DEMERSAL SCALEFISH FIGURE 3

Total annual catch of baldchin groper in the west coast demersal scalefish fishery from 1989/90 to 2004/05. Catch per unit effort (CPUE, kg/adjusted fishing day) is shown for baldchin groper caught by the top 10 boats each year off Geraldton (± standard error).



WEST COAST DEMERSAL SCALEFISH FIGURE 4

Total annual catch of dhufish in the northern (Figure 4a) and southern (Figure 4b) regions of the west coast demersal scalefish fishery from 1989/90 to 2004/05, with catch per unit effort (CPUE, kg/adjusted fishing day) shown for the top 10 fishers in each of the four zones (± standard error).



WEST COAST DEMERSAL SCALEFISH FIGURE 5

Total annual catch of pink snapper in the west coast demersal scalefish fishery from 1989/90 to 2004/05, with catch per unit effort (CPUE, kg/adjusted fishing day) shown for the top 10 fishers in each of the four zones (± standard error).

Wetline Fishing

The CAES database indicates that well over half (69%) of the wetline catch in 2004/05 was reported from the west coast bioregion, which includes the waters of the populous lower west coast and the Abrolhos Islands. Because wetline fishing by commercial vessels in this bioregion is moving towards managed fishery status, there is considerable overlap between this wetline report and the demersal scalefish report above. Nevertheless, full wetline statistics are given here for completeness and for comparison with the other marine bioregions.

The top 10 species comprised pink snapper (*Pagrus auratus*) 321 t, whitebait (*Hyperlophus vittatus*) 214 t, West Australian dhufish (*Glaucosoma hebraicum*) 195 t, sweetlip emperor (*Lethrinus miniatus*) 143 t, redfish (*Centroberyx sp.**) 84 t, Australian herring (*Arripis geogianus*) 50 t, samson fish (*Seriola hippos*) 50 t, wobbegong (*Orectolobus spp.*) 42 t, sea mullet (*Mugil cephalus*) 42 t and grey-banded cod (*Epinephelus octofasciatus*) 41 t, with baldchin groper (*Choreodon rubesens*) 38 t and nor-west snapper (Lethrinidae) 36 t the next most abundant species. It is worth noting the continued prominence of wobbegong shark and redfish, and the elevation of deeper-water species such as grey-banded cod into the 'top 10' wetline species.

These catches of dhufish, pink snapper and emperor are the main product of the demersal scalefish operations reported above, noting that catches of emperors are mostly from the Abrolhos Islands. Whitebait, Australian herring and sea mullet comprise most of the catch of the beach bait fishers who operate between Tim's Thicket and Augusta (see pp. 50–52).

*Expected to be Bight redfish (*C. gerrardi*).

RECREATIONAL FISHERIES

Regional Research Overview

The west coast bioregion continues to be the state's most significant recreational fishing area. During 2005/06, 66% of recreational fishers reported fishing in this region (Baharthah 2006).

Scientific information to underpin recreational fisheries management in this bioregion is provided by dedicated research projects on specifically licensed high-value species (rock lobster and abalone), and research based on commercial fisheries in the finfish sector.

In addition, the estuarine and beach species have been the focus of a number of extensive studies, some undertaken by Department of Fisheries researchers and others in collaboration with postgraduate students, mainly of Murdoch University. These studies have provided biological data on herring, whiting (including King George whiting), blue swimmer crabs, prawns, tailor, cobbler, black bream and other minor species. For west coast offshore boat angling species – whiting (other than King George whiting), wrasse and groper (various species), Western Australian dhufish and snapper – some biological data are also available from previous Department of Fisheries studies based on the commercial fisheries, and from collaborative postgraduate research projects.

Estimates of abundance for most of these recreational species are also provided by statistical information from commercial fishing recorded in the long-run CAES database. To estimate total recreational catch and recreational/commercial catch shares in order to assess the overall status of these stocks, recreational creel survey data are required. Historically, there have been two surveys, one targeting herring in the 1970s and another which assessed beach angling for the lower west coast (Perth to Cape Leeuwin) (Ayvazian et al. 1997).

The most recent survey of recreational boat-based fishing from Augusta to Kalbarri was completed in 1997 (Sumner and Williamson 1999). The main marine species caught by boat-based fishers were (in order of number caught) whiting species (Sillaginidae) other than King George whiting 564,000, Australian herring (*Arripis georgianus*) 425,000, blue swimmer crabs (*Portunus pelagicus*) 255,000, skipjack trevally (*Pseudocaranx dentex*) 123,000, King George whiting (*Sillaginodes punctata*) 94,000, squid 88,000, southern sea garfish (*Hyporhamphus melanochir*) 79,000, various species of wrasse and groper 66,000, and West Australian dhufish (*Glaucosoma hebraicum*) 29,000. The size of the recreational catch for many of these species was of a similar magnitude to the commercial catch. A repeat of the 1997 west coast recreational boat survey has taken place during 2005/06, and this will provide comparative data for management purposes.

Surveys have been completed of recreational fishing in the Leschenault Estuary (Malseed et al. 2000), and in the Swan/Canning and Peel/Harvey Estuaries where the main focus was on the recreational catch of blue swimmer crabs (Sumner et al. 2000). A survey (Sumner and Malseed 2004) which examined changing recreational shares of crab catches in Cockburn Sound and Geographe Bay following management changes provided the data to underpin management of these important recreationally fished stocks. Annual surveys of recreational rock lobster fishers are also undertaken, as reported by Melville-Smith and Anderton (2000). These combined surveys indicate that blue swimmer crabs and rock lobsters are the most commonly taken recreational species in this bioregion, followed by the finfish species reported by Sumner and Williamson (1999).

These survey-based data, integrated with the long-run data sets from the commercial CAES database, provide the core information necessary for management of the most important recreational fish stocks in future.

Licensed Recreational Rock Lobster Fishery Status Report

R. Melville-Smith and A. Thomson
Management input from P. Readhead

FISHERY DESCRIPTION

The recreational rock lobster fishery primarily targets western rock lobsters (*Panulirus cygnus*) but also takes southern and tropical rock lobster species using pots (traps) or by diving. Most of the fishing effort is focused on the western rock lobster fishery in the Perth metropolitan area and Geraldton.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation
Recreational Fishing Licence

Consultation process

Recreational Fishing Advisory Committee

Boundaries

The recreational rock lobster fishery operates on a statewide basis and encompasses the take of all rock lobster species; however, fishing is concentrated on western rock lobsters in inshore regions in depths of less than 20 m between North West Cape and Augusta.

Management arrangements

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

Input controls include the requirement for a recreational fishing licence (either a specific rock lobster licence or an 'umbrella' licence covering all licensed recreational fisheries). Fishers are restricted to two pots per licence holder, although the total number of licences is not restricted. The pots must meet specific size requirements and must 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.

A minimum size limit of 77 mm carapace length applies from 15 November to 31 January, and a minimum of 76 mm from 1 February to 30 June, while the take of female lobsters in breeding condition is prohibited at all times. A maximum size limit for female lobsters was re-imposed in 2002/03 that prohibits the take of female lobsters larger than 105 mm from waters between 21°44´ S and 30° S and those larger than 115 mm between 30° S and 34°24´ S, excluding waters east of 115°08´.

A daily bag limit of 8 lobsters per fisher per day controls individual catches, and limits the ability of recreational fishers to accumulate quasi-commercial quantities of lobsters. A daily boat limit of 16 provides further control on high individual catches where there are two or more people fishing from the same boat. In Ningaloo Marine Park and between Cape Preston and Cape Lambert in the Dampier Archipelago, the daily bag limit is 4 and the boat limit 8 lobsters. 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.

In recent years the Government has introduced an Integrated Fisheries Management process aimed at establishing how fish resources can be best shared between competing users within the broad context of ecologically sustainable development.

The Integrated Fisheries Allocation Advisory Committee (IFAAC) was formed in October 2004 to implement the IFM process for rock lobster. The committee was to investigate IFM resource allocation issues and make recommendations on allocation of the resource between the user groups.

In summary, IFM involves:

- setting the sustainable harvest level (SHL) of the resource that allows for an ecologically sustainable level of fishing;
- allocating explicit catch shares for use by customary, recreational and commercial fishers;
- continual monitoring of each sector's harvested catch;
- managing each sector within its allocated catch share; and
- developing mechanisms to enable the reallocation of catch shares between sectors.

The IFAAC's Western Rock Lobster Draft Allocation Report was released for public comment in November 2005. The public submission period closed at the end of March 2006.

Once submissions have been considered by the IFAAC it is anticipated their final recommendations will go to the Minister for Fisheries in the latter half of 2006.

Research summary

General research for managing the rock lobster stock is covered in the commercial fishery report (pp. 14–21).

For the recreational component of this fishery, an annual mail-based survey of participants has been used to estimate the annual catch and effort for the past 19 years. These trends, together with data on puerulus settlement, are used to predict the recreational catch and effort in following seasons. Telephone diary surveys of recreational rock lobster fishers have been undertaken in 2000/01, 2001/02 and 2004/05. Estimates of recreational catch from this method are considered to be more accurate than those from mail surveys, as the phone diary eliminates the recall bias in the mail survey and there is a higher participation rate in the random sample selected. There is, however, a need to increase the sample sizes for the phone diary surveys.

RETAINED SPECIES

Recreational catch estimate (season 2004/05): 379 tonnes

Landings

Based on the first two 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 third phone diary survey undertaken in the 2004/05 season produced a different ratio between the mail and phone diary recreational catch estimates. In the interests of maintaining consistency from year to year, the 1.9 conversion factor has been maintained as the current best estimate until a series of comparative data are available and a more reliable conversion factor can be determined.

The recreational catch of western rock lobster for 2004/05 was estimated at 379 t based on the adjusted mail survey, with 285 t taken by potting and 94 t by diving. Comparative catch estimates for 2003/04 were 303 t by potting and 126 t by diving. The estimated recreational catch in 2004/05 was 11.7% below the 2003/04 catch. The 2004/05 season catch estimate was within the catch prediction confidence limits (i.e. 350–600 t) produced by the model constructed using adjusted mail survey catch estimates.

Fishing effort/access level

A total of 45,188 licences were sold that permitted fishing for lobsters during some part of the 2004/05 season (rock lobster licences plus umbrella licences), with an estimated 25,900 (57%) utilised for lobster fishing. The number of licences used for rock lobster fishing in 2004/05 was down on the number of fishers (27,690) for the 2003/04 season by 6.5%. The average rates of usage by active pot and diving fishers (excluding all those who held a licence but failed to use it) were 18 and 5 days respectively during the 2004/05 fishing season. These rates are the same as those recorded in the 2003/04 fishing season.

Catch rate

The average pot and diving catch rates were 1.8 and 2.9 lobsters per person per fishing day in the 2004/05 fishing season. These compare closely to the 2003/04 fishing season where potters and divers also caught 1.8 and 2.9 lobsters per person per fishing day respectively.

Commercial share: 97% (approx.)
The commercial fishery accounted for around 97% of the overall catch of western rock lobsters over the past season.

STOCK ASSESSMENT

Assessment complete: Yes
Stock assessments are an important focus of western rock lobster research, but because of the relatively small contribution to the overall catch made by the recreational fishery (around 3%), the full assessment information is provided in the commercial fishery status report.

Breeding stock levels: Adequate
See the commercial fishery status report.

Projected catch next season (2005/06): 250–420 tonnes
The recreational rock lobster catch has been estimated by an annual mail survey since the 1986/87 season. Regional estimates suggest that the number of active licences has remained relatively constant in Zone B (that part of the western rock lobster grounds north of 30° S) and that the resulting catch has hovered at around 50 t per year, based on the adjusted mail survey. By contrast, the level of licence usage has more than doubled in Zone C (south of 30° S), which includes the Perth metropolitan area, over the period surveyed. This has had a significant impact on catch over time with the average annual rate of increase estimated to be 6%.

In addition to long-term trends in licence usage, the annual recreational catch in Zone C has also been shown to be correlated with puerulus settlement indices recorded on the Alkimos collectors three to four years earlier. (Recruitment of lobsters to the fishery is dependent on puerulus settlement with a three- to four-year time lag.) As might be expected, sales of licences and associated usage figures are substantially higher in years of good recruitment into the fishery, which in turn results in those years producing a relatively higher overall recreational rock lobster catch due to a combination of increased lobster abundance and higher fishing effort.

Based on weaker puerulus settlements in the last few years, it is forecast that the recreational rock lobster catch for the whole fishery will be around 335 t in 2005/06 (Recreational Rock Lobster Figure 1), decreasing to 253 t in 2006/07, before increasing to 309 t in 2007/08. Therefore, licence sales and usage in 2005/06 are expected to remain at similar levels; the prediction is that sales will be approximately 45,100 and usage 25,700.

NON-RETAINED SPECIES

Bycatch species impact: Negligible
See commercial fishery status report.

Protected species interaction: Negligible
See commercial fishery status report.

ECOSYSTEM EFFECTS

Food chain effects: Negligible
See commercial fishery status report.

Habitat effects: Negligible
See commercial fishery status report.

SOCIAL EFFECTS

With over 30,000 people taking nearly a million individual lobsters annually, this fishery represents a major recreational activity and provides a significant social benefit to the Western Australian community.

ECONOMIC EFFECTS

The direct value of the recreational catch in the 2004/05 season was about $8.1 million; however, this represents only a minor proportion of the economic activity generated by this sector through the use of boats, fishing gear etc.

FISHERY GOVERNANCE

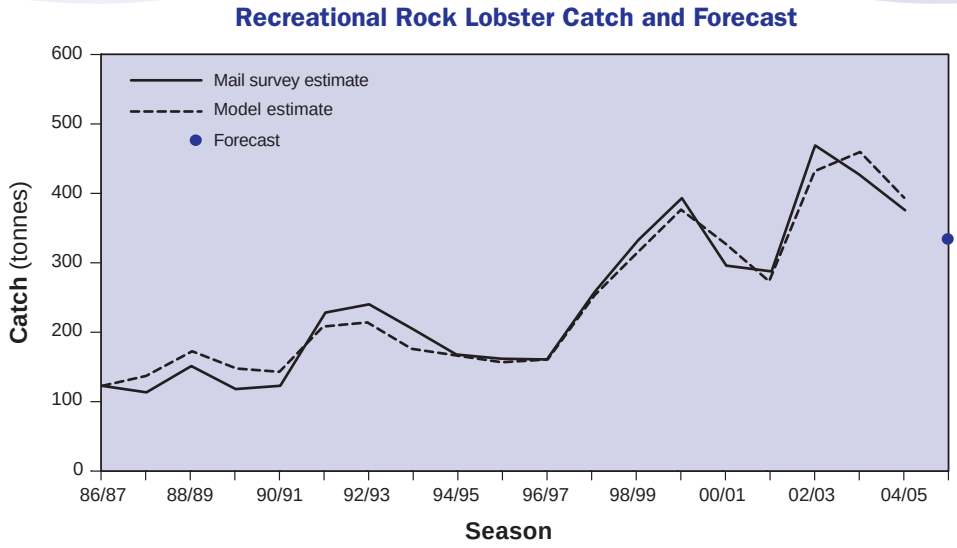
While the annual take by the recreational sector in this fishery is subject to size, bag and pot usage limits and seasonal constraints, there is no direct control on the number of recreational licences issued.

New management initiatives (2005/06)

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

EXTERNAL FACTORS

The recreational catch is strongly influenced by the puerulus settlement in the metropolitan area, which in turn is responding to variations in the Leeuwin Current and related oceanographic factors.



RECREATIONAL ROCK LOBSTER FIGURE 1

Estimates of the recreational rock lobster catch since 1986/87 using adjusted mail survey results, and model estimates of catches in 2005/06 based on puerulus settlement three to four years earlier and expected licence usage.

Licensed Recreational Abalone Fishery Status Report

A. Hart, T. Baharthah and J. Brown
Management input from P. Readhead

FISHERY DESCRIPTION

The recreational abalone fishery exploits three species (Roe's abalone, *Haliotis roei*; greenlip abalone, *H. laevigata*; and brownlip abalone, *H. conicopora*). Roe's abalone is the primary focus for recreational fishers and is taken by wading or snorkelling on reef platforms and sub-tidal reefs mainly between Geraldton and Augusta. South of Cape Naturaliste and on the south coast, the larger greenlip and brownlip abalone are taken in deeper water, mainly on SCUBA or SSBA (surface supplied breathing apparatus). Fishers use a screwdriver or similar implement such as an 'abalone iron' to lever abalone from the reef.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation
Recreational Fishing Licence

Consultation process

Recreational Fishing Advisory Committee

Boundaries

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).

Management arrangements

The recreational component of the fishery for abalone is managed under a mix of input and output controls.

The fishing season in the Northern and Southern Zones extends from 1 October to 15 May. The West Coast Zone is only open for six Sundays annually, between 7 a.m. and 8.30 a.m., commencing on the first Sunday in November. These restrictive management controls on the west coast are necessary to ensure the sustainability of an easily accessible (and therefore vulnerable) stock located adjacent to a population in excess of 1.6 million people (including Geraldton). It is not unusual for over 60% of the entire year's recreational catch of abalone (Roe's, greenlip and brownlip included) to be taken during these nine hours of concentrated fishing.

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.

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. For greenlip and brownlip abalone, the minimum legal size is 140 mm, the combined daily bag limit is 5 per fisher (formerly 10), and the household possession limit is 20.

Research summary

Current annual recreational catch and effort estimates are derived from a field survey of the metropolitan fishery, and a telephone diary survey covering the entire state. The field survey estimates the catch and effort from each distinct Roe's abalone stock within the Perth fishery (West Coast Zone). Field survey estimates are based on average catch (weight and numbers), catch rates (derived from 1,562 interviews in 2005), and fisher counts conducted by Volunteer Fisheries Liaison Officers and research personnel from shoreline vantage points and aerial surveys. This method provides a comprehensive assessment, but is too resource-intensive to be applied routinely outside of the metropolitan area.

The telephone diary survey estimates the catch of all three species on a statewide basis. In 2004, around 500 licence holders were selected from the licensing database, with selection stratified by licence type (abalone or umbrella) and respondent location (country or Perth metropolitan area). The licence holders were sent a diary to record their fishing activity and were contacted each month by telephone for the duration of the abalone season. The telephone diary was not carried out in 2005, but will be completed for the 2006 season.

In addition, an annual telephone recall survey is conducted annually to gather information on a range of licensed recreational fisheries. While this is no longer used as a primary data source for the recreational abalone fishery owing to some identified difficulties with recall bias, it does provide a useful time series for validation and comparison of overall trends in the metropolitan Roe's abalone fishery (see Recreational Abalone Figure 1).

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

RETAINED SPECIES

Recreational catch (season 2005):
Roe's Perth fishery 24 t

(season 2004):
Roe's rest of state 12 t
Greenlip 7 t
Brownlip 3 t

Landings

The catch estimate for Roe's abalone from the Perth metropolitan area in 2005 is 24 t, as estimated from the field survey (Recreational Abalone Figure 1). This is a decrease of about 23% from 2004. This was caused by decreases in effort and catch rate (Recreational Abalone Table 1), and mainly reflects the poorer weather conditions during the 2005 season in comparison with 2004 and 2003.

For the rest of the state, the catch estimates from the 2004 telephone diary survey are repeated here, as this survey was not conducted in 2005.

Catch estimates of Roe's, greenlip, and brownlip abalone for all areas outside the Perth metropolitan fishery in 2004 were 12 t (range: 7–16 t), 7 t (range: 3–11 t), and 3 t (range: 1–5 t) respectively (Recreational Abalone Table 2).

Fishing effort/access level

For the 2005 season around 20,000 licences were on issue, a slight decline from 21,000 in 2004 (Recreational Abalone Figure 2).

The field survey estimated effort in the 2005 metropolitan fishery to be 14,800 days, a decrease of 20% from the 2004 estimate of 18,700 days (Recreational Abalone Table 1).

Effort range estimates for recreational abalone fishing on the west coast (excluding the Perth metropolitan area), from the 2004 telephone diary survey, were between 6,500 and 13,600 days, while the estimated range on the south coast was 1,700–3,700 days (Recreational Abalone Table 2).

Catch rate

The catch rate during the 2005 metropolitan season was estimated at 17.8 abalone per fisher day from the field survey. This represents a decrease of 6% over the 2004 catch rate (Recreational Abalone Table 1).

The Roe's abalone catch rates on the west and south coasts, from the 2004 telephone diary survey, were 11 and 6 abalone per day respectively (Recreational Abalone Table 2).

The greenlip abalone catch rates on the west and south coasts were 0.6 and 2.4 abalone per day respectively, while the brownlip abalone catch rates were 0.4 and < 0.1 abalone per day respectively (Recreational Abalone Table 2).

Commercial share: Roe's 69–77% (approx.)
Greenlip/brownlip 93–98% (approx.)

These estimates for the statewide commercial share of abalone catch are the same as reported in 2004. This is because the recreational component of the catch is estimated from a telephone diary survey, which was not conducted in 2005. The telephone diary survey will be repeated in 2006, and current estimates updated in the next *State of the Fisheries Report*.

Based on commercial abalone catches in 2004, and the estimates of recreational catch derived from the 2004 telephone diary survey, the commercial share of the combined (commercial and recreational) catch statewide represented approximately 69–77% for Roe's abalone and 93–98% for greenlip/brownlip abalone.

STOCK ASSESSMENT

Assessment complete: **Yes**

Size distributions and densities for *Haliotis roei* were measured from nine indicator reefs in the Perth metropolitan fishery. Eight of these are fished recreationally and commercially, while the ninth is a marine protected area (MPA). Surveys were conducted in January and February 2006, and measured the state of abalone stocks following the recreational fishery in November and December of 2005 (Recreational Abalone Table 3).

Densities of sub-legal animals (< 60 mm) on the reef platform habitat had increased by 50% from the 2005 estimate of 26 abalone/m^2, and are now at a record 10-year high (Recreational Abalone Table 3). On the sub-tidal reef habitat, densities of sub-legal animals also increased substantially, from 3 to 7.2 abalone/m^2, which is also the highest recorded.

Densities of legal-sized animals (60+ mm) on the reef platform habitat increased by 20%, from 16 to 21 abalone/m^2. In the sub-tidal reef habitat, densities increased by 50%, from 7 to 11 abalone/m^2 (Recreational Abalone Table 3), which is the highest level recorded.

Mean densities of legal-sized animals in the Waterman's Reserve are usually around two to four times higher than those on the reefs subject to harvesting (Recreational Abalone Table 3). However, for sub-legal animals, the difference in densities between fished and unfished reefs is not as great, at least in the platform habitat,

West and south coast stock assessments of all species utilise the longer-run catch and effort data set from the commercial fishery (see commercial fishery status reports, pp. 22–26 and 190–195), with catch rates and effort ranges being the main data used for assessment of stock performance for both sectors.

Breeding stock levels: **Adequate**

Size at sexual maturity (50% of animals mature) for all species is well below the minimum legal size, and considered to provide adequate protection for the breeding stock in all three species. Roe's abalone stocks are further protected by the fact that commercial fishers in the Perth region and the eastern part of the south coast fishery fish to minimum legal size limits of 70 mm and 75 mm respectively, which are higher than the normal legal minimum size for Roe's abalone of 60 mm applied to the recreational sector.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

See the commercial fishery status reports.

Protected species interaction: **Negligible**

The recreational catching method is wading or snorkelling, and no interactions with protected species occur.

ECOSYSTEM EFFECTS

Food chain effects: **Negligible**

See the commercial fishery status reports.

Habitat effects: **Negligible**

See the commercial fishery status reports.

SOCIAL EFFECTS

Over 20,000 licences were issued that would have allowed fishers to participate in the recreational abalone fishery (Recreational Abalone Figure 2). The recreational fishery provides a major social benefit to those sectors of the community that appreciate the abalone as a delicacy.

ECONOMIC EFFECTS

Not available.

FISHERY GOVERNANCE

For densities of the Perth stocks of Roe's abalone to remain at a historically sustainable level, the research survey densities following the recreational season should fall within the seven-year (1997–2003) range that reflects the acceptable variation in the stocks. This range is 22–35 abalone/m^2 for animals < 60 mm, and 19–23 abalone/m^2 for animals 60+ mm. (It should be noted that this differs from the range given in previous reports, which has now been amended based on recent data validation and improvements to the analysis procedures.) The range applies only to the reef platform stocks that are fished recreationally, as governance ranges for sub-tidal stocks are dealt with in the commercial fishery.

Surveys in early 2006 showed sub-legal densities to be 39 abalone/m^2, which is above the acceptable range. Densities of 60+ mm animals were 21 abalone/m^2, which was within the acceptable range.

High sub-legal densities on the platform coupled with high densities in the sub-tidal stocks have led to consideration of a possible increase in overall sustainable harvest level within the Perth metropolitan abalone stocks. The mechanism for sharing an increase in SHL between recreational and commercial sectors under new Integrated Fisheries Management allocation rules is currently being debated.

New management initiatives (2005/06)

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

- 200 kg should be allocated for customary fishing;
- proportional allocations for the recreational and commercial sectors should be deferred;

- when proportional allocations are implemented, the starting point should be 53% recreational and 47% commercial; and
- a total allowable catch should be introduced for the recreational sector.

EXTERNAL FACTORS

Effort in the Roe's abalone recreational season is primarily controlled by sea conditions on the Sundays of the November–December season. This factor results in large fluctuations in the annual catch from year to year, with calm conditions producing above-average catches (Recreational Abalone Figure 1). The 2005 season had the worst weather conditions in seven years, and consequently, the lowest catch. Illegal fishing also remains a concern, with offences continually being detected, particularly in the Perth metropolitan fishery. The fishery catch rates and the stock surveys take into account the impact of illegal fishing.

RECREATIONAL ABALONE TABLE 1

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

FIELD SURVEY					
YEAR	EFFORT (days)	CATCH RATE	CATCH (number)	CATCH (tonnes)	MEAN WEIGHT (kg)
1997	16,990	18.9	323,200		
1998	20,820	17.5	369,900		
1999	22,070	17.4	383,600	35.3*	0.092*
2000	19,800	16.7	330,300	30.2	0.0913
2001	25,590	18.8	481,300	44.1	0.0917
2002	22,450	17.9	401,500	36.0	0.0897
2003	23,700	18.62	442,405	42.6	0.096
2004	18,661	19.01	342,900	31.7	0.0925
2005	**14,795**	**17.8**	**262,700**	**24.3**	**0.092**

RECREATIONAL ABALONE TABLE 2

Preliminary summary of effort (fisher days), catch rate (abalone per fisher day) and catch (tonnes whole weight) for the Perth metropolitan, west coast (excluding Perth) and south coast recreational abalone fisheries in 2004, from the telephone diary survey.

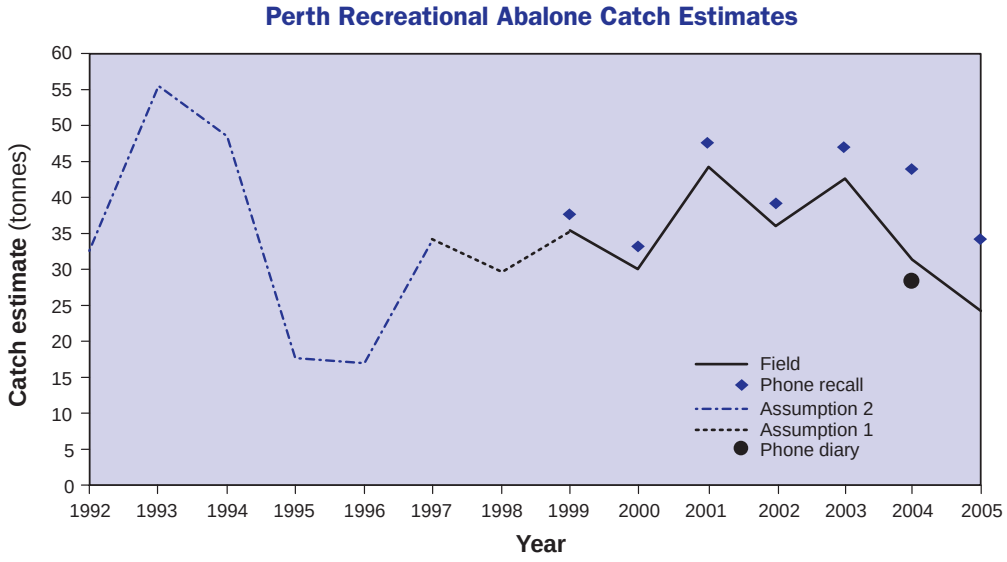
		ROE'S		GREENLIP		BROWNLIP	
AREA	EFFORT	CATCH RATE	CATCH (tonnes)	CATCH RATE	CATCH (tonnes)	CATCH RATE	CATCH (tonnes)
Perth Metro[1]	14,000–20,500	17.8	25–31				
West Coast[1] (excluding Metro)	6,500–13,600	11.0	7–14	0.6	2–6	0.4	1–5
South Coast[2]	1,700–3,700	6.2	1–3	2.4	1–5	<0.1	0–1

1. Both areas are within the west coast bioregion.
2. Survey area is southern bioregion (i.e. east of Black Point).

RECREATIONAL ABALONE TABLE 3

Mean densities of sub-legal (5–59 mm shell length) and legal-sized Roe's abalone (60 mm and over) from eight monitoring sites (fished stocks) and the marine protected area in the Perth fishery, measured as abalone/m^2. The platform habitat is primarily the recreational fishery, while the sub-tidal habitat is primarily the commercial fishery. Data has been standardised by a generalised linear model analysis, as the sites are not the same for all years.

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+
1996	38	19						
1997	24	22	44	26	2	9	9	21
1998	31	22	51	37	3	9	11	29
1999	35	20	52	26	2	5	12	27
2000	33	19	29	35	1	7	8	31
2001	33	21	38	34	2	7	8	28
2002	26	23	42	39	2	7	7	31
2003	22	20	36	41	2	8	4	25
2004	25	16	33	52	2	7	5	20
2005	26	16	43	39	3	7	9	22
2006	**39**	**21**	**49**	**38**	**7**	**11**	**6**	**20**



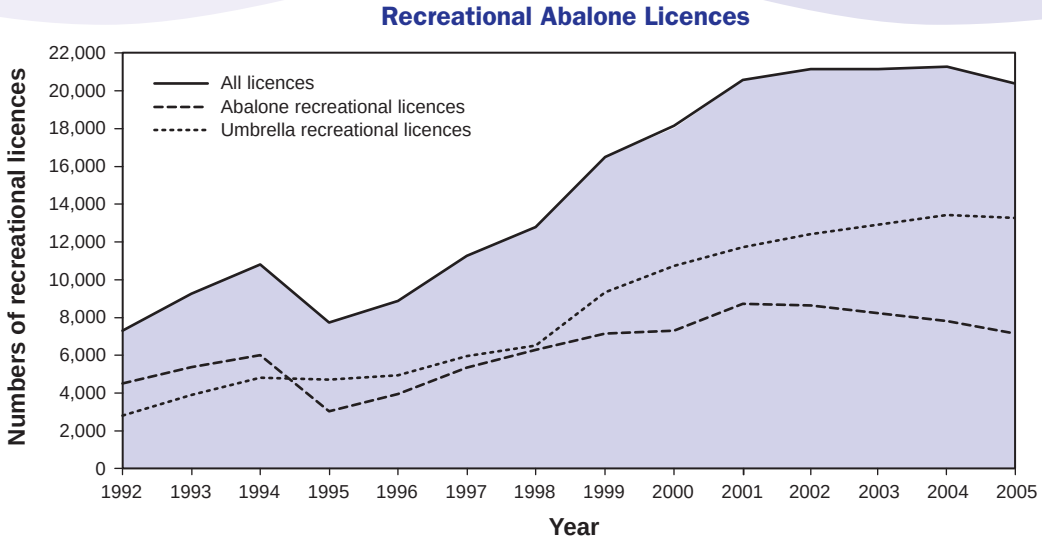
RECREATIONAL ABALONE FIGURE 1

Catch estimates for the Perth recreational abalone fishery for the period 1992 to 2005, including backwards projections through time based on two assumptions.

Assumption 1: assumes that the mean weight of abalone taken during 1997 and 1998 is equal to the average of the two 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 (Recreational Abalone Table 1).

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 1997–2005. In 1992–1994 fishing was permitted for two hours per season day (7 a.m. to 9 a.m., Saturdays and Sundays). Since 1995 permissible fishing time per season day has been 1.5 hours (7 a.m. to 8.30 a.m., Sundays only).



RECREATIONAL ABALONE FIGURE 2

The number of licences issued in the recreational abalone fishery, by licence type, for the period 1992 to 2005.

Recreational Tailor Fishery Status Report

K. Smith and J. Brown

Management input from N. Harrison

FISHERY DESCRIPTION

Tailor (*Pomatomus saltatrix*) is a key target species for recreational anglers in estuaries, along beaches and around coastal reef systems on the lower west coast. This accessible distribution, coupled with strong schooling behaviour, makes the stock relatively vulnerable to growth over-fishing and potentially to recruitment over-fishing. These risk factors, together with naturally variable recruitment and growing inshore fishing pressure, were first recognised in the early 1990s. Since that time, daily bag limits have been reduced twice – from unlimited to 20, then from 20 to 8 per person.

The majority of the recreational catch in WA is taken from the metropolitan area in the west coast region, while the bulk of the commercial catch comes from Shark Bay in the Gascoyne region.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Recreational Fishing Advisory Committee

Boundaries

Tailor inhabit coastal and offshore waters between Shark Bay and the lower west coast, with most of the fishing occurring in the west coast bioregion.

Management arrangements

In the west coast and Gascoyne bioregions, tailor is assigned to the 'medium risk' category. The daily bag limit for recreational fishers is 8, with a condition that only two of these fish may be over 600 mm. A similar provision for the south coast has been introduced from 1 January 2006. The legal minimum length is 300 mm.

Research summary

Following concerns about increasing recreational fishing pressure on tailor in the greater Perth metropolitan area in the early 1990s, two research studies, a tagging and a short-term hooking mortality study, were instigated. This research identified genetically homogeneous populations along the west coast of WA, between Shark Bay and Cape Naturaliste. However, otolith carbonate analysis suggested that the inner Shark Bay populations remain separate after recruitment from populations outside of Shark Bay. Thus, from a management perspective, tailor located south of Shark Bay and within Shark Bay should be managed as separate stocks.

Having established that tailor from the Swan River estuary interchange freely with those in marine waters of the lower west coast, a long-term monitoring program was initiated to

investigate the change in relative abundance of the 0+ and 1+ juvenile year-classes in the Swan River estuary. A volunteer angling survey program for this purpose began in 1995 and is ongoing at Point Walter from February to April each year. Angler catch rates are an indicator of the strength of annual recruitment to the lower west coast population. The Research Division has also been undertaking annual netting surveys of juvenile fish on ocean beaches since 1995, which yield another recruitment index for tailor on the lower west coast.

Recruitment indices have proven useful as predictors of commercial catch rates and new data emerging from recreational angler log books suggest that recruitment indices will also be useful to forecast recreational catch rates on the west coast.

Recent studies by the Department of Fisheries and Murdoch University indicate that tailor larvae off the west coast are restricted to surface waters over the middle and outer continental shelf. Therefore, variations in surface currents (including the southward Leeuwin Current and the northward Capes Current) that disperse eggs and larvae could have an influence on the patterns of juvenile recruitment along the west coast. Tailor spawn within a restricted range of temperatures and salinities, but these conditions occur at various times along much of the west coast, suggesting that recruits to the lower west coast could have been spawned both locally and from distant sites, either north or south. Samples of tailor in spawning condition recently provided by volunteer anglers confirm that spawning aggregations do occur within the metropolitan region. As part of the recently introduced Research Angler Program, a recreational angler daily log book was implemented in 2004. Log book anglers are now providing important annual information about the size structure and relative abundance of tailor in various regions. These data will be used in future stock assessments, in conjunction with other data from recruitment surveys, biological studies and creel surveys. A 12-month creel survey of boat-based recreational fishing in the west coast bioregion commenced in July 2005 and will yield estimates of the annual catches of tailor by this sector.

RETAINED SPECIES

Recreational catch estimate (season 2005): Not assessed

Landings

Comprehensive recreational tailor catch estimates are not available for the current year (2005). The most complete recent estimates (all areas, all methods) for tailor catches are available from the National Recreational Fishing Survey, which was conducted between May 2000 and April 2001. This survey estimated that a total of 587,000 tailor were caught in WA during this 12-month period. The average weight per tailor measured during this survey was 0.319 kg. Therefore, the recreational catch for the state was estimated at 187 t (Henry and Lyle 2003). An estimated 87% of the total catch was from shore-based fishing.

The 2000/01 total recreational catch of tailor occurred in three bioregions, with the majority of the catch (182 t or 97%) occurring in the west coast bioregion (Recreational Tailor Fishery Table 1). In 2000/01, the recreational share of the total tailor catch (i.e. combined commercial and recreational landings) on the west coast was 94%.

A boat- and shore-based angler survey in the Gascoyne region (Steep Point to Exmouth Gulf) between 1 April 1998 and 30 March 1999 estimated a total recreational catch of 6,600 tailor (+ 1,300 fish) kept and 1,600 tailor released. With an estimated average fish weight of 0.757 kg, the retained recreational catch was approximately 5 t. The greatest proportion of the Gascoyne tailor recreational catch (87%) was taken within the Shark Bay Marine Park (Sumner et al. 2002).

Since 2000, annual creel surveys of boat-based fishing have been conducted within the Shark Bay Marine Park at boat ramps at Nanga, Denham and Monkey Mia. Pink snapper are the main focus of these surveys and only minor catches of tailor are reported. Most tailor in Shark Bay are caught by shore-based fishers, whose catches are not recorded in these surveys. The average boat-based catch of tailor since 2000 is estimated to be 0.7 t per year, reaching a high of 1.4 t in 2002 and a low of 0.1 t in 2004. In 2005, an estimated 0.3 t of tailor was landed.

Fishing effort/access level

The 2000/01 national survey, which included all methods and regions, provides the most comprehensive information on fishing effort. The relevant data for the west coast tailor fishery is the line fishing effort. For the 12 months of the survey, line (bait fishing) totalled 1,605,400 'fishing events' and line (lure) effort 82,800 events, while line (both) effort accounted for a further 80,600 events. Earlier data is available in the *State of Fisheries Report 2002/03.*

Catch rate

Not assessed.

Commercial share: 24% (approx.)

The most recent estimate of commercial catch share is based on the total recreational catch of tailor in 2000/01 (from the National Recreational Fishing Survey) and total commercial catch in calendar year 2000. In that year, commercial fishers took an estimated 24% of the total statewide tailor catch.

In 2005, a total commercial tailor catch of 25.9 t was recorded, down 3.4 t from 2004. Most of these landings were recorded in the Gascoyne bioregion (82.3%), with the west coast and south coast bioregions recording 17.5% and 0.2% respectively.

In the Gascoyne bioregion, 89.8% (19.2 t) of the 2005 total commercial catch was recorded by the Shark Bay Beach Seine and Mesh Net Managed Fishery, with the remaining 10.2% (2.2 t) recorded by wetline fishers. In the west coast bioregion, 58.6% (2.7 t) of the total 2005 commercial catch was recorded by wetline fishers in coastal areas between Kalbarri and Cape Naturaliste, with 39.7% (1.8 t) recorded by estuarine fishers (Swan/Canning, Peel/Harvey and Hardy

Inlet) and 1.7% (0.08 t) by the Cockburn Sound finfish fishers. In 2005, minor catches of tailor (0.04 t) were also recorded in two south coast estuaries (Wilson and Irwin Inlets).

STOCK ASSESSMENT

Assessment complete: **Preliminary**

Tailor become susceptible to capture by line fishing at 150–200 mm TL and ~1 year of age, but do not attain the legal minimum length of 300 mm until ~3 years (Ayvazian et al. 2001, K. Smith unpub. data). Tagging studies have found that these sub-legal-sized fish are subject to high fishing pressure, especially in the metropolitan region (Young et al. 1999). Fortunately, survival rates by small tailor after hooking appear to be relatively high (> 90%), except where 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 metropolitan area have been recaptured as adults at locations northwards or immediately offshore, suggesting that at least some fish spawn locally and contribute to local recruitment (Young et al. 1999). However, if local spawners are the main source of recruitment to the metropolitan fishery, then increased targeting of offshore fish by recreational fishers is likely to result in local depletion. The results of the current west coast creel survey should give a better understanding of offshore catch levels. About 21% of the west coast stock is thought to occur offshore (i.e. > 500 m from shore), and this component of the stock is dominated by large breeding fish (Ayvazian et al. 2001).

The recruitment indices from the Swan River estuary and lower west coast, which now span 12 continuous years, indicate quite variable levels of annual recruitment to the lower west coast population. Recruitment peaked in 1995–1997 and 2005, but was consistently low from 1998 to 2004. Log book data and anecdotal evidence from recreational fishers suggest poor catches of mature fish in the metropolitan region over recent years, which is consistent with low recruitment from 1998 to 2004.

Higher recruitment on the lower west coast in 2005 allows for a slightly more optimistic forecast of fishery catch levels than was possible last year. However, the longer-term status of the stock remains of concern due to continuing high fishing pressure and lack of data that would enable a more formal stock assessment. A survey of shore-based recreational catch levels on the west coast is urgently required to estimate the total catch of tailor. Further research is also needed to better understand stock structure, spawning activity and recruitment dynamics. This research is required not only for the sustainable management of the recreational fishery on the lower west coast, but also for the Shark Bay Beach Seine Managed Fishery (pp. 100–105) where annual catches fell below the target level in 2004 and 2005, and were the lowest recorded since 1987.

Breeding stock levels: **Not assessed**

Adult tailor contributing to the breeding stock are distributed from Shark Bay to the lower west coast where they are caught predominantly on offshore reefs. On the lower west coast, the studies referred to above indicated that the breeding stock in 1996 was above 30% of virgin biomass, which is the minimum level generally accepted for this type of fish. Further information is still required on the more northerly (Gascoyne) components of the stock, to determine the overall breeding stock status.

Anecdotal evidence also suggests that recreational fishers are increasingly targeting the large breeding individuals along the lower west coast. Despite better recruitment in 2005, the generally low recruitment on this section of the coast over recent years suggests that there is still an urgent need to obtain more current data on the size of the breeding stock on the lower west coast.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The line fishing methods used to fish for tailor result in catches of other finfish species that are generally sought after by recreational fishers. Very limited discarding of unwanted species occurs.

Protected species interaction: **Negligible**

Recreational fishers angling for tailor are unlikely to capture any protected species. Swans in the river do occasionally take hooks accidentally.

ECOSYSTEM EFFECTS

Food chain effects : **Low**

While excessive removal of tailor from the food chain could potentially allow for some increase in the numbers of its prey species, it is unlikely that this is occurring to a significant level.

Habitat effects: **Negligible**

The line fishing methods used to fish for tailor have a negligible impact on the substrate of the river or ocean.

SOCIAL EFFECTS

The annual spring–summer appearance of tailor along metropolitan Perth beaches has historically been targeted by thousands of shoreline anglers each year; however, recent low catch levels have limited this activity.

FISHERY GOVERNANCE

Control of the recreational exploitation rate is managed through a daily bag limit and a legal minimum size limit; however, there is no limit on the overall catch taken by this sector. Commercial catch is essentially limited to south-west estuaries, Cockburn Sound and Shark Bay where strict licence and gear limits apply.

New management initiatives (2005/06)

A 12-month creel survey of boat-based recreational fishing in the west coast region commenced in July 2005 and will provide up-to-date estimates of this component of the tailor catch. Although tailor are mostly caught by shore-based fishing in the west coast bioregion, the creel survey will provide information about large, breeding tailor that occur offshore. Historically, offshore tailor stocks were not strongly targeted by recreational fishers but anecdotal reports suggest this practice has been increasing in recent years. There is, however, an urgent need to also undertake a survey of shore-based recreational fishing in the west coast bioregion.

A review of recreational fishing in the south coast bioregion was completed and new rules implemented on 1 January 2006. As one of the outcomes of this review, the Minister for Fisheries determined that the 'slot limit' of only two fish over 600 mm should apply to the south coast. The slot limit, which is designed to provide additional protection for large tailor, now applies over the species' entire range within Western Australia. In late 2005 the Metropolitan Region Recreational Fishing Advisory Committee proposed a further reduction in the upper slot limit from 600 mm to 500 mm. This proposal was considered by the state Recreational Fishing Advisory Committee (RFAC) who supported further consultation. The RFAC recommended that the proposal be referred to the next regional review of recreational fishing on the west coast, which is due to commence in 2007.

EXTERNAL FACTORS

It is likely that yearly variation in coastal currents influences settlement of juvenile tailor and thus their subsequent recruitment into the fishery.

RECREATIONAL TAILOR FISHERY TABLE 1

Estimated recreational catch (tonnes) of tailor by boat and shore fishers between May 2000 and April 2001 by region from the National Recreational Fishing Survey (Henry and Lyle 2003).

REGION	INSHORE		OFFSHORE	RIVER/ESTUARY MARINE		TOTAL
	BOAT	SHORE	BOAT	BOAT	SHORE	
Gascoyne	2	1	1			4
West	15	143	1	5	17	181
South		0.5		1	0.5	2
TOTAL	**17**	**144.5**	**2**	**6**	**17.5**	**187**

Fishing and Aquatic Tour Industry

C. Johnson and E. Lai

The west coast bioregion has the highest number of licensed tour operators in the state. At the end of June 2006, there were 138 licensed fishing tour operators, plus 23 licensed restricted fishing or eco-tour operators.

Tour operators were licensed by the Department of Fisheries in 2001, with all licensed operators required to submit daily trip returns. These returns enable data to be compiled on the overall number of tours, number of fishing tours, catch and effort estimates and other statistics.

Starting from the current report, data for this bioregion have been presented by financial year (rather than by calendar year as previously), as returns indicate that the majority of the total catch is taken between September and March. Catch estimates have been enhanced through improved analysis of average fish weights and inclusion of late fishing returns.

Fishing effort

In 2004/05, 55% of tour operators who were licensed to operate on the west coast reported actively using their licence in this bioregion. Operators reported an overall total of 4,885 tours, a decrease from 5,217 tours in 2003/04 and 5,139 in 2002/03. Activities conducted on these tours included fishing, diving, snorkelling, wildlife observation and sightseeing.

The total number of 'fishing only' tours on the west coast in 2004/05 declined to 2,347 from 2,660 in 2003/04 and 2,960 in 2002/03. The total fishing effort reported by tour operators also decreased to 25,609 fisher days in 2004/05, from 27,741 in 2003/04 and 30,266 in 2002/03. This represents a total decrease of 18.2% over three years.

Catch

Catches of the major finfish species for 2002/03, 2003/04 and 2004/05 within the west coast bioregion are shown in West Coast Fishing Tours Table 1.

The estimated total finfish catch for 2004/05 is 110 t, which is similar to the total catch in the previous two years. The catches throughout the period show no consistent pattern, except for an increasing trend in pink snapper.

WEST COAST FISHING TOURS TABLE 1

Estimated catch of major finfish species reported by tour operators. Catches are calculated by financial year as the majority of the total catch is taken between September and March.

SPECIES		ESTIMATED CATCH (tonnes) 2002/03	ESTIMATED CATCH (tonnes) 2003/04	ESTIMATED CATCH (tonnes) 2004/05
Pink snapper	*Pagrus auratus*	17.5	20	26
Dhufish	*Glaucosoma hebraicum*	23	18	24.5
Samson fish	*Seriola hippos*	13	13	12
Baldchin groper	*Choerodon rubescens*	8	5.5	7.5
Sweetlip emperor	*Lethrinus miniatus*	4	5	5.5
Queen snapper	*Nemadactylus valenciennesi*	5	5	5
Breaksea cod	*Epinephelides armatus*	5	4	4
Bight Redfish	*Centroberyx gerrardi*	2	4.5	3
Skipjack trevally	*Pseudocaranx dentex*	3.5	2	1.5
Other finfish		30	21.5	21
Total		**111**	**98.5**	**110**

AQUACULTURE

Regional Research and Development Overview

Aquaculture production statistics are compiled at the WA Fisheries and Marine Research Laboratories (WAFMRL) at Hillarys. The value of aquaculture decreased slightly and aquaculture tonnage decreased by 6% in 2004/05 compared to equivalent data for 2003/04 (excluding marine algae and all pearl oysters). However, while precise data are not available for the aquaculture feeds industry, it is clear that the industry worldwide is increasing its use of lupin kernel meal and Western Australia, as the major lupin producer, is developing a very significant industry as an ingredients supplier for domestic and export use.

An FRDC-funded rock lobster project, completed in 2005/06, assessed the potential for on-growing wild-caught puerulus (post-larvae). Outcomes of this project highlighted the high survival and growth rates that can be obtained in aquaculture systems at acceptable stocking densities, indicating that puerulus on-growing may be one possibility for expanding lobster production in the future. The Department has commenced the development of a scoping paper to consider the allocation of western rock lobster puerulus for commercial grow-out purposes.

Negotiations with the Fremantle Port Authority regarding securing future leases for mussel farmers in Cockburn Sound continued, with the final head lease arrangements now almost complete. The implementation of new leases is expected to occur in 2006/07. The Department has also commenced a review of aquaculture licence conditions using the mussel industry as a pilot. This will see more consistent, streamlined and meaningful licensing and enforcement arrangements across all aquaculture sectors, including mussels.

The Western Australian Shellfish Quality Assurance Program, which ensures that mussels are harvested only when water quality is appropriate for safe consumption of the product, continued to operate effectively. Arrangements with the Department of Health regarding the ongoing management of the program and its links to the new Food Bill are progressing.

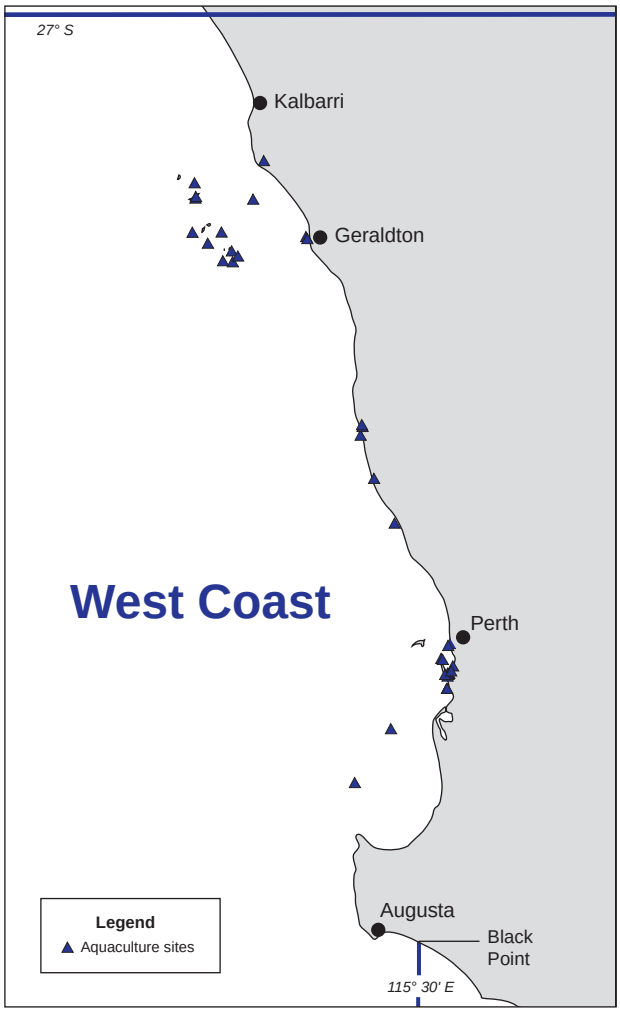
The marine finfish aquaculture research team continued its work on the development of microdiets for larval fish nutrition. The automated feeding system (patent pending) developed in an earlier stage of the project is being manufactured by the Department, with several systems already sold overseas, and was promoted by the team at the World Aquaculture Society Conference 2006. With financial support from the FRDC, the current microdiet research is focusing on easily digested proteins, feed attractants, and the physical and chemical properties of the particles. The team is collaborating with R&D centres in Tasmania, the Northern Territory, Spain, Portugal, Japan and Malaysia. Visiting scientists from Nagasaki University, Japan and the University of the Algarve, Portugal spent time in Perth during 2005/06 conducting collaborative research on larval fish nutrition.

Work also continued on the commercialisation of *Artemia* (brine shrimp) production at Hutt Lagoon, Port Gregory, with background research undertaken this year at the Artemia Reference Centre in Belgium. This project, also supported by FRDC, is a collaboration between the Department of Fisheries and a multi-national industry partner that farms red algae at Hutt Lagoon. Current work is building on the outcomes of previous research which tested the commercial

viability of *Artemia* cysts and biomass through a pilot-scale system. It is anticipated that 'home-grown' *Artemia* products will be available commercially during 2007/08, reducing the reliance on unpredictable supplies of imported product for aquaculture feeds.

The abalone aquaculture research group set up the algal culture facility at the new Hillarys laboratories and continued to isolate and grow single-cell algae (diatoms) as well as seaweed fragments that could provide more and better food for very young abalone.

Funding was provided by the Development and Better Interests Fund to support the maintenance and release of 12,000 hatchery-bred juvenile greenlip abalone. These animals were derived from collaborative research at Great Southern Marine Hatcheries (GSMH) in Albany, and were moved to WAFMRL in October 2005 when GSMH closed. The abalone were maintained at Hillarys for five months on a formulated feed and then weaned on to a seaweed diet one month prior to release at Augusta. The majority of animals were measured and tagged individually with a new design of numbered tag that 'grows' into the shell. These tags will permit individual identification of animals in the field so that growth and survival can be estimated accurately over time.



WEST COAST AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture sites of the west coast bioregion.

Mussel Farming Status Report

C. Lawrence and S. How

INDUSTRY DESCRIPTION

Production method

Mussels (*Mytilus edulis*) are farmed by collecting spat from the wild. These wild-caught juvenile mussels are then attached to vertical ropes called longlines for grow-out to market size. Longlines consist of a rope with buoys to provide flotation, to which droppers are attached every 3–4 m upon which the mussels are seeded. This submerged structure maintains the mussels at least 2 m above the seabed. As mussels are filter feeders, commercial farms rely upon natural feed (algae, detritus and bacteria) rather than artificial diets or pellets.

Production areas

Mussel farms require sheltered sites with adequate natural feed. Farms are found mainly in Cockburn Sound and Warnbro Sound, as well as in the Albany harbours and Wilson Inlet on the south coast. Commercial production continues in the Southern Flats area of Cockburn Sound where mussel farmers now have more secure access to growing areas. Future growth of this industry is constrained by resource-sharing issues that limit access to additional sites in protected and productive areas.

Management arrangements

Licence approvals are required and regular site inspections are carried out to ensure farmers are operating within their site coordinates and that their sites are clearly marked for marine safety compliance.

The mussel industry must also meet the requirements of the WA Shellfish Quality Assurance Program. This program contributes significantly to the overall monitoring of the water quality of waterways such as Cockburn Sound. It also provides the mussel industry with a mechanism whereby harvesting and processing can be stopped when water quality declines.

AQUACULTURE PRODUCTION

Production current year (2004/05): 717 tonnes

Number of producers for year 2004/05: 21

Production projection next year (2005/06): 800 tonnes

Mussel production decreased by 6% in 2004/05 (Mussel Farming Figure 1).

ECOSYSTEM EFFECTS

Mussel farms present a low risk to the environment because there is no addition of feeds. In general, mussel farms can be considered as significant removers of excess nutrients from waterways. The algae that utilise these nutrients are consumed by mussels and are subsequently removed when harvested as mussel biomass.

While faecal wastes from the farms may occur, these are far less likely to cause high organic loadings on the sea bed in Western Australia than in mussel industries elsewhere in the world, because the local mussel lines are more widely separated in response to the low local food (plankton) levels. Previous monitoring of potential impact on seagrass beds below mussel lines at Albany indicated negligible impact. In Cockburn Sound, large pink snapper that aggregate in the area to spawn are attracted to the mussel farms in some years and are thought to consume significant amounts of mussels.

SOCIAL EFFECTS

The industry provides direct employment to 40–50 personnel and adds valuable diversity to the Western Australian seafood industry.

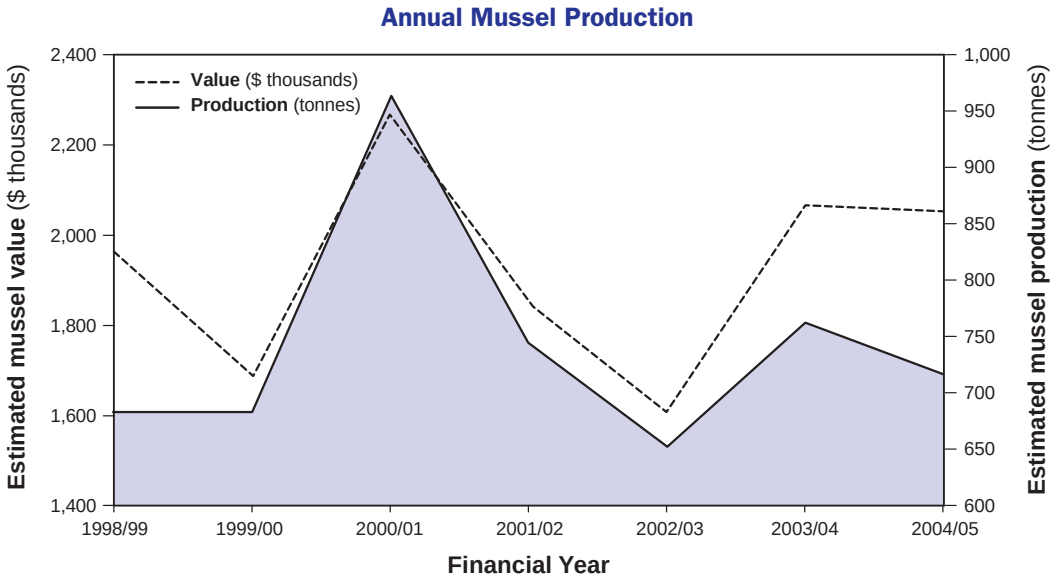
ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2004/05: $2 million

EXTERNAL FACTORS

Productive areas are generally in protected waters where nutrients from terrestrial sources raise the food levels above those in coastal waters, which are dominated by the low-nutrient, tropical Leeuwin Current. Changes in effluent levels entering the region can affect mussel farm productivity.

It is possible that the proposed increased use of Cockburn Sound for ports, desalination and power generation may increase resource-sharing issues within this area.



MUSSEL FARMING FIGURE 1

Estimated mussel production and value from 1998/99 to 2004/05.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education in commercial and recreational fisheries in the west coast bioregion is undertaken by Fisheries and Marine Officers (FMOs) based at the Busselton, Bunbury, Mandurah, Rockingham, Fremantle, Hillarys, Lancelin, Jurien, Dongara and Geraldton offices, as well as aboard the large ocean-going patrol vessels *Hamelin, McLaughlan* and *Walcott.*

Services provided by land-based officers include processing inspections, landing and gear inspections, licensing checks, wholesale/retail checks and inshore sea-based patrols utilising vessels ranging in size from 5 m to 12 m. They also provide support to seagoing personnel and provide a wide variety of educational and extension services through formal and informal media to commercial fishers, fishing operations, other resource management agencies and community members.

The Department 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 and Canning Rivers). Outside of this area marine safety is unfunded and inspections are carried out in combination with fisheries compliance inspections.

Activities during 2004/05

During 2004/05, FMOs delivered a total of 57,055 hours of compliance and community education services (West Coast Compliance Table 1), of which 40% was focused on the West Coast Rock Lobster Managed Fishery. A continuing emphasis was placed on employing risk- and intelligence-based approaches to compliance planning and prioritisation.

Prior to the commencement of the 2004/05 rock lobster season, a Compliance Risk Assessment Conference was held

with industry members to identify ongoing areas of major compliance risk to the fishery, the results being incorporated into the compliance planning process. One of the continuing major areas of concern was that of fishers pulling their rock lobster pots prior to the prescribed starting time each day. While a number of targeted operations were conducted, no apprehensions were made. Other issues addressed included interference with gear, illegal fish sales, over-potting and failing to release totally protected rock lobsters.

Compliance in commercial fisheries was generally good, with 382 infringement warnings and 71 infringement notices issued and 49 prosecutions instigated.

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 7 checks per vessel throughout the fishery (West Coast Compliance Table 2). Decreasing from 26 baskets in 2003/04, the average number of baskets inspected per vessel was 22. This is also reflected in the total catch inspected, which fell to between 2.3% and 2.9% (from 3.3–3.5% in 2003/04).

The Rock Lobster Compliance Coordinator continued the education and liaison program through attendance at association and RLIAC coastal tour meetings, educating fishers about rule changes, providing information and feedback on local compliance issues and receiving complaints from industry members. Fifteen rock lobster fishermen's association meetings were attended; and three major rock lobster compliance operations were carried out utilising staff from throughout the bioregion.

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

Season 2004/05 was the second year that the Abrolhos Islands baldchin groper closure was implemented. Aimed at protecting spawning stocks, the precautionary three-month closure between 1 November and 31 January was introduced to assist with addressing some localised depletion of these fish at the Abrolhos. Officers based at the Abrolhos Islands continued an extensive education and compliance campaign to ensure the closure's success.

Considerable compliance activity was directed towards recreational fisheries within the bioregion, with FMOs achieving 39,229 field contacts with recreational fishers – an increase of 22% on 2003/04. This is largely due to the presence of FMOs at boat ramps within the metropolitan and other regional areas tasked with conducting recreational marine safety vessel inspections. This continues to be a success, with FMOs providing both fisheries and marine safety compliance services more efficiently.

While the recreational rock lobster fishery was the target of much of the compliance effort, once again significant time was also spent on abalone, net fishing, marine finfish and crabs. The possession of under-size rock lobsters and crabs continued to be a problem across the region.

Throughout the bioregion a total of 676 infringement warnings and 235 infringement notices were issued and 103 prosecutions were instigated for recreational offences during 2004/05. This is similar to the figures for 2003/04. It is hoped that these figures will decrease in coming years as recreational fishers become more knowledgeable about fishing regulations.

During 2004/05, FMOs delivered over 15,400 hours to the marine safety compliance program within the bioregion. Officers conducted 8,604 safety checks on recreational vessels and 379 checks on commercial vessels.

The Volunteer Fisheries Liaison Officer (VFLO) program continued to play a vital role in the education of fishers in 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 and fishing workshops, and attended various boat shows and festivals. Research activities in which VFLOs participated included abalone research, tailor research at Point Walter and Floreat Drain, and samson fish research off Rottnest Island.

Metropolitan VFLOs, through the support of the Fishers with Disabilities Association Incorporated, took the Fishers with Disabilities program to Geraldton for the first time. The VFLOs held two fishing workshops in conjunction with the Geraldton VFLOs, which had over 40 participants and 20 carers in attendance.

The Mandurah VFLOs joined forces with the Central and Eastern Wheatbelt Be Active Program to take the Learning Circles for Fishers program to Bruce Rock, Doodlakine, Hyden, Kellerberrin, Kondinin, Karlgarin, Moorine Rock, Tammin and Westonia. This program aims to improve understanding of fishing techniques, ethics and knowledge of fishing bag and size limits amongst school-aged children.

Brendan Mitchell (VFLO) was recognised by a 'Commendation for Brave Conduct' for his actions in rescuing a man caught in a rip during the 2002 recreational abalone fishing season.

Initiatives in 2005/06

A full-time intelligence capability has now been established and provides the Department's centralised control point for compliance information. Intelligence products are being used to support a range of core business functions such as investigations, compliance risk assessments, compliance planning and modelling across all bioregions.

Formal information-sharing agreements with a number of our natural resource management partners and the wider law enforcement community are enabling an effective and smarter use of resources within a safe operating environment. Work has been progressing on a statewide intelligence and case management system to refine our information capture processes and remove existing compliance boundaries. The system should be rolled out in early 2006/07.

The Department has been recognised by the Australian Institute of Professional Intelligence Officers 2006 Awards Scheme as the organisation making the most significant progress in utilising intelligence techniques to support objectives within the criminal intelligence context.

The integration of marine safety compliance services into the Department of Fisheries has led to significant rationalisation

of the combined small patrol vessel fleet following a review of the strengths, weaknesses and tasks undertaken in the new joint servicing role. As small vessels become due for replacement, they are replaced by multi-purpose vessels that better meet the needs of at-sea service delivery. This will also assist service delivery in marine conservation reserves, in keeping with jointly planned initiatives by the Department of Environment and Conservation and the Department of Fisheries. A replacement patrol vessel to for Abrolhos Islands management has been commissioned and is due to be launched in 2006/07.

The new Marine Operations Centre in Fremantle was completed in October 2005. Staff from the Department's Fremantle District Office, Regional Services Management, the Vessel Monitoring System Unit and the Training Unit are now co-located with Marine Officers from the Department for Planning and Infrastructure.

WEST COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types within the west coast bioregion during the 2004/05 financial year

CONTACT WITH THE COMMERCIAL ROCK LOBSTER FISHERY	NUMBER
Hours delivered in bioregion to rock lobster fishery	22,868
Fisher field contacts by Fisheries Officers – rock lobster	2,284
District Office contacts by Fisheries Officers – rock lobster	2,628
CONTACT WITH OTHER COMMERCIAL FISHERIES	
Hours delivered in bioregion to other commercial fisheries	14,799
Fisher field contacts by Fisheries Officers – other fisheries	380
District Office contacts by Fisheries Officers – other fisheries	1,358
COMMERCIAL OFFENCES DETECTED	
Infringement warnings	382
Infringement notices	71
Prosecutions	49
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	19,388
Fisher field contacts by Fisheries Officer	39,229
District Office contacts by Fisheries Officers	15,643
Fisher field contacts by VFLOs	12,846
Fishwatch reports*	306*
RECREATIONAL OFFENCES DETECTED	
Infringement warnings	676
Infringement notices	235
Prosecutions	103

* Data for combined recreational and commercial Fishwatch reports, July 2004 – March 2005. The service provider ceased operation in April 2005, and the interim arrangements implemented do not provide reliable statistics for the period April–June.

WEST COAST COMPLIANCE TABLE 2

Summary statistics of factory inspections of commercially captured western rock lobster in the 2004/05 fishing season.

STATISTIC	VALUE
Number of unique vessels checked	Entire fleet at least once
Average number of inspections per vessel	7
Average number of baskets checked per vessel*	22
Proportion of total commercial catch inspected	2.3 – 2.9%
Non-compliance rate (per-animal basis)**	0.0021 – 0.0033
Total consigned commercial catch ('000 kg)	12 138
Estimated total illegal catch consigned ('000 kg)	25.5 – 32.4

* Calculated as the total baskets checked per vessel divided by total inspections per vessel.

** A rate of 0.001 indicates 1 illegal animal detected in every 1,000 animals checked.

GASCOYNE COAST BIOREGION

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 IMCRA, the bioregion has been divided into four 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, and the Exmouth Gulf section of the bioregion is seasonally influenced by extreme tropical summer cyclones. The Shark Bay end of the region 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 runoff, it has created the highly diverse Ningaloo Reef system and its associated fish fauna. The outer area of the large marine embayment of Shark Bay is also influenced by the warm winter current, while 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 with Exmouth Gulf which has more mud areas and turbidity.

In February 2002, an article in *Science* magazine (Roberts et al. 2002) identified the 18 world hotspots in terms of tropical reef endemism and the threats facing them. The article ranks the west coast of Western Australia as the second most diverse marine environment in the world in terms of tropical reef species, and indicates that is subject to the second lowest level of environmental threat of the 18 areas which were investigated.

Commercial fishing is a very significant industry in the region, with three of the state's most valuable managed fisheries – the Shark Bay Prawn, Exmouth Gulf Prawn and Shark Bay Scallop Fisheries – landing combined catches valued in the range of $40–50 million annually. These fisheries have operated sustainably in the region since the mid-1960s and are internationally recognised as 'best practice' in terms of management and research. The region 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 sector takes demersal species including emperors, baldchin groper/tuskfish and, more recently, the deep-water-dwelling goldband snapper (jobfish). Formal management arrangements for the mackerel fishery were introduced in August 2004.

The special features of the Gascoyne coast, coupled with the warm, dry winter climate and productive fish stocks, have made it a focal point for winter recreation by the Western Australian community. Fishing is a key component of many tourist visits.

A full range of angling activities is available, including beach and cliff fishing (e.g. Steep Point and Quobba), embayment and shallow-water boat angling (Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g. off Ningaloo). 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 region 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 region's developing black pearl farms.

ENVIRONMENTAL MANAGEMENT

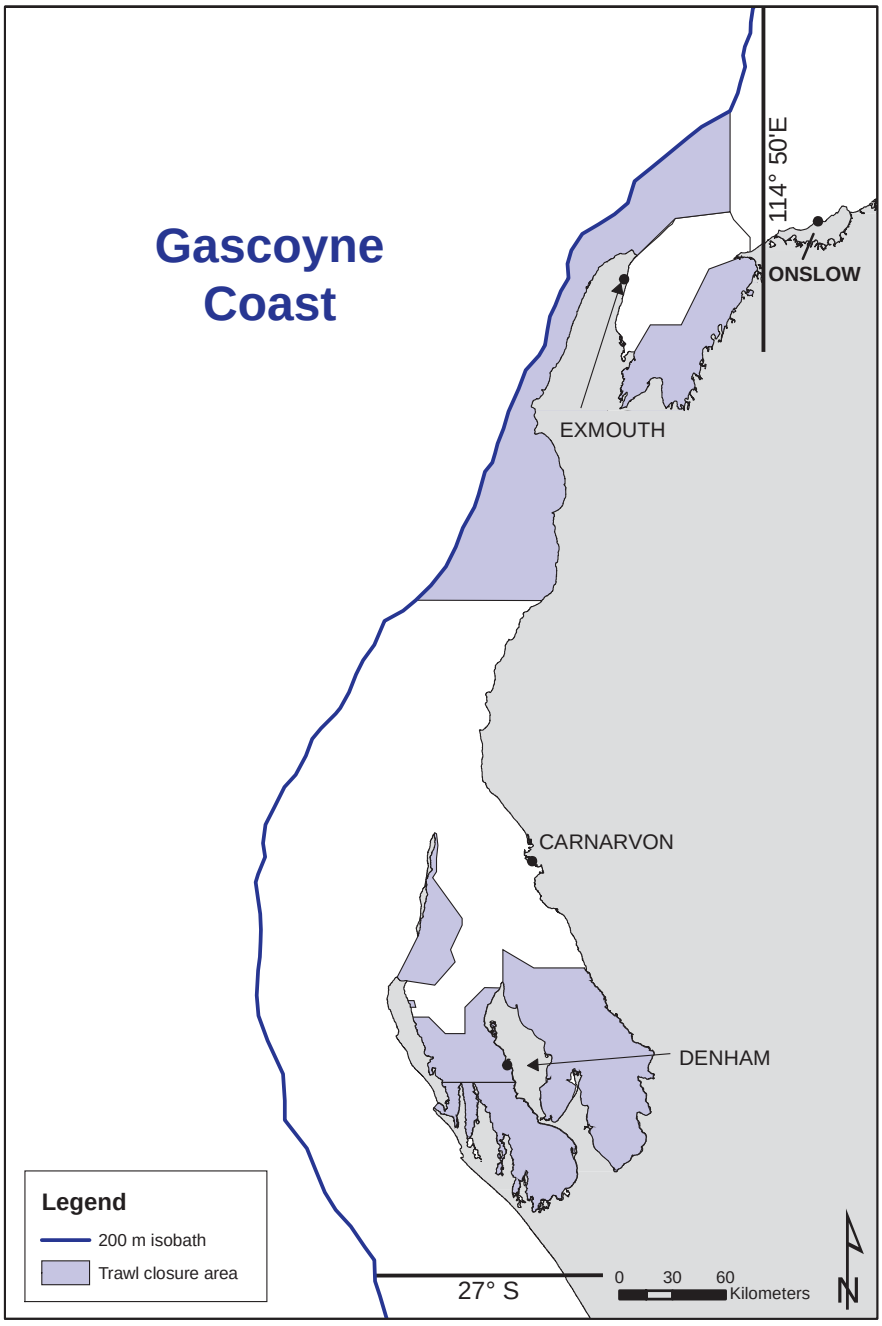
Regional Overview

The naturally attractive features of the Gascoyne, including its protected coastal waters and productive fish stocks, have resulted in the area being a focus of marine management, beginning in the 1960s. The state's earliest marine habitat protection areas, in the form of extensive prawn nursery trawl closures over the sand flats and seagrass beds, were introduced in the 1960s in both Shark Bay and Exmouth Gulf. This system of fisheries closures, later expanded to cover all significant coral areas, has provided long-standing protection to virtually all fragile marine habitats in the bioregion (Gascoyne Coast Habitat Protection Figure 1). The subsequent development of marine parks over Ningaloo Reef and the inner gulfs of Shark Bay (Gascoyne Coast Habitat Protection Figure 2) have added further, complementary protection to these highly valued areas.

Specific commercial fishing regulations implemented in the 1970s and 1980s also preclude the use of large-mesh gillnets and longlines throughout the Gascoyne, to prevent the incidental entanglement of the large populations 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.

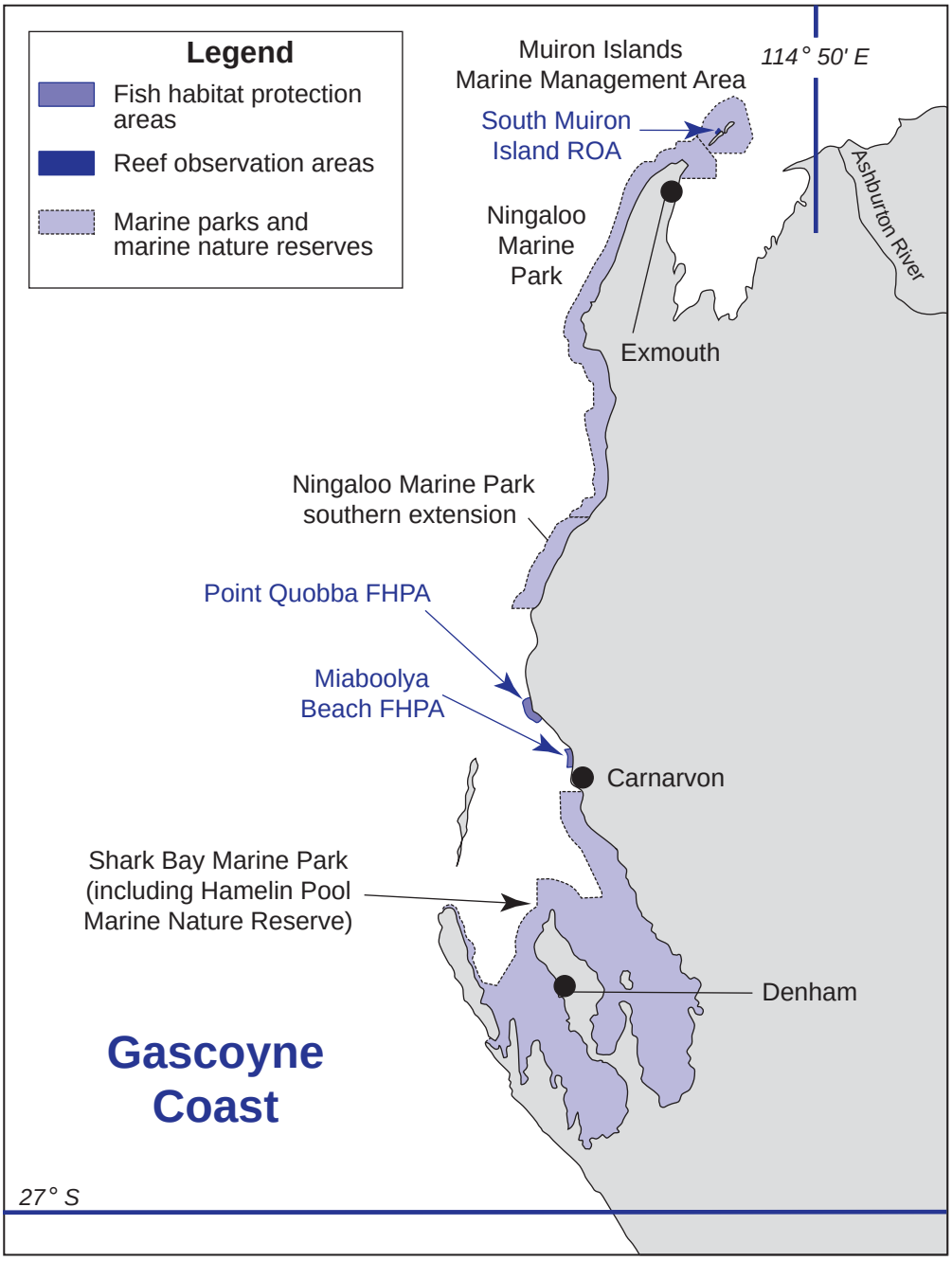
These measures encompassed in the region's long-standing commercial management plans, coupled with recent recreational fishing controls, have enabled this region to retain its high biodiversity status through more than 30 years of commercial fishing and 15 years of significant recreational fishing pressure.

During 2005/06 the Department of Fisheries gazetted orders under under the *Fish Resources Management Act 1994* to modify fisheries regulations to give effect to new management arrangements for the Ningaloo Marine Park. The Department has commenced preparation of orders to implement new management arrangements for the Muiron Islands Marine Management Area.



GASCOYNE COAST HABITAT PROTECTION FIGURE 1

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



GASCOYNE COAST HABITAT PROTECTION FIGURE 2

Map showing areas of protected fish habitat in the Gascoyne coast bioregion.

COMMERCIAL FISHERIES

Shark Bay Prawn Managed Fishery

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

FISHERY DESCRIPTION

The Shark Bay Prawn Managed Fishery targets western king prawns (*Penaeus latisulcatus*) and brown tiger prawns (*Penaeus esculentus*) and takes a variety of smaller prawn species including coral prawns (various species) and endeavour prawns (*Metapenaeus* spp.). King prawns are the dominant species, comprising about 70% of the catch. Tiger prawns make up most of the remaining 30%.

Fishing is undertaken using otter trawls, with 'bison' otterboards (under exemption) and standard flat wooden otterboards.

Governing legislation/fishing authority

Shark Bay Prawn Management Plan 1993
Shark Bay Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Joint Trawl Management Advisory Committee
Department–industry meetings

Boundaries

The boundaries of this managed fishery are the waters of the Indian Ocean between latitudes 23°34′ S and 26°30′ S and adjacent to Western Australia on the landward side of the 200 m isobath (Shark Bay Prawn Figure 1).

Management arrangements

Management of the fishery is based on input controls which include limited entry, seasonal and area openings and closures, moon closures and gear controls. These management arrangements are designed to keep effort at levels that will maintain sufficient spawning stocks and achieve optimal yields.

The yearly cycle of operation for the fishery is dynamic and multi-faceted. Opening and closing dates vary each year depending on environmental conditions, moon phase and the results of surveys, which predict recruitment dynamics. The timing of the opening of the season allows the harvesting of the current season's recruits and the large residual prawns not caught in the previous season. Permanently closed nursery areas within the fishery prevent the fishing of small prawns and provide habitat preservation, while spatio-temporal closures serve to maintain tiger prawn breeding stocks above the threshold abundance level. Within the main fishing period, there are various subsidiary openings and closures designed to increase size, quality and market value while protecting the stocks from recruitment over-fishing. Moon closures run for seven days around each full moon during the season, though on occasions the industry has voluntarily extended these closures to increase economic efficiency by shifting fishing effort away from these times of reduced catch rate. In addition, since 1996 the fishing arrangements in Denham Sound have incorporated industry closures aimed at preventing the take of small prawns early in the season and controlling fishing in the southern part of the Sound where there may be juvenile snapper aggregations.

In 2005, the Shark Bay prawn fishing season formally commenced on 8 March and closed on 13 October (a total of 169 nights). Fishing patterns during the season involved flexible fishing arrangements and voluntary industry closures based on assessment of both king and tiger prawn size through fishery-independent surveys.

The vessel monitoring system continues to monitor the activities of all boats.

The fishery as a whole is subject to a maximum headrope allocation. However, the basis on which the total allocation may be divided among the fleet is under review. For the past few seasons all boats have operated under an exemption from the '375 boat unit rule' currently provided for in the management plan.

Bycatch reduction devices (BRDs) are implemented in this fishery, with all vessels required by way of a condition on the managed fishery licence to fish with a grid and a secondary BRD or fish escapement device (FED) in each net.

A comprehensive ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The issues identified through this process were breeding stock levels of target prawn species, bycatch species impacts, protected species interactions, habitat effects and provisioning effects. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Research activities continue to focus on stock assessment and annual monitoring of the prawn stocks, particularly tiger prawns. All boats complete detailed research log books, and these, together with pre-season recruitment surveys and in-season surveys of size composition and spawning stock, provide the information sources for monitoring the status of the stocks.

An FRDC-funded project examining the biodiversity of bycatch species in trawled and untrawled areas of Shark Bay will be completed in 2006. A second FRDC project with Edith Cowan University has been examining the spatial distribution of abundance of the recruitment survey and the spatial distribution of catch during the fishing season to improve catch forecasting. This project will be completed in 2007.

RETAINED SPECIES

Commercial production (season 2005): 1,628 tonnes

Landings

The total landings of major penaeids for the 2005 season were 1,628 t, comprising 1,049 t of king prawns, 579 t of tiger prawns and less than 1 t of endeavour prawns (Shark Bay Prawn Figure 2). In addition there were also 91 t of minor penaeids (coral prawns) landed.

The total landings were within the target catch range (1,500–2,330 t). Tiger prawn landings were also within the target range for that species (400–700 t). King prawn landings were the lowest in 10 years and slightly below the acceptable catch range (1,100–1,600 tonnes). For the 2005 season, the king prawn effort levels affected catches as the fleet targeted larger king prawns for economic value. There was also a small shift of effort by some boats to target scallops at the end of the season due to good market prices.

Scallop landings by the prawn fleet in 2005 totalled 835 t whole weight. For a more detailed description refer to the Shark Bay Scallop Managed Fishery section (pp. 96–100).

By-product landings included 152 t of blue swimmer crab (*Portunus pelagicus*), 51 t of squid, 11 t of tuna (wetlining), 11 t of cuttlefish, 4 t of mulloway (*Argyrosomus hololepidotus*) and 1 t of other miscellaneous finfish species.

Fishing effort/access level

Twenty-seven boats are licensed for prawn trawling in this fishery, with 25 licences active in 2005 because of gear amalgamation on to other fishing boats.

The total nominal effort recorded by the prawn fleet in 2005 was 39,327 hours, which is much lower than the average level recorded since the 1990 restructure of the fishery to 27 boat licences. This level should not be directly compared to past effort due to changes in gear configuration of boats. Four boats towed more net headrope in quad gear configuration (4 x 5.5 fathom nets) compared to the remainder of the fleet (2 x 8 fathom nets), giving a total headrope length of 424 fathoms compared to 432 in past years. The adjusted nominal effort to reflect the increased headrope (37.5%) towed by the quad boats is 41,716 hours, which is still equal to the lowest level of effort in 35 years.

Catch rate

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 26.7 kg/hr (equivalent to twin gear units) for king prawns observed in 2005, compared to 25.8 kg/hr in 2004, is relatively high given the total landings of king prawns were just below the lower end of the target catch range. The 2005 tiger prawn catch rate of 14.7 kg/hr was higher compared to the 2003 (10.9 kg/hr) and 2004 seasons (12.8 kg/hr) and a significant increase compared to the low catch rates during the 1980s (mean 4.9 kg/hr).

As in 2004, the overall 2005 daily catch rates were maintained at a relatively high rate for the season by the extended full moon closures, which are designed to reduce the period of inefficient fishing.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

King and tiger prawn stock levels are monitored and assessed using catch and effort information from log books, recruit surveys (March and April), surveys in Denham Sound in June and July and tiger prawn spawning stock surveys in June–August.

Voluntary log books provide information on the daily catch (kg) of target species and effort (hours trawled) expended in each fishing area by each boat based on the trawl duration and catch of every shot. From these data catch and effort is obtained for each fishing area.

Spawning stock and recruitment indices are derived from log book data and are compared to the accepted spawning stock–recruitment relationship (SRR) for tiger prawns in Shark Bay. Mature female tiger prawns are mainly caught in deep water north-east of Bernier Island (Area B) and on the trawl grounds west of Carnarvon (Area D) (Penn 1988). Female tiger prawns show advanced gonad development (spawning condition) from July through to November. Therefore, commercial catch rate information in Area D in July and in Area B in August has provided a good estimate of abundance of tiger prawn spawning stock. Due to increasing catch efficiency over recent years there has been a need to monitor the tiger prawn spawning stock levels in the main spawning grounds prior to July to ensure an appropriate catch rate level is maintained (by closing Area D) for the spawning period. The standardised spawning index of Area B in August and Area D in July was above the required catch rate of 2 kg/hr (based on the catch and effort rate of the fishing fleet in the 1970s). The preferred level is 3–4 kg/hr. In 2005 the level was 2 kg/hr. However, it should be noted that in area D the prime tiger prawn spawning grounds are closed to fishing from June onward, therefore the catch rate obtained using daily log book data is conservative. More recently, however, trawl closures (triggered annually by a tiger prawn catch rate threshold) during the spawning season (July and August) have resulted in the fleet not fishing the most productive part of Areas B and D at these times. Therefore, since 2003 this indicator has been estimated by using the relationship between catch rates in adjacent months and areas and the traditional spawning area catch rates. This method of estimation will continue until fishery-independent survey-based threshold limits are developed.

Fishery-independent surveys are also undertaken to measure recruitment and ensure that fishing is undertaken on appropriate sizes for market value each season and with the aim of providing catch predictions. Environmental factors, in particular the variation in the strength of the Leeuwin

Current, are being examined to improve the understanding of variations in the annual catch and hence SRR for the king prawn stock.

Breeding stock levels: Adequate

The multi-species nature of this fishery requires the levels of harvest for both king and tiger prawn stocks to be carefully monitored to simultaneously achieve the optimum sustainable catches. Current stock and recruitment studies indicate that at current exploitation levels the king prawn stock remains above the level where recruitment is 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 abundance of the spawning stock.

In contrast, the recruitment levels of tiger prawns during the 1980s were demonstrably affected by reduced spawning stock biomass. Management practices have subsequently been improved to increase the level of the spawning stock. This included the implementation of a temporal closure of the Carnarvon/Peron line, aimed at reducing effort on tiger prawns early in the season, as well as the introduction of a tiger prawn spawning area (TPSA) closure in 1996. These measures have both had favourable impacts on the tiger prawn stock. In addition, commencing in 2005 the Research Division and industry agreed to raise the catch rate threshold level for the TPSA from 10 kg/hr to 18–22 kg/hr. Tiger prawns have seen relatively stable catches over the last 10 years even though there is increasing effective fishing effort.

Two standardised research surveys (to confirm commercial catch rates derived from log book information) were carried out in the TPSA (Shark Bay Prawn Figure 1) in July and August to obtain the catch rate of tiger prawns. The average catch rate of tiger prawns from the surveys was 30 kg/hr in 2005 compared to 20.3 kg/hr in 2004, 26.8 kg/hr in 2003 and 15.5 kg/hr in 2002.

This regime of surveys and closures will continue to allow an analysis of its usefulness in protection of spawning stock. The threshold catch rate level will be monitored to ensure that it is set at the desirable level.

Variable quantities of minor penaeids (predominantly coral prawns) are retained, depending on the catch of the target species. Owing to the small size of these species, it is likely that the majority of the stock is able to pass through the mesh, suggesting that the overall exploitation is low and that breeding stock levels will therefore be adequate.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2005, the breeding stock indicators for tiger prawns and coral prawns were met. The king prawns were slightly below the catch range but this was due to reduced effort, targeting of larger size prawns and a small shift of effort away from king prawns. Endeavour prawns were also below the catch range, but this is not of concern as this species is not targeted in this fishery.

NON-RETAINED SPECIES

Bycatch species impact: Moderate

Bycatch composition is dominated by dead wire weed, which breaks off the extensive shallow Wooramel seagrass bank annually over summer. The bycatch also contains a number of small fish species mostly not taken by other sectors. Small blue swimmer crabs and other crustacean species are also taken in significant quantities but are generally released alive. Overall bycatch levels are moderate relative to other subtropical trawl fisheries at about 4–8 times the prawn catch. Field sampling for a study on the composition and abundance of bycatch of trawled and untrawled areas of Shark Bay was completed in 2004, with data analysis and report writing to be completed by late 2006. Secondary bycatch reduction devices (square mesh panels in cod ends) are now fully implemented and should further reduce the quantity of small fish retained in trawls.

The two performance measures for the fishery relate to (i) its impact on biodiversity through the take of no-ntarget (bycatch) species, and (ii) its impact on associated species, e.g. dolphins, through the discarding of bycatch (provisioning). In the case of biodiversity, a major project surveying bycatch species on and off the trawl grounds has been completed, with the final report underway. Preliminary analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas (even though abundances may vary), indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort and implementation of 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. However, there is a short period of time in a specific area that is grid-exempt due to excessive weed. This area generally has low occurrence of turtles, minimising captures during this time, and the short trawl duration (maximum 60 minutes) required in Shark Bay to accommodate the high prawn catch rates and the clogging effects of dead wire weed means that any turtles caught can be returned to the sea alive.

One performance measure for the fishery is for 90% of turtles from non-BRD nets to be returned alive. For the 2005 season, 2 turtles (1 loggerhead and 1 unidentified) were recorded as caught in nets (either during the grid-exempt period or caught on the grid). Both were recorded as being returned to the sea alive.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Although the harvest rates of the retained target species are high, such species have very high natural mortality rates and make up a relatively small proportion of the 'fish' biomass on the trawl grounds. Thus, most prawn predators are opportunistic due to these natural variations in prawn populations. Consequently, it is not likely that the commercial take of prawns impacts significantly on the upper trophic levels within the Shark Bay ecosystem. The reduced levels of effort now used by the fishery, combined with the modifications to gear to reduce unwanted catch, will have further reduced the potential for indirect impacts to occur.

Habitat effects: **Moderate**

As a result of the extensive permanent and temporary closures first introduced via the management plan in the 1960s and 1970s respectively (Shark Bay Prawn Figure 1), the fleet operates in approximately 5% of the overall licensed area of the fishery. Inside Shark Bay, trawl fishing is focused in the deeper areas (predominantly sand/shell habitats) of the central bay, north of Cape Peron and in the northern area of Denham Sound. The majority of sponge/coral habitats are contained within specific trawl closures to protect these areas.

Performance measures for habitat impact relate to the spatial extent of trawling within Shark Bay's sand/shell and coral/sponge habitats. In 2005 the performance measure was met as the total area trawled within Shark Bay, at approximately 884 square nautical miles or ~18% of inner Shark Bay, was below the 40% level and focused only in areas of sand/shell habitat. Most sponge/coral habitats in Shark Bay are now protected by fishery closures, and in 2005 no trawling occurred on the few known sponge/coral habitats areas within the designated trawlable area of the fishery.

SOCIAL EFFECTS

The estimated employment for the year 2005 was 120 skippers and crew. There are also prawn processing and support staff employed at Carnarvon and Fremantle. This industry, in conjuction with the other trawl fisheries for prawns and scallops in the Gascoyne bioregion, is a major contributor to regional employment.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $22.7 million

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, the price of prawns was similar to those in 2004 and 2003 and average ex-boat prices were as follows:

King prawns	$12.60/kg
Tiger prawns	$15.70/kg
Endeavour prawns	$6.70/kg
Coral prawns	$4.00/kg

FISHERY GOVERNANCE

Target catch range: **1,501–2,330 tonnes**

Under current effort levels and normal environmental conditions, and based on catches in the 1990s following the restructuring of the fishery to 27 licences, the target catch range for major penaeids is 1,501–2,330 t. Target catch ranges for individual species are king prawns 1,100–1,600 t, tiger prawns 400–700 t and endeavour prawns 1–30 t. King and endeavour prawn catches during 2005 were just below the target ranges set, while tiger prawn catches were within the target range.

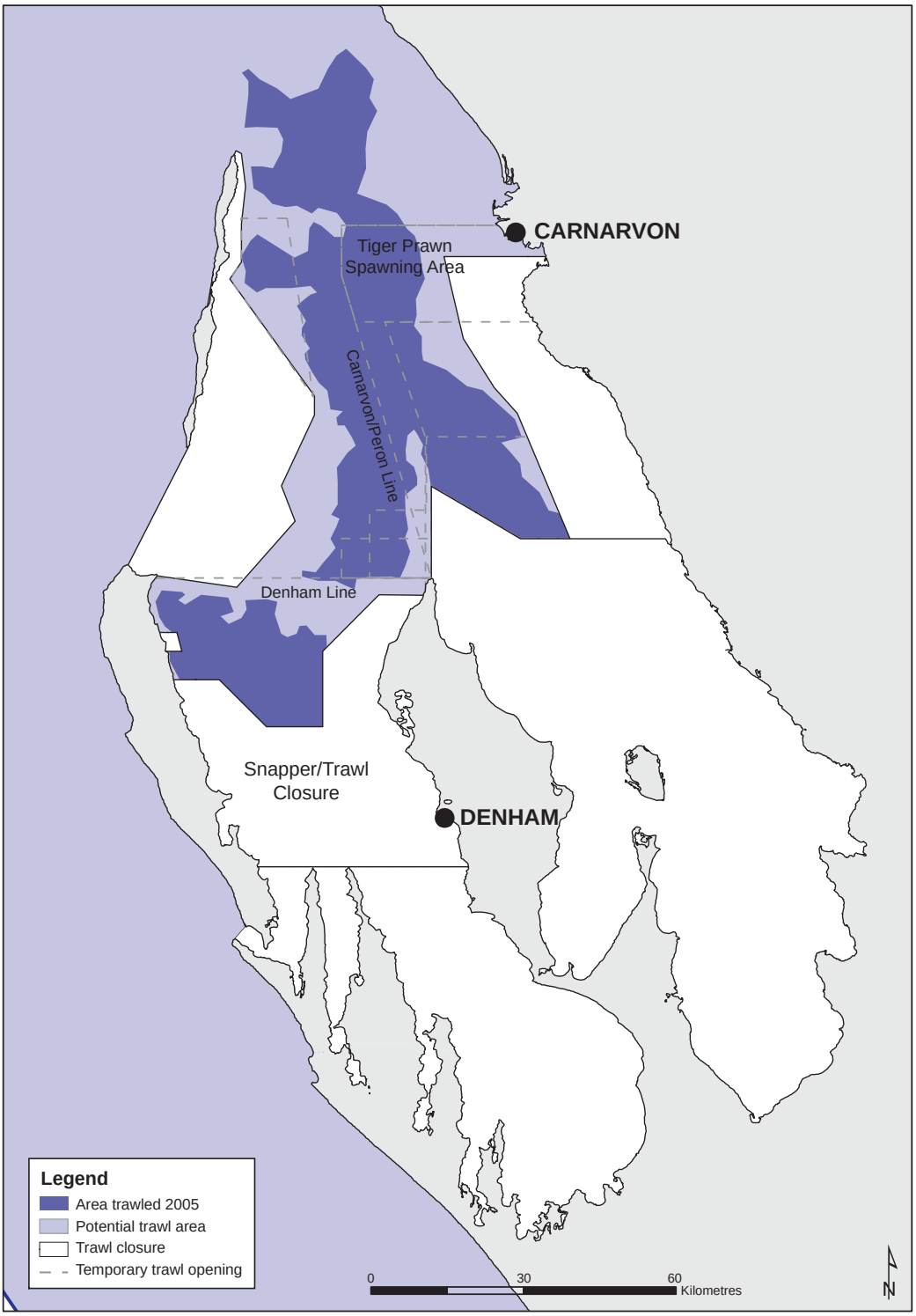
New management initiatives (2005/06)

Legislative changes to permit greater flexibility in the distribution of gear units among the fleet are currently in the drafting stage.

EXTERNAL FACTORS

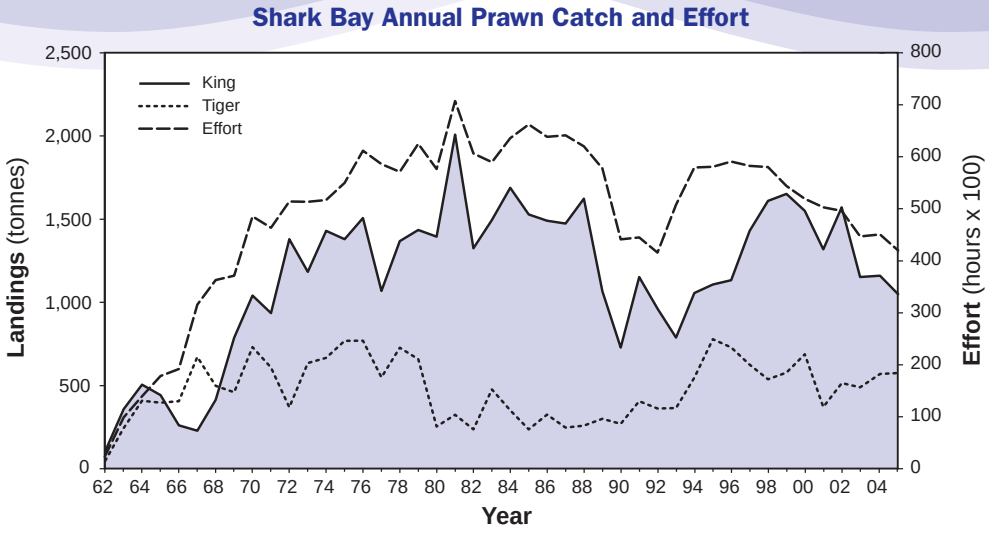
The catches of prawns in Shark Bay are relatively stable compared with other penaeid fisheries. The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment. A relationship between current strength (as measured by Fremantle sea level) and king prawn catches has been identified and may be used to indicate broad catch trends. The mechanism proposed is that higher current flows increase water temperatures and catch rates of the prawns.

The Leeuwin Current also appears to affect scallop recruitment, which can cause a redirection in effort away from prawn areas and artificially lower prawn catches when scallops are very abundant due to a shift in effort/targeting.



SHARK BAY PRAWN FIGURE 1

Boundaries of the Shark Bay Prawn Managed Fishery.



SHARK BAY PRAWN FIGURE 2

Shark Bay Prawn Managed Fishery annual landings and effort, 1962–2005.

Exmouth Gulf Prawn Managed Fishery Status Report

E. Sporer and M. Kangas

Management input from S. O'Donoghue

FISHERY DESCRIPTION

The Exmouth Gulf Prawn Managed Fishery targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*). Fishing is undertaken using otter trawls.

Governing legislation/fishing authority

Exmouth Gulf Prawn Management Plan 1989
Exmouth Gulf Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Joint Trawl Management Advisory Committee
Department–industry meetings

Boundaries

The boundaries of the Exmouth Gulf Prawn Managed Fishery are *'the waters of the Indian Ocean and Exmouth Gulf below high water mark lying south of a line starting at Point Murat and extending northeasterly to the southern extremity of South Muiron Island; thence generally northeasterly along the southeastern shore of that island to its easternmost extremity; thence northeasterly to the southern extremity of North Muiron Island; thence northeasterly and northerly along the southeastern and eastern shores of that island to its northern extremity; thence easterly to the northern extremity of Serrurier Island; thence generally southerly along the western shores of that island to its southern extremity; thence southeasterly to the southern extremity of Locker Island and then due south to the mainland'* (Exmouth Gulf Figure 2).

Management arrangements

Management of this fishery is based on input controls which include limited entry, seasonal and area openings and closures, moon closures and gear controls. These management arrangements are designed to keep fishing effort at levels that will maintain sufficient spawning biomass of prawns (particularly tiger prawns).

The yearly cycle of operation for the fishery is dynamic and multi-faceted. Opening and closing dates vary each year depending on environmental conditions, moon phase and the results of fishery-independent surveys, which predict tiger prawn recruitment. Management arrangements in recent seasons have provided for 200 fishing nights with a minimum of 28 non-fishing nights for moon closures (i.e. four nights each full moon). For the 2005 season, official opening and closing dates were set at 7 April and 30 November 2005 respectively. However, this is a flexible arrangement and the season actually commenced on 17 April, based on results from pre-season surveys, and closed at 8 a.m. on 24 November (a total of 173 days). There were also spatio-temporal closures during the early part of the season (April–July) to avoid fishing on small prawns.

Stringent measures are in place to ensure that spawning stock levels are adequate and that the prospect of both recruit and growth over-fishing is avoided. These measures will continue to be applied while incorporating a flexible

fishing regime to optimise size and value of tiger prawns. There is a consultative process in operation whereby the Research Division and industry jointly decide on the timing and extent of areas to be fished or closed according to size and abundance of prawns. This process allows industry to undertake supervised research surveys to determine changes in prawn distribution, abundance and size composition during the season, thus enabling a rapid response to resource fluctuations to maximise tiger and king prawn size (and hence market value) while still providing a sustainable approach to stock management.

Management guidelines first introduced for the 2002 season prescribe a mandatory closure of the tiger prawn spawning area when the tiger prawn catch rate falls to 19 kg/hr (quad gear catch rate) or on 1 August, whichever is the sooner. From 1 November, after the main spawning period, the catch rate threshold level is reduced from 19 kg/hr to 14 kg/hr.

The vessel monitoring system continues to monitor the activities of all boats.

The fishery as a whole is subject to a maximum headrope allocation. However, the gear configuration package (net and board sizes) permitted within this total allocation are under review, with vessels operating for the past few seasons under an exemption allowing the use of 'quad gear' (four smaller nets) rather than the standard twin 7.5-fathom nets. This has resulted in a reduction in the number of boats with the headrope allocation redistributed among the remaining boats.

Bycatch reduction devices are implemented in this fishery, with all vessels required by way of a condition on the managed fishery licence to fish with a grid and a secondary BRD or 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. Industry also installed 'hopper' in-water sorting systems in 2002, which provides an improved quality of prawns and reduces mortality for some bycatch species.

A comprehensive ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The issues identified through this process were breeding stock levels of target prawn species, bycatch species impacts, habitat effects and provisioning effects. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Research activities continue to focus on stock assessment and surveys to monitor both annual recruitment of tiger prawns and the residual spawning stock levels, and a pre-season survey of king prawns to assist with harvesting strategies. Monitoring of fleet fishing activity is undertaken to determine the timing of the closure of the tiger prawn spawning area. All boats complete detailed research log books, which together with survey data and factory catch unload records, provide the information sources for managing the fishery.

The Department and industry continued the monitoring of juvenile tiger prawn habitats (seagrass/algal communities) and their regeneration after being depleted by the effects of Cyclone Vance in 1999 (which resulted in a very poor recruitment in 2000).

The FRDC-funded project examining the biodiversity of bycatch species in trawled and untrawled areas of Exmouth Gulf will be completed in 2006.

RETAINED SPECIES

Commercial production (season 2005): 1,068 tonnes

Landings

The total landings of major penaeids for the 2005 season were 1,068 t, comprising 449 t of king prawns, 416 t of tiger prawns and 203 t of endeavour prawns. The total landings were lower than in the last two seasons, though within the target catch range.

The tiger prawn landings were lower than in 2004 but within the normal catch range of 250–550 t (Exmouth Gulf Prawn Figure 1). Historically, king prawn landings have been relatively stable compared to tiger prawn catches, irrespective of the high fishing effort levels. Following Cyclone Vance in 1999, annual king prawn catches fell below 300 t, but recovered to within the target catch range of 350–500 t in 2004 and remained so in 2005. The endeavour prawn landings of 203 t were within the target catch range for this species.

Recorded landings of by-product included 32 t of coral prawns, 18 t of blue swimmer crab (*Portunus pelagicus*), 10 t of squid, 2 t of bugs (*Thenus orientalis*) and 1.5 t of cuttlefish.

Fishing effort/access level

There are 16 boat licences in this managed fishery, but as a result of changes in gear configuration only 12 boats operated during the 2005 season. Since 1990 the total allocation of net headrope for this fishery has been set at 240 fathoms, based on 16 boats each towing 15 fathoms. An ongoing restructure of the fleet to achieve economic efficiency while maintaining sustainable catch levels has seen trialling of quad gear (four nets). In 2003 the boats towed 4.5 fathom nets in quad gear configuration and the fleet was reduced to 13 boats while utilising 234 fathoms. Because of the unused fathoms, a trial was undertaken in 2004 with two boats towing larger nets, with the aim of utilising all the net allocation and further reducing boat numbers in the fleet. These two boats towed 7 fathom and 6 fathom quad gear. For the 2005 season these same two boats towed 6 fathom quad gear but with different sized otter boards and two other boats trialled 5 fathom quad gear. One other boat in the fleet towed 3.75 fathom quad gear (this boat is a single licensee with a maximum net headrope allocation of 15 fathoms). The remainder of the fleet remained unchanged, each towing 4.5 fathom quad gear nets. The total net headrope length used during the 2005 season was 229 fathoms, the same as in 2004, but less than that used during the 2003 season (234 fathoms) with 13 boats fishing.

Total nominal effort for the 2005 season was 24,039 hours. The equivalent effort in twin-gear terms (16 boats), after

adjusting for changes in configuration from twin to quad gear, was 32,052 hours, which was slightly lower than in 2004 (33,165 hours). Of the 200 nights allocated to fishing, the fleet fished 173 nights during the season, less than the 183 nights fished in 2004. The 2005 nominal effort level was the lowest since 1971.

Fishing ceased on 24 November when the catch rate of tiger prawns declined but was still above the threshold level

Catch rate

The standardised catch per unit of effort data from the fishery is an indicator of abundance which can be used to monitor changes in stock levels from year to year. The catch rate in twin-gear terms (two 7.5 fathom standard nets) for king prawns increased from 6.9 kg/hr in 2003 to 13.1 kg/hr in 2004 and 14 kg/hr in 2005, which is higher than the average catch rate recorded for this species in the 1990s. The catch rate of 13 kg/hr for tiger prawns is down on the 19 kg/hr in 2004 and 2003 and back to average levels.The endeavour prawn catch rate of 6.3 kg/hr was lower than in 2004 but similar to 2003 (6.7 kg/hr).

STOCK ASSESSMENT

Assessment complete: **Yes**

The tiger and king prawn stocks are assessed each year using regular surveys, which permit variations to the management arrangements within the season to optimise catch and size grades.

For tiger prawns, this process involves analysis of survey-based indices of recruitment and spawning stock, which are assessed against the spawning stock–recruitment relationship. 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 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 higher, 'normal' range catch in 2004 and 2005, without any significant change to fishing practice, indicates that the low recruitment was unlikely to be related to the breeding stock levels. Further years of catch data will be required to both confirm this recovery and assess the spawning stock–recruitment relationship for this king prawn stock.

Breeding stock levels: **Adequate**

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 of 8–10 kg/hr (twin gear) adjusted for effective effort. Adjustments to the catch rate threshold level over time have occurred to account for gear efficiency. Prior to 2002 the catch rate threshold level had been raised from 12 kg/hr to 16 kg/hr nominal effort for twin gear (7.5 fathom nets). It was then further readjusted to the present cut-off threshold catch rate of 19 kg/hr based on 4.5 fathom quad gear boats. During 2005, tiger prawn catch rates were closely monitored from May to August and the tiger prawn grounds closed on 1 August with the catch rate still above the threshold level. Three standardised tiger prawn breeding stock surveys carried out from August to October showed an average CPUE of 25.1 kg/hr in the main spawning area (Q1), above the threshold level. The August, September and October surveys showed a CPUE of 25.6 kg/hr, 28.2 kg/hr and 21.5 kg/hr respectively, and therefore the tiger prawn spawning area (Area B) was reopened for fishing on 2 November 2005 for the remainder of the season until the fleet ceased fishing. For this period the tiger prawn catch threshold level was lowered from 19 kg/hr to a catch range between 12 and 14 kg/hr. This was done to further investigate the effect on recruitment in the following season from having a harvest strategy that maintained relatively high levels of tiger prawns during the spawning season (August–October) but allowed these to be fished to levels below 19kg/hr after the main spawning period had finished. The spawning survey regime extends to the central Gulf (Q2 area) and the spawning indices there were higher (average 4.5 fathom quad gear 31.3 kg/hr) than seen in the Q1 area each month.

The long-term effects of this strategy upon recruitment will be assessed. During the fishing period in November 2005 the daily catch was monitored, showing that the catch rate of tiger prawns in the spawning grounds was approximately 15 kg/hr when fishing ceased on 24 November.

King prawn breeding stock levels in the fishery are maintained at adequate levels during normal environmental conditions through controls on fishing effort and the extended breeding period and lower catchability of the species compared to tiger prawns.

The 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 2005 season, with no cyclonic impacts or heavy rainfall during the summer months (December–March).

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2005, the breeding stock indicators (catches within specified ranges) for king, endeavour, banana and coral prawns were all met, as was the catch rate indicator for 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.

Projected catch next season (2006): 225–340 tonnes tiger prawns

The catch prediction for tiger prawns is based on the relationship between recruitment survey indices (early and late March and early April) and the season's landings (April–November of the same year). For 2006, the projected tiger prawn catch range is 225–340 t under normal environmental conditions.

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, nine boats during 2005 (compared to eight in 2004 and seven during 2003) used hoppers (in-water catch sorting systems), which adds another level of improvement for bycatch survival and product quality.

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 underway. Preliminary analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas (even though abundances may vary), indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort and implementation of 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. Grids are now compulsory, which has largely eliminated the capture of any turtle or other large animal. In addition, secondary bycatch reduction devices (square mesh panels) were implemented all nets in 2005. No turtles were reported as being caught in nets during 2005.

ECOSYSTEM EFFECTS

Food chain effects: Low

Although the prawn species are managed at relatively high levels of annual harvest, the impact of the catch on local food chains is unlikely to be significant in view of the high natural mortality, extent of non-trawled nursery areas and variable biomass levels of prawns resulting from variable environmental conditions such as cyclone events.

Habitat effects: Low

Historically the fishery impacted on some shallow water areas (< 12 m) 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 2005 the performance measure was met as the total area trawled, at approximately 410 square nautical miles or ~33% of Exmouth Gulf, was below the 40% level.

SOCIAL EFFECTS

The estimated employment for the year 2005 was 37 skippers and crew. Additional processing and support staff are also based in Exmouth Gulf and Fremantle. Within the Exmouth area the fishery is one of the major regional employers and contributes to the economic viability of the Exmouth township.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $12.6 million

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

King prawns	$12.50/kg
Tiger prawns	$13.60/kg
Endeavour prawns	$6.70/kg
Coral prawns	$2.00/kg

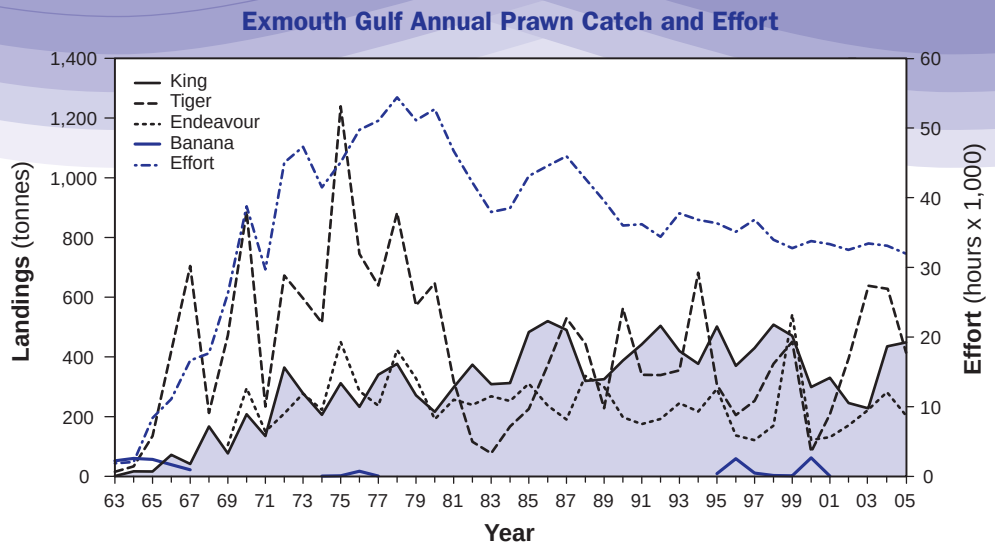
FISHERY GOVERNANCE

Target catch range: 771–1,276 tonnes

Under current fishing effort levels, the target catch range for major penaeids is 771–1,276 t. The long-term target catch ranges for individual species are king prawns 350–500 t, tiger prawns 250–550 t and endeavour prawns 120–300 t (noting that maximum or minimum catches do not occur for all species simultaneously). These overall and individual figures are for normal environmental conditions and are generally based on a 10-year average during the 1990s. The target catch ranges for all species were met for the 2005 season.

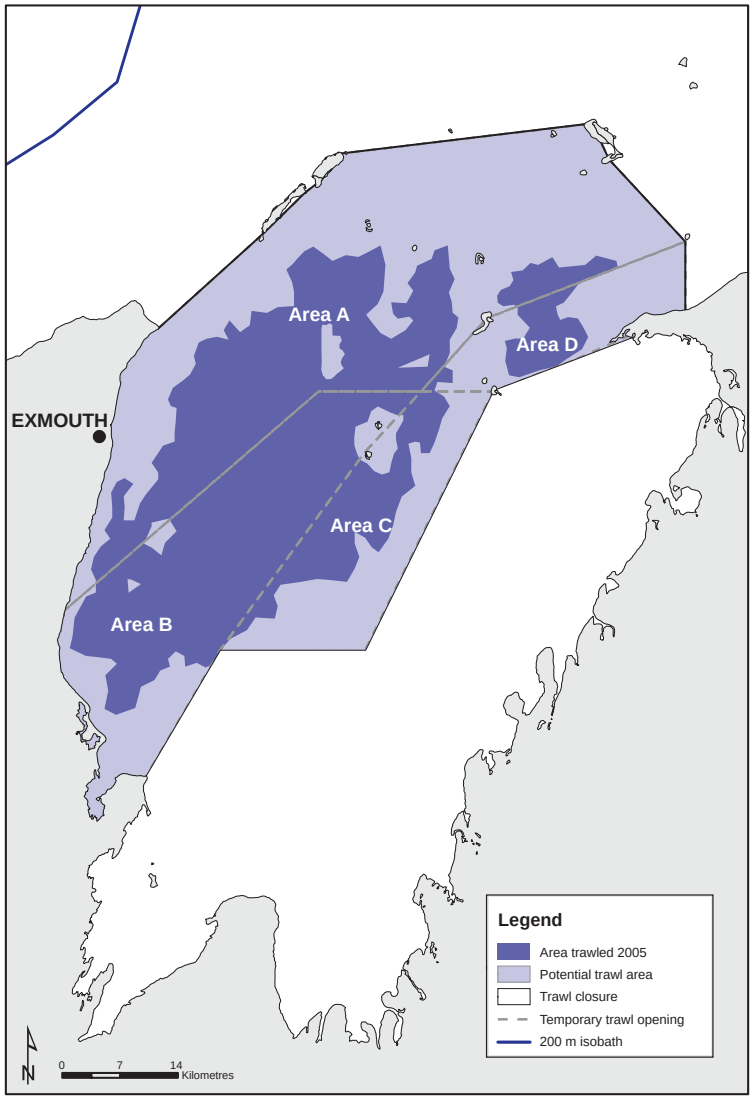
EXTERNAL FACTORS

The impacts of cyclones appear to have a significant effect on the productivity of Exmouth Gulf.



EXMOUTH GULF PRAWN FIGURE 1

Exmouth Gulf Prawn Managed Fishery annual landings and effort, 1963–2005.



EXMOUTH GULF PRAWN FIGURE 2

Boundaries of the Exmouth Gulf Prawn Fishery.

Shark Bay Scallop Managed Fishery Status Report

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

FISHERY DESCRIPTION

The Shark Bay Scallop Managed Fishery catches the southern saucer scallop (*Amusium balloti*), and is usually Western Australia's most valuable scallop fishery. The catch is taken using otter trawl by boats licensed to take only scallops (14 Class A licences) and boats that also fish for prawns in the Shark Bay Prawn Managed Fishery (27 Class B licences).

Catch in this fishery varies widely depending on the strength of recruitment, which is thought to be influenced by the strength of the Leeuwin Current. Most of the catch is marketed to south-east Asia as frozen scallop meat (roe-off).

Governing legislation/fishing authority

Shark Bay Scallop Management Plan 1994

Shark Bay Scallop Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption).

Consultation process

Joint Trawl Management Advisory Committee
Department–industry meetings

Boundaries

The outer boundaries of the fishery encompass '*the waters of the Indian Ocean and Shark Bay between 23°34′ south latitude and 26°30′ south latitude and adjacent to Western Australia on the landward side of the 200 m isobath, together with those waters of Shark Bay south of 26°30′ south latitude*'. Within these general areas, scallop trawling only occurs in waters east of the outer islands of Shark Bay, in depths between 16 m and 40 m. In addition to the outer shelf region, a reef area eastward of the Naturaliste Channel, between the northern end of Dirk Hartog Island and the southern end of Bernier Island, is also closed to scallop (and prawn) trawling; and no scallop trawling is allowed east of a line extending northward from Cape Peron to the mainland.

The boundaries for Class A boats are the waters of Shark Bay and Denham Sound west of longitude 113°30′36′′ E and north of a line running due east from the northern extremity of Cape Bellefin to Peron Peninsula (Shark Bay Scallop Figure 2)

Management arrangements

Management of the fishery is based on input controls which include limited entry, seasonal and area closures, gear controls including bycatch reduction devices (grids) and crew limits.

Management is aimed at catching scallops at the best size and condition for the market, thereby maximising the economic return, while maintaining breeding stock levels. The scallop stock in Shark Bay commences spawning in mid-April (continuing through until the end of November) and meat condition declines as spawning continues. Therefore, the opening date of the season is a compromise between maintaining breeding stock levels (measured by a pre-season survey of stock abundance and commercial catch rates during the fishing season) and the seasonal decline in meat condition associated with spawning.

The 2005 scallop season commenced on 10 March, with all 14 Class A scallop boats fishing in Denham Sound. The early opening of the season was aimed at increasing the total weight of scallops caught by taking them at a time when the meat size is large prior to spawning. To ensure that sufficient stock remained for spawning, the fishing arrangements provided a threshold catch limit whereby the scallop fleet would cease fishing when the catch rate of scallops reached 125 kg meat weight per day fished. (In fact, fishing ceased when the catch rate level was approximately 300 kg meat weight/day). In 2005, for the first time, fishing for scallops in Denham Sound was restricted to daylight hours (6 a.m. – 6.30 p.m.), in order to reduce interaction with prawn stocks.

During the November 2004 scallop survey, a patch of scallops was located in an area named 'the Leads', which lies just south of the Denham Sound trawl area within the snapper/trawl closure. The survey catch prediction for this area was 20–40 t meat weight. Fishing for scallops in this area in 2005 was approved after discussions with the Department of Fisheries and the Snapper–Trawl Working Group (including representatives of the Denham Shire), and subsequent review of the Research survey report. When the scallop fleet ceased fishing in northern Denham Sound, all the dedicated scallop boats moved to fish in the Leads area. The scallop fleet agreed to have observers on board some boats to count pink snapper (*Pagrus auratus*) caught in the area. The scallop boats fished for only two days in April and voluntarily ceased fishing due to the incidental capture of small pink snapper. When fishing ceased in the Leads area, Denham Sound was closed to fishing until 29 July 2005.

The dedicated scallop boats (Class A) moved into the northern part of Shark Bay to commence fishing in the North West Peron and Red Cliff areas on 10 April. Part of the Red Cliff ground was set aside for closure when the catch rate of 400 kg meat weight per 24 hour period was reached. This area closed on 13 April after three days' fishing; fishing continued outside the closed part of Red Cliff for a further day and then the dedicated scallop boats left Shark Bay to fish in the Abrolhos Islands and Mid West Trawl Managed Fishery.

The vessel monitoring system continues to monitor the activities of all boats.

A comprehensive ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The issues identified through this process were breeding stock levels of target scallop species and interactions with protected species (loggerhead turtles). Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Research for monitoring the status of the scallop stock in Shark Bay is based on detailed research log book records

and factory receivals provided by industry. In addition, an annual research survey is carried out in November, which, together with existing detailed biological knowledge, enables an annual catch forecast to be provided. These survey data are also used as the basis for the management arrangements in the following year.

An FRDC-funded project examining the biodiversity of bycatch in trawled and untrawled areas of Shark Bay will be completed in 2006. A second FRDC project with Edith Cowan University has been examining the spatial distribution of abundance of the recruitment survey and the spatial distribution of catch during the fishing season to improve catch forecasting. This project will be completed in 2007.

RETAINED SPECIES

Commercial production (season 2005): 1,923 tonnes whole weight

The total scallop landings for this fishery, for both A and B Class scallop boats, were 1,923 t whole weight, of which the A Class boats landed 1,088 t (56.6%) and the B Class boats landed 835 t. The A Class scallop boat landings comprised 71 t taken from the Red Cliff grounds, 10 t from the North West Peron grounds, 951 t from Denham Sound and the remaining 55 t from the Leads area.

The November 2004 scallop survey provided a catch forecast of 1,240–1,865 t for the entire Shark Bay scallop fishery for 2005, but this did not take into account the catch achieved from the Leads area. The projection may also be affected by the change in fishing pattern (daylight fishing in Denham Sound) and the use of catch threshold limits.

Fishing effort/access level

The total effort recorded by the Class A boats in 2005 was 4,887 hours, a significant decrease from 2004 (8,093 hrs) though an increase compared to the 2003 season (1,598 hours). The lower effort in 2003 and 2005 was due to boats leaving Shark Bay to fish at the Abrolhos Islands where catches were much better.

Catch rate

A mean catch per unit effort of 222 kg/hr (whole weight) was recorded for the Class A fleet in 2005 compared to 147 kg/hr in 2004. This catch rate was substantially higher than the 10-year average of 116 kg/hr.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

The status of the stock is determined from a pre-season survey of recruitment and residual stock carried out in November–December on the main fishing grounds and in Denham Sound. This survey enables management arrangements for the fishery to be determined that take into account fishing scallops at best size, while at the same time conserving appropriate levels of spawning stock. The survey design and analysis of the data provides separate catch forecasts for the northern Shark Bay (Red Cliff and North West Peron) and Denham Sound areas, allowing separate opening dates to be determined for each area to optimise scallop catches each season.

Breeding stock levels: Adequate

Research by the Department has shown that scallops mature at about 1 year of age and spawning typically occurs from April to November. Fishing is therefore controlled to ensure that sufficient scallops remain through the spawning season, particularly winter which is the critical period for generating future recruits.

The performance measure for the fishery is based on the start date for the season which is adjusted annually, using pre-season survey information, to ensure adequate breeding stock levels. In 2005 the fishing season was opened prior to the start of spawning, but with specific cut-off catch rate thresholds applied to certain areas to maintain adequate breeding stock levels.

Projected catch next season (2006): 1,550–2,300 tonnes whole weight

The catch projection for the 2006 season is based on the 2005 survey results. On the main fishing grounds (North West Peron and Red Cliff) in Shark Bay, recruitment was higher than in 2004 and there was a slightly higher abundance of residual animals that will form the broodstock in 2006. The predicted catch forecast for this area is 975–1,450 t whole weight. Lower recruitment levels and higher abundance of residuals were observed in the Denham Sound area, giving a predicted catch of 575–850 t whole weight. The catch projection for the fishery as a whole is therefore 1,550–2,300 t whole weight.

NON-RETAINED SPECIES

Bycatch species impact: Low

Owing to the legislated mesh size of the nets (100 mm) and the relatively short time spent by boats in this fishery, the total bycatch of fish is minimal.

Protected species interaction: Low

Protected species, occasionally captured, are released alive due to the relatively short duration of trawls. During 2003, grids were installed in all nets to minimise the capture of large animals on Class A scallop boats. The risk to these animals is negligible now that grids have been fully implemented.

The performance measure for this fishery is for 90% of turtles from non-BRD nets to be returned alive. BRDs are now compulsory in all nets, and no turtles were reported as being caught by scallop boats in 2005.

ECOSYSTEM EFFECTS

Food chain effects: Low

The ecosystem impacts of saucer scallop fisheries are

unlikely to be significant, taking into account the typically high annual variation in abundance of the species and the high natural mortality associated with short life cycles and natural mortality in the third year of life.

Habitat effects: **Low**

The scallop fleet operates over a limited portion of the licensed fishing area, primarily in the oceanic centre section of Shark Bay. Fishing is concentrated on a small sector of the typically bare sand habitat associated with concentrations of this species. In 2005, 17% of the area available for trawling was fished. As a result of the small area impacted and the short-term impact of the gear on sand habitats, the overall effect of fishing on benthic habitats is low.

SOCIAL EFFECTS

The estimated employment for the year 2005 was approximately 160 skippers and crew. There are also processing and support staff employed at Carnarvon, Fremantle and Geraldton. This and other trawl fisheries in the Gascoyne generate a major component of employment in the region.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $6.5 million

The wholesale price of scallops varies depending on the type of product (grade and meat condition) and the market forces operating at any one time. The average wholesale price across all grades of scallops was $3.40/kg whole weight or $17/kg meat weight. Meat weight is 20% of whole weight.

FISHERY GOVERNANCE

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

The target catch range is approximately 1,250–3,000 t whole weight, based on catches over the 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 three years of El Niño conditions. The projected catch for next season, based on a pre-season survey, is at the middle of this acceptable catch range.

New management initiatives (2005/06)

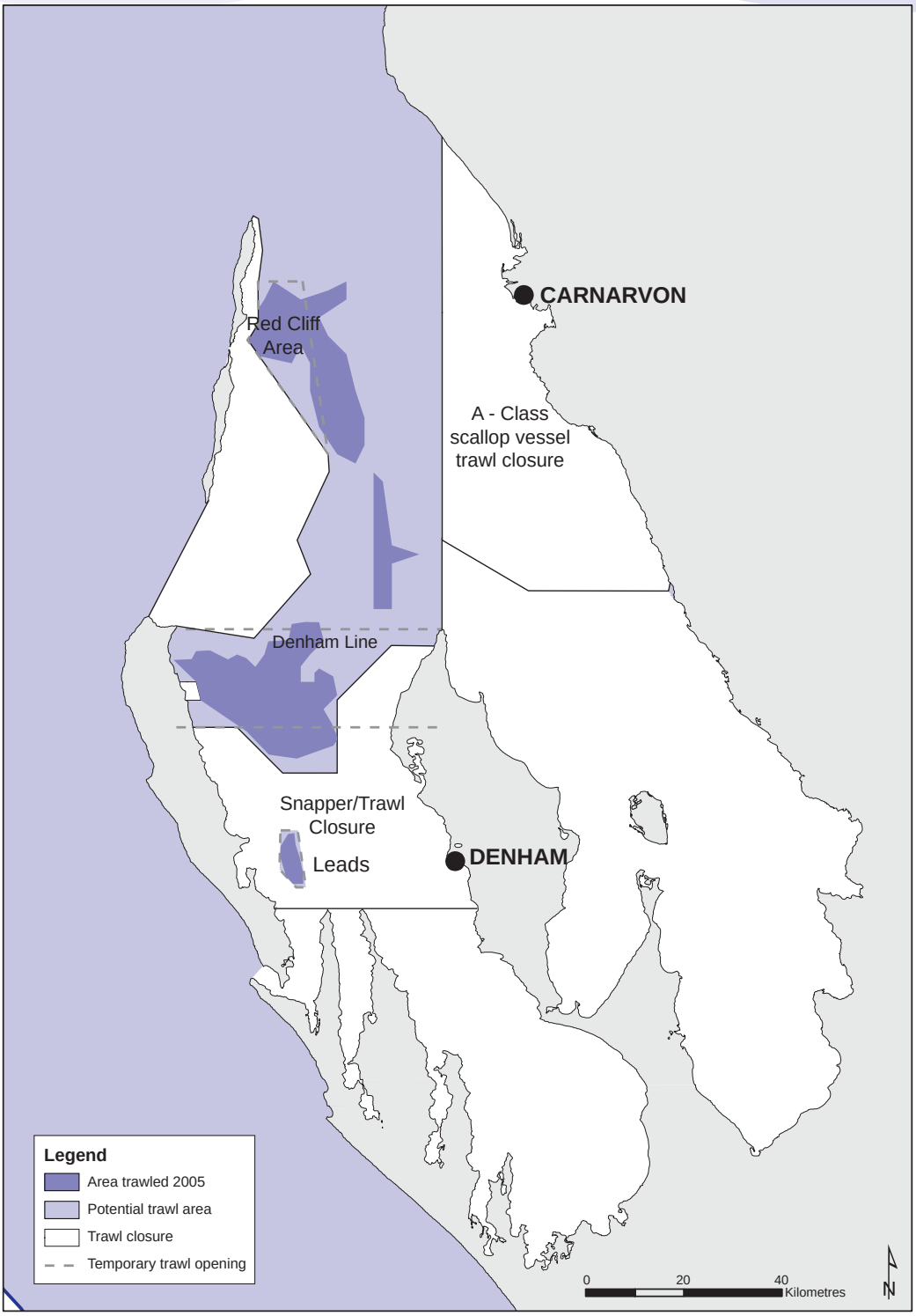
A review of the season opening process was carried out for 2004 and 2005, with selected areas opened to fishing earlier than the time indicated from recruit/residual scallop abundance indices. This initiative aimed to maximise the size and therefore value of scallop meat. As a counter-measure to fishing earlier, all fishing for scallops ceased at a conservative catch rate level in these areas, thereby providing adequate spawning stock protection. These arrangements will continue for the 2006 season and in addition, after the cut-off catch rate is reached the Red Cliff area will remain closed for the remainder of the fishing season to both A and B Class boats.

A trial was implemented for A Class boats during the 2005 season to fish for scallops only during daylight hours (6 a.m. to 6.30 p.m.) each day, rather than over a full 24-hour period. This trial will continue for the 2006 season, although the daily start time will be brought forward half an hour to 5.30 a.m. This initiative is aimed at minimising trawl activity disturbance on the recruiting prawn stock into the northern Denham Sound area.

The threshold catch rate for Denham Sound in 2006 will be set by industry agreement at 280–300 kg meat weight/day. This cooperative agreement, which is significantly more conservative than the threshold rate originally set to ensure that sufficient stock remains for spawning, aims to maintain equity by leaving stock available for fishing by the Class B (prawn) boats after the Class A boats leave the area.

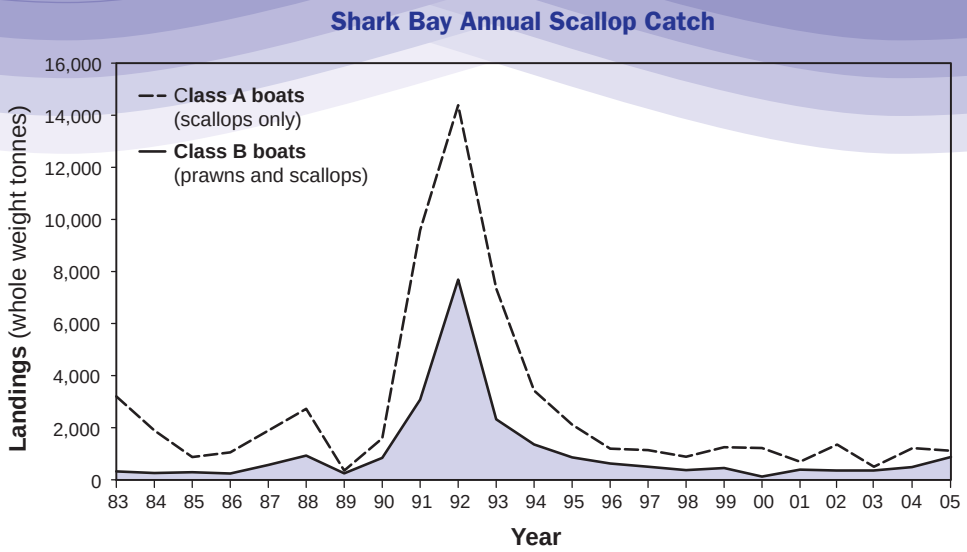
EXTERNAL FACTORS

A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay, particularly in the Red Cliff area. Generally, high sea levels (corresponding to strong Leeuwin Current) correlate with poor recruitment. There is a need to examine the mechanisms that control recruitment success in greater detail in future in order to explain more of the inter-annual variation that occurs. The recovery of this fishery to average catch levels (similar to those before the peak years of 1991–1993) is expected if environmental conditions (including the El Niño/Southern Oscillation index) become favourable.



SHARK BAY SCALLOP FIGURE 1

Boundaries of the Shark Bay Scallop Fishery.



SHARK BAY SCALLOP FIGURE 2

Annual scallop landings by fleet for the Shark Bay Scallop Managed Fishery, 1983–2005.

Shark Bay Beach Seine and Mesh Net Managed Fishery Status Report

J. Norriss and G. Jackson

Management input from M. Stadler

FISHERY DESCRIPTION

The Shark Bay Beach Seine and Mesh Net Managed Fishery (SBBSMNF) is based at Denham and uses a combination of beach seine and haul net gears in the waters of inner Shark Bay. Four main species/groups are taken by the fishery: whiting (*Sillago schomburgkii* and *S. analis*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and yellowfin bream (*Acanthopagrus latus*). Small quantities of other assorted species (e.g. garfish and trevallies) are also caught.

Governing legislation/fishing authority

Shark Bay Beach Seine and Mesh Net Management Plan 1994
Shark Bay Beach Seine and Mesh Net Managed Fishery Licence

Consultation process

Department–industry meetings

Boundaries

The boundaries of the SBBSMNF are '*the waters of Shark Bay from high water mark lying*

(a) south of a line drawn from the northernmost point of Cape Inscription on Dirk Hartog Island due east to the mainland; and

(b) east of a line drawn from Surf Point on Dirk Hartog Island to Steep Point on the mainland; but excluding the waters of Shark Bay due south of a line drawn west of the highwater mark of Kopke Point on the mainland to the highwater mark on the mainland south of Petit Point on Peron Peninsula'.

Management arrangements

The SBBSMNF is managed through input controls in the form of limited entry and gear restrictions. A unit in the fishery comprises one primary vessel, a maximum of three netting dinghies and a maximum team size of three individual fishers, one of whom must be the owner of a managed fishery licence. Most of the catch is marketed through the fish processing factory in Denham, which sets weekly delivery quotas, and commercially acceptable size limits which are above the minimum legal size for the species concerned.

Under the current management plan, licensed operators are subject to net length and mesh size controls which require that:

- *the mesh not be less than 48 mm for taking whiting;*
- *the mesh not be less than 86 mm for taking mullet; and*
- *the mesh not be greater than 38 mm and not less than 26 mm throughout and the net shall not be more than 200 m in total length and have a pocket no more than 30 m in length when used to take garfish.*

Research summary

Monitoring of the status of the targeted stocks is undertaken annually using industry-based data coupled with the extensive scientific knowledge gained from previous research. A draft ESD report for the fishery has been completed which determined performance indicators based on catch and catch rates for the four main target species (whiting, sea mullet, tailor and yellowfin bream).

RETAINED SPECIES

Commercial production (season 2005): 263 tonnes

Landings

The total catch (all species combined) in 2005 was 263 t. While this was 61 t lower than in 2004 (Shark Bay Beach Seine Figure 1), it was within the typical annual catch range which has been relatively stable since 1990 (average 279 t). Catches of the individual target species have varied during this period, however. The total overall catch in 2005 included 115.7 t of whiting (*S. schomburgkii* and *S. analis* combined, although *S. schomburgkii* comprises the greater proportion of the catch), 84.6 t of sea mullet, 19.2 t of tailor and 26.6 t of yellowfin bream (Shark Bay Beach Seine Figures 2–5). In addition, 17 t of more than 13 other assorted species of finfish were reported in 2005, including 0.9 t of pink snapper, 0.8 t of which was caught in the Western Gulf.

Whiting and sea mullet dominate the overall catch by weight and represented 44% and 32% respectively of the total catch in 2005. Because of the higher price paid, whiting represented 52% of the total catch value compared to 18% for sea mullet and 13% for yellowfin bream.

Fishing effort/access level

In 2005, there were 10 registered SBBSMNF licences although only seven boats were recorded as actively fishing. Since 1990, total fishing effort has averaged 1,240 boat days per year, with a peak of 1,760 in 1991 and a low of 979 in 1995 (Shark Bay Beach Seine Figure 1). In 2005, there was a total of 1,140 boat days of fishing effort expended in the fishery, with an average of 6.5 boats fishing per month. Levels of fishing effort have been at historically low levels for the last 10 years, partly due to a reduction in the number of licensees.

Catch rate

The catch per unit effort (CPUE) presented here is the species' total annual catch divided by total boat days for the fishery for the year. In 2005, the CPUE was 230.7 kg/boat day for all species combined. While this represents a decrease from the all-time-high of 309.6 kg/boat day in 2004 (Shark Bay Beach Seine Figure 1), it is similar to the 1990–2004 average of 230.1 kg/boat day. The decrease was primarily due to a decline in mullet catch rate, which attained a record high in 2004.

The CPUE for whiting has fluctuated between 90 and 115 kg/boat day since the early 1990s. A historic peak of 113.6 kg/boat day in 2004 has now been followed by a slight fall to 101.5 kg/boat day (Shark Bay Beach Seine Figure 2).

The CPUE for mullet has been quite variable since the early 1990s, but the rising trend that reached an all-time high of 136.8 kg/boat day in 2004 fell sharply to 74.2 kg/boat day in 2005 (Shark Bay Beach Seine Figure 3). This is more representative of catch rates in earlier decades.

The CPUE for tailor also increased during the early 1990s to a peak of 35.6 kg/boat day in 1995. The high catch rates between 1995 and 2000 were influenced by factory-induced quotas and an increase in market demand for tailor (Shark Bay Beach Seine Figure 4). After 2000 the CPUE declined, stabilising around an average of 21.9 kg/boat day from 2001 to 2004. The 2005 CPUE of 16.8 kg/boat day is similar to CPUE levels in the 1980s and may reflect a decline in abundance.

From 1990 to 2001, the CPUE for yellowfin bream was stable at between 5 and 12 kg/boat day. From 2002, the CPUE began to increase, reaching a historic peak of 26.2 kg/boat day in 2004 (see 'Stock Assessment' below). In 2005, the CPUE declined to 23.3 kg/boat day (Shark Bay Beach Seine Figure 5).

Recreational component < 1%

From the results of the 2001/02 survey of boat-based recreational fishing in Shark Bay, it was estimated that a total of 50 t (all species combined) was taken in 34,000 fisher days, and included an estimated 1.1 t of tailor, 0.8 t of whiting and 0.3 t of sea mullet. The estimated recreational component of the combined commercial and recreational catch for these species at that time was 0.9%. More recently, in 2004, a boat-based recreational survey in Shark Bay estimated that from 34,000 fisher days, 1.3 t of whiting, 0.1 t of tailor and 0.01 t of mullet were taken, representing approximately 0.5% of the combined commercial and recreational catch of these species.

The assessed proportion of catch taken by the recreational sector is therefore estimated to be less than 1%. However, it should be noted that this does not include shore-based catches, of which the four key species are likely to represent a significant component. The recreational catch given here is, therefore, a minimum estimate from the best available data.

STOCK ASSESSMENT

Assessment complete: Yes

Assessment of the SBBSMNF is based on analyses of catch and effort data for the four target species – whiting, sea mullet, tailor and yellowfin bream. A target range of annual catch levels and a trigger level for CPUE have been determined for each species (Shark Bay Beach Seine Table 1). In the event that a catch is outside the acceptable range or CPUE is below the trigger level, a review is initiated, the results of which are used to determine whether further management action is required.

In 2005, the catch levels of whiting and mullet were both within their target ranges (93–127 t and 77–144 t respectively). The 2005 catches of tailor (19.2 t) and yellowfin bream (26.6 t) were, respectively, below and above their target ranges (tailor 25–40 t, yellowfin bream 7–15 t). The tailor catch has been below the target level for two consecutive years. While this will require further investigation, it should be noted that for eight of the 12 years between 1976 and 1987 the annual catch for the species was also below the more recently determined target range.

The catch level for yellowfin bream has been above the target range for four consecutive years. For the past three years (2003–2005), the annual catch has been more than twice the 30-year average. Recent research has shown the increase in catch to be due to a large increase in abundance resulting from an exceptionally strong recruitment in 1999. This is based on the ages of fish collected from the commercial fishery in 2005. Although this recruitment spike coincides with a strong Leeuwin Current in 1999 and 2000 along the outer coast, hydrodynamic evidence suggests there would be

little direct influence on the inner gulfs. The factors which determine annual recruitment strength of yellowfin bream in Shark Bay remain to be determined.

The 2005 CPUEs of whiting (101.5 kg/boat day) and sea mullet (74.2 kg/boat day) were above their trigger levels of 75 kg/day and 62 kg/day respectively. The catch levels and CPUEs for both species over a period of many years (since the 1960s) indicate that the level of harvesting by the fishery is sustainable.

The CPUE of tailor (16.8 kg/boat day) in 2005 was below the trigger level (20 kg/boat day). While the tailor CPUE was low compared to results since about 1992, it compares favourably with catch rates in the 1970s and 1980s.

The 2005 CPUE of yellowfin bream (23.3 kg/boat day) was well above the trigger level of 5 kg/boat day, reflecting the high natural abundance following a significant recruitment event.

In summary, in 2005, catches of the two main target species (whiting, sea mullet) were both within their respective target ranges while the catch rates were above their respective trigger levels. The yellowfin bream catch continued to exceed the target range; however, this has been shown to be due to a natural increase in abundance rather than any increase in targeted effort. Catches of tailor were below the target range and the catch rate was below the trigger level. The status of this stock will therefore be subject to further review.

Breeding stock levels: **Adequate**

The legal requirement that a net of mesh size not less than 48 mm be used for whiting ensures that virtually all of the catch is made up of mature fish. Consistent levels of catch of whiting and sea mullet over recent years suggest that the breeding stocks are being maintained. Breeding stock levels of tailor are unknown. The higher catches and CPUE of yellowfin bream, due to strong natural recruitment, indicate that breeding stock levels are healthy.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The methods used in this fishery sees fishers targeting specific schools of fish. Bycatch is likely to be minimal because seine netting is a highly selective method of fishing. Based on experience, fishers can determine the species and size of the school, and the size of individual fish within the school, before shooting the net. Fish are easily observed in the very shallow near-shore waters of Shark Bay so schools of non-target species and 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 they are immediately released.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The overall catch levels in the fishery have been relatively stable over several decades, despite a long-term reduction in effort, suggesting that total finfish recruitment to Shark Bay has not been affected by removals. Therefore, the total biomass of key target species in the region appears sufficient to maintain trophic function.

Habitat effects: **Negligible**

Seine nets are set and hauled over shallow sand banks, including 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

Up to 30 fishers can be employed in the fishery, based on 10 managed fishery licences each with a maximum of three crew. In 2005 there was employment for 2,980 crew-days. Fishing and associated local fish processing is one of the major sources of employment for the Denham community. The fishery, although relatively small-scale, makes a significant contribution to the Denham economy and community.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: **$809,000**

The overall value of the Shark Bay Beach Seine and Mesh Net Managed Fishery in 2005 was estimated at $809,000 and includes catch values of $467,000 for whiting, $144,000 for sea mullet, $106,000 for yellowfin bream and $42,000 for tailor.

FISHERY GOVERNANCE

Target catch range: **235–335 tonnes**

Under the current management arrangements, the acceptable range for total catch in this fishery is 235–335 t. Acceptable catch ranges for individual species are whiting 93–127 t, sea mullet 77–144 t, tailor 25–40 t and yellowfin bream 7–15 t. Acceptable catch ranges were derived by a statistical quality control chart using catch data from 1990 to 2003. Catch ranges are designed to allow catch levels to fluctuate in response to normal variations 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.

In 2005, tailor was below its target catch range and CPUE, which requires further investigation. For yellowfin bream, such an investigation has been completed and an increase in natural abundance was concluded to be responsible for the catch exceeding the target range. Overall, at least three of the four key target species were considered to be fished at sustainable levels.

In addition, catches of pink snapper (*Pagrus auratus*) taken by the SBBSMNF are closely monitored. Following a review of the inner gulf pink snapper fishery in 2002, TAC-based

management was introduced for the period 2003–2005, with explicit allocations of approximately 75% for the commercial sector and 25% for the recreational sector for each pink snapper stock/fishery area (see Inner Shark Bay Recreational Fishery status report, pp. 110–116). The SBBSMNF pink snapper catches in 2005 were well within the commercial catch allocation in each area.

New management initiatives (2005/06)

A comprehensive review of the SBBSMNF management plan was completed in 2005 following a series of meetings held in Denham between the Department of Fisheries and licensees. A series of recommendations, including full transferability of all licences in the fishery and the removal of owner-operator clauses, will form the basis of amendments to the management plan following approval by the Minister.

The minimum legal length for yellowfin bream was increased statewide from 250 mm to 350 mm on 1 January 2006 following a review of recreational fishing in the Pilbara and Kimberley. This minimum size increase was initiated in an effort to protect breeding females, following research undertaken by Murdoch University which showed the species to be a protandrous hermaphrodite (i.e. individuals change sex from male to female) (Hesp et al. 2004). The study found that 50% of males were sexually mature at a total length of 245 mm while 50% of females only reached sexual maturity at 348 mm.

However, an exemption to the new 350 mm size limit has been issued for one year pending further review and consultation with the commercial and recreational fishing sectors throughout WA.

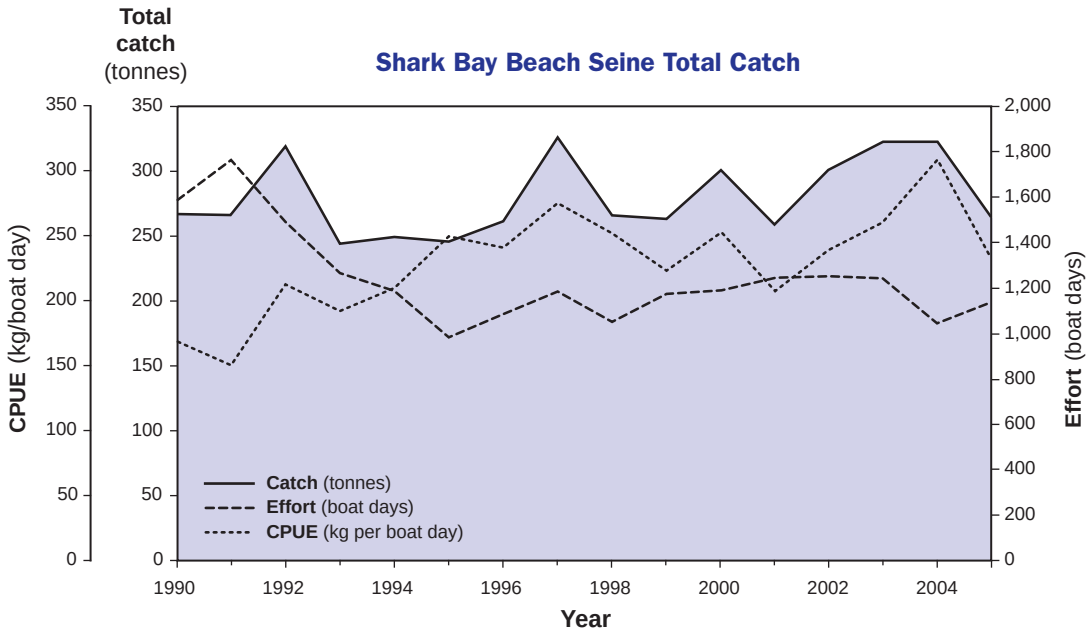
EXTERNAL FACTORS

The inner Shark Bay environment, which supports the finfish stocks harvested by this fishery, is particularly stable as a result of its low-rainfall, arid environment. Hence, the abundances of target species tend to be stable and fishery production is mainly determined by the level of fishing effort. However, the catch levels of yellowfin bream and possibly tailor appear to have been influenced by strong, environmentally driven variations in recruitment in recent years.

SHARK BAY BEACH SEINE TABLE 1

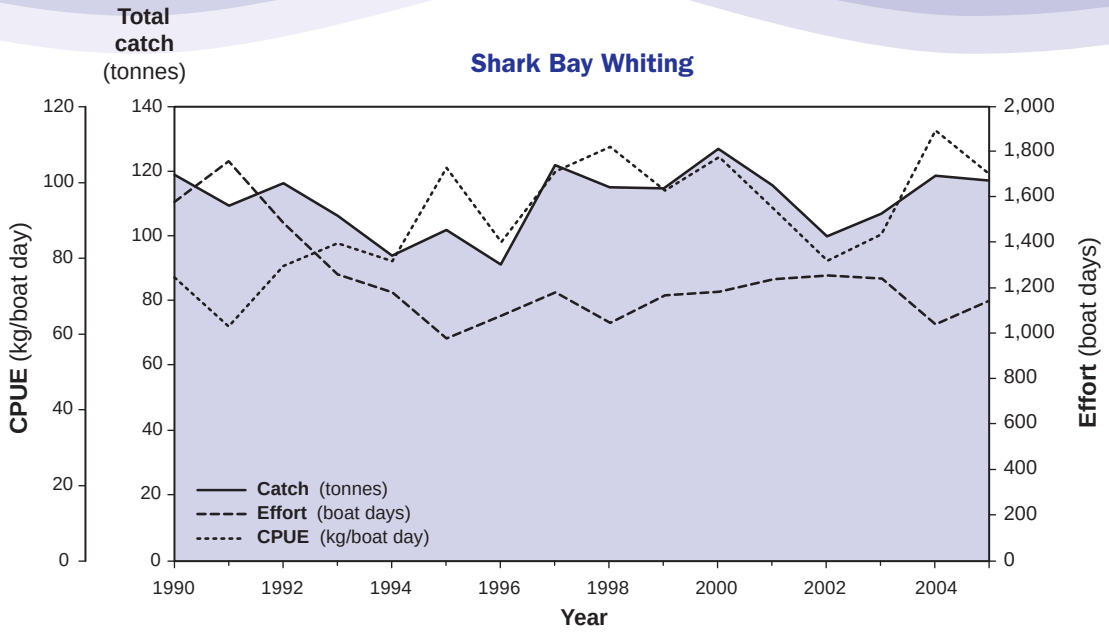
Annual catch per unit effort (kg/boat day) and minimum CPUE trigger levels for key species from Shark Bay for the period 1999–2005.

SPECIES	TRIGGER LEVEL (kg/boat day)	1999	2000	2001	2002	2003	2004	2005
Whiting	75	97	106	92	79	86	114	101.5
Mullet	62	98	107	93	80	120	137	74.2
Tailor	20	32	32	21	21	22	23	16.8
Bream	5	5.9	7.3	6.2	13	19	26	23.3



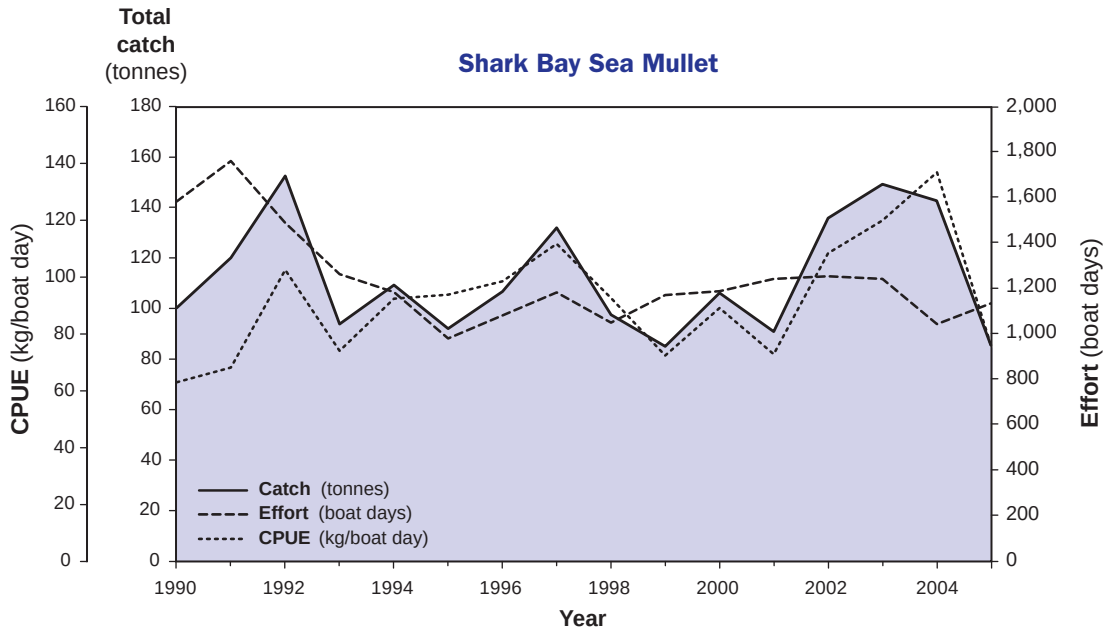
SHARK BAY BEACH SEINE FIGURE 1

The total finfish annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2005.



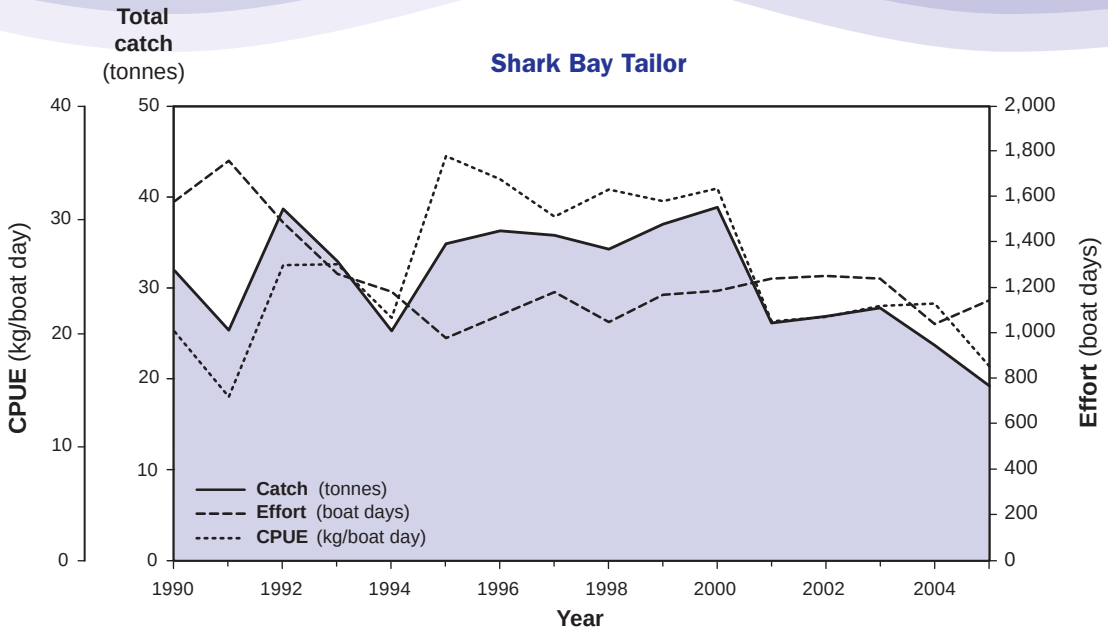
SHARK BAY BEACH SEINE FIGURE 2

The whiting annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2005.



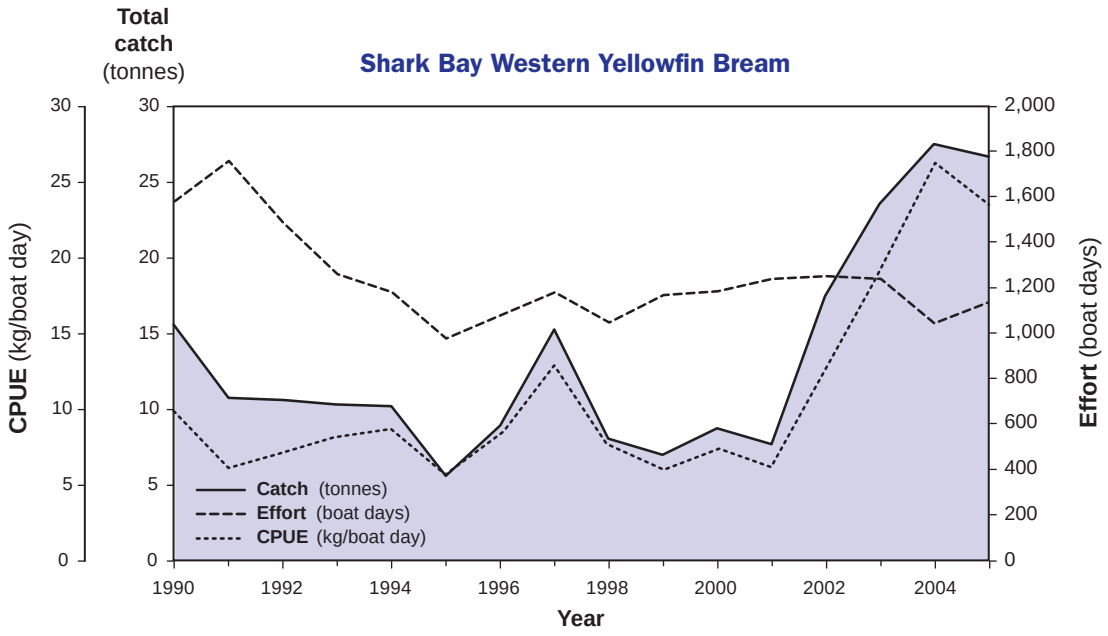
SHARK BAY BEACH SEINE FIGURE 3

The sea mullet annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2005.



SHARK BAY BEACH SEINE FIGURE 4

The tailor annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2005.



SHARK BAY BEACH SEINE FIGURE 5

The yellowfin bream annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2005.

Shark Bay Snapper Managed Fishery Status Report

G. Jackson
Management input from L. Caporn

FISHERY DESCRIPTION

The Shark Bay Snapper Managed Fishery (SBSF) targets the oceanic stock of pink snapper (*Pagrus auratus*) in continental shelf waters off Shark Bay. Stock identification studies have shown that this stock is quite distinct from pink snapper stocks found in the inner gulfs of southern Shark Bay (see Inner Shark Bay Recreational Fishery, pp. 110–116). Pink snapper in the Kalbarri region directly to the south of the SBSF management zone are currently treated as a separate population (see West Coast Demersal Scalefish Fishery). The SBSF uses mechanised handlines and, in addition to pink snapper, targets a number of other species including jobfish (*Pristipomoides* spp., mainly goldband snapper), emperors (Lethrinidae), ruby snapper (*Etelis carbunculus*), pearl perch (*Glaucosoma magnificum*) and cods (Serranidae).

Governing legislation/fishing authority

Shark Bay Snapper Management Plan 1994
Shark Bay Snapper Managed Fishery Licence
Prohibition on commercial line fishing in waters of Shark Bay Snapper Managed Fishery Order 2004
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Department–industry meetings

Boundaries

The fishery operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°34´ S and 26°30´ S; however, inner gulf waters are not available to licensees.

Management arrangements

The SBSF came under formal management for the first time in May 1987. Between then and 2000, snapper catches taken during the peak season (May–August) were subject to individual quotas while gear controls applied in the off-peak season. From 2001, the fishery has been quota-managed on a year-round basis. A minimum holding of 100 quota units applies and all units are transferable. These units operate from 1 September to 31 August, with a total of 5,125 units in the fishery. In 2004, in recognition of depleted spawning stock and to assist stock recovery, the total allowable commercial catch was reduced to 338,250 kg, with the value of each unit at 66 kg. In the same year, the commercial quota was effectively reduced further by Shark Bay Scallop and Prawn Managed Fishery licensees volunteering not to take any snapper. This resulted in an effective TACC of 313,000 kg in 2004. In 2005, the TACC effectively remained at 313,000 kg.

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

Research summary

Detailed research on oceanic snapper and the SBSF was undertaken throughout the 1980s and early 1990s. An age-structured model, developed as part of an FRDC-funded project which utilised catch-at-age data for the period 1982–2003, was used to assess the status of the oceanic snapper stock for the first time in 2003. The size and age composition of commercial catches have been closely monitored since the quota was significantly reduced in 2004. Catch and effort data and the results from the most recent age-based stock assessment modelling were used to provide this status report.

While some limited biological sampling of goldband snapper in the Gascoyne has been ongoing since 2005, there has been no dedicated research on the other key species taken by the SBSF.

All data reported here are for SBSF licensed vessels fishing between latitudes 23°34´ S and 26°30´ S only unless stated otherwise.

RETAINED SPECIES

Commercial production (season 2005):

Snapper 304 tonnes
Jobfish 146 tonnes
Other species 132 tonnes

Landings

The commercial catch of snapper taken by SBSF licensed vessels in 2005 was 304 t. The fishery also caught 146 t of jobfish (mainly goldband snapper) and 132 t of other species in 2005 (Shark Bay Snapper Table 1).

It should be noted that the total catch of jobfish taken within the Gascoyne biogregion (by SBSF vessels and ‘open access’ wetline vessels combined) increased significantly from less than 10 t in 2001 to nearly 300 t in 2003, since which time catches have declined (Shark Bay Snapper Figure 2).

Fishing effort/access level

As a consequence of the 2004 requirement for all wetline vessels operating within the waters of the SBSF to possess a minimum holding of snapper quota, all commercial line fishing between latitudes 23°34´ S and 26°30´ S is now conducted by SBSF licensed vessels. Following the introduction of these arrangements, a 70% decrease in wetline effort in the region was observed in 2005, which follows the 80% decrease seen in 2004.

In 2005 there were 52 licences in the SBSF. A total of 23 vessels actively participated in fishing for snapper. The effectiveness of fishing effort varies markedly on a seasonal basis, peaking in June–July when snapper are aggregated to spawn. Because of this, data are assessed using ‘standard boat days’ only, i.e. days fished by vessels that caught more than 4 t each of snapper by line during the period June–July. Fishing effort in the SBSF was 616 standard boat days in 2005 (676 in 2004).

Catch rate

The snapper catch per boat day of the SBSF licensed boats for the peak months (June–July) was 491 kg snapper/boat day in 2005, slightly up on the catch rate in 2004 (465 kg snapper/boat day) (Shark Bay Snapper Figure 1).

The overall jobfish catch rate for the Gascoyne was 99 kg jobfish/boat day in 2005, which represents a minor decline on the catch rate in recent years (107 kg jobfish/boat day in 2003 and 2004) (Shark Bay Snapper Figure 2).

Recreational component: **Snapper 11% (approx.)**
Jobfish 2% (approx.)

In 2005, the recreational catch of oceanic snapper landed at Denham was estimated at 8 t with at least the same amount assumed to have been landed at Carnarvon (no data available). The recreational catch of oceanic snapper taken from charter boats in 2005 was 21 t (25 t in 2004). Based on these data, the recreational catch of oceanic snapper was estimated at approximately 11% of the total catch in 2005. In the inner gulfs, most of the snapper catch is taken by recreational boats and is subject to separate management arrangements (see Inner Shark Bay Recreational Fishery).

The recreational catch of goldband snapper taken from charter boats in the Gascoyne in 2005 was approximately 3 t (see Fishing and Aquatic Tour Industry report, p 116).

STOCK ASSESSMENT

Assessment complete: **Yes (snapper)**

Based on stock assessment modelling in 2003 and 2004, which indicated that the spawning biomass of the oceanic snapper stock was depleted, the TACC was reduced by 40% for the 2003/04 season. The stock assessment was updated in 2005 based on data obtained from monitoring the commercial fishery in 2004. The stock assessment was most recently updated again in April 2006, using data obtained from the fishery in 2005; this assessment has been independently reviewed by a New Zealand-based fishery scientist. The current status report is based on these data and the most recent model-based assessment and forms the basis of management advice prior to the start of the 2006/07 season.

Breeding stock levels: **Inadequate (snapper)**

Snapper: The spawning biomass of the oceanic stock is estimated to be below both 40% of the unexploited level ('management target level') and 30% of the unexploited level ('management limit level'). There appears to have been minimal recovery since the reduction in quota in 2004. At current harvest levels, it is estimated that the 40% target level will not be reached within the maximum permissible (10-year) timeframe. As a consequence, further reductions in the overall catch are being considered for the 2006/07 season.

The performance measure for this fishery is that the catch rate for the peak months (June–July) should not fall below 500 kg/standard boat day. While catch rates in 2005 have increased on levels in 2003 and 2004, they remain slightly below the fishery's spawning stock indicator, despite the significant reduction in TACC in 2004.

Jobfish: There has for some years been concern over the level of commercial catch of jobfish in the Gascoyne, particularly goldband snapper. A stock assessment of goldband snapper in the Gascoyne coast bioregion remains to be undertaken. Based on existing biological information for goldband from the Pilbara, very preliminary estimates indicate a sustainable annual catch for the Gascoyne of around 100 t, i.e. substantially less than the levels taken in recent years.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

Virtually all the catch consists of demersal fish with a medium to high market value, therefore the catch of non-retained species is insignificant.

Protected species interaction: **Negligible**

The line fishing methods used do not catch any protected species.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Snapper are generalist feeders and are just one of a number of such species inhabiting the continental shelf waters in this region. Food chain effects are considered to be low because the quota system restricts SBSF catches to a small percentage of the total biomass of snapper. While the spawning biomass for the oceanic stock is currently depleted, management action has been and will continue to be taken to facilitate stock recovery to at least 40% of the unexploited level. The juvenile and sub-adult components of the stock would be subject to large, environmentally driven fluctuations in abundance even in the absence of fishing, due to significant variability in recruitment.

Habitat effects: **Negligible**

The nature of the fishery, targeting aggregations of adult snapper using hooks and lines, means that the fishery has virtually no direct impact on the habitat.

SOCIAL EFFECTS

The fishing pattern in 2005 was similar to that seen in recent years and reflects the shift from the traditional complete focus on pink snapper during the peak season to a fishery more targeted at outer-shelf species throughout the whole year. In 2005, 17 vessels fished for more than 10 days during the peak season (May–August) with average crew of 2.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: **$3 million**

The overall value of the fishery declined slightly in 2005 to around $3 million ($3.3 million in 2004), with $1.68 million from pink snapper and $1.36 million from all other finfish species.

FISHERY GOVERNANCE

Target effort range: 425–558 days

While the effective TACC in 2005 was 313 t (with Shark Bay prawn and scallop trawlers not taking any snapper), the 616 boat days of fishing effort used to obtain the landed catch of only 304 t was still above the target effort range of 425–558 boat days. While the average CPUE increased to 491 kg/June–July boat day for 2005, it remained slightly below the ESD performance measure of 500 kg/standard boat day.

New management initiatives (2005/06)

The Department is considering further reductions in overall snapper catch for the 2006/07 season. A reduction in the recreational daily bag limit from 6 snapper to 4 snapper per day was introduced in January 2006.

More broadly, issues around sustainability of the more vulnerable deeper-water species (e.g. jobfish, ruby snapper, pearl perch) will be resolved through implementation of new management arrangements within the proposed Gascoyne Demersal Wetline Managed Fishery, following the Gascoyne Wetline Review.

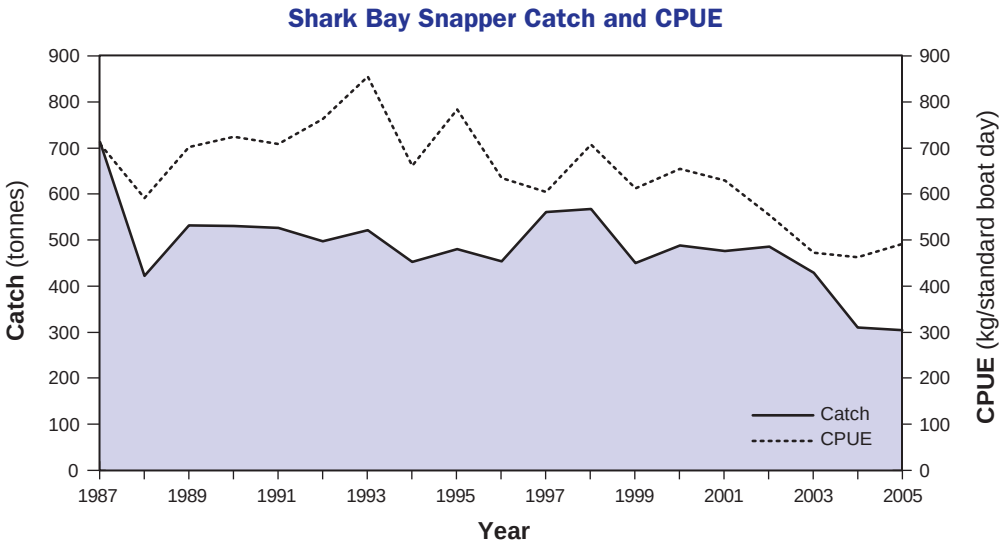
EXTERNAL FACTORS

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. In 2005, a single Commonwealth licence was active in the region, with < 100 kg of pink snapper reported. The quantity of pink snapper returned to the water is unknown.

SHARK BAY SNAPPER TABLE 1

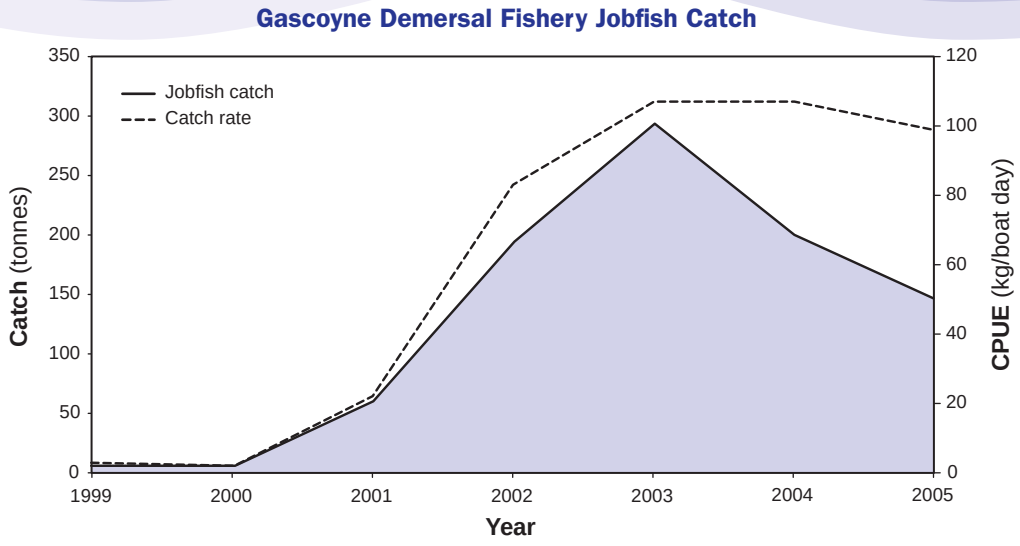
Catches of species other than snapper taken in the years 2001–2005 by SBSF licensed boats in the area between 23° S and 26° S (This list excludes mackerels, reported on pp. 159–164, and tunas which are reported to the Commonwealth Government.)

SPECIES		2001 (tonnes)	2002 (tonnes)	2003 (tonnes)	2004 (tonnes)	2005 (tonnes)
Jobfish	*Pristipomoides* spp.	5.1	41.0	120.5	186.0	146.3
Emperors	Lethrinidae	31.1	27.0	34.0	49.9	42.4
Cods	Serranidae	11.3	19.8	24.9	26.7	20.0
Red emperor	*Lutjanus sebae*	9.1	9.5	11.5	16.4	17.3
Trevallies	Carangidae	8.1	9.3	9.3	6.7	6.7
Mulloway	Sciaenidae	15.9	21.4	12.0	7.7	5.8
Other		24.4	29.8	32.6	41.0	39.4
Total		**105.0**	**157.9**	**244.8**	**334.4**	**277.9**



SHARK BAY SNAPPER FIGURE 1

Catch and catch per unit effort by year from 1987 to 2005 for the SBSF. Units are kg whole weight of pink snapper per standard boat day. As catchability varies markedly throughout the year, the CPUE for line fishing from June–July (peak season) is used as the index of abundance.



SHARK BAY SNAPPER FIGURE 2

Catch and catch per unit effort for jobfish (mainly goldband snapper) taken by both the SBSF and the 'open access' wetline fishery in the Gascoyne region between 23° S and 26° S, 1999–2005.

Wetline Fishing

The CAES database indicates that relative to other bioregions, the contribution from the Gascoyne has declined to around 6% of the state's wetline catch during 2004/05. The top 10 species comprised goldband snapper (*Pristipomoides multidens*) 32 t, sea mullet (*Mugil cephalus*) 16 t, pink snapper (*Pagrus auratus*) caught outside of the Shark Bay Snapper Managed Fishery 14 t, ruby snapper (*Etelis carbunculus*) 12 t, Spanish mackerel (*Scomberomorus commerson*) 6 t*, unspecified tuna (Scombridae) 5 t, saddletail snapper (formerly scarlet sea perch) (*Lutjanus malabaricus*) 5 t, crimson snapper (formerly red snapper) (*Lutjanus erythropterus*) 4 t, rosy jobfish (*Pristipomoides filamentosus*) 3 t, and grey-banded cod (*Epinephelus octofasciatus*) 3 t. Most of the demersal species are taken by vessels targeting pink snapper in the region's oceanic managed fishery for that species (see above), with the deep-water species continuing their prominence in the 2004/05 catch.

*An interim management plan for the troll fishery for mackerel (details of which are reported under the north coast bioregion on pp. 159–164) commenced in August 2004, precluding mackerel from the wetline catch after that date. The catch reported above was taken during July 2004.

RECREATIONAL FISHERIES

Regional Research Overview

Recreational fishing is a major activity in the Gascoyne. Around 11% of the state's recreational fishers reported fishing in this region during 2005/06 (Baharthah 2006). Fishing activity tends to peak between April and August each year. Most fishers stay an average of less than two weeks and intend to fish every day (Sumner and Steckis 1999).

Scientific information to underpin management of recreationally important fish stocks in this bioregion in the past has been provided primarily from Department of Fisheries biological research conducted on commercial fisheries. This research has covered pink snapper (*Pagrus auratus*), emperors (lethrinid species) and whiting (Sillaginidae), and more recently tailor (*Pomatomus saltatrix*) and Spanish mackerel (*Scomberomorus commerson*).

Over recent years, research undertaken in the region by Murdoch University postgraduate students has contributed significantly to our knowledge of the biology of several other prominent species taken by the recreational fishery. In particular, information on size at maturity and sex change in western yellowfin bream (*Acanthopagrus latus*), baldchin groper (*Choerodon rubescens*) and three other species of tuskfish (*Choerodon* spp.) have provided a useful basis for the recent review of the minimum legal sizes of these species.

In addition, two dedicated, recreationally focused studies on inner Shark Bay fish stocks commenced in the late 1990s. These studies, on pink snapper (ongoing) and black snapper (*Lethrinus laticaudis*; now completed) provide the basis for ongoing management and a status report on the inner bay fishery.

Data on recreational catches have been collected previously in the Gascoyne region (Sumner and Steckis 1999), in Shark Bay (Moran 1983, unpub.) and at Ningaloo (Moran et al. 1996). The first full recreational creel survey for the Gascoyne bioregion, of recreational boat- and shore-based fishing from Steep Point to Exmouth Gulf, was conducted between April 1998 and March 1999 (Sumner et al. 2002). A total of 243,000 fisher days were recorded over the survey period, of which 89,000 days were recorded within the Shark Bay Marine Park and 85,000 in the Ningaloo Marine Park. The majority of fishers came from Perth (44%) or rural Western Australia (34%), with 13% being based locally and the remainder (9%) from the Eastern States. The total recreational catch of all finfish species for the region in 1998/99 was estimated at 350 t, excluding charter vessel catches. This was approximately one-third of the commercial catch of 1,082 t at the time.

Important recreational species, in order of weight caught, were spangled emperor (*Lethrinus nebulosus*) (30,000 fish kept, or 79 t); pink snapper (*Pagrus auratus*) (28,000 fish or 79 t); mackerel (*Scomberomorus* spp.) (Spanish mackerel 8,000 fish or 47 t, other mackerel 8 t); black snapper or grass emperor (*Lethrinus laticaudis*) (33,000 fish or 34 t); golden trevally (*Gnathanodon speciosus*) (6,000 fish or 20 t); sweetlip emperor (*Lethrinus miniatus*) (13,000 fish or 16 t); Chinaman cod (*Epinephelus rivulatus*) (23,000 fish or 10 t gilled and gutted); western yellowfin bream (*Acanthopagrus latus*) (10,000 fish or 5 t); tailor (*Pomatomus saltatrix*) (7,000 fish or 5 t); and whiting (Sillaginidae) (34,000 fish or 5 t).

The 1998/99 survey also provided extremely useful estimates of the recreational catch of key recreational species from within the inner gulfs of Shark Bay; the recreational catch of pink snapper from the western gulf was estimated at approximately 40 t. Further surveys to monitor the recreational catch of pink snapper and other species in Shark Bay have been conducted annually since 2000.

Inner Shark Bay Recreational Fishery Status Report

G. Jackson and E. Lai

FISHERY DESCRIPTION

The 'inner Shark Bay recreational fishery' encompasses the recreational fishing activities undertaken within the Shark Bay Marine Park and the waters of Denham Sound (Inner Shark Bay Recreational Fishery Figure 1). Most recreational fishing is boat-based (rod and line, handline) with a minor shore-based (rod and line) component. A limited number of licensed charter vessels operate out of Monkey Mia (4) and Denham (3). A range of species are regularly caught by boat-based recreational fishers with principal target species being black snapper (blue-lined or grass emperor, *Lethrinus laticaudis*), pink snapper (*Pagrus auratus*), whiting (*Sillago* spp.), and blackspot tuskfish (bluebone, *Choerodon schoenleinii*) (Inner Shark Bay Recreational Fishery Table 1).

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Recreational Fishing Advisory Committee
Regional Recreational Fishing Advisory Committees (Denham, Carnarvon)
Direct consultation with local community on specific issues (e.g. Shark Bay Snapper Ministerial Working Group)

Boundaries

The areas covered by this report are shown in Inner Shark Bay Recreational Fishery Figure 1. Fishing is not permitted in the Hamelin Pool Marine Reserve.

Management arrangements

The recreational fishery is principally managed using daily bag, possession, size and gear limits. More detailed arrangements are used for pink snapper which has historically been the most popular target species.

Pink snapper inhabiting the inner gulfs comprise several reproductively isolated populations. Because there is little or no apparent mixing between these, or with snapper living in oceanic waters outside Shark Bay (oceanic stock), management recognises three separate fishable stocks in the inner gulfs, i.e. the Eastern Gulf, Denham Sound and Freycinet Estuary stocks (Inner Shark Bay Recreational Fishery Figure 1). Research advice for the management of pink snapper is provided on the basis of these divisions.

Prior to 2003, recreational catches of pink snapper in the inner gulfs were managed using only a combination of size and bag limits and fishery closures. In 2003, a total allowable catch (TAC) was set for each pink snapper stock for the first time which included explicit allocations of the available catch for the recreational and commercial sectors. In 2005 the TACs were set as follows (same levels as in 2003 and 2004):

- Eastern Gulf – 15 t (approx. 5,000 fish)
- Denham Sound – 10 t (approx. 3,300 fish)
- Freycinet Estuary – 5 t (approx. 1,200 fish)

The recreational sector, which includes catches from charter vessels, was allocated 75% and the commercial sector 25% of the available catch in each management area.

To manage the recreational pink snapper catch in each area, the fishing regulations in 2005 were as follows (same as in 2003 and 2004):

- Daily bag limit 1 pink snapper per person
- Minimum size 50 cm
- Maximum size 70 cm
- Closed season 1 April – 31 July (Eastern Gulf only)
- Closed season 15 August – 30 September (Freycinet Estuary only)

- Freycinet Estuary only – limited number (900) of single-use 'management quota tags' available, each 'tag' entitling the fisher to retain one pink snapper only per tag

These arrangements were designed to keep the recreational catch of pink snapper in each management area to a sustainable level, to allow the breeding stocks to recover to and be maintained at or above the target level (40% of the unfished spawning biomass).

To manage the recreational catch of other targeted 'Category One' (highest risk) demersal species in the inner gulfs of Shark Bay and elsewhere in the Gascoyne, the following regulations applied in 2005:

Black snapper:
- Daily bag limit 4
- Minimum size 32 cm

Estuary cod:
- Daily bag limit 2 within combined bag limit of 4 for all cod species
- Maximum size 1,200 cm (no minimum size)

Tuskfish:
- Combined daily bag limit 4
- Minimum size 40 cm

In addition, an overall finfish possession limit applies throughout Western Australia which restricts the quantity of fillets and/or whole fish an individual person can have in their possession.

Research summary

Research to support the management of inner Shark Bay pink snapper has been carried out since 1996/97. This research is ongoing and includes daily egg production method surveys to estimate the size of spawning stocks, trawl surveys to measure annual variation in juvenile recruitment, and creel surveys to estimate recreational catch and fishing effort. Scientific assessments of the status of the three inner gulf pink snapper stocks have been provided each year since 1998. A review of the research carried out between 1997 and 2001 and results of preliminary model-based stock assessments were used in 2002 to determine appropriate levels of TAC for each pink snapper stock for the period 2003–2005. In June 2005, the results of an FRDC-funded project which evaluated TAC-based management of pink snapper and results of updated stock assessments were presented to a Ministerial Working Group. This advice formed the basis for determining management arrangements for pink snapper and other 'Category One' demersal species for the period 2006–2008.

An FRDC-funded project (1999–2002) provided important biological information on black snapper in Shark Bay. This species, like pink snapper, displays a high degree of site fidelity with little or no significant mixing of sub-adults and adults among closely adjacent areas. Although black snapper in Shark Bay are currently managed as a single unit stock, data are presented in this report separately for each management area to allow comparison with pink snapper.

An FRDC-funded project undertaken by Murdoch University (2000–2003) provided important biological information on blackspot tuskfish in Shark Bay. Adults of the species are highly residential in and around the limited areas of reef habitat.

The first survey of recreational fishing in Shark Bay was undertaken in 1983. More recently, estimates of recreational catch and effort in the inner gulfs of Shark Bay have been derived from the results of recreational fishing surveys undertaken initially as part of a broader survey of the Gascoyne region in 1998/99. Results showed that 99% of both the pink and black snapper recreational catch was taken by boat-based fishers. Since then, recreational fishing surveys in inner Shark Bay have focused on boat-based fishing, with interviews conducted with boat crews returning to the Monkey Mia, Denham, and Nanga boat ramps each year since 2000.

Catches of the key species taken by licensed charter fishing vessels, estimated from data provided via compulsory catch returns, have been available since 2002.

RETAINED SPECIES

Recreational catch estimates (season 2005):

Pink snapper:	**Eastern Gulf 2 tonnes** **Freycinet Estuary 2.5 tonnes** **Denham Sound 5 tonnes**
Black snapper:	**Eastern Gulf 9 tonnes** **Freycinet Estuary 0.5 tonne** **Denham Sound 2.5 tonnes**
Blackspot tuskfish:	**Eastern Gulf 4 tonnes** **Freycinet Estuary nil** **Denham Sound 0.5 tonne**

Landings

All catches reported here have been rounded to the nearest 0.5 t.

Pink snapper: As a direct result of management intervention, recreational catches of pink snapper have decreased significantly since 1998 (Inner Shark Bay Recreational Fishery Figure 2). In 2005, the third year under TAC-based management, recreational pink snapper catches in the Eastern Gulf (2 t) and Denham Sound (5 t) had declined by 30–40% on estimated levels in 2004. In contrast, the pink snapper catch in Freycinet was estimated to have more than doubled to 2.5 t, but remained well below the TAC. As has been the case in previous years, large numbers of pink snapper were released by recreational fishers in 2005 (approximately 20,000 in the Eastern Gulf, 35,000 in Denham Sound and 7,000 in Freycinet). The above catches include 300 kg of pink snapper taken in the Eastern Gulf and 200 kg taken in Denham Sound by licensed charter vessels in 2005 (nil catch in Freycinet Estuary).

Black snapper: Black snapper are now the most common species landed (in order of number kept) by recreational boats in inner Shark Bay, mostly as a consequence of the highly restrictive management arrangements which have been introduced for pink snapper. The catch of black snapper taken by recreational boats is estimated to have varied between 7 and 17 t since 1998. In 2005 the recreational catch was estimated at 12 t (17 t in 2004) (Inner Shark Bay Recreational Fishery Table 3).

Less than 100 kg of black snapper was taken by licensed charter vessels in the inner gulfs in 2005 (300 kg in 2004, 500 kg in 2003).

Blackspot tuskfish: Blackspot tuskfish are the next most common finfish species landed by recreational boats after black snapper, pink snapper, and whiting (Inner Shark Bay Recreational Fishery Table 3). In 2005 the recreational catch was estimated at 4.5 t (3.5 t in 2004). No catch of this species was reported by licensed charter vessels in the inner gulfs in 2005.

Fishing effort/access level

In 2005, boat-based recreational fishing effort was estimated to have increased to approximately 38,000 fisher days (34,000 in 2004), with the effort shared equally between both gulfs (Inner Shark Bay Recreational Fishery Table 3). Compared with 2004, recreational fishing effort increased in all three areas, by 10% in the Eastern Gulf, by 12% in Denham Sound and by 41% in Freycinet. Effort in the Eastern Gulf in 2005 was higher than in any previous year since surveys commenced in 1998.

Catch rate

Pink snapper: Catch rates are of limited use as a measure of abundance for pink snapper in this fishery owing to the many management changes in recent years and the highly aggregating behaviour of the species during the winter (spawning) period.

Black snapper: The overall estimated recreational catch rate of black snapper for boat-based fishers in inner Shark Bay has varied between 0.21 and 0.39 fish kept per fisher day since 1998. Catch rates declined in 2005 to 0.25 fish kept per fisher day (0.39 in 2004).

Blackspot tuskfish: Catch rate data are not available for this species.

Commercial share:

Pink snapper:	Eastern Gulf 5%
	Freycinet Estuary nil
	Denham Sound 14%

Pink snapper: Commercial fishing for pink snapper inside Shark Bay is limited to the 10 licensed fishing units of the Shark Bay Beach Seine and Mesh Net Managed Fishery with only small quantities taken each year as bycatch by beach seine and haul net. The reported commercial catch of pink snapper in 2005 was 0.1 t in the Eastern Gulf and 0.8 t in Denham Sound, equating to around 5% and 14% respectively of the total catch in these areas. No pink snapper were reported by commercial fishers in Freycinet in 2005.

Black snapper: Black snapper are not targeted by the commercial fishery.

Blackspot tuskfish: Blackspot tuskfish are not targeted by the commercial fishery.

STOCK ASSESSMENT

Assessment complete:

Pink snapper:	Yes
Black snapper:	Preliminary
Blackspot tuskfish:	Not assessed

Pink snapper: The daily egg production method has been used to directly estimate pink snapper spawning stocks in the Eastern Gulf, Denham Sound and Freycinet Estuary since 1997. Research trawl surveys, to provide information on the abundance of 0+ age snapper in the inner gulfs, have been conducted each year since 1996. Results indicate that juvenile recruitment is highly variable, as is the case with the oceanic pink snapper stock in waters outside Shark Bay. Between 1998 and 2001 these data, combined with reported commercial catches (from CAES) and estimates of recreational catch (from boat ramp surveys), were used to determine the status of each inner gulf pink snapper stock. Since 2002, age-based population models, which have been internationally peer-reviewed, have been used to assess the status of the three pink snapper stocks. Stock assessment models are now updated every three years to suit a three-year-cycle of fishery review (next review scheduled for mid-2008).

Black snapper: A preliminary yield-per-recruit model was developed based on biological data for black snapper collected between 1999 and 2002. No further stock assessment has been undertaken since then.

Blackspot tuskfish: No stock assessment has been undertaken for the species.

Breeding stock levels:

Pink snapper:	Eastern Gulf adequate
	Freycinet Estuary inadequate (locally depleted)
	Denham Sound adequate
Black snapper:	Adequate
Blackspot tuskfish:	Not assessed

Pink snapper: The breeding stock (spawning biomass) of each pink snapper stock is estimated using age-structured models, and assessed in relation to the management target (40% of the unfished spawning biomass).

At the time of the last stock assessments (June 2005), spawning biomass was estimated at approximately 64% and 59% of the unfished levels in the Eastern Gulf and Denham Sound respectively, i.e. above the management target in both areas. Although the spawning biomass in the Freycinet Estuary was estimated at only 31% of the unfished level, i.e. below the management target, the breeding stock is rebuilding and it is estimated that the 40% level will be reached by 2007–2008.

Black snapper: The minimum legal size was increased to 320 mm in October 2003. Breeding stocks are currently believed to be adequate.

Blackspot tuskfish: The daily bag limit for tuskfish was reduced from 4 to 2 in January 2006. Breeding stock levels are unknown.

SOCIAL EFFECTS

Shark Bay is a very popular tourist destination, especially during the winter months and school holidays. Of the 150,000 tourists estimated to visit the region each year, approximately 30% (50,000) are thought to participate in recreational fishing.

ECONOMIC EFFECTS

While an actual dollar value cannot be assigned to the fish taken recreationally in inner Shark Bay at this time, the availability of fish underpins the tourism industry and generates significant income for the regional economy.

FISHERY GOVERNANCE

New management initiatives (2005/06)

Catches of pink snapper in 2005 remained significantly below the agreed TAC in each inner gulf area indicating that the management arrangements continued to be successful (Inner Shark Bay Recreational Fishery Table 4).

Based on an evaluation of TAC-based management in 2003 and 2004, and results of updated pink snapper stock assessments, management arrangements for pink snapper will remain broadly unchanged for the period 2006–2008, as follows (management changes indicated in italics):

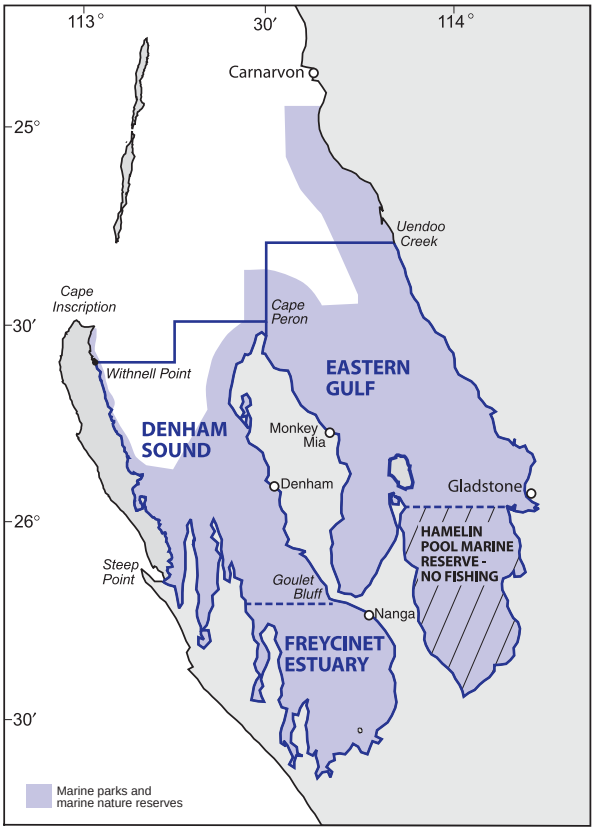
- Eastern Gulf: TAC 15 t; slot limit 50–70 cm TL; daily bag limit one pink snapper; spawning season closure 1 May to 31 July inclusive (*closure period reduced by one month*).
- Denham Sound: TAC 15 t (*increased by 5 t*); slot limit 50–70 cm TL; daily bag limit one pink snapper.
- Freycinet Estuary: TAC 5 t; 1,400 management tags available *(number of tags increased from 1,200 to 1,400 per year, i.e. 1,050 recreational, 350 commercial*); slot limit 50–70 cm TL; spawning season closure 15 August to 31 October inclusive.

Additional protection for other 'Category One' demersal species targeted by recreational boats was achieved with the introduction of the following changes:

- Estuary cod: bag limit reduced from 2 to 1 fish per day, with a minimum legal size of 40 cm (TL).
- Tuskfish/baldchin groper: combined bag limit reduced from 4 to 2 fish per day.

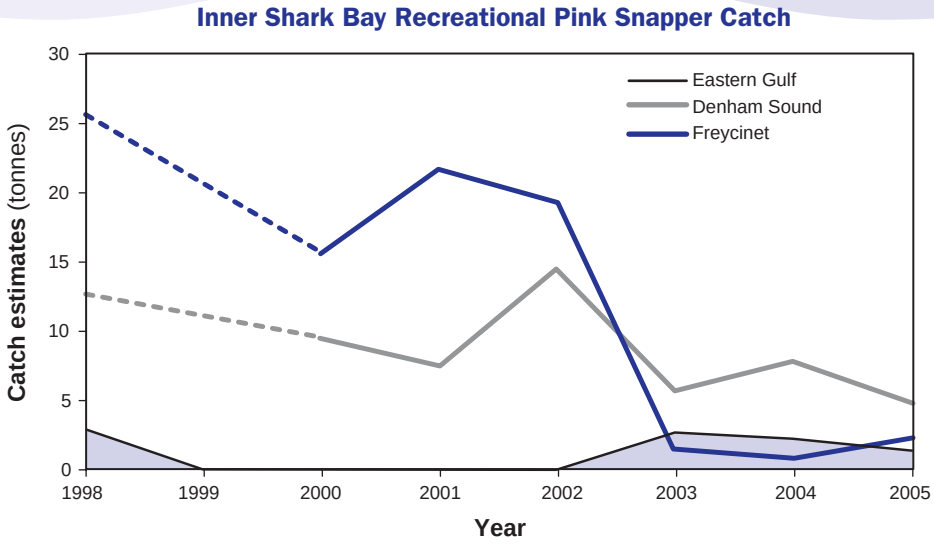
EXTERNAL FACTORS

Research on pink snapper stocks in the Shark Bay region, both in oceanic waters and the inner gulfs, and snapper stocks elsewhere in Australia and New Zealand, has demonstrated high variability in recruitment between years. In most cases this appears to be caused by environmental (probably oceanographic) variation affecting survival at the pre-settlement (eggs, larvae) and post-settlement phases (snapper early in their first year). With heavily fished stocks, there is a particular need to better understand these environmental drivers of annual recruitment strength, to distinguish them from the recruitment effects of fishing on the breeding stock. Variation in Leeuwin Current strength may play some role in affecting pink snapper recruitment processes. Because Shark Bay is at the northern limit of pink snapper distribution on the west coast of Australia, some sensitivity to environmental variation between years (e.g. sea temperature) would be expected.



INNER SHARK BAY RECREATIONAL FISHERY FIGURE 1

The recreational fishing areas of inner Shark Bay. Waters to the west of the Peron Peninsula, i.e. Denham Sound and Freycinet Estuary, are collectively known as the Western Gulf.



INNER SHARK BAY RECREATIONAL FISHERY FIGURE 2

Estimated catches of pink snapper taken by recreational boats in the three fishing areas of inner Shark Bay, 1998–2005 (does not include catches taken by charter vessels). The Eastern Gulf was closed to the take of pink snapper from June 1998 to March 2003.

INNER SHARK BAY RECREATIONAL FISHERY TABLE 1

Estimated annual catch, in numbers, of key species taken by recreational boats in inner gulfs of Shark Bay (does not include charter catches). Numbers of fish released are shown in brackets.

YEAR	PINK SNAPPER	BLACK SNAPPER	WHITING	BUTTERFISH	TAILOR	MULLET	BLACKSPOT TUSKFISH	BAR-TAILED FLATHEAD	MULLOWAY
1998	13,926 (88,020)	17,073							
1999	na	na	na	na	na	na	na	na	na
2000	8,387 (53,493)	10,042 (18,272)	3,105 (61)	3,452 (11,099)	1,128 (72)	901 (19)		565 (349)	895 (443)
2001	8,319 (87,655)	7,357 (15,470)	5,071 (203)	2,605 (9,508)	1,774 (128)	550 (0)	260 (4,667)	542 (219)	563 (115)
2002	9,130 (95,920)	11,286 (21,417)	9,043 (6,152)	1,545 (8,067)	2,123 (362)	755 (0)	1,160 (4,583)	526 (356)	445 (110)
2003	3,803 (84,622)	9,982 (20,548)	3,281 (730)	868 (7,030)	924 (27)	51 (0)	1,967 (4,703)	790 (446)	101 (44)
2004	4,418 (97,780)	13,376 (21,382)	9,979 (1,635)	796 (9,396)	265 (590)	49 (0)	1,552 (5,201)	605 (336)	197 (17)
2005	**3,311 (62,068)**	**9,987 (25,218)**	**5,142 (514)**	**662 (11,854)**	**455 (38)**	**1,303 (0)**	**1,771 (5,205)**	**474 (692)**	**198 (62)**

INNER SHARK BAY RECREATIONAL FISHERY TABLE 2

Estimates of recreational boat fishing effort (fisher days) and retained pink snapper catch (tonnes) in inner Shark Bay, 1998–2005 (does not include charter catches). Total catches are rounded to the nearest tonne.

	EASTERN GULF		DENHAM SOUND		FREYCINET			
YEAR	EFFORT	CATCH	EFFORT	CATCH	EFFORT	CATCH	TOTAL EFFORT	TOTAL CATCH
1998	11,066	2.9[1]	21,047	12.2	17,208[2]	25.7[2]	49,321	38
1999	na	na	na	na	na	na	na	na
2000	9,438	closed	15,753	9.5	9,625[2]	15.8[2]	34,816	25
2001	7,254	closed	11,958	7.5	15,452[3]	21.8[3]	34,664	29
2002	10,621	closed	18,530	14.5	14,747[3]	19.3[3]	43,898	34
2003	15,602	2.7[4]	22,338	5.7	4,130[3,5]	1.5[3,5]	42,070	10
2004	17,405	2.3[4]	13,976	7.7	2,556[2,5]	0.9[2,5]	33,937	11
2004	**19,059**	**1.5**[4]	**15,713**	**4.6**	**3,624**[2,5]	**2.4**[2,5]	**38,396**	**9**

1. For period April–June only (fishery closed June 1998)
2. Estimates for Nanga only; surveys did not include Tamala
3. Estimates for all Freycinet Estuary; surveys included Tamala
4. Fishery closure 1 April – 31 July inclusive
5. Management tags required (900 recreational tags/year available)

INNER SHARK BAY RECREATIONAL FISHERY TABLE 3

Estimated catch of black snapper taken by recreational boats in the inner gulfs of Shark Bay (does not include catches take by licensed charter vessels).

YEAR	AREA	FISHING EFFORT (fisher days)	NUMBER KEPT	NUMBER RELEASED	WEIGHT KEPT (tonnes)
1998	**TOTAL**	**49,321**	**17,073**		**16**
1999		na	na	na	na
2000	Western Gulf	25,378	5,425	11,404	6
	Eastern Gulf	9,438	4,617	6,868	6
	TOTAL	**34,816**	**10,042**	**18,272**	**12**
2001	Western Gulf	27,410	5,152	12,314	5
	Eastern Gulf	7,254	2,205	3,156	2
	TOTAL	**34,664**	**7,357**	**15,470**	**7**
2002	Western Gulf	33,277	7,792	14,257	7
	Eastern Gulf	10,621	3,494	7,160	4
	TOTAL	**43,898**	**11,286**	**21,417**	**11**
2003	Western Gulf	26,468	4,824	7,022	4
	Eastern Gulf	15,602	5,158	13,526	5
	TOTAL	**42,070**	**9,982**	**20548**	**9**
2004	Western Gulf	16,532	4,964	11,159	6
	Eastern Gulf	17,405	8,412	10,223	11
	TOTAL	**33,937**	**13,376**	**21,382**	**17**
2005	Western Gulf	**19,337**	**2,871**	**634**	**3**
	Eastern Gulf	**19,059**	**7,115**	**13,165**	**9**
	TOTAL	**38,396**	**9,986**	**25,218**	**12**

INNER SHARK BAY RECREATIONAL FISHERY TABLE 4

Catches (tonnes) of inner Shark Bay pink snapper taken by each sector in 2005 and total catch relative to TAC for each stock. Recreational share includes catch estimated from survey results and catch reported by charter vessels.

	EASTERN GULF	DENHAM SOUND	FREYCINET
Recreational	1.5	4.6	2.4
Charter vessels	0.3	0.2	0
Commercial	0.1	0.8	0
Total catch	**1.9**	**5.6**	**2.4**
TAC	15	10	5
Commercial share (%)	5	14	0
Recreational share (%)	95	86	100
Total catch : TAC (%)	**13**	**56**	**48**

Fishing and Aquatic Tour Industry

C. Johnson and E. Lai

The Gascoyne coast bioregion had 78 licensed fishing tour operators plus 16 licensed restricted fishing tour or eco-tour operators at the end of June 2006.

Tour operators were licensed by the Department of Fisheries in 2001, with all licensed operators required to submit daily trip returns. These returns enable data to be compiled on the overall number of tours, number of fishing tours, catch and effort estimates and other statistics.

Data for this bioregion continue to be presented by calendar year as returns indicate that the majority of the total catch is taken between March and October. Catch figures may differ slightly from those reported in previous years as a result of improved analysis of average fish weights and inclusion of some late returns.

Fishing effort

In 2005, 40.5% of tour operators who were licensed to operate in the Gascoyne reported actively using their licence in this bioregion. Operators reported 2,594* tours during 2005 which was a decrease from 3,709 in 2004, 4,501 in 2003 and 4,081 in 2002. Activities conducted on these tours included fishing, diving, snorkelling, wildlife observation and sightseeing.

The total number of 'fishing only' tours in the Gascoyne in 2005 also declined to 992* from 1,032 in 2004, 1,289 in 2003 and 1,445 in 2002. In 2005 the total fishing effort for the Gascoyne bioregion was 8,990* fisher days, an increase from 8,486 in 2004 but still lower than the 10,481 fisher days in 2003 and 12,046 in 2002.

Catch

Catches of the major finfish species for the Gascoyne coast bioregion between 2002 and 2005 are shown in Gascoyne Fishing Tours Table 1.

The estimated total finfish catch for 2005 was 74.5* t. The catch of pink snapper has remained relatively consistent between 24 t and 29 t over the last four years.

GASCOYNE FISHING TOURS TABLE 1

Estimated catch of major finfish species reported by tour operators. Catches are calculated by calendar year as the majority of the total catch is taken between March and October.

SPECIES		ESTIMATED CATCH (tonnes) 2002	ESTIMATED CATCH (tonnes) 2003	ESTIMATED CATCH (tonnes) 2004	ESTIMATED CATCH (tonnes) 2005*
Pink snapper	*Pagrus auratus*	24	29	26	24
Spangled emperor	*Lethrinus nebulosus*	17	14.5	9.5	11.5
Red emperor	*Lutjanus sebae*	10	6.5	6.5	8
Sweetlip emperor	*Lethrinus miniatus*	7	6.5	4.5	6
Rankin cod	*Epinephelus multinotatus*	4.5	3	3	4
Goldband snapper	*Pristipomoides multidens*	0.5	0.5	3	3
Black snapper (blue-lined emperor)	*Lethrinus laticaudis*	2	2	1.5	1.5
Spanish mackerel	*Scomberomorus commerson*	4	3.5	3	1.5
Chinaman cod	*Epinephelus rivulatus*	0.5	0.5	0.5	0.5
Other finfish		24.5	20	17.5	14.5
Total		**94.5**	**86**	**74.5**	**74.5**

* Denotes some missing data (~10%)

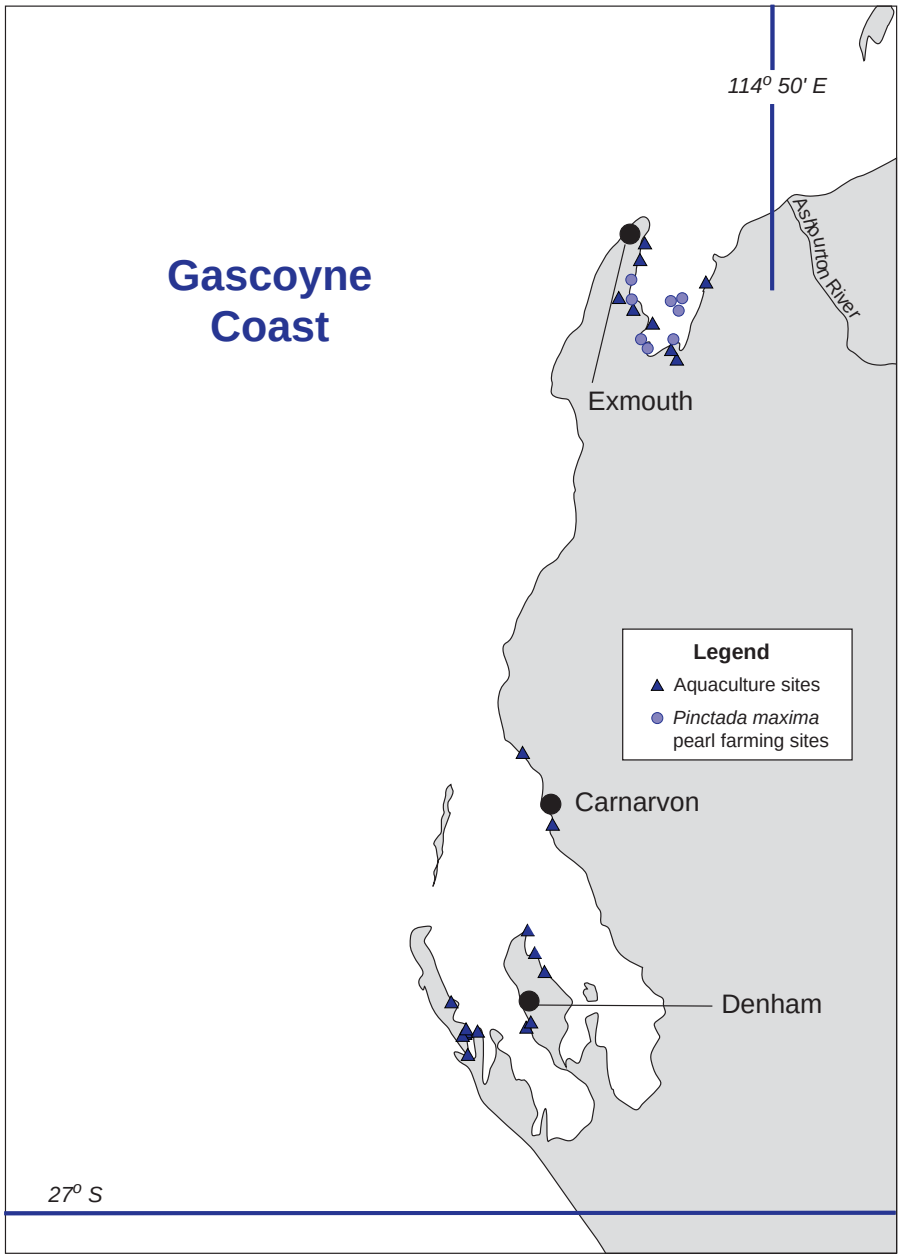
AQUACULTURE

Regional Research and Development Overview

The Department's main focus in the Gascoyne continues to be on the regulation of the regional pearling industry, based on species such as *Pinctada margaritifera*, that complements the major state industry built on silverlip pearls (*Pinctada maxima*) (see p. 180).

Major research activities during 2005/06 included health monitoring by the Fish Health Unit for pearl oysters and marine finfish (see Appendix 5). In addition, the marine finfish aquaculture research team is actively collaborating with an industry partner in Exmouth who is currently producing mahi mahi (*Coryphaena hippurus*). The team is assisting the company with the design of different systems as well as feeds for larvae and adult fish.

Other key development tasks continue to involve supporting the emergence of a local aquarium fish production sector. A draft policy document for the culturing of live coral, sand and rock has been developed and released for public comment.



GASCOYNE COAST AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture and pearl farming sites of the Gascoyne coast bioregion. Note that aquaculture operations may also encompass the culture of non-*Pinctada maxima* pearl oysters.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services in the Gascoyne coast bioregion are delivered by Fisheries and Marine Officers and associated management and administrative support staff based at District Offices in Denham, Carnarvon and Exmouth. During 2004/05 the three offices supported a total of seven FMOs who delivered services to a number of client groups including commercial and recreational fisheries, pearling and aquaculture and fish-habitat-related areas. Fisheries and Marine Officers continued to carry out at-sea marine safety compliance, inspecting recreational and commercial vessels for compliance with marine safety legislation as well as promoting safer boating practices. A further aspect of their work was the commencement of dedicated marine park services, initially in Ningaloo Marine Park and then in Shark Bay Marine Park. This involved developing and operating under a new and dynamic collaborative model in conjunction with the Department of Environment and Conservation.

Officers undertake regular land and sea patrols throughout the bioregion using specially equipped four-wheel-drive vehicles, quad bikes and small towable vessels. Staff at Denham make extensive use of the 10 m patrol vessel *John Brockman* to conduct inspections throughout Shark Bay, while those in Exmouth use the 8 m patrol vessel *Gnulli* to conduct at-sea inspections in Exmouth Gulf and within the Ningaloo Marine Park. Large fisheries patrol vessels (greater than 20 m in length) also assist FMOs at different times of the year for offshore patrols, especially in the Shark Bay Prawn and Scallop Fisheries. In addition, FMOs also conducted aerial surveillance, dive inspections, at-sea and on-land catch, licence, gear and marine safety inspections, and attend community events.

The management of the Shark Bay Snapper Fishery continues to be a priority. The monitoring of commercial catch quota via the catch and disposal records remains an integral part of the management process, as does the monitoring of recreational snapper tags in the Freycinet Estuary area. Ensuring balanced and equitable access to the fishery for both commercial and recreational fishers while ensuring the sustainability of the species remains a high priority for management and FMOs in the region.

Fisheries and Marine Officers continue to foster important and long-term relationships with the community through their participation in community events and coordination of educational interpretive activities during peak periods throughout the bioregion. These peak periods commence in late March and finish in early October. During this peak season, fishing competitions like Carnarfin, Shark Bay Fishing Fiesta and Gamex, and community events such as the Whale Shark Festival and Gascoyne Expo, provide high-exposure community education opportunities for FMOs. The officers also dedicate time to attending local primary and high schools to deliver educational programs.

The Department's satellite-based vessel monitoring system (VMS) continues to be a valuable compliance tool enabling positional surveillance and monitoring of commercial vessels and provides an important safety tool for fishers in case of emergency. The VMS allows for fishery-specific management plan closures to be enforced remotely by triggering an alarm should a boundary be crossed. Officers can program their inspection regimes and apply their investigation methods more efficiently by using the facilities provided by VMS. The future expansion of the VMS into other fisheries such as the snapper and mackerel fisheries will assist in achieving a higher rate of compliance.

Activities during 2004/05

During 2004/05 FMOs delivered a total of 10,280 hours of compliance services as presented in Gascoyne Coast Compliance Table 1 (excluding pearling compliance activities which are reported in the north coast bioregion). The decreased hours delivered in the region during 2004/05 were mainly due to long-term vacancies within the FMO work group. Since these vacancies were filled late in the financial year, routine visits to commercial fishers by a familiar group of FMOs has led to better understanding and knowledge of the regulations and a higher rate of compliance.

In delivering these services the FMOs made use of a risk assessment and intelligence analysis-driven approach to compliance planning and prioritisation. A number of risk assessments were completed in the previous year, which set the scene for the development of compliance operational plans in this year. The plans will help to deliver a more targeted and effective compliance service in terms of both cost and activities. It is expected that a more planned approach to compliance delivery will better deliver the outcomes expected for each particular fishery.

Officers delivered 4,137 hours of compliance activities targeted at commercial fisheries, mostly through pre-season inspections, catch inspections and quota monitoring, at-sea inspections and investigations resulting from offences detected via the VMS. The efforts of FMOs were directed in particular this year to building relationships with industry through higher levels of contact both at sea and in port. The number of breaches of fishery closures detected through the VMS was down significantly this year. A forensic audit of the amount of snapper landed relative to the catch and disposal records received was also carried out. This had positive results in that a number of anomalies were rectified but no offences were detected. In general, compliance activities again confirmed the positive approach of the commercial fisheries in complying with regulations and playing their part in ensuring sustainability. A total of 4 infringement warnings and 5 infringement notices were issued and 12 prosecutions were instigated from a total of 2,507 contacts with the commercial fishing industry.

A total of 6,143 hours of compliance services were delivered to recreational fisheries during 2004/05. The focus of FMOs during this period was on compliance and education programs in expectation of the extensions to the Ningaloo Marine Park and a new focus on marine park compliance across the state. These activities proved successful, as only 59 infringement warnings and 57 infringement notices were issued and 8 prosecutions instigated from a total of 20,360 recreational fishing contacts.

During the peak period the region again welcomed the addition of two FMOs from 'Mobile 1', a dedicated mobile recreational fishing patrol using specialised remote-area-equipped vehicles and surveillance equipment. Mobile 1 patrols extended throughout the region, working in a coordinated approach with District Officers to provide greater coverage and improved compliance outcomes. The focus for this unit was twofold with respect to education and enforcing management arrangements for Shark Bay Inner Gulf pink snapper.

During 2004/05, FMOs delivered over 100 hours to the marine safety compliance program within the bioregion. Officers conducted 1,000 safety checks on recreational vessels and 20 checks on commercial vessels. In particular, marine safety checks were carried out on much of the Shark Bay prawn fleet prior to the commencement of the season. Regionally, marine safety checks continued to be a developing aspect of FMO activity.

The bioregion's Volunteer Fisheries Liaison Officer program continued to find it difficult to attract volunteers during 2004/05. Previous analysis of the region's demographic base has revealed that the population of less than 12,000 people cannot support the large number of volunteer organisations existing within the region. Given that the population decreased marginally over this period, solutions to this problem are difficult to identify. VFLOs from other areas of the state continue to travel to the Gascoyne during the peak winter holiday period and assist with education and research activities. This provides a viable alternative to sourcing volunteers from the region.

Initiatives in 2005/06

During 2005/06 a number of new initiatives have been introduced across the Gascoyne coast bioregion. The priority has been the development and creation of Operational Compliance Plans for the major trawl fisheries, aquaculture and pearling fisheries and marine parks. Following on from this is development of the collaborative framework and process for both the Department of Environment and Conservation and the Department of Fisheries to deliver compliance services to marine parks. As part of this process the Ningaloo Marine Park Patrol has been set up and become operational with the delivery of a new rigid inflatable boat and patrol vehicle. The patrol provides a specified number of inspections in sanctuary zones across the Ningaloo Marine Park to verify compliance with the no-fishing rules.

A further initiative has involved working more closely with the commercial fishing industry through more contact at sea and in port. As a result there has been a significant increase in the days that FMOs spend at sea, in particular in the Denham and Exmouth Districts. Port inspections of commercial catch have been increased, especially in Carnarvon, enabling more contact with commercial fishers and the development of more effective means of communication in terms of the sustainability and management of the fisheries.

Broadening of the FMO skill base has been a further initiative for the year with the development of a dedicated dive team, improved marine qualifications and further training in investigation methodology.

GASCOYNE COAST BIOREGION TABLE 1

Summary of compliance and educative contacts and infringement types within the Gascoyne coast bioregion during the 2004/05 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	*NUMBER*
Hours delivered in bioregion	4,137
Fisher field contacts by Fisheries Officers	484
District Office contacts by Fisheries Officers	2,023
COMMERCIAL OFFENCES DETECTED	
Infringement warnings	4
Infringement notices	5
Prosecutions	12
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	*NUMBER*
Hours delivered in bioregion	6,143
Fisher field contacts by Fisheries Officers	10,878
District Office contacts by Fisheries Officers	9,482
Fisher field contacts by VFLOs	n/a
Fishwatch reports*	7*
RECREATIONAL OFFENCES DETECTED	
Infringement warnings	59
Infringement notices	57
Prosecutions	8

* Data for combined recreational and commercial Fishwatch reports, July 2004 – March 2005. The service provider ceased operation in April 2005, and the interim arrangements implemented do not provide reliable statistics for the period April–June.

NORTH COAST BIOREGION

North Coast Bioregion

ABOUT THE BIOREGION

The oceanography of the north coast bioregion is generally tropical, with its origins in the flow of Pacific Ocean waters through the Indonesian archipelago. Under IMCRA, the bioregion has been divided into eight meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley.

Ocean temperatures range between 22°C and 33°C, with localised higher temperatures in coastal waters due to the arid nature of the hinterland, particularly along the Pilbara coastline. Fish stocks in the north coast bioregion are entirely tropical, with most having an Indo-Pacific distribution extending through Indonesia to the Indian subcontinent and Arabian Gulf regions.

Coastal waters are generally low-energy in terms of wave action, but are seasonally influenced by infrequent but intense tropical cyclones, storm surges and associated rainfall runoff. 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 runoff and associated coastal productivity is only associated with cyclone events, with runoff ceasing during winter. The entire north coastal region is subject to very high evaporation rates (3 m per year), although the Pilbara coastline is more arid than the Kimberley due to its lower cyclone frequency.

The second significant influence on coastal waters is the extreme tidal regime related to the wide continental shelf. Spring tides range from up to 11 m along the Kimberley section of the coast down to around 2 m at Onslow in the west Pilbara.

As a result of these factors, the generally tropical low-nutrient offshore waters are significantly influenced by rainfall runoff and tidal mixing to generate varying water quality in different sections of the bioregion. Along the Kimberley coastline, waters are turbid and relatively productive, while the Pilbara coast with its lower runoff 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 intertidal sand flats. Softer sediments and mangroves occur around the river entrances. The western Pilbara coastline is characterised by a series of significant but low-relief islands including the Dampier Archipelago, Barrow Island and the Montebello Islands. Near-shore coastal waters include rocky and coral reef systems, creating significant areas of protected waters. West Pilbara shorelines also include areas of soft sediment and mangrove communities.

The principal commercial fisheries in this region focus on tropical finfish, particularly the high-value emperors, snappers and cods which are taken by the Pilbara Fish Trawl Fishery and the Pilbara and Northern Demersal trap fisheries. The typical catch is in the order of 3,000 t annually, making these fisheries, at an estimated annual value of around $12 million, the most valuable finfish sector in the state. The region 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. The region is, however, increasingly coming under threat from international poaching, particularly for sharks. A number of wetline activities, including offshore demersal line fishing and near-shore beach seining and gillnetting, also occur in the region.

Recreational fishing is experiencing significant growth in the north coast bioregion, with a distinct seasonal peak in winter when the local population is swollen by significant numbers

of metropolitan and interstate tourists travelling through the area and visiting particularly 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's 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.

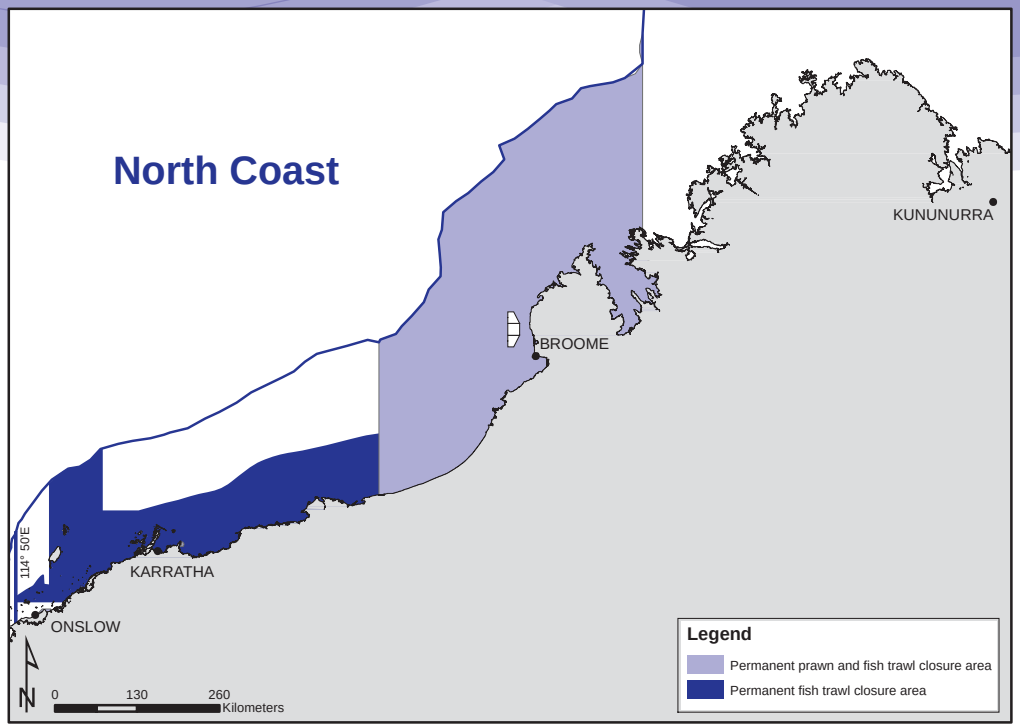
ENVIRONMENTAL MANAGEMENT

Regional Overview

On the north coast, marine habitats have been locally affected by port developments, oil and gas exploration and extraction, and some fishing activities across the continental shelf. The offshore Pilbara area in particular was heavily trawled by international vessels in the 1960s and 1970s; however, this activity was completely phased out by the Commonwealth Government in the early 1980s. Since that time, extensive fisheries closures over coastal and most offshore waters have been introduced to manage finfish trawling by Australian vessels (North Coast Habitat Protection Figure 1). Trawling for prawns is permitted at a number of locations and occurs on a series of small grounds associated with inshore nursery areas (see specific commercial trawl fishery reports). In each of these fisheries, trawling occurs over a small proportion of the habitat, and is managed to ensure that impacts are acceptable and localised to areas of high target species abundance.

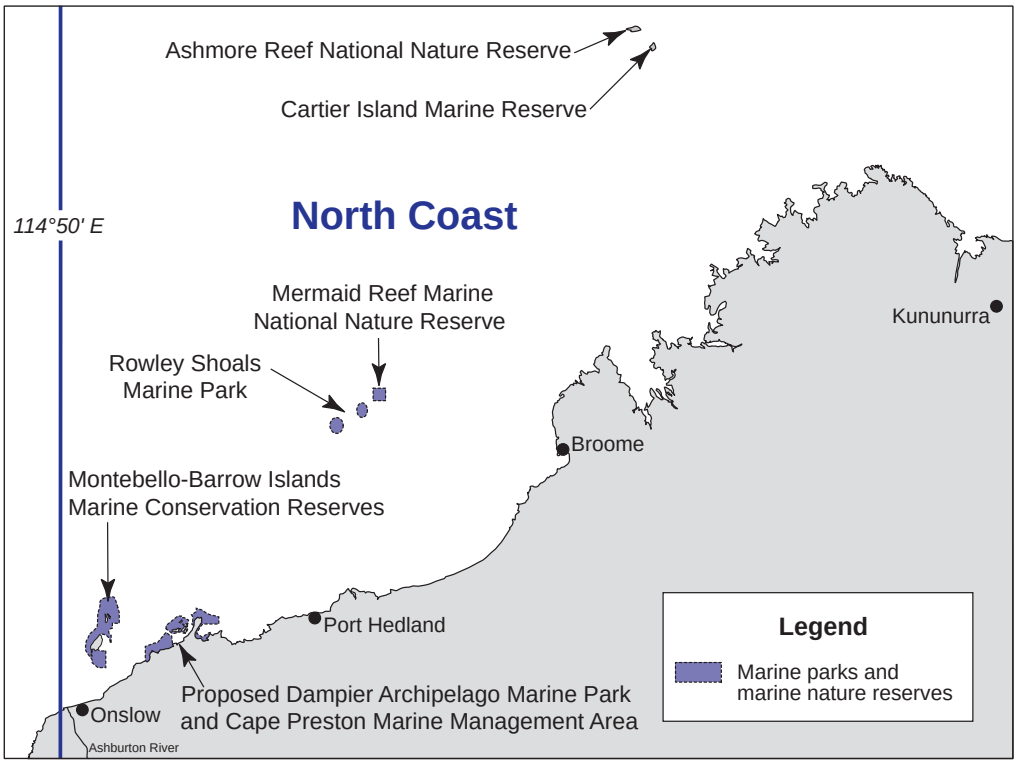
In addition to the extensive fisheries closures protecting marine habitats, the bioregion has a number of marine parks and reserves around offshore islands and reefs (North Coast Habitat Protection Figure 2).

During 2005/06, the Department has continued to provide scientific and management advice in relation to the planning of the proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area. Management plans for the Rowley Shoals Marine Park and the Montebello and Barrow Islands Marine Conservation Reserves are near to completion. The Department will proceed under the *Fish Resources Management Act 1994* to give effect to fishing restrictions once the management plans have been formally approved.



NORTH COAST HABITAT PROTECTION FIGURE 1

Map showing areas permanently closed to trawling in the north coast bioregion.



NORTH COAST HABITAT PROTECTION FIGURE 2

Map showing current and proposed areas of protected fish habitat in the north coast bioregion.

COMMERCIAL FISHERIES

Onslow Prawn Managed Fishery Status Report

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

FISHERY DESCRIPTION

The Onslow Prawn Managed Fishery operates along the western part of the North West Shelf and targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*) using otter trawl.

Governing legislation/fishing authority

Onslow Prawn Fishery Management Plan 1991
Onslow Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Department–industry meetings

Boundaries

The boundaries of this fishery are *'all Western Australian waters of the Indian Ocean below high water mark lying west of 116°45´ east longitude and east of a line commencing at the high water mark on the mainland due south of the southernmost extremity of Locker Island drawn due north to the high water mark at that extremity; thence northwesterly to the high water mark at the southernmost extremity of Serrurier Island; thence northerly along the high water mark of that island on its western shore to its northernmost point; thence due north*' (Onslow Prawn Figure 1).

The fishery is divided into three fishing zones with associated size management fish grounds (SMFGs) and nursery areas as follows: Area 1, incorporating the Ashburton SMFG; Area 2, incorporating the Mangrove Island and Weld Island SMFGs and Coolgra Point Nursery; and Area 3, incorporating the Fortescue SMFG.

Management arrangements

Management controls for the Onslow Prawn Managed Fishery are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices (grids).

The opening and closing dates for the fishery are generally the same each year and are based on advice from the Research Division after consultation with industry. Different areas and SFMGs within the fishery have different opening and closing dates within the season, which protects smaller prawns and allows access to the various target species, primarily tiger and banana prawns, at appropriate times. The vessel monitoring system continues to monitor the activities of all boats.

The 2005 fishing season officially commenced on 4 March and closed on 15 November. Within these dates, the season arrangements for the various areas were as follows:

Area 1	1 April – 15 November
Area 2	4 March – 15 November
Area 3	4 March – 15 November
Fortescue SMFG	1 May – 15 November
Ashburton SMFG	1 June – 31 July

Discussions regarding the merit of opening later were held between the Research Division and industry prior to the commencement of the 2005 season, and it was agreed to commence fishing later than the official opening date, as occurred in 2004. This decision was based on the expectation of improved prawn size and quality, combined with rising fuel costs and a more favourable moon phase. Industry agreed to commence fishing Areas 2 and 3 on 2 April and Area 1 on 17 April.

When Area 1 opened to fishing, a closed buffer zone was implemented seaward of the Ashburton SMFG to protect small tiger prawns inshore. This buffer zone was opened on 23 April for two days only, partially re-opened (offshore portion only) on 13 May, and fully opened on 30 May following a survey.

The Ashburton SMFG itself was opened according to the season arrangements. However, industry made a voluntary decision not to fish this banana prawn ground because of very low banana prawn abundance as reported from surveys and by the fishing fleet in the adjacent area.

The Fortescue and Weld Island SMFGs opened on 1 May, but the Mangrove Islands SMFG remained closed for the entire season. Industry has agreed that this closure should be maintained for most or all of each season, with any opening to depend on the results of a survey undertaken during August to establish the size and catch rate of prawns within the area. The boundary of this SFMG was realigned closer inshore this season to improve the protection of small prawns while permitting fishing on larger prawns.

The management system involves a total allowable effort arrangement whereby all boats have an equal allocation of headrope length for all areas. The fleet is composed of trawlers up to 23 m, operating twin- or quad-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m).

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

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

Research summary

Research needed to manage this small fishery involves stock monitoring and assessment utilising the CAES monthly returns data provided by industry, along with information from voluntary daily log books and some interviews with boat skippers. Annual meetings are held with licence holders to consider the status of the stocks and recommend changes to fishing operations. In 2004, a field-based consultative process was introduced whereby industry and the Research Division decide on the extent of an area to be fished within areas that are opened by Notice, and this has continued for the 2005 fishing season.

An FRDC-funded project examining the biodiversity of bycatch species in trawled and untrawled areas of Shark Bay, Exmouth Gulf and Onslow Area 1 will be completed in 2006.

RETAINED SPECIES

Commercial production (season 2005): 85 tonnes

Landings

The total landings of major penaeids for the 2005 season were 85 t, including 20 t of king prawns, 55 t of tiger prawns and 10 t of endeavour prawns. This season's catch was lower than in 2003 and 2004 but within the target range for this fishery (60–180 t).

Tiger prawn landings dominated the very high catches in 2003 and 2004, and their lower level in 2005 mirrored a similar decline observed in the adjacent Exmouth Gulf fishery. This lower tiger prawn abundance reflects the normal environmental conditions in the region for the 2005 season. The king prawn catch was slightly below average but within the target catch range for the species. Landings of secondary prawn species were 4 t of coral prawns and less than 1 t of black tiger prawns (*Penaeus monodon*).

Recorded landings of by-product species included 7 t of bugs (*Thenus orientalis*), 4 t of blue swimmer crabs (*Portunus pelagicus*), 1 t of squid and less than 1 t each of cuttlefish and mixed finfish species.

Fishing effort/access level

Different licence classes apply to this fishery allowing boats to trawl in specific zones. These classes are listed below, with figures in brackets indicating 2005 endorsements:

Class A Areas 1, 2 and 3 (4 boats)
Class B Areas 2 and 3 (3 boats)
Class C Area 2 (12 Exmouth Gulf boats)
Class D Area 3 (12 Nickol Bay boats)

During 2005, boats licensed to fish in the Onslow prawn fishery recorded 523 fishing days. This was less than the effort recorded during the past two years and was reflected in the total landings.

Catch rate

Not assessed.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

The prawn landings during 2005 were slightly below the average for tiger, king and endeavour prawns but within their individual target ranges. The lower tiger prawn landings reflect the return to average environmental conditions. Fishing effort has been targeted towards larger tiger prawns by opening the season later and including surveys to close areas where small-sized prawns occur. This prevents growth over-fishing and reduces impacts on recruitment with the aim of providing more stable catches under increasing effective fishing effort. This is being achieved in combination with moon closure periods of three days. In addition, the closure of the Coolgra area and its inclusion as a nursery provides added protection of habitat and of small prawns in this area.

The king and endeavour prawn landings were at the lower end of the catch range but acceptable.

Banana prawn catches were negligible, therefore industry maintained a voluntary closure of the Ashburton SMFG for the season. As only 4 mm of rain was recorded for the 2004/05 summer period (December to March), these low banana prawn catches were anticipated. Work continues on assessing the relationships between spawning stock, summer rainfall and river flow, and banana prawn catches from Area 1, which includes the Ashburton River estuary. The rainfall recorded for the 2005/06 summer was 272 mm so an improved banana prawn catch may occur in 2006.

Breeding stock levels: Adequate

For most penaeid stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from reducing breeding biomass to critical levels.

For king prawns the analysis of catch and effort data in the 1980s and 1990s provides no evidence of a stock–recruitment relationship. For tiger prawns, the catches are mostly related to the level of effort on the stocks and the normal environmental fluctuations (primarily rainfall) among years. Current catch and effort levels are considered adequate to maintain breeding stocks because they are distributed in discrete areas and not all areas of tiger prawn stocks are necessarily fished each year. Banana prawn catches are highly variable and mainly related to the amount of rainfall recorded in the region, with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment. The low banana prawn stock was not fished in 2005, which would have allowed all the stock to contribute to egg production. The endeavour prawn is a by-product species and is not specifically targeted, so the exploitation levels are low and there is adequate protection of breeding stock.

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

The main performance measures for the Onslow fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2005 the breeding stock indicators (catches within specified ranges) for king, tiger and endeavour prawns were met. The poor catch of banana prawns is due to a run of low rainfall years and to the decision not to fish this species in order to protect the breeding stock.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Bycatch from the fishery is typical of tropical trawl fisheries (i.e. from 2:1 up to about 5:1 relative to the target species), but the effort levels and spatial coverage are too low to impact bycatch species populations. The introduction of fish escapement devices within half the nets towed by each vessel in 2005 should reduce this risk even further.

Protected species interaction: **Low**

The Onslow prawn fishery has on rare occasions previously caught turtles and sea snakes, which are generally returned to the sea alive, but the overall low effort level and targeted coverage of the fishery suggest that such interactions would not have been significant. Bycatch reduction devices (grids) are now fully implemented in the fishery, minimising the capture of large animals including turtles.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Given the limited spatial coverage of this fishery and its low levels of catch, it is unlikely to have any significant ecological consequences.

Habitat effects: **Low**

This fishery targets primarily king and tiger prawns in most years and, occasionally, schooling banana prawns in the infrequent high rainfall periods, as in 2000. Within the extensive licensed fishing zone, relatively few discrete areas offshore from size management fish grounds are fished and in 2005 again the area fished was less than 5% of the overall fishery. The fishery is restricted to clean sand and mud bottoms, where trawling has minimal long-term physical impact.

SOCIAL EFFECTS

Estimated employment for the year 2005 was 12–15 skippers and crew, with up to 10 people involved in local processing.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: **$1 million**

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices received by vessels fishing in this fishery in 2005 were as follows:

King prawns	$12.50/kg
Tiger prawns	$13.60/kg
Endeavour prawns	$6.70/kg
Banana prawns	$9.00/kg
Coral prawns	$2.00/kg

FISHERY GOVERNANCE

Target catch range: **60–180 tonnes**

Under current effort levels and previous environmental conditions, the target ranges of prawn catches, based on the catches of the 1990s, are as follows:

King prawns	10–55 t
Tiger prawns	10–120 t
Endeavour prawns	5–20 t
Banana prawns	2–90 t

The overall acceptable range for all species combined is different from the aggregate of the individual species ranges shown above. This is because the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species, as occurred in 1997 and 2000. The overall catch for the fishery in 2005 was within the target range.

New management initiatives (2005/06)

The Department of Fisheries continues to work with industry to realign size management fish grounds within each sector of the fishery with the aim of maximising economic benefits and ensuring the sustainability of tiger prawns.

The introduction of secondary bycatch reduction devices (square mesh panels) in the cod ends of nets commenced in the 2005 season.

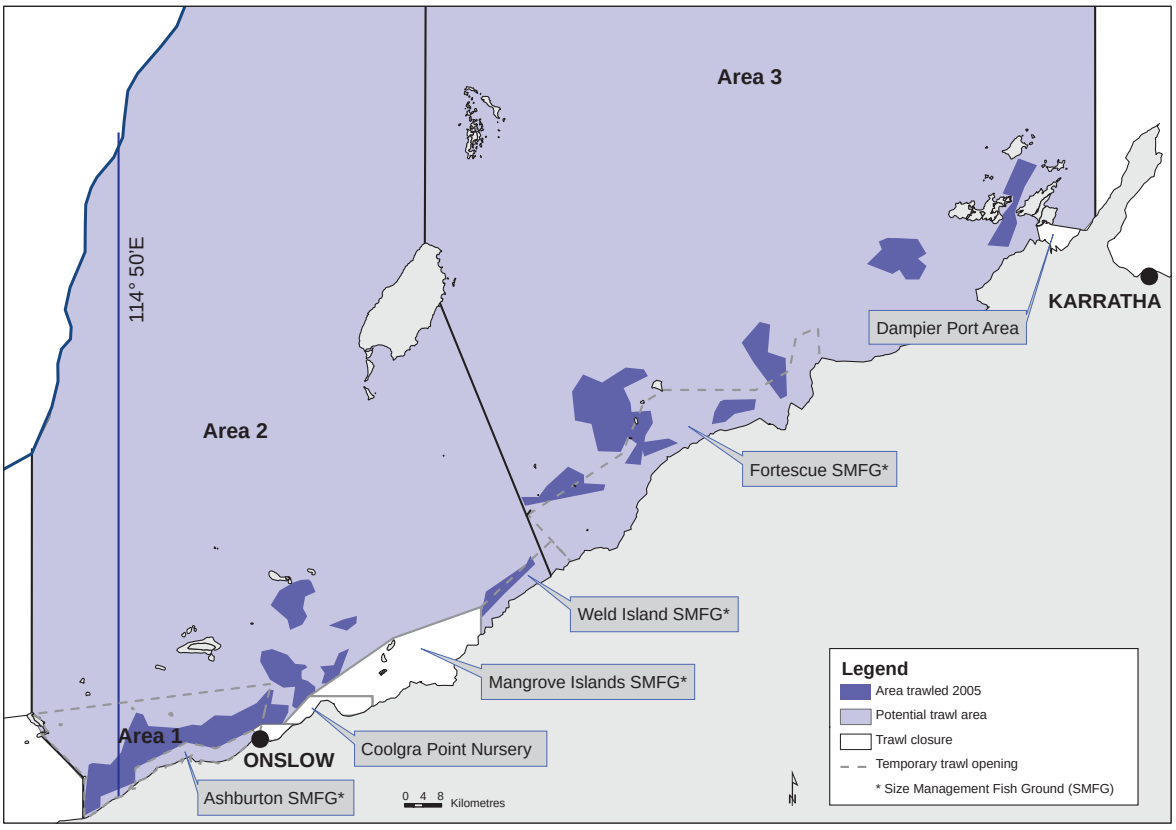
Changes to the management arrangements were implemented during 2004, helping to bring the Onslow fishery into line with the management controls used in the state's other prawn trawl fisheries and to streamline trawl operations, providing economic benefits to industry. These changes included the removal of the hull size control (by way of exemption) and the re-description of port areas and the Onslow townsite closure (amalgamating the former port and townsite areas to simplify the nomination process). Legislation to incorporate these amendments formally into the management plan is pending.

EXTERNAL FACTORS

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

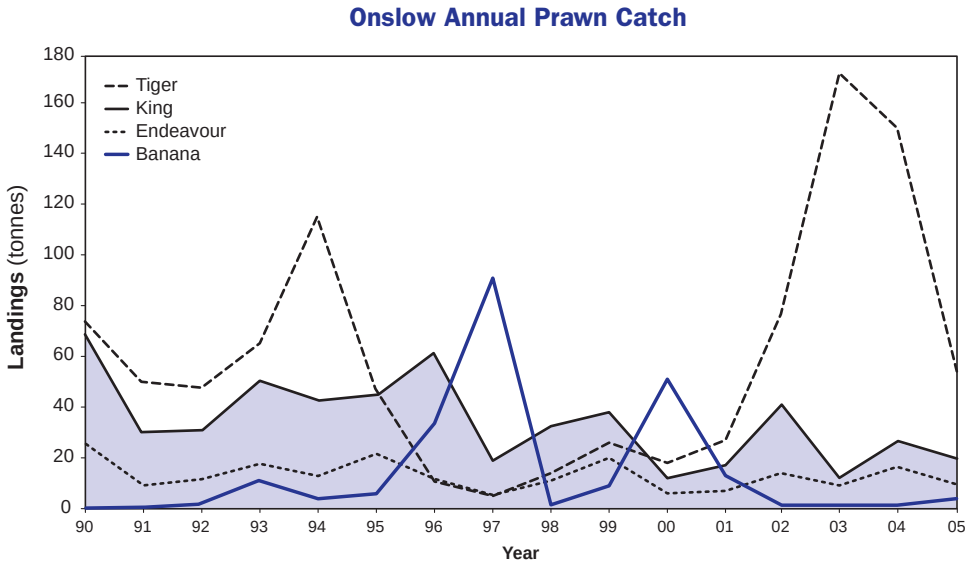
Catches of tiger prawns from this fishery are also quite variable, with very high catches seen in 2003 and 2004 following beneficial environmental conditions. Severe

cyclonic activity can have negative impacts on tiger prawns in some years. The effect is thought to vary depending on whether juvenile prawns are still in vulnerable, shallow nursery areas at the time. The king prawn catch has remained stable, indicating that environmental effects such as cyclonic activity (producing heavy rainfall) have limited effect on the abundance of the king prawn stock.



ONSLOW PRAWN FIGURE 1

Boundaries of the Onslow Prawn Managed Fishery indicating nursery areas and size management fish grounds.



ONSLOW PRAWN FIGURE 2

Annual landings for the Onslow Prawn Managed Fishery, 1990–2005.

Nickol Bay Prawn Managed Fishery Status Report

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

FISHERY DESCRIPTION

The Nickol Bay Prawn Managed Fishery (NBPF) operates along the western part of the North West Shelf and targets banana prawns (*Penaeus merguiensis*), western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*) and endeavour prawns (*Metapenaeus* spp.) using otter trawl.

Governing legislation/fishing authority

Nickol Bay Prawn Fishery Management Plan 1991
Nickol Bay Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Department–industry meetings

Boundaries and access

The boundaries of this fishery are '*all the waters of the Indian Ocean and Nickol Bay between 116°45´ east longitude and 120° east longitude on the landward side of the 200 m isobath*' (Nickol Bay Prawn Figure 1).

Management arrangements

Management controls for the Nickol Bay Prawn Managed Fishery are based on limited entry, seasonal and area closures, gear controls including bycatch reduction devices (grids), and restrictions on boat size. Different areas within the fishery have different season dates allowing access to target species at appropriate times. The vessel monitoring system continues to monitor the activities of all boats.

The 2005 season commenced on 1 March and closed on 15 November, and the season arrangements specified that the major fishing areas would be open during the following periods:

Nickol Bay	1 May – 31 August
Extended Nickol Bay SMFG	1 May – 15 November
Depuch SMFG	1 May – 31 August
De Grey SMFG	1 May – 15 November

Although the SMFGs were opened by Notice on 1 May 2005, industry agreed not to commence fishing in these areas until 24 May.

The management system involves a total allowable effort arrangement whereby all boats have an equal allocation of headrope length. The fleet is composed of trawlers up to 23 m, operating twin- or quad-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m).

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

Research summary

Research for the management of this small fishery involves stock monitoring and assessment utilising monthly returns data provided by industry, voluntary daily log book information from boat skippers, and rainfall records. Stock assessment of the banana prawn stocks involves updating the catch–rainfall relationship. Research outcomes are reviewed at annual industry meetings, which consider the status of the stocks and recommend changes to fishing arrangements.

During the 2005 season, bycatch samples were obtained from one of the boats in the fishery, and all species in the samples were identified and recorded. These will be analysed in association with an FRDC-funded project examining the biodiversity of bycatch species in trawled and untrawled areas of Shark Bay, Exmouth Gulf and Onslow Area 1, which is due for completion in 2006.

RETAINED SPECIES

Commercial production (season 2005): 84 tonnes

Landings

The total landings of major penaeids for the 2005 season were 84.3 t, comprising 66.3 t of banana prawns, 13 t of king prawns, 4 t of tiger prawns and 1 t of endeavour prawns (Nickol Bay Prawn Figure 2). The catch of banana prawns in 2005 was at the low end of the target range but above the very low catch range (5–20 t) projected based on the rainfall–catch relationship. Tiger and endeavour prawn catches were within the target ranges for these species. The king prawn landings, however, were below the target catch range.

Recorded by-product species for 2005 were 3.1 t of bugs (*Thenus orientalis*), 2.4 t of coral prawns, and less than 1 t each of black tiger prawns (*Penaeus monodon*), blue swimmer crabs (*Portunus pelagicus*), squid, cuttlefish, shark and mixed finfish species.

Fishing effort/access level

There were 14 boats licensed to trawl for prawns in Nickol Bay during 2005, with 10 boats fishing during the season.

During 2005, boats licensed to fish in the NBPF recorded 240 days of fishing effort. This is significantly down (approximately 60%) on effort expended in the fishery in the last three years, and reflects the predicted low availability of banana prawns.

Catch rate

Not assessed.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

A broad relationship exists between the summer rainfall (December–March) and the catch of banana prawns in the following season (April–July). This relationship is assessed annually (Nickol Bay Prawn Figure 3).

Breeding stock levels: **Adequate**

For most penaeid stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from reducing breeding biomass to critical levels.

For king prawns the analysis of catch and effort data in the 1980s and 1990s provides no evidence of a stock–recruitment relationship. For tiger prawns, the catches are mostly related to the level of effort on the stocks and the normal environmental fluctuations (primarily rainfall) amongst years. Current catch and effort levels are considered adequate to maintain breeding stocks because they are distributed in discrete areas and not all areas of tiger prawn stocks are necessarily fished each year. Banana prawn catches are highly variable and mainly related to the amount of rainfall recorded in the region, with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment. The endeavour prawn is a by-product species and is not specifically targeted, so the exploitation levels and low and there is adequate protection of breeding stock.

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

The performance measures for the Nickol Bay fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2005 the breeding stock indicators (catches within specified ranges) for banana, tiger and endeavour prawns were all met. The king prawn catches were below the target catch range, partly due to the low effort expended in the fishery in 2005.

Projected catch next season (2006):
Banana prawns 290–440 tonnes

The catch projection for banana prawns, based on the high summer rainfall level of 547 mm during the 2005/06 summer period, is between 290 t and 440 t (Nickol Bay Prawn Figure 3). This projection is above the normal target catch range for banana prawns.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The Nickol Bay prawn fishery operates predominantly by specifically targeting schools of banana prawns. This results in relatively low effort and minimal bycatch compared with other trawl fisheries. In 2005, only 2% of the total Nickol Bay prawn fishery area was fished. The introduction of fish escapement devices within half the nets towed by each vessel in 2005 should reduce this risk even further.

Protected species interaction: **Negligible**

The Nickol Bay prawn fishery has on rare occasions previously caught turtles and sea snakes, but the very low effort levels and targeted coverage of the fishery suggest that such interactions would not have been significant. Bycatch reduction devices (grids) are now fully implemented in the fishery, further reducing the capture of large animals including turtles.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

In view of the highly variable nature of banana prawn recruitment, positively related to cyclonic rainfall, any food chain impacts from fishing are likely to be minimal despite the relatively high annual exploitation rate.

Habitat effects: **Low**

The small fleet fishes on a limited number of discrete fishing grounds, which make up approximately 5% of the coastal habitat within the fishery. Habitat types on the trawl areas associated with banana and king prawns are mud and sand respectively, which are not impacted significantly by trawl gear.

SOCIAL EFFECTS

The estimated employment for the year 2005 was 35 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005:
$800,000

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices received by vessels fishing in this fishery in 2005 were as follows:

King prawns	$12.50/kg
Tiger prawns	$13.60/kg
Endeavour prawns	$6.70/kg
Banana prawns	$9.00/kg
Coral prawns	$2.00/kg

FISHERY GOVERNANCE

Target catch range: **90–300 tonnes**

Under current effort levels and previous environmental conditions, the acceptable ranges of prawn catches, based on the catches of the 1990s, are as follows:

Banana prawns	40–220 t
King prawns	20–70 t
Tiger prawns	2–40 t
Endeavour prawns	1–10 t

The overall target range for all species combined is different from the aggregate of the individual species ranges shown because the environmental circumstances that benefit banana prawns generally result in decreased catches of the other

species in the same year. It should also be noted that the banana prawn catch has exceeded 400 t following extreme cyclonic rainfall on three occasions over the past 35 years.

New management initiatives (2005/06)

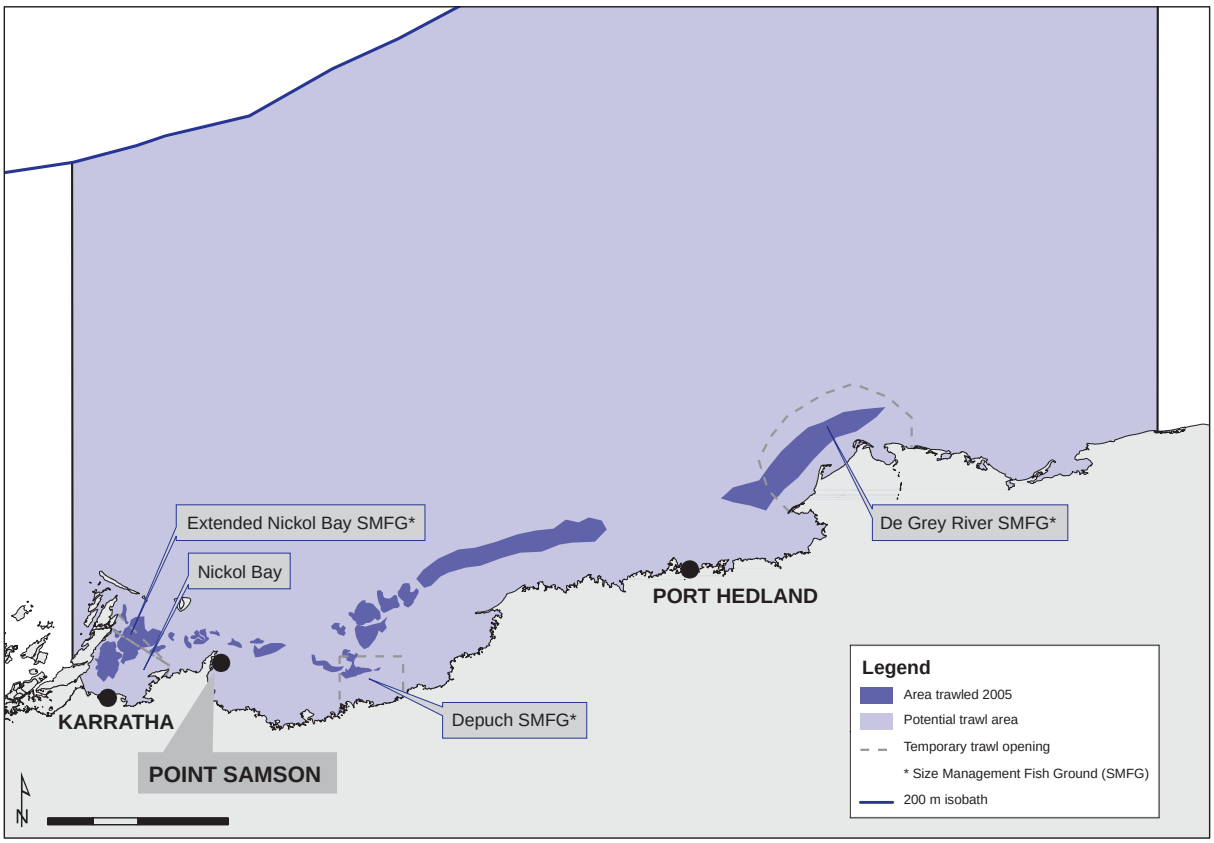
The introduction of secondary bycatch reduction devices (square mesh panels) in the cod ends of nets commenced in the 2005 season.

From the 2006 season, daily prawn log books are to be introduced to provide catch, effort, fishing location and prawn size category data so that research assessments can be improved in the future.

EXTERNAL FACTORS

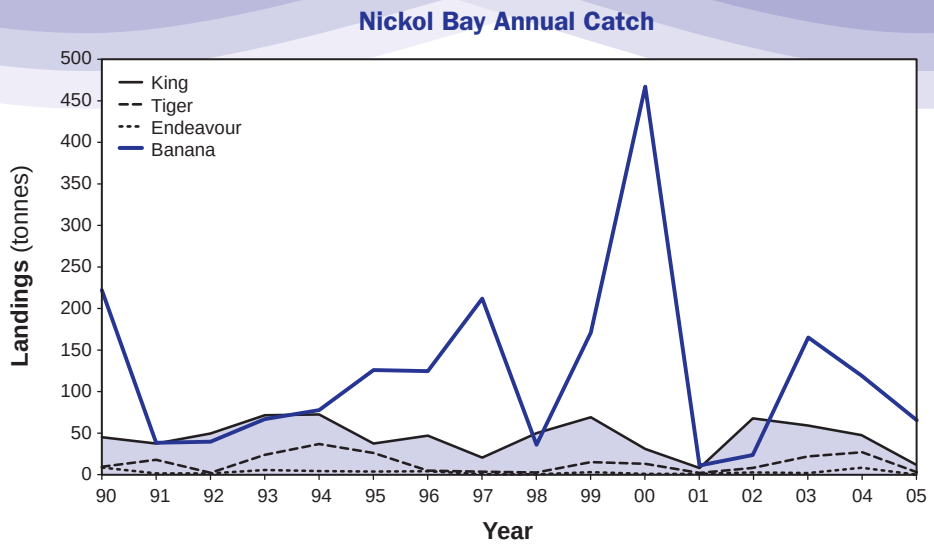
There are a small number of boats in the prawn fleet of Nickol Bay which are also licensed to trawl for finfish stocks offshore in the Pilbara Fish Trawl (Interim) Managed Fishery (PFTF). All boats are also licensed to fish for prawns in the Kimberley Prawn Managed Fishery. As such, the fishing effort in the Nickol Bay Prawn Managed Fishery is also affected by management measures imposed elsewhere. Also, when predicted catches (primarily of banana prawns) are high in other fisheries, licensees may choose to move and fish in these fisheries instead of remaining in the Nickol Bay fishery. Changes in the opening schedules in these fisheries may impact on effort levels in this fishery.

The smaller boats formerly used in this fishery are being replaced by larger boats that have the capacity to process prawns to freezer relatively fast, thus maintaining high catch rates for longer periods than seen before. This increased capacity may have an impact on the prawn stocks and needs to be monitored.



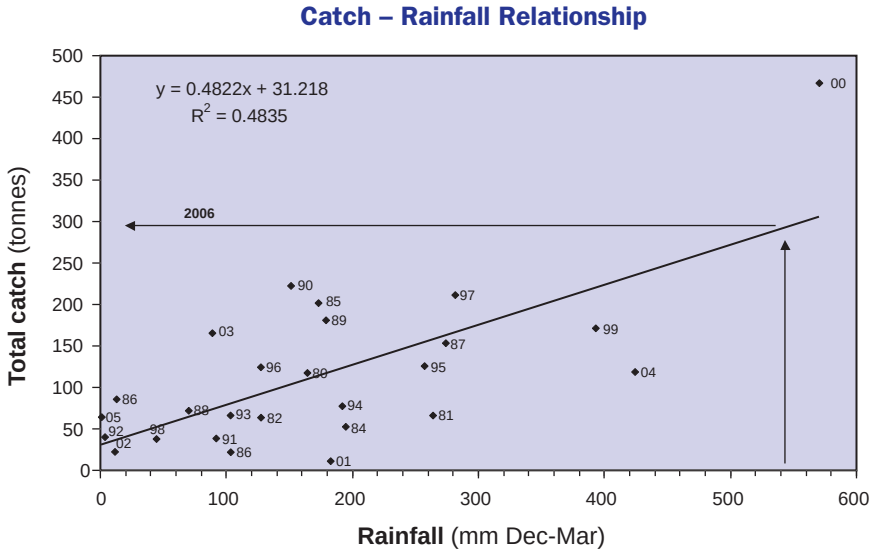
NICKOL BAY PRAWN FIGURE 1

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



NICKOL BAY PRAWN FIGURE 2

Annual landings for the Nickol Bay Prawn Managed Fishery, 1990–2005.



NICKOL BAY PRAWN FIGURE 3

Relationship between banana prawn landings and rainfall between December and March for the years 1966–2005.

Broome Prawn Managed Fishery Status Report

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

FISHERY DESCRIPTION

The Broome Prawn Managed Fishery operates in a designated trawl zone off Broome and targets western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species) using otter trawl.

Governing legislation/fishing authority

Broome Prawn Managed Fishery Management Plan 1999
Broome Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Department–industry meetings

Boundaries

The boundaries of this fishery are '*all waters of the Indian Ocean off the north-west coast of Western Australia east of 120° east longitude and west of 123°45´ east longitude on the landward side of the 200 m isobath*'.

Within this schedule, the permitted fishing area is '*all Western Australian waters bounded by a line commencing at the intersection of 17°50´ south latitude and 121°50´ east longitude; thence east to the intersection of 17°50´ south latitude and 121°55´ east longitude; thence north-east to the intersection of 17°40´ south latitude and 122°00´ east longitude; thence north to the intersection of 17°30´ south latitude and 122°00´ east longitude; thence north-west to the intersection of 17°20´ south latitude and 121°55´ east longitude; thence west to the intersection of 17°20´ south latitude and 121°50´ east longitude; thence south to the commencement point*' (Broome Prawn Figure 1).

Management arrangements

Management controls for the Broome Prawn Managed Fishery (BPF) are based on limited entry, seasonal closures and gear controls including bycatch reduction devices (grids).

The fishery's open period generally coincides with the seasonal closures for the Commonwealth Northern Prawn Fishery (NPF) and the Kimberley Prawn Managed Fishery. In 2005, the season commenced on 30 May and closed on 20 August. This included three new moon phases, thus optimising the best catching periods for king prawns for the time available in this fishery.

Four boats commenced fishing at the season opening, whereas the fifth boat did not commence fishing until 30 June. All boats had left the fishery by 6 August owing to low king prawn catch rates and small prawn sizes.

The fishery was reopened on 1 November to permit industry to conduct a survey to confirm whether commercial quantities of prawns remained during November. However, the survey results showed a low catch rate of king prawns, and no fishing was undertaken.

The vessel monitoring system continues to monitor the activities of all boats.

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

Research summary

Research data for managing this small seasonal fishery are provided by detailed research log books completed by all boats. These data are used for stock assessment and monitoring which is discussed with industry at annual review meetings. A Delury depletion analysis is usually completed which assists in the assessment of the king prawn stocks within this region.

RETAINED SPECIES

Commercial production (season 2005): 47 tonnes

Landings

The total landings for the 2005 season were 47 t, comprising 28 t of king prawns and 19 t of coral prawns (Broome Prawn Figure 2). King prawn landings for 2005 were the lowest recorded in this fishery and below the target range. The catch of coral prawns was just below the target range. No by-product species were recorded in 2005.

Fishing effort/access level

Five boats are licensed to operate in this fishery. Owing to a number of transfers during the 2005 season, a total of nine different boats fished during the overall period, but with a maximum of five at any one time.

Of the 82 nights available for fishing, a total of 63 nights were fished in 2005. Nominal effort recorded in the daily research log books for the fleet was 1,974 hours, down considerably from the previous two seasons and much lower than the average effort of 3,287 hours.

Catch rate

Generally, fishing is continuous during the BPF season, and shows high and low prawn catchability periods influenced by the lunar phase. In 2005, however, due to low fishing effort in the months of May (84 hours) and August (193 hours), meaningful catch rates for these months could not be determined. In addition, during June and July there were non-fishing periods around the full moon periods. Therefore, using the catch and effort data from log books for the 2005 season, the data are separated into three lunar phase periods around the new moon: 30 May to 21 June; 26 June to 20 July; and 25 July to 6 August.

The king prawn catch rate was the lowest observed in this fishery, following a steadily declining catch rate trend over the last four years. The catch rate during the first period

was 11.2 kg/hr for king prawns and 11.5 kg/hr for coral prawns. For the second period the catch rates for king prawns improved slightly to 18.1 kg/hr, but for coral prawn catch rates declined to 7.4 kg/hr. During the third period the catch rates were 13.7 kg/hr for king prawns and 9.2 kg/hr for coral prawns. Over the entire fishing period a relatively low catch rate of 14.2 kg/hr was observed for king prawns and 9.5 kg/hr for coral prawns.

Recreational component: **Nil**

STOCK ASSESSMENT

Assessment complete: **Yes**

In this fishery, once fishing commences it is usually continuous for the entire fishing period and over all moon phases. As the actual fishing area is relatively small and confined, normally a Delury depletion analysis can be undertaken to provide an estimate of the standing stock for the whole fishing period. For the 2005 season, however, owing to non-fishing periods and initial low catch rates of king prawns during the first period with increasing catch rates between June and July, it was not possible to complete the depletion analysis for the whole fishing period.

A Delury depletion analysis was carried out for the fishing period 3 July to 6 August (30 days' fishing) and the estimated standing stock was calculated at approximately 78 t. The exploitation rate was therefore 36%, with 28 t caught in the fishery and 64% stock remaining on the fish grounds when fishing ceased. It is expected that the catch will return to historical levels in the future. It is unlikely that commercial fishing will have an impact on the breeding stock of king prawns due to the widespread nature of this species and the low fishing effort applied in this fishery.

A more detailed stock assessment is not undertaken for the coral prawn stock, as the small size of these species relative to the trawl mesh size ensures a low exploitation rate is maintained.

Breeding stock levels: **Adequate**

Even though depletion analysis was not effective for use over the entire 2005 season, the analysis completed indicated that the king prawn stock remaining at the end of the season was considerably above the level considered sufficient for sustainability.

In the case of coral prawns, the annual catch is a good index of breeding biomass, noting that the species has an annual life history and low catchability with the mesh size used.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2005 the breeding stock indicators for king prawns were met, as the exploitation rate for the king prawn stock was less than 60%. Coral prawns were below their target catch range but this was acceptable due to low effort this year and the restricted size of the area fished which limits overall exploitation of both species.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Owing to the short duration of this fishery and the small number of boats involved, the impact on bycatch species is considered to be minimal. In 2005, 36% of the gazetted fishing area was fished, which represents less than 1% of the total Broome Prawn Managed Fishery area. Over the last four years the area trawled has declined in line with the catches each year. The introduction of fish escapement devices within half the nets towed by each vessel in 2005 should reduce this risk even further.

Protected species interaction: **Negligible**

The fishery operates in relatively deep water, and this fact, combined with the short season, restricted trawl area and low number of boats involved, means that interaction with protected species is minimal. Bycatch reduction devices (grids) are now fully implemented in the fishery, minimising the capture of large animals including turtles.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The short duration and limited spatial coverage of this fishery, combined with the small number of boats involved, results in a relatively small amount of biomass being taken by the fishery. Consequently the impacts on the food chain will be small to insignificant.

Habitat effects: **Negligible**

The fishery targets non-schooling king prawns with a secondary catch of coral prawns (common name due to colour, not habitat association) in relatively deep water. In this fishery the boats are permitted to operate only in a discrete area offshore, north-west of Roebuck Bay (which is the nursery area for this king prawn stock). The defined trawling area was surveyed by the Research Division and the sea floor examined by industry and Research divers prior to establishment of the management plan to ensure minimal impact on the adjacent pearl fishery habitat. The sea floor in the trawl area was mud or sand, which is unlikely to be adversely impacted by trawling.

SOCIAL EFFECTS

The estimated employment generated by the fishery for the year 2005 was 20 skippers and crew over the three-month season. The vessels operate for the remainder of the year in the prawn fisheries further north.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $390,000

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices received by boats fishing off Broome for 2005 were as follows:

King prawns	$12.50/kg
Coral prawns	$2.00/kg

FISHERY GOVERNANCE

Target catch range: 55–260 tonnes

Under current effort levels and previous environmental conditions, the acceptable ranges of prawn catches are as follows:

King prawns	35–170 t
Coral prawns	20–90 t

For king prawns the acceptable range is based on the catches of the 1990s, while for coral prawns it is based on the seven-year range (1996–2002) since catches were first recorded. Therefore, the 28 t of king prawns and the 19 t of coral prawns taken in 2005 were below the minimum set for the target range for each species. In both cases the low landings are due in part to low effort levels resulting from market forces (fuel costs, small size of product yielding low value). Other factors influencing catches are that the timing of the season is set by the mid-season closure for the Northern Prawn Fishery, 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. This situation will be monitored over the next few years.

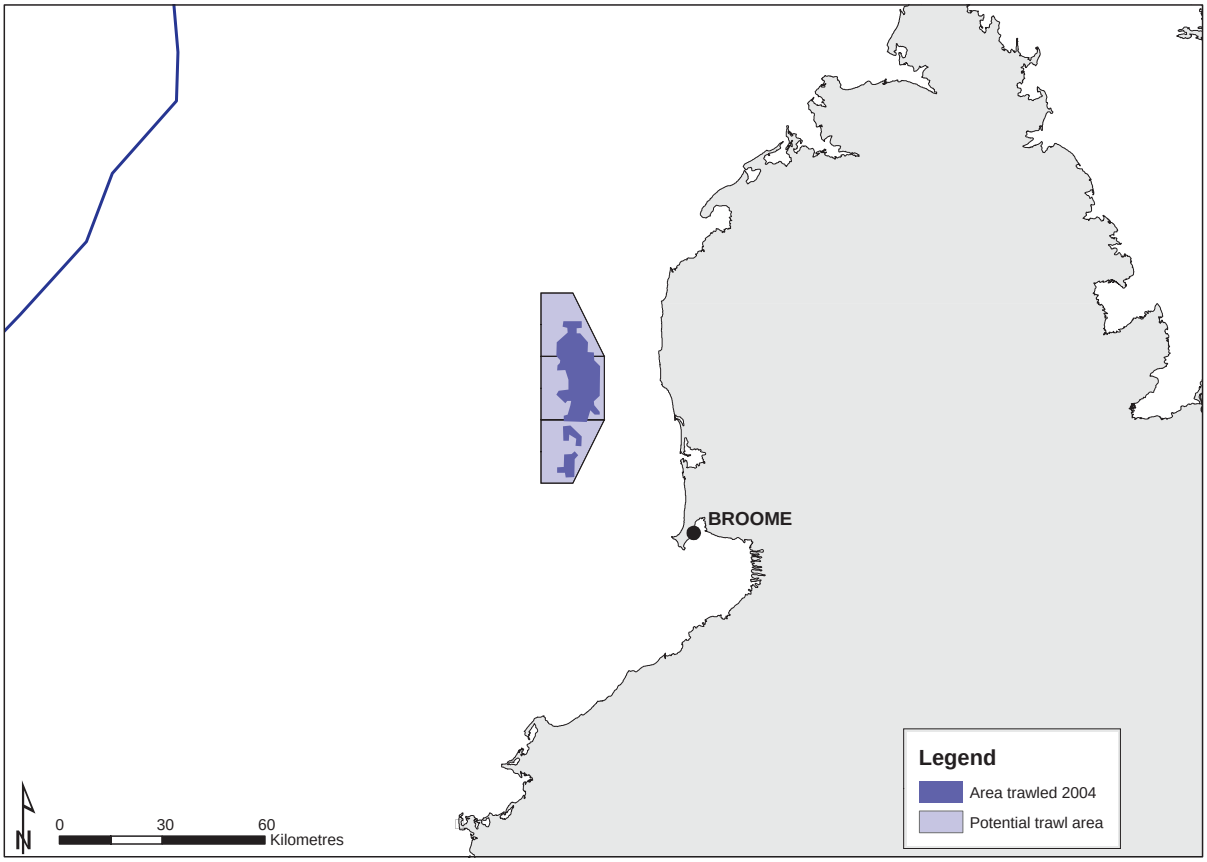
New management initiatives (2005/06)

The introduction of secondary bycatch reduction devices (square mesh panels) in the cod ends of nets commenced in the 2005 season.

EXTERNAL FACTORS

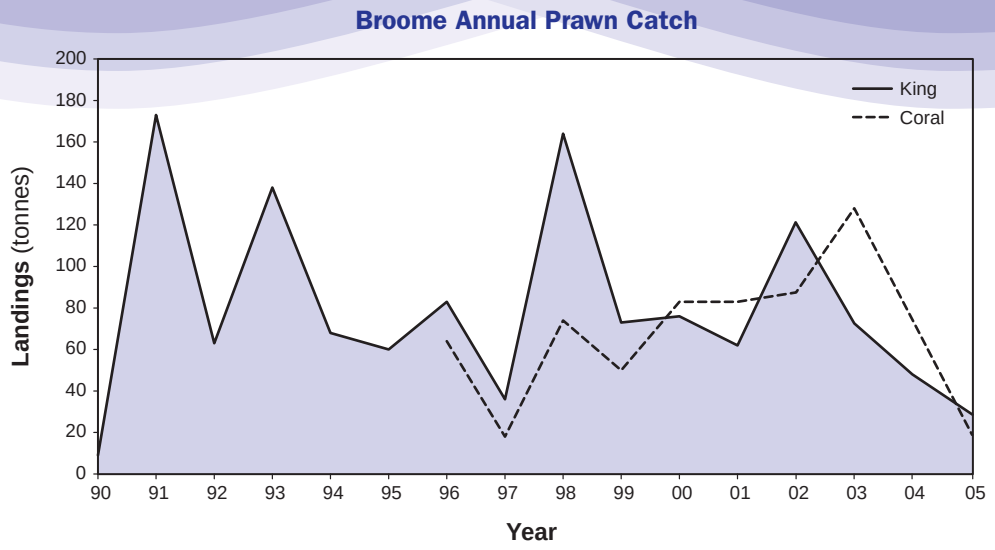
The success of this fishery depends on how the limited fishing season coincides with the king prawn recruitment and catchability, which is strongly influenced by the lunar period.

This fishery is valuable, despite its short season, because it allows up to 11 weeks of fishing by five boats in a way that complements their fishing activity in the NPF, and in other fisheries in Western Australia.



BROOME PRAWN FIGURE 1

Boundaries of the Broome Prawn Managed Fishery.



BROOME PRAWN FIGURE 2

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990–2005.

Kimberley Prawn Managed Fishery Status Report

E. Sporer, G. Parry and M. Kangas

Management input from S. O'Donoghue

FISHERY DESCRIPTION

The Kimberley Prawn Managed Fishery (KPF) operates off the north of the state between Koolan Island and Cape Londonderry. It predominantly targets banana prawns (*Penaeus merguiensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*). Fishing is undertaken using otter trawl.

Governing legislation/fishing authority

Kimberley Prawn Fishery Management Plan 1993
Kimberley Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation Process

Department–industry meetings

Boundaries

The boundaries of this fishery are *'all Western Australian waters of the Indian Ocean lying east of 123°45´ east longitude and west of 126°58´ east longitude'*. It abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF).

Management arrangements

The management controls for the Kimberley Prawn Managed Fishery are based on limited entry, effort controls, seasonal closures, gear controls including bycatch reduction devices (grids), and restrictions on boat replacements.

Seasonal dates for the Kimberley Prawn Managed Fishery are generally aligned with those of the adjacent NPF. A significant number of vessels hold authorisations to operate in both the KPF and the NPF, and opening and closing dates are aligned to prevent large shifts of fishing effort into the KPF. Consequently, the 2005 KPF season opened on 9 April and closed for the mid-season closure on 21 May. The fishery re-opened on 10 August with a promulgated final season closure on 15 November.

The vessel monitoring system continues to monitor the activities of all boats.

In 2005, as in 2004 and 2003, a total effort cap system was in place that restricts the number of fishing days available within the fishing season, based on historical effort levels in the fishery. This was split as 600 days for the first half of the season and 900 days for the second half.

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

Research summary

Research data for monitoring this fishery are provided by Western Australian fishers' monthly returns, and by research log books collected by the Australian Fisheries Management Authority for NPF boats licensed to operate in the Kimberley fishery. Research assessments are provided to annual meetings of boat operators and provide the basis for recommending changes to management arrangements each year.

RETAINED SPECIES

Commercial production (season 2005): 265 tonnes

Landings

The total recorded landings for the 2005 season were 265 t, comprising 220 t of banana prawns, 32 t of tiger prawns, 12 t of endeavour prawns and less than 1 t of king prawns (Kimberley Prawn Figure 1).

The banana prawn catch was within the projected catch range (190–290 t) calculated using the relationship between summer rainfall and catches. Catches of all species were within their target catch ranges. Recorded by-products were 2 t of bugs (*Thenus orientalis*) and less than 1 t each of coral prawns and shark.

Fishing effort/access level

Although a total of 137 managed fishery licences have access to the KPF, the number of individual boats which actually operated in the fishery during some period of 2005 was 21. Twenty boats fished in the first half of the season and 10 during the second half.

During the 2005 season, the boats operated in the fishery for a total of 1,051 days. The effort cap in the first half of the season was 600 days and 570 days were recorded by VMS polling during this period. The effort cap in the second half of the season was set at 900 days and 481 days were fished.

Catch rate

Not assessed.

Recreational component: **Nil**

STOCK ASSESSMENT

Assessment complete: **Yes**

While no formal stock assessment based on catches and fishing effort has been completed for the Kimberley prawn stocks, the relationships identified between rainfall and catches of banana prawns (the dominant species taken in this area) may provide a degree of forecasting.

Investigations have shown a promising relationship between early season rainfall (January and February) and the subsequent catch of banana prawns.

Breeding stock levels: **Adequate**

For most penaeid stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from reducing breeding biomass to critical levels.

Banana prawn catches are highly variable and mainly related to the amount of rainfall recorded in the region, with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment. For tiger prawns, the catches are mostly related to the level of effort on the stocks and the normal environmental fluctuations (primarily rainfall) among years. Current catch and effort levels are considered adequate to maintain breeding stocks because they are distributed in discrete areas and not all areas of tiger prawn stocks are necessarily fished each year. The endeavour prawn is not specifically targeted, so there is adequate protection of breeding stock.

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

The main performance measures for the Kimberley fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2005, the breeding stock indicators (catches within specified ranges) for banana, tiger and endeavour prawns were all met.

Projected catch next season (2006):
Banana prawns 230–350 tonnes

Rainfall during the period January–February 2006 was 440 mm at Derby and 570 mm at Kalumburu so the rainfall–catch relationship predicts that banana prawn catches for 2006 should be in the range of 230–350 tonnes.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The majority of the catch in this fishery comprises banana prawns, which usually form schools that are specifically targeted, meaning that bycatch is minimal. However, banana prawns may occasionally be dispersed due to the local tidal conditions in the Kimberley, with the result that some untargeted trawling may also occur. Overall, the fishery is likely to have a low impact on bycatch species. The introduction of fish escapement devices within the nets in one side in 2005 will reduce this risk even further.

Protected species interaction: **Negligible**

Bycatch reduction devices (grids) are now fully implemented in the fishery, minimising the capture of large animals including turtles.

ECOSYSTEM EFFECTS

Food chain effects: **Neglibible**

As the fishery targets banana prawns, which are highly variable in recruitment due to cyclonic rainfall, any food chain impacts from fishing are likely to be negligible.

Habitat effects: Low

The KPF operates over a very limited area, estimated to be about 5% of the licensed area. Owing to the unusual nature of the envrionment, characterised by extreme (10m) tidal ranges, heavy mud substrates and high turbidity, fishing is judged to have minimal impact on the habitat.

SOCIAL EFFECTS

Estimated employment for the year 2005 was 80 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $2.5 million

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices received by boats fishing along the Kimberley coast in 2005 were as follows:

Banana prawns	$9.00/kg
Tiger prawns	$13.60/kg
King prawns	$12.50/kg
Endeavour prawns	$6.70/kg

FISHERY GOVERNANCE

Target catch range: 240–500 tonnes

Under current effort levels and previous environmental conditions, the acceptable ranges of prawn catches, based on the catches of the 1990s, are as follows:

Banana prawns	200–450 t
Tiger prawns	15–60 t
Endeavour prawns	7–80 t

Note the overall acceptable range for all species combined is different from the aggregate of the individual species ranges shown, as the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species in the same year.

New management initiatives (2005/06)

From the 2006 season, daily prawn log books are to be introduced to provide catch, effort, fishing location and prawn size category data so that research assessments can be improved in the future.

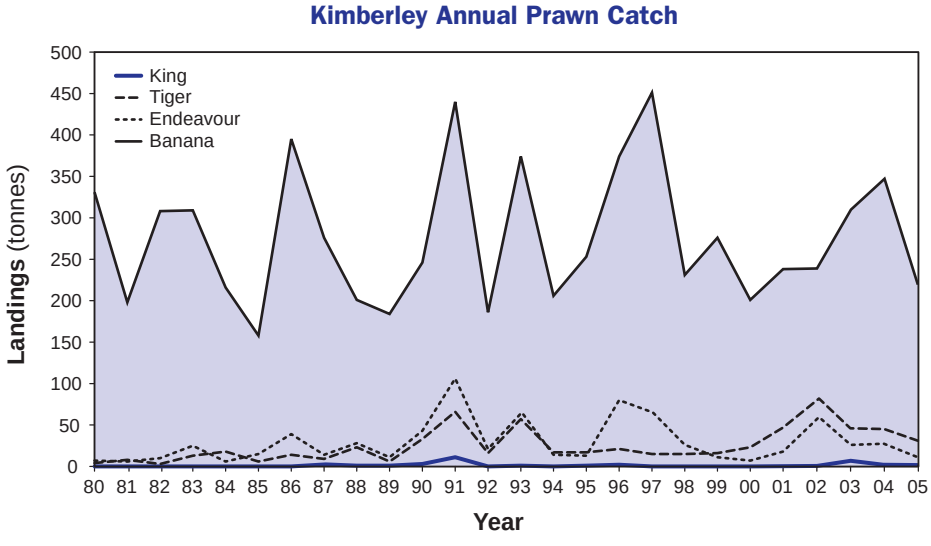
The introduction of size management fish grounds associated with flexible opening and closing arrangements is under consideration. These planned new management areas will provide economic benefits by optimising the size at harvest as well as minimising the capture of small prawns at the start of the season and protecting the spawning stocks during the latter part of the season.

The feasibility of introducing a maximum net headrope size into the fishery will also be investigated. This is associated with the possibility of unitising this fishery in the future.

EXTERNAL FACTORS

The relationship between summer rainfall and the catch of banana prawns continues to be examined. Banana prawns usually comprise the majority of the prawn catch from this fishery, therefore this correlation will assist fishers and managers to plan the best use of this resource.

This fishery has few boats that operate for the complete fishing season. Other boats operate within this fishery at certain times of the year to complement catches in their 'local' fisheries. Currently the KPF fishing season is set to mirror dates used in the NPF to prevent the Kimberley fishery from attracting too much fishing effort from the NPF. The recently introduced effort cap also addresses the issue of latent effort in the fishery.



KIMBERLEY PRAWN FIGURE 1

Annual landings for the Kimberley Prawn Managed Fishery, 1980–2005.

Kimberley Gillnet and Barramundi Managed Fishery Status Report

S. Newman, C. Skepper and R. McAuley
Management input from A. Bain

FISHERY DESCRIPTION

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) extends from the WA/NT border to the northern end of Eighty Mile Beach, south of Broome. It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi by any means.

The species taken are predominantly barramundi (*Lates calcarifer*), giant threadfin salmon (*Polydactylus macrochir*) and blue threadfin salmon (*Eleutheronema tetradactylum*). The main areas of the fishery are the river systems and tidal creek systems of the Cambridge Gulf, the Ria coast of the northern Kimberley, King Sound, Roebuck Bay and the top end of Eighty Mile Beach.

Governing legislation/fishing authority

Kimberley Gillnet and Barramundi Managed Fishery Management Plan 1989
Kimberley Gillnet and Barramundi Managed Fishery Licence

Consultation process

Annual Department–industry meeting

Boundaries

The waters of the KGBF are defined as '*all Western Australian waters lying north of 19° south latitude and west of 129° east longitude and within three nautical miles seaward of the low water mark of the mainland of Western Australia and the waters of King Sound of 16°21.47′ south latitude and Jacks Creek, Yardogarra Creek and in the Fitzroy River north of 17°27′ latitude*'.

The distribution of barramundi and threadfin salmon catches in Western Australia extends south of the KGBF along the Pilbara coast. Catches south of the southern boundary of the managed fishery have been included in the summary table (Kimberley Gillnet Table 1) for completeness.

Management arrangements

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures and gear restrictions.

Access to the KGBF is currently limited to seven licences, with all seven vessels fishing during 2005. Currently there are also two exemption holders authorised to fish commercially with gillnets along the Eighty Mile Beach in the Pilbara coast fishing area south of the managed fishery.

There is a closed season in which fishing is prohibited in the KGBF. In the southern 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.

Following the development in 2000 of the 'Barramundi Accord', additional management arrangements were put into place for both the commercial and recreational exploitation of barramundi. These arrangements include extensive areas closed to commercial fishing around major town sites and recreationally important fishing locations, namely Broome Jetty to Crab Creek, Jacks Creek, Yardogarra Creek, Thangoo Creek, Cape Bossut to False Cape Bossut, Derby Jetty, the Fitzroy River north of 17º27′ S and the lower Ord River upstream of Adolphus Island.

There are also limits on the length of net and mesh sizes to be used in the fishery.

Research summary

A collaborative three-year FRDC-funded research project between Murdoch University and the Department of Fisheries to study the biology of both the threadfin salmon species along with estuary cod, Malabar grouper and mangrove jack was completed in 2005. These data are to be used to provide a detailed stock assessment of threadfin salmon in the KGBF and Pilbara when resources permit.

The bycatch of elasmobranchs (sharks and rays) in the KGBF and the Pilbara coast fishing area was examined during 2002 and 2003 (McAuley et al. 2005).

The data used in this report to assess the status of the series of barramundi stocks targeted by this fishery are provided from the CAES database. This status report is compiled annually and provided to industry and regional management.

RETAINED SPECIES

Commercial production (season 2005):

All species 118 tonnes
Barramundi 36 tonnes
Threadfin salmon 71 tonnes

Landings

The principal species in the landed catch are two species of threadfin salmon, the giant threadfin salmon (also called whites) and the blue threadfin salmon (also called blues), and barramundi. Lesser quantities of elasmobranchs, black jewfish (*Protonibea diacanthus*) and tripletail (*Lobotes surinamensis*) are also landed.

The composition of the elasmobranch catch varies considerably between fishing areas. However, it mainly consists of whaler shark species (Carcharhinidae), including pigeye sharks (*Carcharhinus amboinensis*), blacktip whalers (mainly *C. tilstoni*) and various species of rays, including sawfish (Pristidae).

There are five principal fishing areas within the north coast (Pilbara/Kimberley) bioregion: Cambridge Gulf (including Ord River), Kimberley coast (six small river systems), King Sound (including Fitzroy River), Broome coast (Roebuck Bay), and Pilbara coast (extending to the Ashburton River). Only four of these fishing areas lie within the boundaries of the prescribed KGBF, with the Pilbara coast fishing area

lying outside the managed fishery area below latitude 19° S (Kimberley Gillnet Figure 1). Each of these principal fishing areas is considered separately because of their differing histories of development, effort application, and recreational fishing interest and unit stock considerations. Landings from the Pilbara coast are not included in the total catch figure for the KGBF, but are reported in Kimberley Gillnet Table 1 for completeness along with the catch from each of the four sectors within the managed fishery.

The total reported catch of all species in the KGBF in 2005 was 118 t (Kimberley Gillnet Figure 2). Recent annual catches of the major target species by the KGBF are reported in Kimberley Gillnet Table 2.

The total landings of barramundi from all four prescribed fishing areas within the KGBF were 35.6 t for 2005 (Kimberley Gillnet Figure 3). This level of catch is lower than that reported in 2004.

The 2005 landings of threadfin salmon in the KGBF were 70.6 t, which is higher than the reported catch of barramundi (Kimberley Gillnet Figure 4). Catches of threadfin salmon from the KGBF in 2005 are similar to those reported in 2004, but lower than the near-record high catch of 94 t in 2003. The reported catch of 24 t of threadfin salmon in the Pilbara coast fishing sector in 2005 was substantially lower than the 2004 catch.

These two main species groups (barramundi and threadfin salmon) comprise 90% of the total catch of the KGBF. The reported catch in tonnes and the percentage composition of each of the major species taken in the fishery in 2005 are summarised in Kimberley Gillnet Table 3.

Fishing effort/access level

Procedures to validate and standardise reported fishing effort in the KGBF (and Pilbara gillnet sector) were developed by McAuley et al. (2005) and have been used to reassess the fishery's historical levels of effort. The resulting time series of effort data provide a more accurate record of fishing activity in the KGBF than was previously available and these validation procedures will therefore be used in future to document KGBF fishing effort.

As such, the annual fishing effort levels in this and subsequent reports will not be comparable to those reported in previous *State of the Fisheries Reports*. The fishery's 'effective effort' is now calculated from the validated data as the total length of net set per gillnet hour (km gn hr). During 2005, the total effective effort across the four prescribed fishing areas was 1,072 km gn hr. This level of effort is much lower than that reported in the fishery in 2003 (1,933 km gn hr) and 2004 (1,811 km gn hr) (Kimberley Gillnet Figure 2).

Catch rate

The catch rate of barramundi declined from the early 1980s to 1992. In the period from 1992 to 1999 the catch rate was relatively stable, before increasing in 2000. From 2001 to 2003 the catch rate declined again to levels commensurate with those in the mid-1990s before rising again in 2004 and 2005. The catch rate now appears to be varying around a higher level than that evident in the 1990s (Kimberley Gillnet Figure 3).

Historically, the catch rate of threadfin salmon was relatively stable at low levels in the period from 1984 to 1996, increased rapidly from 1997 to 1998 and was then relatively stable at a high level from 1998 to 2000. From 2001 to 2004 there has been a downward trend in the catch rate data. In 2005 the catch rate increased to levels commensurate with those evident in the late 1990s.

Recreational component:Key species 2–10% (approx.)

The most recent data available is 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 2005 were estimated to be approximately 5.5 t of barramundi and 0.5 t of threadfin salmon.

STOCK ASSESSMENT

Assessment complete: Yes (barramundi)

The last detailed stock assessment (undertaken in 2002) indicated that the barramundi stocks in the Cambridge Gulf, Kimberley coast and King Sound sectors were being harvested at sustainable levels, while in the Broome coast sector the spawning biomass was declining. There is a need to undertake a further stock assessment of barramundi to examine the impact of recent catches on the status of the stocks. No formal assessment of threadfin salmon stocks has been undertaken.

Breeding stock levels: Adequate (barramundi)

Assessment of the barramundi stocks indicates that breeding stocks in most areas are adequate. There has been no formal assessment of the breeding stock levels of threadfin salmon.

NON-RETAINED SPECIES

Bycatch species impact: Low

The fishery operates at a relatively low intensity over a wide area of the Kimberley region, specifically targeting barramundi and threadfin salmon. The fishing gear uses large mesh sizes, and hence does not generate a significant

bycatch of species important to other sectors, but does take some unwanted sharks and rays including sawfish (Pristidae). Because of the low effort levels, these impacts are unlikely to be significant to the stocks involved. Overall, this fishery is likely to be having only a minimal effect on the Kimberley ecosystem as a whole.

Protected species interaction — Low

The fishing gear used for this fishery does take some protected estuarine crocodiles (*Crocodylus porosus*) and freshwater sawfish (*Pristis microdon*). These species are released alive or avoided as far as is practicable. Because of the low effort levels, these impacts are unlikely to be significant.

There are no documented catches of either the speartooth shark (*Glyphis* sp. A) or the northern river shark (*Glyphis* sp. C), which are listed under the *Environment Protection and Biodiversity Conservation Act 1999* as critically endangered and endangered, respectively. Given the fishery's low effort levels, particularly inside the freshwater drainages in which these species may occur, the KGBF is unlikely to be having a significant impact on the populations of these species.

ECOSYSTEM EFFECTS

Food chain effects: Not assessed

Habitat effects: Low

The fishing gear has minimal impact on the habitat. The area and habitat fished is subject to extreme tidal currents and associated effects.

SOCIAL EFFECTS

During 2005, seven vessels fished in the KGBF with an average crew level of 2, indicating that at least 14 people were directly employed in the fishery. There was additional employment through local processors and distribution networks. The fishery provides fresh fish for the local communities and the tourism industry throughout the Kimberley region.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $713,000

The KGBF landed a total of 118 t of fish in 2005, for a catch value of approximately $713,000 (including an estimate of the value of shark fins landed by this fishery). This estimate is based on the landed weight of each species recorded in the CAES system and the 2003/04 average price per kilogram of whole weight of each species as supplied by fish processors.

The Pilbara coast sector landed a total of 25.4 t of fish in 2005 for a catch value of around $112,000 (including an estimate of the value of shark fins landed by this fishery). The value of this sector is lower than the KGBF value as the catch of the highly prized barramundi is negligible in this sector.

FISHERY GOVERNANCE

Target catch range: Barramundi 25–40 tonnes

The target catch range for barramundi (25–40 t) is derived from a double exponential smoothed forecasting model of the annual barramundi catches of the KGBF up to 1999. For the five years from 1999 to 2003, the level of barramundi catch was at the top end of the target catch range. The catch in 2004 exceeded the target range, although this was achieved at a CPUE reflecting higher abundance levels than during the 1980s and 1990s. The barramundi catch in 2005 is within the target range.

New management initiatives (2005/06)

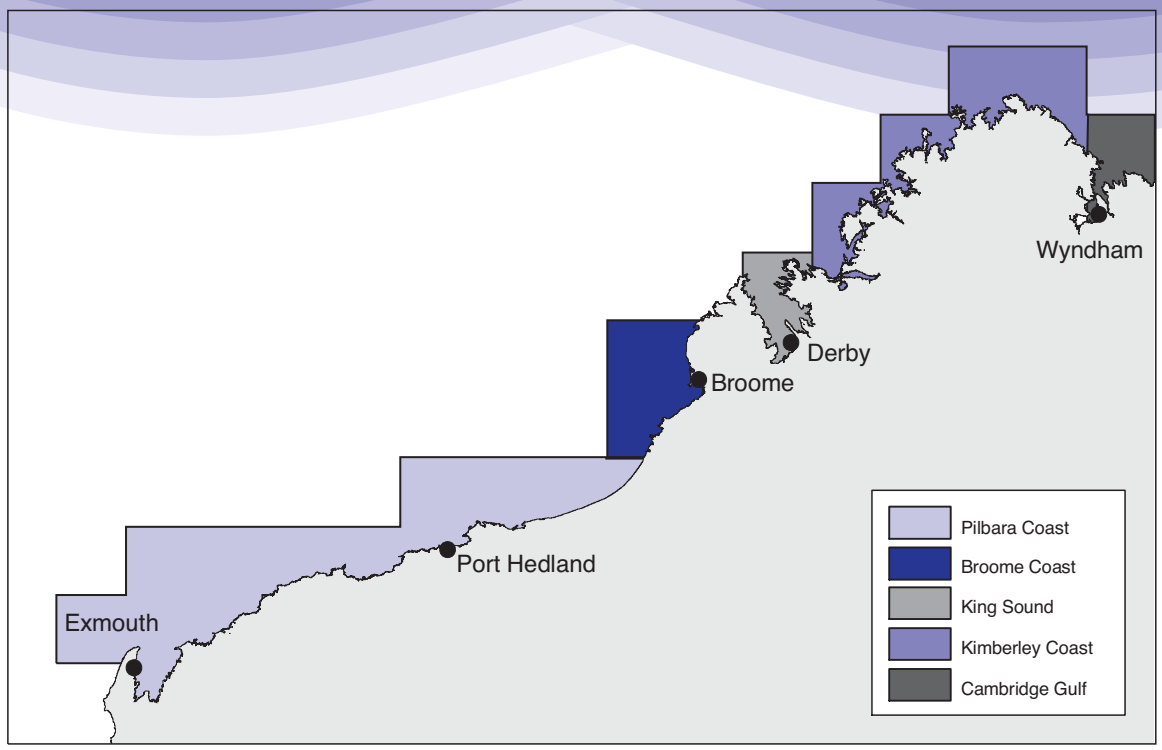
The Barramundi Accord 2000 expired at the end of 2005. Negotiations commenced in 2005 towards the establishment of a new Accord to apply to the recreational and commercial take of barramundi and threadfin salmon throughout the Pilbara and Kimberley. The Department of Fisheries is facilitating meetings between commercial, recreational and charter stakeholders towards developing the new agreement.

A review of the KGBF management plan began in 2005 in order to modernise the fishery management arrangements and address concerns in relation to transferability of licences and the potential for shifting of effort and localised depletion of stocks.

While at current levels of fishing there is little concern regarding elasmobranch bycatch in the KGBF, this is an issue of growing concern at state, national and international levels. In recognition of this, the Commonwealth Government released a National Plan of Action for the conservation and management of sharks (and the related skates, rays and chimaeras) in May 2004. Although reported landings in the KGBF are low, elasmobranch bycatch is significant and several of the objectives of this plan are therefore applicable, including identifying and providing 'special attention to vulnerable or threatened sharks' and collecting 'improved species-specific catch and landings data and monitoring of shark catches'. As Western Australia is regarded as having some of the last relatively unexploited sawfish populations on earth, the Department of Fisheries is in the process of listing all species, except for the narrow sawfish (*Anoxypristis cuspidata*), as commercially protected fish. This measure is aimed at encouraging gillnet fishers in the KGBF and Pilbara gillnet sector to develop and implement methods for mitigating the bycatch mortality of these vulnerable species.

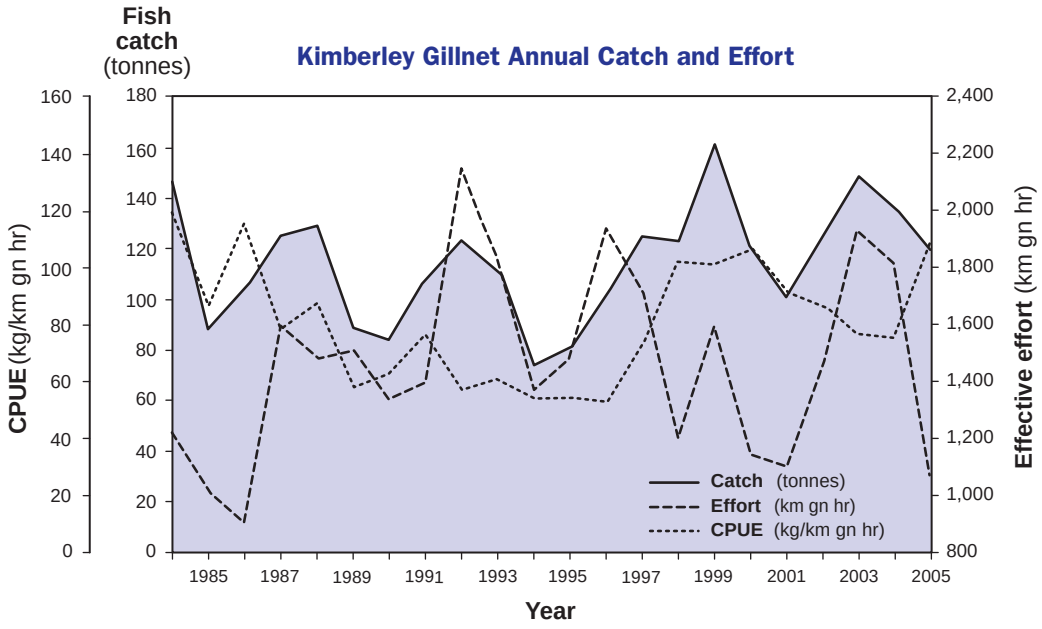
EXTERNAL FACTORS

The barramundi stocks utilising the large Kimberley river systems as nursery areas are expected to be reasonably resilient to fishing pressure. However, the smaller, isolated stocks along the arid Pilbara coastline are likely to experience more variable recruitment. These stocks are subject to relatively uncontrolled levels of fishing pressure from wetline licence holders, as well as from recreational fishers, and are likely to need more specific management arrangements in the future.



KIMBERLEY GILLNET FIGURE 1

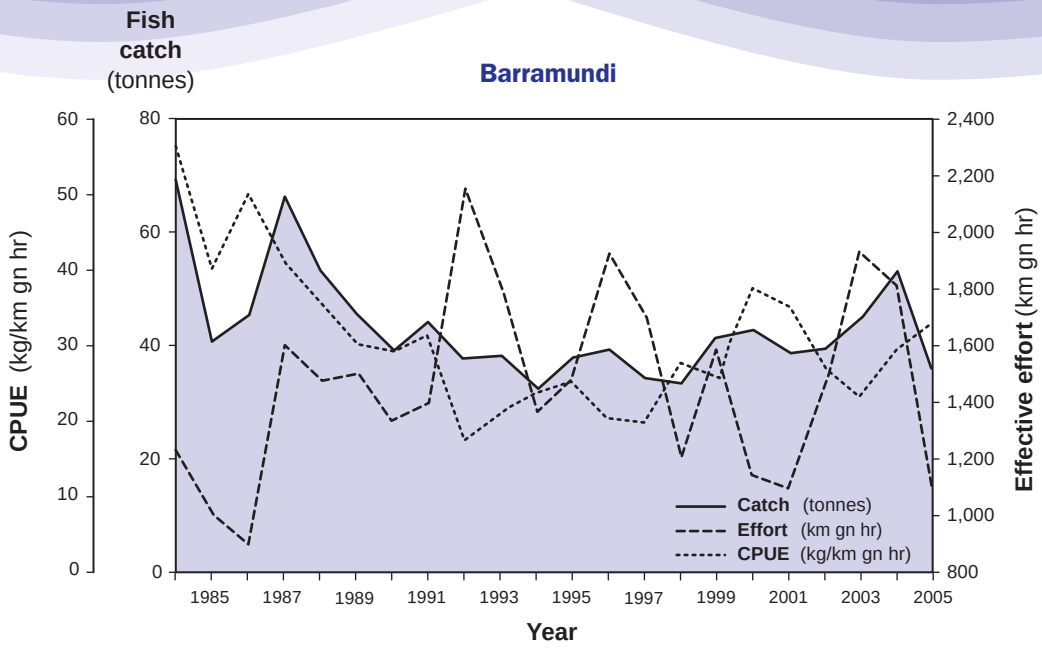
Location of the five principal fishing areas within the north coast (Pilbara/Kimberley) bioregion. Four of the principal fishing areas from the Broome coast to the Cambridge Gulf lie within the boundaries of the Kimberley Gillnet and Barramundi Fishery, with the Pilbara coast fishing area lying outside the managed fishery area south of latitude 19°S.



KIMBERLEY GILLNET FIGURE 2

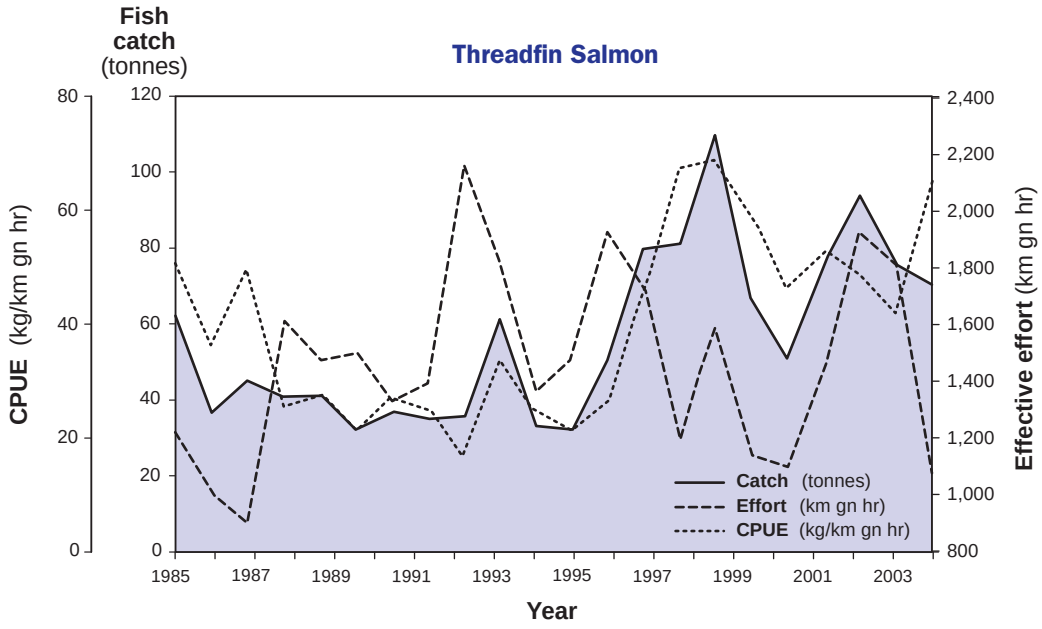
The annual total catch, effective effort (km gn hr) and catch per unit effort (CPUE, kg/km gn hr) from the KGBF over the period 1984 to 2005.

Note: Owing to a mistake in transcription, Kimberley Gillnet Figures 2–4 in the previous report (*State of the Fisheries Report 2004/05*) contained a number of errors.



KIMBERLEY GILLNET FIGURE 3

The annual catch, effective effort (km gn hr) and catch per unit effort (CPUE, kg/km gn hr) for barramundi from the KGBF over the period 1984 to 2005.



KIMBERLEY GILLNET FIGURE 4

The annual catch, effective effort (km gn hr) and catch per unit effort (CPUE, kg/km gn hr) for threadfin salmon from the KGBF over the period 1984 to 2005.

KIMBERLEY GILLNET TABLE 1

The reported catch (t) of the major commercial species from each of the principal fishing areas in the north coast bioregion in 2005.

CATCH CATEGORY	PRINCIPAL FISHING AREA				
	CAMBRIDGE GULF	KIMBERLEY COAST	KING SOUND	BROOME COAST	PILBARA COAST
Barramundi	3.3	17.1	5.0	10.1	0.0
Threadfin salmon	1.5	3.7	1.1	64.3	24.0
Total	**5.6**	**23.5**	**8.7**	**80.0**	**25.4**

KIMBERLEY GILLNET TABLE 2

Recent annual catches of the major target species by the KGBF.

SPECIES	KIMBERLEY GILLNET ANNUAL CATCH (tonnes)									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Barramundi	39.4	34.3	33.5	41.2	42.9	38.8	39.5	45.0	53.5	35.6
Threadfin salmon	51.0	80.2	81.3	109.8	66.7	50.9	76.4	94.1	75.8	70.6
Total	**101.0**	**124.6**	**123.2**	**160.4**	**120.7**	**100.5**	**124.4**	**148.0**	**136.1**	**117.8**

KIMBERLEY GILLNET TABLE 3

Summary of the reported catch (t) and the percentage composition of each of the major species taken in the KGBF in 2005.

SPECIES	CATCH (tonnes)	COMPOSITION %
Threadfin salmon	70.6	59.9
Barramundi	35.6	30.2
Sharks and rays	4.6	3.9
Tripletail	3.0	2.5
Black jewfish	1.2	1.0
Other fish	2.8	2.5
Total	**117.8**	**100**

Northern Demersal Scalefish Managed Fishery Status Report

S. Newman and C. Skepper

Management input from A. Bain

FISHERY DESCRIPTION

The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the north-west coast of Western Australia in the waters east of 120° E longitude. The permitted means of operation within the fishery include handline, dropline and fish traps. Tropical snappers, emperors and groupers (or cods) dominate the landed catch in this fishery.

Governing legislation/fishing authority

Northern Demersal Scalefish Managed Fishery Management Plan 2000

Northern Demersal Scalefish Managed Fishery Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Department–industry meeting

Boundaries

The waters of the NDSF are defined as all Western Australian waters off the north coast of Western Australia east of longitude 120° E. These waters extend out to the edge of the Australian Fishing Zone (200 nautical mile) limit under the Offshore Constitutional Settlement arrangements (Northern Demersal Scalefish Figure 1).

The fishery is further divided into two fishing areas, an inshore sector (Area 1) and an offshore sector (Area 2) (see Northern Demersal Scalefish Figure 1). The demersal scalefish resources of the deeper waters of the offshore sector (greater than 200 m depth) remain to be adequately investigated; these waters are shown on Northern Demersal Scalefish Figure 1 as a 'research fishing zone'.

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

Management arrangements

The NDSF is managed primarily through input controls in the form of annual fishing effort quotas, with supplementary gear controls and area closures.

The annual fishing effort quota limits the amount of effort available in the fishery to achieve the notional target total allowable catch. The annual effort quota is determined by dividing the notional target TAC by the average catch rates per vessel per day within the fishery and dividing this allocation equitably among vessels in the fishery.

The notional target TAC 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 2005, the notional TAC was 800 t of demersal scalefish and the total effort allocation was 1,760 days.

Access to the offshore sector (Area 2) of the NDSF is currently limited to 11 licences under an individually transferable effort quota system. This allows the effort quota to be operated by a lesser number of vessels. For example, during 2005, 5 vessels (trap fishing only) collectively held and operated the effort individually assigned to the 11 licences.

Each trap must have an internal volume equal to or less than 2.25 m^3. There is no restriction on the number of traps that can be fished per vessel. However, as each licensee is allocated an annual effort quota in 'standard fishing days' based on the use of 20 traps (or 5 lines) per day, if the number of traps (or lines) being fished increases, the number of allowable fishing days declines. The number of days fished, as recorded by the vessel monitoring system, is converted to standard fishing days and adjusted to take into account an allocation of travel days for travelling across sectors within the NDSF.

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 the breeding stocks of the two indicator species, red emperor and goldband snapper, and the cod/grouper complex, as reflected by their catch levels. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Baseline research data on growth rates, age structure, reproductive biology and yield analyses, together with information gathered from the fishery, have been used within age-based stock assessment models to assess the status of the two key species, red emperor and goldband snapper. Ongoing monitoring of this fishery is being undertaken using both CAES data and VMS records.

The third largest component of the NDSF catch is the cod/grouper group. Information currently available on their species composition and relative abundance is limited to CAES records. This gap in the knowledge of the NDSF represents an area of future research work, as does an improved understanding of the catchability of the key species in the fishery that would facilitate improved stock assessments and management arrangements.

The future catch from the NDSF may also include some species from the waters of Area 2 in depths greater than 200 m. This area of the fishery is available as a research fishing zone, and fishers have the option to explore the deeper waters, though to date industry has had little success in this zone. The resources of this sub-region are therefore unlikely to be substantial, and given the lower production potential of these longer-lived deeper-slope reef fish, the sustainable catch from this zone is likely to be low.

RETAINED SPECIES

Commercial production (season 2005): 922 tonnes

Landings

The reported catch in the NDSF rose steadily after the initial development period from 1990 to 1992, reaching a peak in catch levels in 1996 (Northern Demersal Scalefish Table 1 and Figure 2). Catch levels decreased after 1996 and were relatively stable in the period from 1998 to 2003, beginning to increase in 2004. The catch of demersal scalefish in the NDSF in 2005 was much higher than that reported in 2004 due to a large increase in the trap catch, with no line catch reported.

The NDSF principally targets red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidens* and related *Pristipomoides* species), with a number of species of snappers (Lutjanidae), emperors (Lethrinidae) and cods (Serranidae) comprising the remainder of the catch. The catch of the major target and secondary target species over the last five years is provided in Northern Demersal Scalefish Table 1. The species composition of the landed catch is similar to that reported in 2004. There was an increase in the landed catch of red emperor, up from 144 t in 2004 to 192 t in 2005 (Northern Demersal Scalefish Figure 3), and a very large increase in the catch of goldband snapper from 283 t in 2004 to 429 t in 2005 (Northern Demersal Scalefish Figure 4). Furthermore, there was an increase in the landed catch of the cod/grouper complex, up from 103 t in 2004 to 110 t in 2005 (Northern Demersal Scalefish Table 1). The increase in catch of the cod/grouper complex was driven by an increase in landings of one species, the Rankin cod (*Epinephelus multinotatus*). The 2004 and 2005 level of catch of Rankin cod is similar to that reported in the fishery in the early 1990s.

The 2005 catch of all three key species/groups (red emperor, goldband snapper and cods/groupers) were above the acceptable levels for the second consecutive year (see 'Fishery Governance' section).

Fishing effort/access level

The five fish trap vessels that fished in the NDSF in 2005 reported using between 20 and 48 fish traps per day. No line fishing was undertaken in the NDSF in 2005.

The effort allocated in 2005 was 160 fishing boat days per licence, or a total of 1,760 standard fishing days (i.e. using 20 traps). The number of standard fishing days (SFDs) recorded using VMS data was 1,318, indicating that 442 SFDs remained unutilised in the fishery at the end of the season.

This level of fish trap effort in 2005, at 1,318 SFDs, was 75% of the total effort allocation and was the highest recorded since the introduction of management controls in 1998 (Northern Demersal Scalefish Table 2), though still below the effort level in the early 1990s prior to formal management. Over this recent period, fish trap effort has varied between 890 and 1,318 SFDs, and a large proportion of the effort allocated to both line and trap vessels in the fishery has remained voluntarily unutilised in each fishing year for economic reasons.

Catch rate

The catch per unit of effort from the fishery provides an indicator of annual variations in stock abundance, although changes in vessel efficiency need to be taken into account when using the data as a time series.

The introduction of management controls in 1998 resulted in an increase in CPUE for trap vessels in the NDSF. This increase was related to increases in efficiency as fishers sought to maximise their catch return from each day fished in the fishery as the available fishing effort was limited.

The CPUE for line vessels (handline and dropline only) in the period from 1998 to 2001 declined from 527 kg/day to 316 kg/day and subsequently no line fishing has been undertaken in the fishery in the period from 2002 to 2005. Prior to 1998 the handline and dropline CPUE was low and variable.

The average trap CPUE during 2005 was 702.9 kg per standard trap fishing day (20 traps x 35.14 kg/trap/day). This annual average trap CPUE in the fishery in 2005 is significantly higher than that reported in 2004 (537.6 kg/SFD) and appears to be driven by large increases in efficiency from some vessels within the fleet.

During 2005, catch rates for the indicator species also increased and were for red emperor 146 kg/SFD, for goldband snapper 331 kg/SFD and for cods 83 kg/SFD. In the case of both goldband snapper and red emperor catch rates in 2005 increased significantly while the amount of effort utilised remained similar to that used in 2004.

Recreational component: **Not assessed**

Historically, there has been little recreational or charter boat fishing effort directed towards the deeper-water fish species in Area 2 of the NDSF that are the key species targeted by commercial fishers. However, this is now changing with charter vessels moving into the offshore waters of the NDSF. The reported charter vessel catch of demersal scalefish in the offshore waters of the NDSF (depth > 30 m) in 2005 is estimated to be approximately 3 t. Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is thought to be concentrated in the Broome sector of Area 1, which is closed to commercial fishing. The magnitude of recreational fishing catch is small relative to the total commercial catch.

STOCK ASSESSMENT

Assessment complete: **Yes**

A notional target TAC of 800 t for all species 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 2006 fishing season is outlined in the 'Target catch range' section below. Prior to the 2004 and 2005 fishing years, the level of catch in the NDSF from 1998 to 2003 (since effort controls were implemented) was relatively stable in the range of 500–600 t due to the decision by vessel operators not to fully utilise the allocated effort each year. In 2004 and 2005 the amount of unutilised effort remaining in the fishery at the completion of each fishing year was much reduced. The catch in each of these recent years has increased substantially and appears to be also driven by increases in efficiency by some vessels in the fleet.

The 2005 trap catch rates increased substantially for the two main target species, with the cods/groupers catch rate remaining at the increased 2004 level, suggesting that the stock size of these species may be on the increase. However, efficiency increases need to be taken into consideration. Therefore, the increased levels of catch of red emperor, goldband snapper and the cods need to be assessed. A stock assessment review of the key target species in the NDSF will be undertaken in 2006–2007.

Breeding stock levels: **Adequate**

The spawning biomass of the key target species in the NDSF has been estimated by an age-structured stock assessment model and assessed in relation to the accepted international reference point for these types of species of 40% of virgin biomass.

The most recent full assessment of breeding stock levels for the two key species in 2002 was based on outputs from the stock assessment model incorporating catch history and catch rate data from the area of the fishery. This assessment indicated that goldband snapper was at approximately 41% of the estimated virgin level, while red emperor was at approximately 54% of the estimated virgin level. These levels were both above the recommended limit of 40% of the virgin spawning biomass and were considered adequate at that time.

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 2005, the catches of red emperor, goldband snapper and the cod/grouper complex all exceeded the trigger point of a 20% increase in catch, as a result of higher effort (but at a level permitted under the management plan). In the case of red emperor and goldband snapper, catch rates increased at the higher catch levels currently being achieved. As abundance has probably been maintained at higher catch levels, all three species/groups were still considered to have adequate breeding stock levels. However, the increasing trend in catch for these species has triggered the requirement for an updated stock assessment in 2006–2007.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

As a result of the catching capacity of the gear and the marketability of most species caught, there is a limited quantity of non-retained bycatch in this fishery. The most common bycatch species is the starry triggerfish, *Abalistes stellatus*, but the numbers taken are not considered to be significant, and most are released alive.

Protected species interaction: **Negligible**

Trap fishing in deep water does not create any significant opportunities for the gear to interact with protected species.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Low**

As a result of the gear design, the fishery has little impact on the habitat overall, although there may be some interaction with coral habitats. 'Ghost fishing' by traps is unlikely to be significant, as similar fish species have been observed on video to be able to exit traps if left undisturbed.

SOCIAL EFFECTS

Five vessels fished in the 2005 fishing season with an average crew level of 3 people per vessel, indicating that 15 people were directly employed in the NDSF.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $5.4 million

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery landed a total of 922 t of demersal scalefish in 2005, for a catch value of approximately $5.4 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 2003/04).

FISHERY GOVERNANCE

Target catch range: **600–1,000 tonnes**

In the eight years since the introduction of management controls (1998–2005), the fleet has only achieved its 800 t notional TAC in the most recent year (2005). In 2005, a large amount of the allocated effort remained unutilised. As such, industry and fishery managers agreed to remove all unutilised effort from the central area of the fishery for the 2006 fishing season.

For the calendar year 2006, the total allowable effort in the central area 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 have been allocated to fishers to facilitate the exploration and development of the deep-slope and inner shelf areas of the fishery.

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 2005, the acceptable level of catch (average + 20%) for red emperor was less than 138 t, for goldband snapper less than 261 t, and for the cods/groupers less than 93 t. All three of these individual trigger points were exceeded in 2005. This increased level of catch and CPUE and its possible impact on the stocks needs to be assessed and discussed with industry. A stock assessment review of the fishery will need to be undertaken in 2006–2007 in association with the collection of new age data for each of the key species.

New management initiatives (2005/06)

Discussions are currently in progress with fishers in order to divide the fishery into zones to provide an adaptive management framework for the development of both the deep-slope and inner shelf fish resources within the fishery. This zoning arrangement will be informally trialled through voluntary industry cooperation during the 2006 fishing season, with formal zones to be established and implemented in subsequent years.

EXTERNAL FACTORS

The impacts of environmental variation on the fishery are not considered to be large. There are no data to indicate significant variation in recruitment amongst years for either of the two key species.

Fishers within the fishery are concerned about the increasing numbers of charter vessels operating in the offshore waters of the NDSF, which could generate resource-sharing issues in the future.

NORTHERN DEMERSAL SCALEFISH TABLE 1

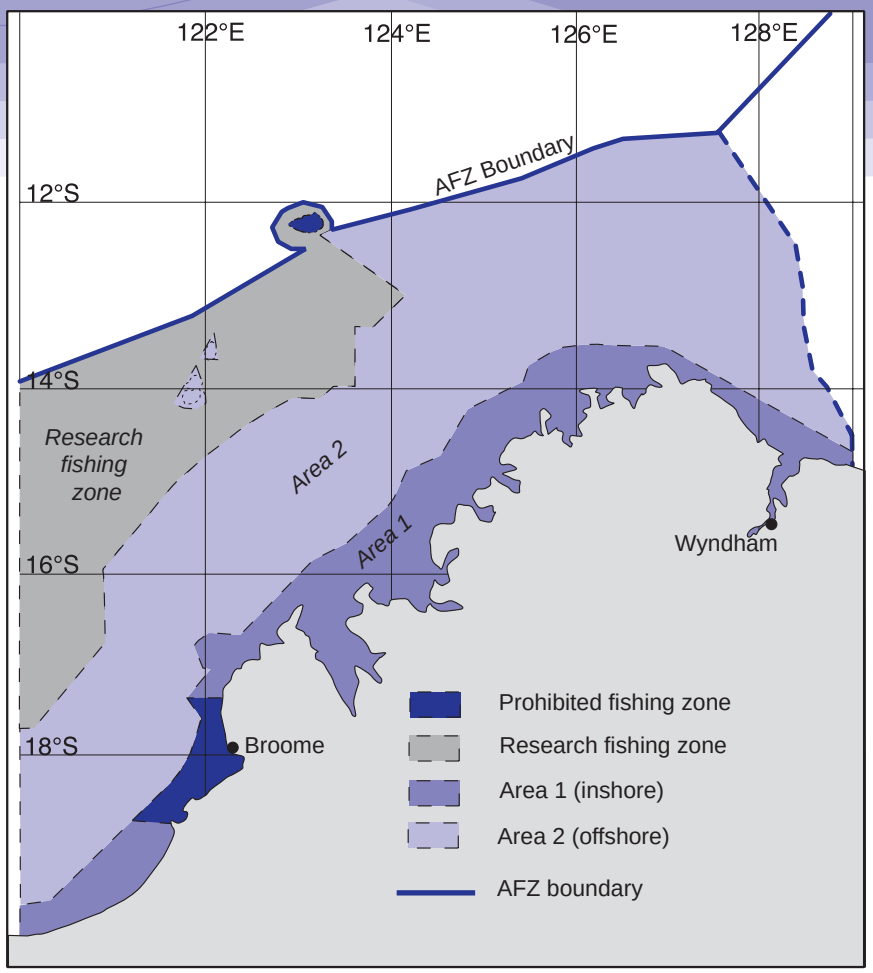
Recent annual catches of major target and by-product species or species groups by the NDSF.

SPECIES		NDSF ANNUAL CATCH (tonnes)				
		2001	2002	2003	2004	2005
Goldband snapper	*Pristipomoides* spp.	209	152	226	283	429
Red emperor	*Lutjanus sebae*	95	101	118	144	192
Saddletail snapper (formerly scarlet perch)	*Lutjanus malabaricus*	39	61	48	68	92
Spangled emperor	*Lethrinus nebulosus*	36	35	39	33	21
Cod/grouper	Serranidae	84	49	74	103	110
Other species		45	36	47	59	78
Total demersal scalefish catch		**509**	**434**	**552**	**690**	**922**

NORTHERN DEMERSAL SCALEFISH TABLE 2

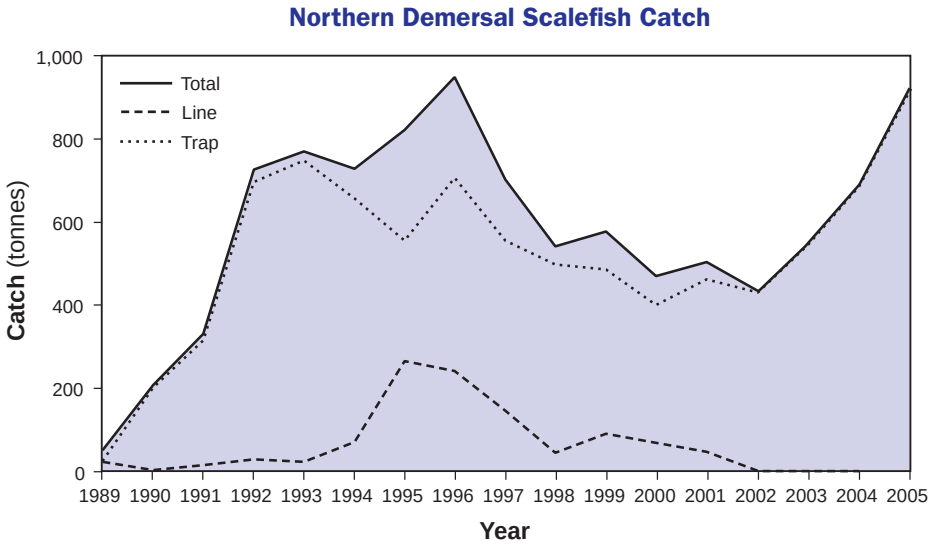
Catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF since the introduction of full management arrangements in 1998.

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**



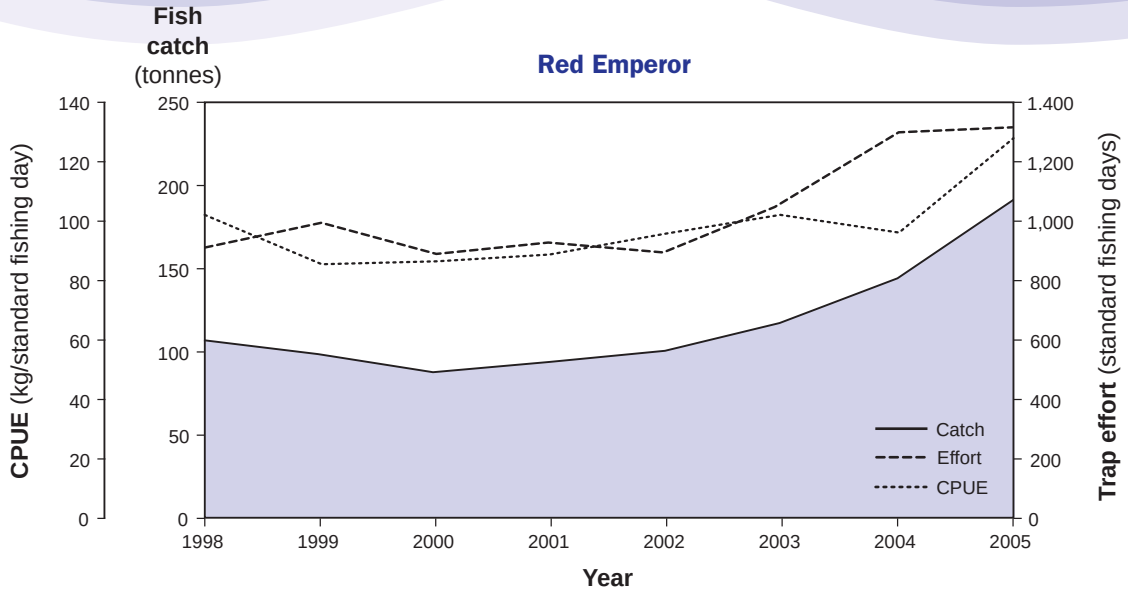
NORTHERN DEMERSAL SCALEFISH FIGURE 1

Location of the Northern Demersal Scalefish Managed Fishery in the Kimberley region of Western Australia. Access areas and boundaries within the fishery are shown.



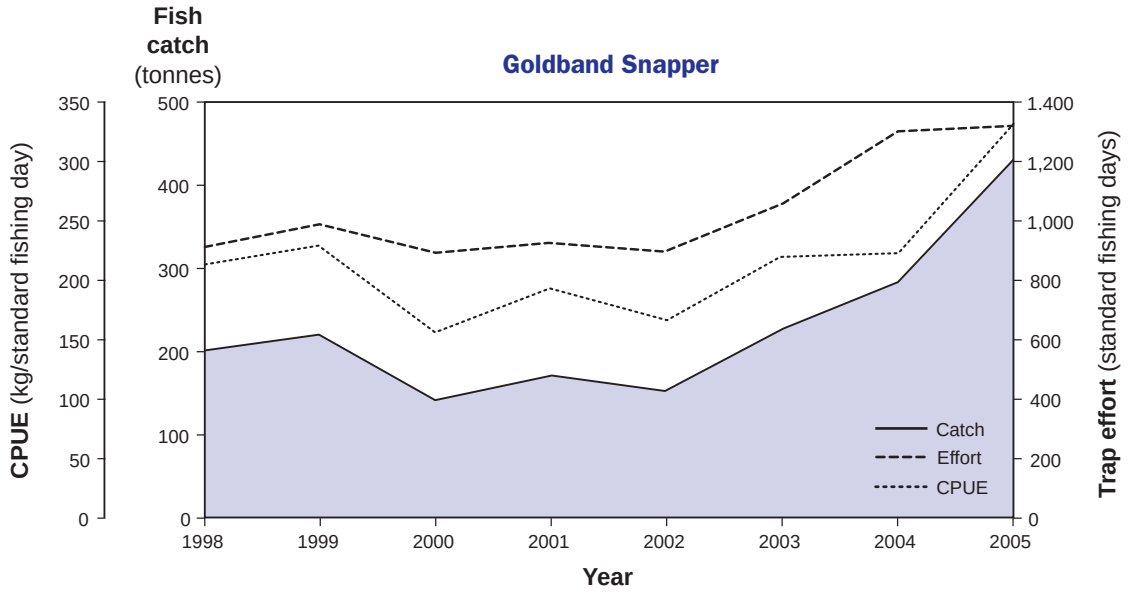
NORTHERN DEMERSAL SCALEFISH FIGURE 2

Catch levels of demersal finfish in the NDSF by line and trap, 1989–2005.



NORTHERN DEMERSAL SCALEFISH FIGURE 3

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2005.



NORTHERN DEMERSAL SCALEFISH FIGURE 4

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998–2005.

Pilbara Demersal Finfish Fisheries Status Report

P. Stephenson and J. King
Management input from K. Saville

FISHERY DESCRIPTION

The majority of the demersal finfish caught in the Pilbara region are taken by the Pilbara Fish Trawl (Interim) Managed Fishery, with a lesser quantity taken by the Pilbara Trap Managed Fishery. In addition, demersal scalefish are taken by line operators with a fishing boat licence entitling them to unrestricted access to the fishery.

The trawl fishery targets 10 main species, namely bluespot emperor (*Lethrinus hutchinsi*), threadfin bream (Nemipteridae), flagfish (*Lutjanus vitta*), crimson snapper (formerly red snapper) (*Lutjanus erythropterus*), red emperor (*Lutjanus sebae*), saddletail snapper (formerly scarlet sea perch) (*Lutjanus malabaricus*), goldband snapper (*Pristipomoides multidens*), spangled emperor (*Lethrinus nebulosus*), frypan snapper (*Argyrops spinifer*) and Rankin cod (*Epinephelus multinotatus*).

The main catch in the trap fishery comprises six of these same species (bluespot emperor, spangled emperor, red emperor, Rankin cod, crimson snapper and goldband snapper).

Governing legislation/fishing authority

Pilbara Fish Trawl Fishery (Interim) Management Plan 1997
Pilbara Trap Management Plan 1992
Fishing Boat Licence (line fishing)
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Department–industry meetings for the trawl and trap fisheries

Boundaries

The boundaries of the Pilbara Fish Trawl (Interim) Managed Fishery are the waters lying north of latitude 21°35´ S and between longitudes 114°9´36´´ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 50 m isobath (Pilbara Figure 1). The trawl fishery consists of two zones. Zone 1, in the west of the fishery, is currently not being trawled. In Zone 2, the interim management plan introduced in 1998 set down boundaries for six management sub-areas. The exact latitudes and longitudes delineating the areas are listed in the Pilbara Fish Trawl Fishery (Interim) Management Plan 1997.

The Pilbara Trap Managed Fishery (Pilbara Figure 1) lies north of latitude 21°44´ S and between longitudes 114°9´36´´ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath. The exact latitudes and longitudes delineating the fishery are listed in the Pilbara Trap Management Plan 1992 as amended in 2000.

Management arrangements

The trawl and trap fisheries are both managed primarily by the use of input controls in the form of individual transferable effort allocations monitored with a satellite-based vessel monitoring system.

The trawl fishery came into a formal management framework in 1998 with effort levels determined (FRDC project 93/125) to achieve the best yield from the fishery while keeping exploitation rates of the key indicator species, red emperor and Rankin cod, at sustainable levels. This involved a number of areas being closed to trawling, namely Zone 1, Area 3, Area 6, and the area inshore of the 50 m depth isobath. Since then, effort has been reduced and redistributed on the basis of annual assessments of the status of the main target species and age-structured modelling of red emperor, Rankin cod, bluespot emperor and goldband snapper. There are 11 licence units with varying time allocations throughout the various areas, with the allocation being used by the equivalent of four full-time vessels.

The ITE management arrangements introduced into the trap fishery in January 2000 dealt with the issue of latent effort in the fishery and proved effective at holding the fishery within its acceptable 300 t limit. However, the ability of the fishery to target long-lived species like red emperor may require limits on the catch of specific species in the future. There are six licences in the fishery, with the allocation used by three vessels in 2005.

Plans for future management of line fishing in the Pilbara are being formulated through the statewide wetline fishing review.

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 breeding stock levels, protected species interactions and habitat effects. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

The monitoring of the Pilbara fishery involves the collection of spatial data on effort and catch of 10 major target species in the trawl and trap fisheries from log books, VMS pollings, and weighed catches from unload data. Otoliths are collected each year for one of the four indicator species (red emperor, Rankin cod, bluespot emperor, and goldband snapper).

The status of the Pilbara stocks is determined annually using catch and catch rates of the 10 major species. Every three to four years a formal age-structured model stock assessment is completed for the four indicator species using the age-composition data.

An FRDC-funded bycatch mitigation project completed in 2005 determined that acoustic pingers were not effective in reducing dolphin catches, but that the use of semi-flexible separation grids appeared promising in reducing the capture of dolphins, turtles, and large elasmobranchs.

RETAINED SPECIES

Commercial production (season 2005):
Trawl 2,371 tonnes
Trap 408 tonnes
Line 226 tonnes

Landings

Catches of the major species for 2005 are shown in Pilbara Table 1. The catches by different fishing methods for the years 1985 to 2005 are shown in Pilbara Table 2 and illustrated in Pilbara Figure 2. Demersal scalefish catch by trawl, trap and line was 2,371 t, 408 t and 226 t respectively.

The trawl catch decreased in 2005 due to the fishers purposely decreasing their catch of the short-lived species. It is now within the target range. The major target species landed in 2005 (2004 catch in brackets) were bluespot emperor 451 t (627 t), crimson snapper 328 t (327 t), threadfin bream 236 t (302 t), flagfish 192 t (228 t), red emperor 96 t (111 t), goldband snapper 78 t (101 t), saddletail snapper 72 t (89 t), Rankin cod 34 t (36 t) and spangled emperor 26 t (32 t). The total retained by-product was 80 t (114 t) including cuttlefish 51 t (60 t), shark 19 t (45 t), bugs 7 t (7 t) and squid 3 t (2 t). The performance indicators based on landed catch were not triggered for any species in 2005.

The trap fishery catch increased to 408 t in 2005 from 395 t in 2004. Major species taken by the trap fishery in 2005 (2004 figures in brackets) were red emperor 90 t (58 t), bluespot emperor 76 t (79 t), goldband snapper 51 t (38 t), Rankin cod 48 t (54 t) and crimson snapper 39 t (37 t). The trap catch was again outside the target catch range due to increased catches of red emperor and goldband snapper. The catch-based performance indicator was triggered in 2005 with goldband snapper, red emperor and Rankin cod exceeding their four-year averages by 216%, 50% and 44% respectively. There is no by-product in this fishery.

Demersal scalefish catches taken by line fishing increased slightly in 2005, with a total catch of 226 t compared to 217 t in 2004. The catches in 2005 (2004 figures in brackets) were mainly goldband snapper 84 t (58 t), saddletail snapper 14 t (16 t), red emperor 8 t (9 t), Rankin cod 6 t (6 t) and spangled emperor 4 t (5 t.) The increase in goldband snapper is a matter for considerable concern. The Pilbara shark catch is reported in the Northern Shark Fisheries Status Report (pp. 165–169).

Fishing effort/access level

The fishing effort in the trap, line and trawl sectors of the commercial fishery is shown in Pilbara Table 3. The effort measured in days comes from monthly catch and effort returns. For the trawl fishery, however, the effort from 1991 to 2005 is also recorded as the net bottom time (hours) taken from skippers' voluntary log book data validated by VMS data.

In the trawl fleet, there are the equivalent of four full-time vessels. The number of hours allocated to the fleet in each area of the fishery, the number of hours used (verified by VMS) and the percentage of the allocation used over the period 1998–2005 are shown in Pilbara Table 4. In 2003, the licensing year changed from a calendar year to a financial year basis (July 1 to June 30). Because the reporting of the fishery has continued on a calendar year basis, the time used can exceed the allocated time in any one season. Trawling was not allowed in either Area 3 or Area 6 during 2005.

The number of trap days allocated, the number of days used and the percentage of the allocation used for the period 2000–2005 are shown in Pilbara Table 5. In 2005, the three trap boats were allocated 5,867 trap units (days multiplied by number of traps), with the number of these units used, calculated from VMS, being 5,519 (94%). This number of units equates to 403 days fished with an average of 12.6 traps per day, a slight decrease from the average of 12.8 traps used per day in 2004.

In 2005, line fishers reported operating for 784 days, compared with 769 days in 2004. This effort does not include trolling, which is reported in the Mackerel Fishery Status Report (pp. 159–164), nor the dropline and longline effort in the Northern Shark Fisheries (pp. 165–169).

Catch rate

The trawl catch rates (based on nominal VMS effort) of the major species between 1989 and 2005 are shown in Pilbara Figures 3 and 4.

Catch rates of the major species in the trap fishery (based on reported number of days fished) from 1985 to 2004 are shown in Pilbara Figure 5.

The line catch rate in 2004 was more than double that in 2003 due to a small number of dedicated and efficient operators.

Recreational component: < 2%

While there is a major recreational fishery in the Pilbara and the charter sector is an increasing user of the resource, the inshore closures to the commercial sector provide a high degree of separation between the user groups. These do not catch significant quantities of most species targeted by the commercial Pilbara trawl, trap and line fisheries.

STOCK ASSESSMENT

Assessment complete: Yes

The assessment in 2005 was based on catch and catch rates. The trawl catch rates, based on nominal effort, decreased for four of the six long-lived target species. As there have been considerable efficiency increases in recent years, these decreases may be indicative of decreasing stock sizes. The catch rates should be closely monitored in the next few years with consideration given to further effort reduction in the near future.

The unrestricted access of line fishers in the Pilbara is a major concern. The line scalefish catch of 217 t is almost twice the upper limit of the acceptable catch range. The goldband snapper catch, which increased dramatically to 58 t in 2004 and 84 t in 2005, poses a considerable risk to the Pilbara stock of this species.

Breeding stock levels: **Adequate**

The major performance measures for the fish stocks in the Pilbara demersal fisheries relate to breeding stock levels of the long-lived and short-lived finfish indicator species.

The target level of spawning biomass is 40% of the initial level when the catch was first recorded. The limit level is 30% of the initial spawning biomass.

The spawning biomass levels of the target species were assessed as adequate in 2002 by synthesizing the available data in an age-structured model. The age-structured model stock assessment will be updated in 2006.

NON-RETAINED SPECIES

Bycatch species impact: **Moderate**

The observer program and the FRDC bycatch mitigation project confirmed the level of scalefish bycatch in the trawl fishery at about 30%, similar to that reported in Stephenson and Chidlow (2003). The trap and line fisheries have minimal bycatch.

Protected species interaction: **Moderate**

The trawl fishery has an incidental capture of dolphins, turtles, sea snakes, pipefish and seahorses. Turtles and sea snakes are generally returned to the water alive but dolphins, pipefish and seahorses are generally dead when landed. The catch of these species is recorded in skippers' log books and reported every three months to the Department of Environment and Heritage. The 2005 reported catch of protected species is shown in Table 6. Given the area of distribution and expected population size of these protected species, the impact of the trawl fishery on the stocks of these protected species is probably minimal. There is a small catch of green sawfish, a species that is expected to be protected in the near future.

An FRDC-funded project to evaluate methods of reducing bycatch found that acoustic pingers were not effective in reducing the dolphin numbers in the trawl net, but that a semi-flexible separation grid appeared to reduce the capture of dolphins, turtles and elasmobranchs. A further study to quantify the catches of dolphins and turtles with grids deployed has taken place between March and July 2006.

There is no indication of interactions between the line fishery and protected species. Similarly, the trap fishery has a negligible impact on protected species.

The performance measures for the impact of the trawl fishery on protected species require skippers to record incidents of capture and minimise mortality. In 2005, the dolphin mortality recorded was about half the limit set and the turtle catch was acceptable at one-quarter of the limit set. Syngnathid, sawfish, and seasnake catches were all below their maximum levels and are therefore considered acceptable (Pilbara Table 6).

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The current fish trawl fishery operates with standard stern trawling gear (single net with extension sweeps) within an area previously trawled by a Taiwanese fleet. Historical research by CSIRO has suggested that the extensive Taiwanese pair trawl fishery caused a significant decrease in the biomass of finfish on the North West Shelf, and a change in species composition towards smaller species. The current Australian trawl fishery, which developed when the fish stocks had somewhat recovered, uses a much larger mesh size and much lighter ground rope, and operates at lower exploitation rates. The present levels of trawl and trap effort appear to be resulting in increased catch rates, probably due to increased stock size. Overall, the effect of the fishery on the food chain of the North West Shelf is considered to be at an acceptable level.

Habitat effects: **Moderate**

Impacts to the habitat are restricted to those of the trawl fishery, which is confined to around 7% of the North West Shelf (Pilbara Figure 1). Area 3 and the waters inside 50 m are permanently closed to trawling, Zone 1 is currently closed to trawling, and Area 6 has had no trawl effort allocation since 2000.

Within the areas actually trawled, past research has indicated that approximately 10% of the sessile benthic fauna (e.g. sponges) is detached per year, with higher rates in Area 1 where the effort is concentrated. It is not known whether the detachment rate exceeds the rate of regrowth.

The performance measure for the trawl impact on the North West Shelf ecosystem was set as a maximum area of operation by the trawlers. With the current closures within the licensed area of the fishery (50 m to 200 m depth), 46% of the area is accessible to the trawl vessels. The actual area trawled is less than this as some of the area is too rough to be trawled.

SOCIAL EFFECTS

It is estimated that 22 fishers on 4 vessels were directly employed during 2005 in the Pilbara trawl fishery, and 10 fishers on 3 vessels in the trap fishery. The level of employment in line fishing is not available.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $11.6 million

This estimate is based on the landed weight and price of each species as supplied by fish processors.

There has been little overall increase in fish prices in the last two years. The trawl demersal finfish catch is dominated by lower-valued species such as bluespot emperor and threadfin bream, and its value in 2005 was $8 million. The trap and

line catches are dominated by the valuable species such as red emperor and goldband snapper, and the demersal scalefish catch from these sectors was valued at approximately $2.1 million (trap) and $1.2 million (line). Important components of the line catch are shark and Spanish mackerel, which have not been included in the value of the line fishery, but are recorded in the Northern Shark Fisheries Status Report (pp. 165–169) and the Mackerel Fishery Status Report (pp. 159–164) respectively. The trawl fishery also has a retained by-product valued at $269,000.

The catches from the Pilbara fisheries dominate the Western Australian metropolitan markets and support the local fish processing sector. There is also an increasingly important export of scalefish to Europe and Asia.

FISHERY GOVERNANCE

Acceptable catch range: Trawl 2,000–2,800 tonnes
Trap 160–360 tonnes
Line 50–115 tonnes

In the trawl fishery, catch in 2005 was within the target catch range. In the trap fishery, the catch is again well above the upper limit of the target range, with the major increase being for red emperor. Adjustment to the allocated effort in the trawl and trap sectors may be necessary to compensate for significant efficiency increases and, in the case of the trap fishery, to reduce the catch to within the target range.

The increased line catch of deep-water species like goldband snapper has taken the catch to almost twice the upper limit of the acceptable catch range. This is of major concern.

New management initiatives (2005/06)

The Australian Government Department of Environment and Heritage has certified the Pilbara Trap Fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999.*

In 2005 the Pilbara Trawl Fishery was declared a Wildlife Trade Operation by DEH, permitting the continued export of product until August 2006 (pending results of the research into methods to reduce turtle and dolphin catches). Bycatch reduction grids were made compulsory in the trawl fishery on 1 March 2006, and the progress made in reducing catches of these protected species through the use of these exclusion grids has resulted in an extension of the declaration until 1 December 2007.

Consultation with stakeholders for an interim management plan for the Pilbara line fishery is expected to commence in 2007. As an interim measure, it is anticipated that the Minister will prohibit commercial line fishing between Tantabiddi Well and 120° E longitude in August 2006 (with the exception of around nine wetline operators with a long history of fishing in the area). This prohibition is aimed at reducing access to the line fishery and protecting deep-water species such as goldband snapper and ruby snapper until such time as the fishery can be brought under formal management.

EXTERNAL FACTORS

The area available for fishers has decreased over recent years as a result of exclusion zones for gas pipeline and facilities. Seismic surveys also restrict the operation of fishers. However, neither of these operations is expected to significantly affect fish stocks or catches.

PILBARA TABLE 1

Commercial catches (to the nearest tonne) and the percentages (to the nearest 1%) of each major species taken by trawl, trap and line in the Pilbara in 2005.

SPECIES		FISH TRAWL CATCH		TRAP CATCH		LINE CATCH		TOTAL CATCH
		tonnes	%	tonnes	%	tonnes	%	tonnes
Blue spot emperor	*Lethrinus hutchinsi*	451	86%	76	14%	–	–	527
Crimson snapper	*Lutjanus erythropterus*	328	85%	39	10	17	5%	384
Threadfin bream	*Nemipteridae*	236	100%	1	–	–	–	237
Flagfish	*Lutjanus vitta*	192	93%	14	7%	–	–	206
Goldband snapper	*Pristipomoides multidens*	78	37%	51	24%	84	39%	213
Red emperor	*Lutjanus sebae*	96	50%	90	46%	8	4%	194
Saddletail snapper	*Lutjanus malabaricus*	72	73%	13	13%	14	14%	99
Spangled emperor	*Lethrinus nebulosus*	26	48%	24	45%	4	7%	54
Frypan snapper	*Argyrops spinifer*	45	98%	–	–%	1	2%	46
Rankin cod	*Epinephelus multinotatus*	34	39%	48	54%	6	7%	88
Other demersal scalefish		813	85%	52	5%	92	10%	957
All demersal scalefish		**2,371**	**79%**	**408**	**14%**	**226**	**7%**	**3,005**

PILBARA TABLE 2

Summary of reported commercial catches (t) of demersal scalefish by line, trap and trawl in the Pilbara fishery, as well as by-product from the fish trawl fishery.

YEAR	DEMERSAL SCALEFISH				BY-PRODUCT*
	Line	Trap	Trawl	Total	Trawl*
1985	180	168	–	348	–
1986	65	113	–	178	–
1987	67	192	3	262	–
1988	136	243	3	382	–
1989	104	457	124	685	–
1990	157	407	421	985	4
1991	107	119	754	980	14
1992	63	148	1,413	1,624	21
1993	67	178	1,724	1,969	42
1994	79	207	2,506	2,792	102
1995	95	222	2,821	3,138	77
1996	136	302	3,201	3,639	102
1997	109	234	2,630	2,973	133
1998	78	250	2,512	2,840	119
1999	50	371	2,136	2,419	69
2000	59	257	1,995	2,314	80
2001	99	266	2,221	2,592	150
2002	90	306	2,310	2,706	180
2003	81	363	2,860	3,304	154
2004	217	395	2,837	3,449	113
2005	**226**	**408**	**2,371**	**3,005**	**80**

* By-product consists of shark, cuttlefish, rays, bugs, and tropical lobster.

PILBARA TABLE 3

Summary of effort in the Pilbara fishery. The trap, line and trawl effort (days) is from monthly catch and effort returns. The trawl effort (hours) is nominal effort from operators' log book data.

YEAR	LINE (days)	TRAP (days)	TRAWL (days)	TRAWL (hours)
1985	809	709	–	–
1986	655	548	19	–
1987	614	507	17	–
1988	985	804	32	–
1989	863	1,198	310	–
1990	1,332	1,321	698	–
1991	740	472	1,132	8,660
1992	514	681	983	10,030
1993	876	696	832	10,725
1994	732	545	1,484	22,087
1995	852	608	1,571	21,529
1996	814	513	1,550	25,246
1997	809	483	1,389	19,810
1998	692	503	1,291	20,555
1999	453	842	1,139	15,963
2000	500	518	957	14,084
2001	401	446	1,162	15,330
2002	660	418	1,035	14,830
2003	715	412	1014	14,663
2004	769	418	953	15,372
2005	**784**	**431**	**886**	**14,721**

PILBARA TABLE 4

The number of hours allocated, the number of hours used and the percentage of the allocation used in each area of the Pilbara trawl fishery.

		AREA 1	AREA 2	AREA 3	AREA 4	AREA 5	TOTAL
1998	time allocation	17136	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	5198	23,096
TRAWL	time used	9,438	3,928	0	3,358	4476	21,199
	% of time used	82%	117%	–	110%	86%	92%
2001	time allocation	10,624	3,797	0	3,528	5141	23,090
TRAWL	time used	10,428	4,091	0	3,644	4819	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	8,911	3,542	0	3,293	4,325	20,070
TRAWL	time used	9,562	4,303	0	3,299	2,995	20,159
	% of time used	107%	121%	–	100%	69%	100%
2004	time allocation	8,911	3,542	0	3,293	4,325	20,070
TRAWL	time used	8,802	4,159	0	4,101	4,341	21,404
	% of time used	99%	117%	–	125%	100%	107%
2005	**time allocation**	**8,911**	**3,542**	**0**	**3,293**	**4,325**	**20,070**
TRAWL	**time used**	**9,328**	**4,367**	**0**	**3,144**	**3,595**	**20,439**
	% of time used	**105%**	**123%**	**–**	**95%**	**83%**	**102%**

PILBARA TABLE 5

The number of days allocated, the number of days used and the percentage of the allocation used in the Pilbara trap fishery.

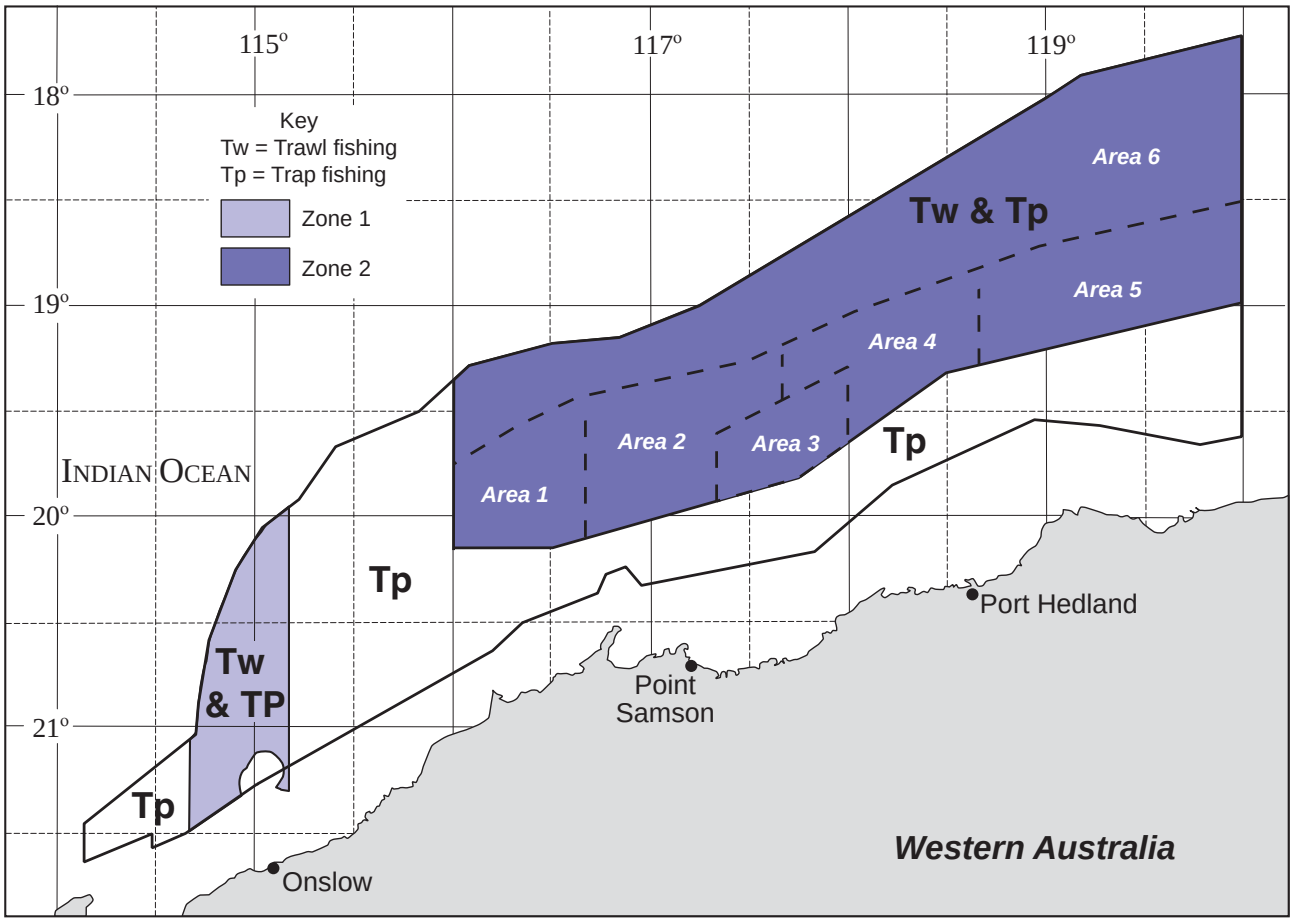
2000	time allocation	524
TRAP	time used	507
	% of time used	97%
2001	time allocation	420
TRAP	time used	414
	% of time used	99%
2002	time allocation	385
TRAP	time used	382
	% of time used	99%
2003	time allocation	399
TRAP	time used	389
	% of time used	98%
2004	time allocation	425
TRAP	time used	419
	% of time used	99%
2005	**time allocation**	**429**
TRAP	**time used**	**403**
	% of time used	**94%**

PILBARA TABLE 6

Reported by-catch of protected species by skippers in the Pilbara trawl fishery in 2005.

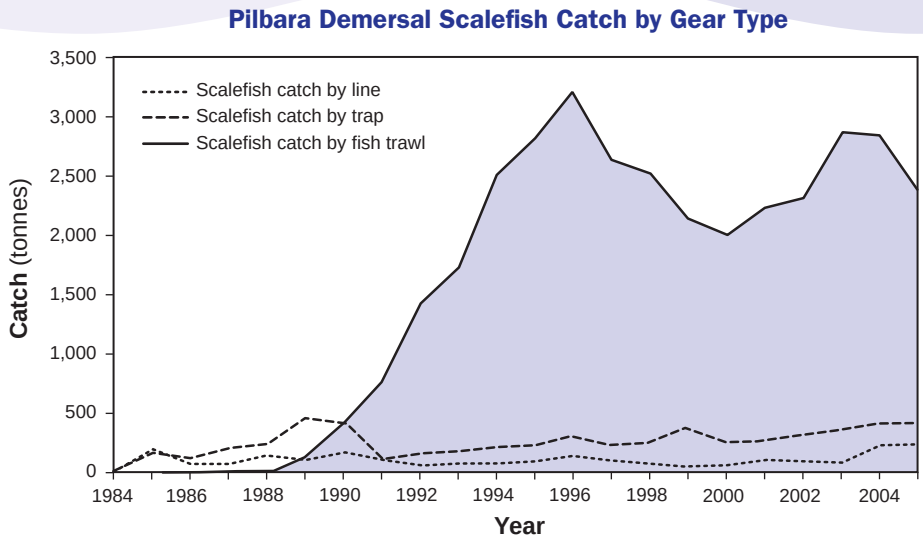
SPECIES	NUMBER ALIVE	NUMBER DECEASED*	TOTAL REPORTED
Dolphins	4	52	56
Pipefish	6	105	111
Sawfish, green	8	5	13
Sawfish, narrow	1	0	1
Seahorses	0	0	0
Sea snakes	39	6	45
Turtles, green	15	4	19
Turtles, leatherback	1	1	2
Turtles, loggerhead	6	0	6
Turtles, olive ridley	3	0	3
Total protected species	**83**	**173**	**256**

*Where the condition was not reported the animal was considered deceased.



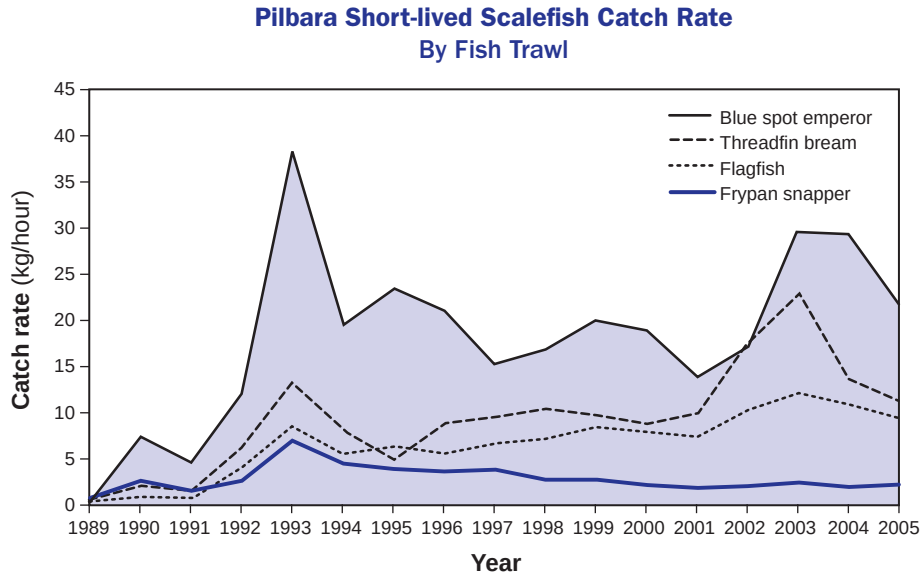
PILBARA FIGURE 1

Demersal scalefish fisheries of the Pilbara region of Western Australia. Areas 1 to 6 refer to the management regions in Zone 2 of the trawl fishery. Zone 1 has been closed to trawling since 1998.



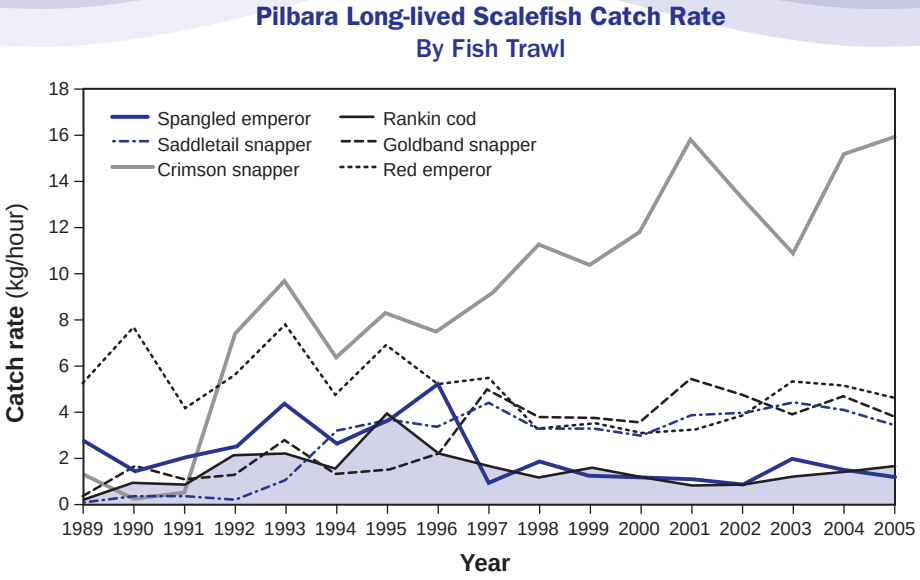
PILBARA FIGURE 2

Demersal scalefish catches by trawl, trap, and line from 1985 to 2005.



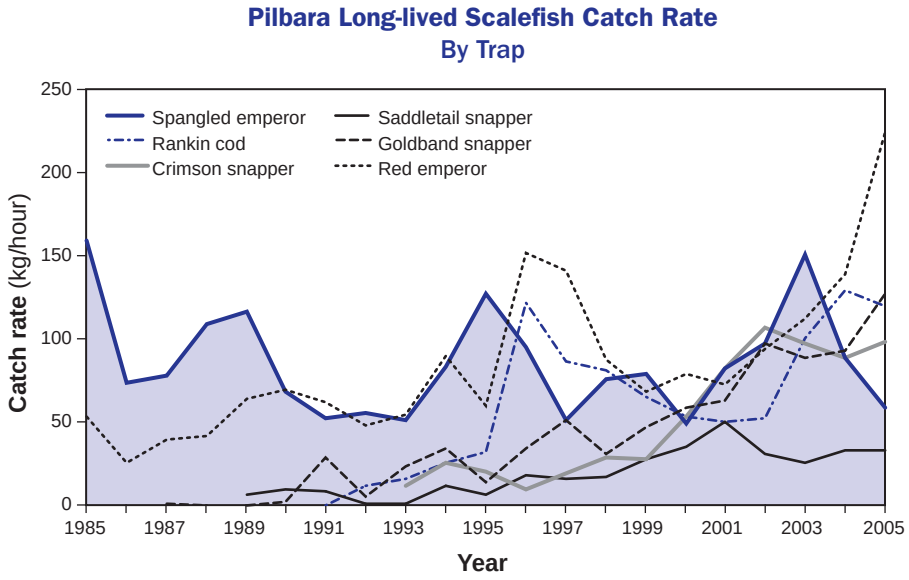
PILBARA FIGURE 3

Catch rates (kg/hour) of short-lived scalefish caught by trawl from 1989 to 2005.



PILBARA FIGURE 4

Catch rates (kg/hour) of long-lived scalefish caught by trawl from 1989 to 2005.



PILBARA FIGURE 5

Catch rates (kg/day) of long-lived scalefish caught by trap from 1985 to 2005.

Mackerel (Interim) Managed Fishery Status Report

M. Mackie
Management input from K. Saville

FISHERY DESCRIPTION

The mackerel fishery includes the taking of all species of the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium*, but the most commonly targeted species is Spanish mackerel (*Scomberomorus commerson*). Mackerel are usually taken by trolling close to the surface in coastal areas around reefs, shoals and headlands, but some operators also jig for grey or broad-barred mackerel (*Scomberomorus semifasciatus*). The commercial fishery mainly operates between Geraldton and the WA/NT border, with the largest catches taken off the Kimberley and Pilbara coasts.

Governing legislation/fishing authority

Mackerel Fishery (Interim) Management Plan 2004
Fish Resources Management Regulations 1995
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Department–industry meetings.

Boundaries

Catches are reported for four areas: Kimberley (121° E to WA/NT border), Pilbara (114° E to 121° E), Gascoyne (27° S to 114° E) and West Coast (Cape Leeuwin to 27° S). The managed fishery is comprised of Area 1 (Kimberley), Area 2 (Pilbara) and Area 3 (combined Gascoyne and West Coast).

Management arrangements

The fishery is subject to an interim management plan which came into effect in August 2004. During the season being reported here (2004/05), the management arrangements included limitations on the number of permits authorising a person to fish in the fishery and the type of gear that may be used, and a closed season.

Permit holders may only fish for mackerel by trolling or handline. The initial numbers of permits issued were 19 in Area 1, 16 in Area 2 and 18 in Area 3.

Fishing for mackerel was prohibited between 1 December and 31 May in the Kimberley, 1 October and 31 May in the Pilbara and 1 October and 28 February in the Gascoyne-West Coast.

Additional management controls are being implemented during 2006 (see 'New management initiatives').

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

Research summary

Two mackerel-related FRDC funded research projects were completed in 2002. Both projects ran for three years and focused on the narrow-barred Spanish mackerel, *Scomberomorus commerson*, which is the main target species in the Western Australian mackerel fishery. Together, these projects have provided description of the biology, spatial structure and status of Spanish mackerel stocks in Western Australian waters, and serve as a basis for management arrangements to control future catches from the fishery. This status report for the mackerel fishery is based on analyses of Spanish mackerel catches.

RETAINED SPECIES

Commercial production (season 2005):
Spanish mackerel 310 tonnes
Grey mackerel 12 tonnes
Other mackerel 23 tonnes

Landings

Spanish mackerel (*Scomberomorus commerson*) is the main target species and may comprise more than 90% of the catch. Grey or broad-barred mackerel (S. *semifasciatus*) is the dominant secondary target, particularly in the Gascoyne and West Coast areas where it is sometimes captured in large numbers. However, because fishing methods need to be modified (i.e. from trolling to jigging) in order to catch this species in quantity, it is essentially a separate component. Other secondary target species of the trolling operation for Spanish mackerel include spotted mackerel (S. *munroi*), shark mackerel (*Grammatorcynus bicarinatus*), wahoo (*Acanthocybium solandri*), cobia (*Rachycentron canadum*), tunas, smaller sharks and the occasional reef fish such as spangled emperor and coral trout.

The reported catch of 310.4 t of Spanish mackerel in 2005 comprised 173.4 t from the Kimberley area, 101 t from the Pilbara area, 18 t from the Gascoyne area and 17.9 t from the West Coast area (Spanish Mackerel Figure 1 and Table 1). The catch of other mackerel species in 2005 was 35.5 t, including 12.4 t of grey mackerel.

Historic trends in catches were detailed in the *State of the Fisheries Report 2000/01*. Overall catches of Spanish mackerel have increased through time particularly in the Kimberley and Pilbara areas. Catches in both areas dropped substantially in 2005 as a result of the introduction of seasonal closures and a reduction in the number of fishers due to new management arrangements. Catches in the Gascoyne area have declined in recent years with the downward trend continuing in 2005 as a result of the new arrangements. The West Coast area has always been a marginal fishery for Spanish mackerel with catches least affected by the closures.

Annual catches of the other species of mackerel, including grey, spotted, shark and school mackerel, caught by this fishery show large fluctuations, including peaks in total catch in 1992 and 1997 (Spanish Mackerel Table 1). These peaks are mainly due to high catches in the Pilbara and Kimberley areas and reflect periods of high abundance and/or catchability of grey mackerel. This species comprises up to 90% of the catch of mackerel other than Spanish mackerel

and makes up a high proportion of the total catch in the Gascoyne area. However, it is often reported simply as 'mackerel' by fishers and hence recorded in the CAES system as 'other mackerel'. Little is known about the distribution and abundance of grey mackerel in the north of the state where they are captured in large numbers in some years. Catches of grey mackerel have been recorded separately in CAES since 2000 with the highest reported catch during 2004 (15.7 t) occurring in the Pilbara area. Fishers report that in some years grey mackerel may be present in large numbers but cannot be captured by line methods. This was the case during 2005 in the Pilbara and Gascoyne areas, with overall catches dropping to 12.4 t.

The remainder of the catch mainly comprises spotted and shark mackerel. In recent years, each of these species has contributed less than 5% to the catch of 'other mackerel'. School mackerel (*Scomberomorus queenslandicus*) is occasionally caught, mainly in the West Coast area. In recent years the total catch of 'other mackerel' has decreased, and in 2005 a total of 35.5 t 'other mackerel' (including grey mackerel) were reported, with catches in each area ranging from 0.6 t (West Coast) to 21.3 t (Pilbara).

Fishing effort/access level

The commercial fishing effort for Spanish mackerel recorded in the CAES database for the 2005 season was:

			(2004)	(2003)
Kimberley area	4 boats	401 days	(612)	(713)
Pilbara area	8 boats	362 days	(475)	(721)
Gascoyne area	10 boats	252 days	(480)	(736)
West Coast area	8 boats	289 days	(795)	(972)

This is a substantial decrease in effort from 2004, with between 53% and 69% fewer boats in each of the four areas as a result of the new management measures. Between 1980 and 2004 the number of boats recording catches of Spanish mackerel each year varied substantially, from 4 to 20 boats in the Kimberley area, 17 to 53 boats in the Pilbara area, 13 to 56 boats in the Gascoyne area, and 10 to 40 boats in the West Coast area. The number of boats in the fishery is expected to drop further in 2006 as the main operators consolidate through purchase of additional quota.

The unit of effort recorded here is CAES fishing days, i.e. the total number of days fished by a vessel for any month during which they landed Spanish mackerel. Historic effort data has not been a reliable indicator of mackerel fishing effort because many fishers have not specifically targeted mackerel. A daily log book being introduced in 2006 under the interim management plan will provide more detailed and reliable data on effort (and catch) in the mackerel fishery.

Fishing catch and effort for Spanish mackerel is seasonal. Historically, approximately 85% of the total annual catch occurred from May to October each year with the peak in monthly catch varying between areas. Seasonal closures introduced in 2005 have further restricted fishing effort for Spanish mackerel.

Catch rate

The use of catch rates (kg whole fish per day) as a measure of Spanish mackerel abundance has historically been complicated because many fishers who catch Spanish mackerel do not normally target them. The effort these fishers expend in catching mackerel was therefore confounded with effort spent catching other species. Trends in catch rates have thus previously been based on data from vessels in each area that are known to target mackerel.

Since 1985 catch rates in the Kimberley and Pilbara areas have been similar (averages of 165 kg/day and 164 kg/day respectively), although they have been higher in the Pilbara area since 1999 (Spanish Mackerel Figure 2). In both areas catch rates have exhibited an increasing trend reaching historically high levels during the past two years. In 2005 catch rates were 265 kg/day in the Kimberley area (up from 208 kg/day in 2004) and 278 kg/day in the Pilbara area (down from 311 kg/day in 2004). Discussion with fishers indicates that poor weather hampered fishing in the Pilbara area during 2005. While catch rates in the combined West Coast/Gascoyne area are lower than in the two northern areas and are more variable in nature, the average catch rate in these areas has remained fairly stable since 1993 at 85 kg/day. In 2005 catch rates were relatively high at 139 kg/day. (It should be noted that these data may differ slightly from those reported last year due to late catch returns and a reassessment of data for the West Coast area.)

In each area the inter-annual fluctuations in catch rate of vessels targeting mackerel are considered to be a reflection of changing abundance. However, the overall upward trends in catch rates in the Kimberley and Pilbara areas since the early 1990s are more likely to be due to changes in fleet behaviour and efficiency.

Recreational component West coast 40% (approx.) Gascoyne 40% (approx.) Pilbara 20% (approx.)

Recreational survey data are available for the west coast in 1996/97, the Gascoyne in 1998/99 and the Pilbara in 1999/2000. Data obtained during the Pilbara survey also included an estimate of recreational catches in the Broome region of the Kimberley sector. Mackerel catch estimates from these surveys were detailed in the *State of the Fisheries Report 2001/02*.

In 2001, the National Recreational Fishing Survey collected data on the recreational catch of mackerel in all parts of Western Australia. Results of this survey indicate that 278 t of Spanish mackerel and 75 t of other mackerel were captured by recreational fishers (including charter boat fishers) in WA waters during the survey period (N. Sumner, pers. comm.). The recreational catch was therefore about 42% and 57% of the total catch for Spanish and other mackerel, respectively, in 2001.

Reported catches of Spanish mackerel by recreational charter boats are relatively minor. In 2005 approximately 14 t of Spanish mackerel were reported by these boats. Catches were mainly taken in the Kimberley and Pilbara areas (71%). However, it should be noted that more fish are released than are kept by charter boats. As direct observations suggest that

Spanish mackerel do not survive catch and release well, the actual fishing-related mortality of this species is likely to be substantially higher than indicated by catch returns.

STOCK ASSESSMENT

Assessment complete: **Yes**

An initial assessment of Spanish mackerel stocks (which are used as the indicator stock in this fishery) was completed in 2002. This assessment used biomass dynamics and yield-per-recruit modelling, and was presented in the *State of the Fisheries Report 2001/02*. Inputs to the models included biological information and annual catch and effort data. These models have not been updated in the current year, with new management arrangements reducing former concerns about over-fishing. Future monitoring of stock levels will be based on daily log books introduced in 2006.

Insufficient data are available for assessment of stocks of other mackerel species.

Breeding stock levels: **Adequate**

Spanish mackerel rapidly attain sexual maturity: size and age at 50% maturity is 898 mm and 706 mm total length for females and males respectively (< 2 years of age). With the current minimum legal size of 900 mm total length and the focus by the fishery on 1- to 3-year-old fish (59–79% of fish in the catches are in these age groups), the breeding 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 level.

The performance measure set for the fishery is the status of the Spanish mackerel spawning stock as reflected by catches being within target ranges. Catches in 2005 were within target range in the Kimberley and Pilbara areas. The more variable Gascoyne/West Coast catch was below the target range; however, this is not a significant spawning area.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Fishing for Spanish mackerel uses specialised troll lines to target the schooling fish and involves limited discarding. Species occasionally caught and generally discarded include sailfish, pike, barracuda, shark, mackerel tuna, queenfish and trevally. A high proportion of these species are expected to survive capture and release by the fishery. Consequently, it is considered likely that the fishery has a negligible impact on stocks of discarded species.

Protected species interaction: **Negligible**

The fishery may occasionally catch some protected billfish species, but these are generally released alive and are expected to survive.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The effect of the fishery on the food chain is likely to be minimal because a relatively low proportion of the total mackerel biomass is caught, and because discards of non-retained bycatch and fish waste products are low in this fishery.

Habitat effects: **Negligible**

The troll line fishing methods used in this fishery have minimal impact on the habitat.

SOCIAL EFFECTS

Approximately 42 people were employed catching Spanish mackerel during the 2005 mackerel fishing season. This estimate is based on those boats recording significant catches of Spanish mackerel (> 500 kg in the Gascoyne, > 1,000 kg in the Pilbara and Kimberley). The average number of crew on each boat (2 per boat in the Gascoyne and Pilbara, 4 per boat in the Kimberley) was then pooled to determine overall employment. For many of the fishers included as employees of the mackerel fishery, the duration of employment is only about six months each year.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005:
Spanish mackerel $2.7 million
Other mackerel $144,000

Overall ex-vessel prices for Spanish mackerel ($5–7/kg) and other mackerel ($3–6.50/kg) were obtained from fishers and represent an average price per kilogram of whole weight. Actual prices may reach over $10/kg for fillets and trunks.

FISHERY GOVERNANCE

Target catch range: **246–410 tonnes**

Current target catch ranges are inclusive of catches for all mackerel species except grey mackerel, which is consistent with total allowable commercial catch arrangements in the interim management plan (see below). In 2005, reported catches were within the target catch ranges for the Kimberley (110–205 t) and Pilbara (80–126 t) areas, reflecting high catch rates despite the reduction in effort. In contrast, catches in the combined Gascoyne/West Coast area were below the target catch range of 56-79 t (combined). This is not of immediate concern because of the greater reduction in effort in these areas (58% decrease from 2004) and the fact that catch rates increased.

From the 2006 season, landings will be constrained by TACCs, with a separate TACC allocated for grey mackerel to allow further development of the fishery for this species. This will probably mean that the use of target catch ranges will no longer be appropriate. The development of suitable effort ranges to take the TACCs will require a number of years of data.

New management initiatives (2005/06)

A number of new management controls have recently been introduced by amendment to, or determination under, the Mackerel Fishery (Interim) Management Plan 2004.

In January 2006 separate TACCs were introduced for each area as follows:

Area 1:
Spanish and other mackerel (excluding grey mackerel) 205,000 kg
Grey mackerel 60,000 kg

Area 2:
Spanish and other mackerel (excluding grey mackerel) 126,000 kg
Grey mackerel 60,000 kg

Area 3:
Spanish and other mackerel (excluding grey mackerel) 79,000 kg
Grey mackerel 60,000 kg

These TACCs are allocated as individual transferable quotas, with fishers requiring a minimum of 5% (if already in the fishery) or 10% (if entering the fishery) of the 'Spanish and other mackerel' TACC for an area in order to participate in the fishery in that area. Of the permits initially issued at the commencement of the management plan (19 in Area 1, 16 in Area 2 and 18 in Area 3), only 6 permits in Area 1, 7 in Area 2 and 6 in Area 3 had the required amount of ITQ units to continue in the fishery. These figures are being further reduced as ITQ is bought and sold by fishers.

In February 2006 the fishing season in Areas 1 and 2 was extended slightly in response to industry requests. Fishing for mackerel is now prohibited between 16 December and 14 May in the Kimberley, 16 October and 14 May in the Pilbara and 1 October and 28 February in the Gascoyne/West Coast.

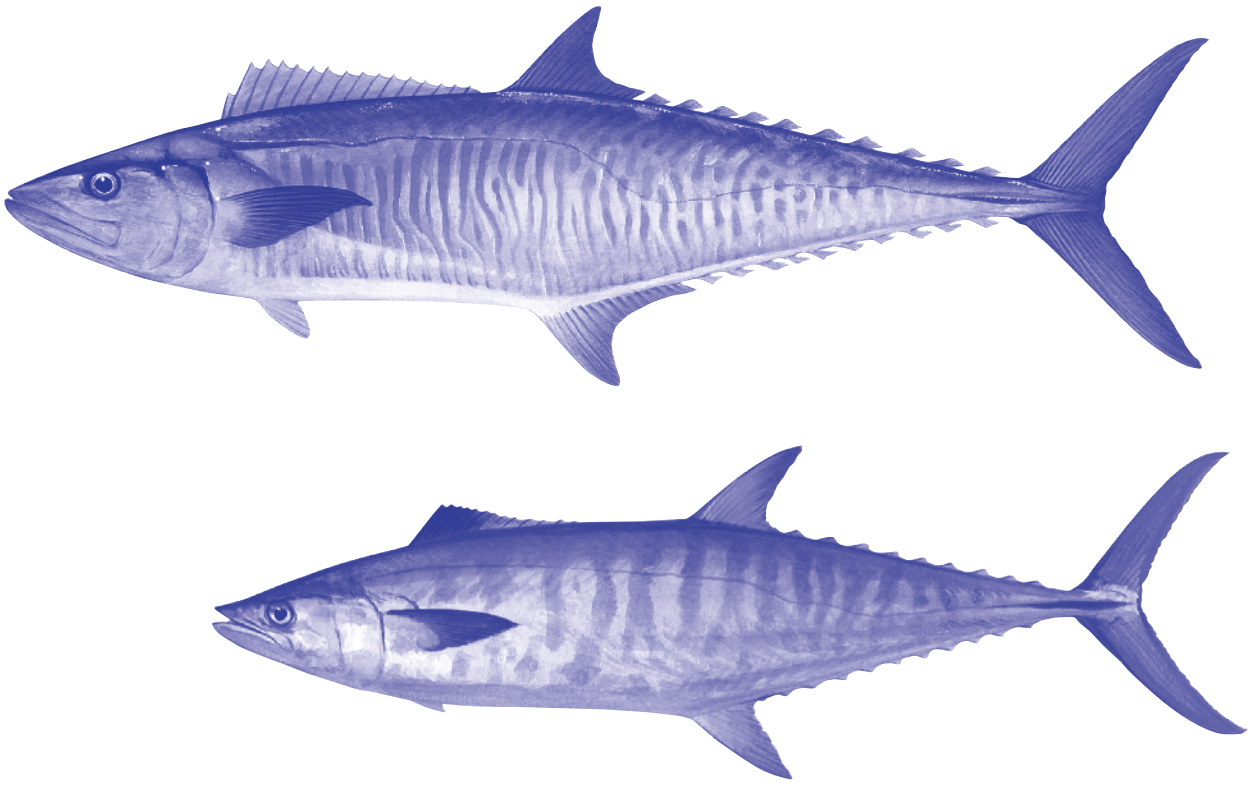
In May 2006 the installation of an automatic location communicator on all boats in the fishery became compulsory, enabling them to be tracked by the Department's vessel monitoring system and enhancing the efficiency and effectiveness of compliance operations.

In June 2006 the compulsory CAES monthly return was replaced by a compulsory daily log book. The detailed spatial and temporal data gained from these log books will provide the principal means of monitoring the fishery now that catch and effort has been constrained under the management plan.

EXTERNAL FACTORS

Spanish mackerel and the other mackerel species caught by this fishery are relatively short-lived, fast-growing species that exhibit annual variations in recruitment strength due to environmental fluctuations. This was exemplified by the appearance of a large number of juvenile Spanish mackerel in 1999/2000 that corresponded with increased catches in subsequent years.

There is concern over the bycatch of mackerel by pelagic gillnets in the Joint Authority Northern Shark Fishery. The main issues are potential increases in mackerel catches beyond sustainable limits, net damage leading to inferior product, capture of immature fish, and wastage of fish.

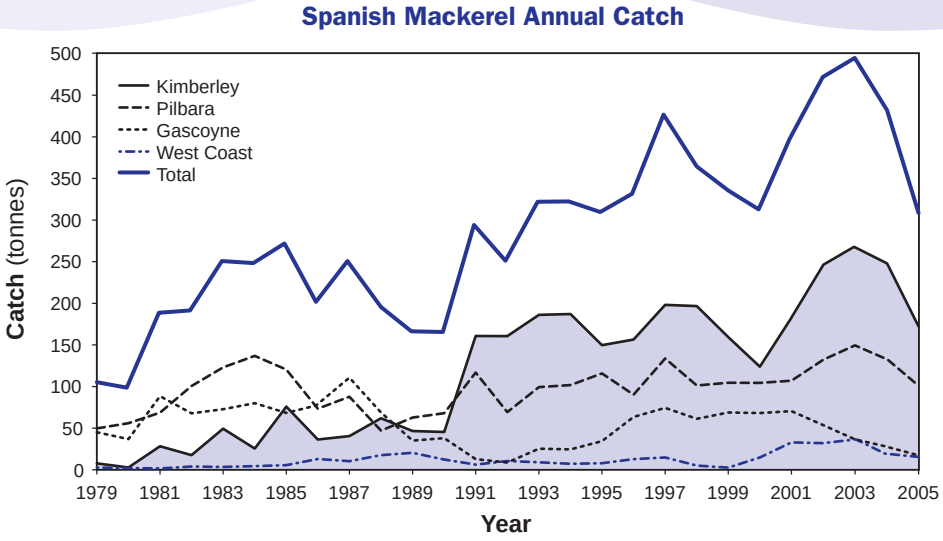


SPANISH MACKEREL TABLE 1

Catches of Spanish, grey and other mackerel, 1980-2004. 'Other mackerel' includes school mackerel, spotted mackerel and shark mackerel. Prior to 2000 catches of grey mackerel were also included in this category. Note that reported catches may differ from those reported previously due to late receival of log book data.

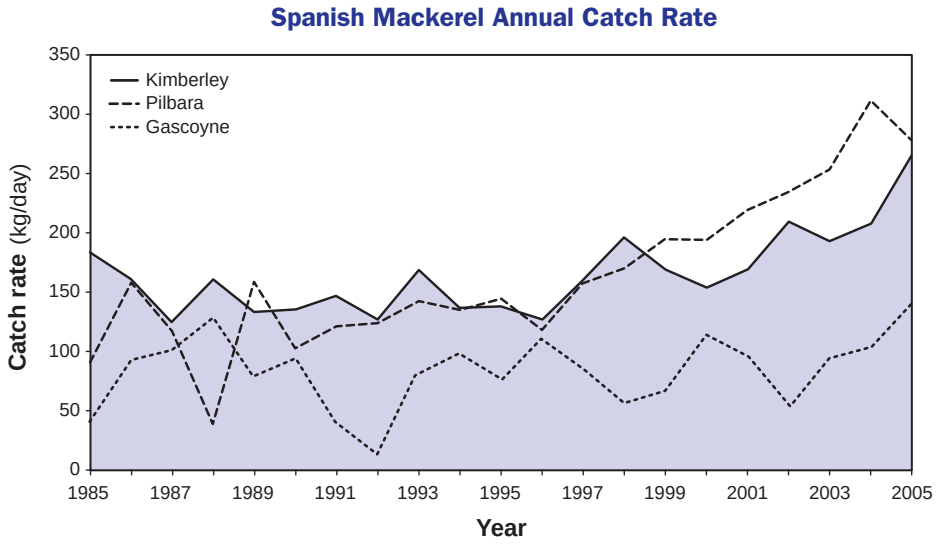
YEAR	SPANISH MACKEREL (tonnes)					GREY MACKEREL (tonnes)	OTHER MACKEREL (tonnes)
	KIMBERLEY*	PILBARA	GASCOYNE	WEST COAST	TOTAL		
1980	2.8	56.0	36.9	2.2	97.9		10.8
1981	28.3	68.7	88.5	1.7	187.2		2.5
1982	17.6	100.7	67.8	4.0	190.1		19.9
1983	49.5	123.0	72.8	3.5	248.7		3.6
1984	25.5	136.9	80.1	4.5	247.0		1.8
1985	75.9	120.4	68.3	5.7	270.3		19.4
1986	36.4	73.5	72.3	12.9	195.1		43.5
1987	40.6	87.8	110.6	10.3	249.3		23.9
1988	62.0	47.1	68.8	17.6	195.5		89.3
1989	46.6	62.7	35.1	20.4	164.8		104.5
1990	45.4	68.0	38.1	12.3	163.8		166.5
1991	160.7	116.8	12.8	6.3	296.7		116.2
1992	160.6	69.3	8.7	10.6	249.2		79.5
1993	186.1	99.3	25.4	9.1	319.9		75.0
1994	187.1	101.8	24.6	7.2	320.7		87.9
1995	149.7	115.8	34.5	7.9	307.9		56.1
1996	156.4	90.3	66.7	12.8	326.2		92.4
1997	198.2	133.2	77.6	14.9	423.9		120.7
1998	196.7	101.2	61.2	5.2	364.3		65.8
1999	159.5	104.7	68.8	2.6	335.6		72.7
2000	123.8	104.5	68.1	14.9	311.3	21.6	53.0
2001	179.3	107.0	70.5	33.0	389.9	14.7	41.4
2002	245.8	136.8	53.5	31.9	467.9	24.2	32.7
2003	267.0	152.0	36.0	36.7	491.8	22.5	19.4
2004	249.9	126.2	28.1	19.4	423.6	23.3	9.4
2005	**173.4**	**101.0**	**18.0**	**17.9**	**310.4**	**12.4**	**23.1**

* Catches by Taiwanese gillnet fishers of approximately 5–90 t per year (mean approx. 50 t) between 1980 and 1986 (Stevens and Davenport 1991) are not included in these estimates. These gillnet catches include data east to longitude 131° E and therefore are not directly comparable with Kimberley catches.



SPANISH MACKEREL FIGURE 1

Annual catch of Spanish mackerel in Western Australia. Note that catches for 2004 have been adjusted slightly to include late catch returns.



SPANISH MACKEREL FIGURE 2

Estimated catch per unit effort (kg/day) for vessels specialising in catching Spanish mackerel. Effort data was based on only those vessels known to target the species.

Northern Shark Fisheries Status Report

R. McAuley
Management input from R. Gould

FISHERY DESCRIPTION

The 'northern shark fisheries' comprise the state-managed WA North Coast Shark Fishery (WANCSF) in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery (JANSF) in the eastern Kimberley. The primary method employed in these fisheries is demersal longline with a relatively small amount of pelagic gillnetting in the JANSF. The northern shark fisheries target a variety of species including sandbar, blacktip, tiger and lemon sharks, with the principal fishing method and some target species being common to both the WANCSF and the JANSF. The data have thus been combined and the two regions are considered as a single fishery for reporting purposes.

Governing legislation/fishing authority

Fisheries Notice no. 476 (Section 43 Order)
Fisheries Notice no. 602 (Section 43 Order)
Fisheries Notice no. 601 (Section 43 Order)
Offshore Constitutional Settlement 1995
Condition 127 on a Fishing Boat Licence

Consultation process

WA Demersal Net and Hook Fisheries Management Advisory Committee
Department–industry 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.

Management arrangements

The northern shark fisheries are input-controlled, with limited numbers of operators authorised to fish in each fishery.

The solely Western Australian-managed sector of the northern shark fishery is managed by orders under Section 43 of the *Fish Resources Management Act 1994*. Those permitted to fish in the WANCSF with shark gear do so under a fishing boat licence condition and are permitted to use longlines with metal traces and powered hauling gear.

The commercial take of shark in Western Australian waters east of 123°45´ E longitude is controlled by a joint authority arrangement between the Commonwealth and the State of Western Australia, which was gazetted 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 Australian Ministers for Fisheries. Permitted fishing methods are longlines and gillnets, though gillnet fishing is not permitted within 12 nautical miles of the coast.

There are 14 licences in the northern shark fisheries, 9 allowing access to the WANCSF and 5 to the JANSF. However, not all of these are fished full-time and there has until now been considerable scope for mobilisation of latent effort under the management arrangements. During the season being reported here (2004/05), there were no limits on the amount of gear these licences could use or on the amount of time they could fish. New management arrangements for the WANCSF and JANSF were implemented in June 2005 (see 'New management initiatives' below) which will greatly reduce the level of access to these fisheries. The new management arrangements also rectify existing legislative inadequacies and are expected to prevent increased shark fishing effort on the north coast, outside of the northern shark fisheries.

Research summary

Research to monitor the status of northern shark stocks was initiated as an extension of the south and west coast shark research project. A three-year research project funded by the FRDC has provided an age-structured demographic assessment of the status of the fisheries' principal target species, the sandbar (thickskin) shark. Data collected from the northern shark fisheries during this project have also provided an improved understanding of the fisheries and of northern shark stocks generally. Additional information on these fisheries and those which take sharks as bycatch on the north coast was collected during a series of Department of Environment and Heritage and FRDC-funded research projects, beginning in 1999, to examine the sustainability of Australia's tropical sharks and rays. Results from these projects have further improved our understanding of the impacts of the various fishing sectors that exploit elasmobranchs across the northern half of Australia. This work involves shark researchers from the Department of Fisheries, CSIRO, and the Northern Territory and Queensland fisheries agencies. Phase 2 of the latest FRDC-funded component is scheduled for completion in October 2006.

This status report is prepared based on research data from these projects, CAES data supplied by industry and additional knowledge of tropical shark stocks obtained from the scientific literature. CAES data from the northern shark fisheries are available from 1994/95, although the reliability of early records is uncertain due to species identification and related issues. Since July 2000, catch identification and reporting in the northern fisheries has been validated by at-sea observation of catches and voluntary research log books.

Future research will involve monitoring the catch and effort of the northern shark fisheries and will also need to focus on the biology of secondary target species.

RETAINED SPECIES

Commercial production (season 2004/05):
Northern shark fisheries 1,294 tonnes
Other fisheries 53 tonnes

Landings

All total shark catches given in this report include rays, unless otherwise specified. The combined shark catch in the state's

two northern shark fisheries has risen significantly over the past four years (Northern Shark Figure 1). In 2004/05, the fisheries' total shark catch increased to 1,294 t, more than double its previous highest level of 591 t in 2003/04.

The northern shark fisheries' reported catch of sandbar sharks (*Carcharhinus plumbeus*) nearly quadrupled from 209 t in 2003/04 to 762 t in 2004/05. This massive increase was caused by a combination of a continued escalation in fishing effort, concentrated in the Pilbara and western Kimberley where sandbars are prevalent, and increasing efficiency as the fleet's targeting practices have improved. Conversely, the fisheries' catch of 'blacktip' sharks (primarily the Australian and common blacktip whaler sharks, *Carcharhinus tilstoni* and *C. limbatus*, and the spot-tail shark, *C. sorrah*), which are more common in northern Kimberley waters, remained relatively low at 78 t in 2004/05.

The bulk of the remaining catch comprised 114 t of hammerhead species (family Sphyrnidae), 83 t of pigeye sharks (*Carcharhinus amboinensis*)*, 81 t of tiger sharks (*Galeocerdo cuvier*) and 62 t of lemon sharks (*Negaprion acutidens*). Comparison of reported CAES catches from the northern shark fisheries with log book and fishery-independent research data prior to 2004/05 suggested that catches of some target species may previously have been under-reported. However, no such comparison was possible this year.

At 8 t, the northern shark fisheries' scalefish catch was 175% higher than in 2003/04 but nonetheless accounted for only 0.1% of total fishery landings.

In addition to the catch by the two dedicated shark fisheries, sharks are also caught incidentally by other commercial operators in waters off the north coast. During 2004/05, vessels licensed in other managed fisheries operating in the area between North West Cape and the WA/NT border reported catches of sharks and rays totalling 36 t, which was 20 t less than the previous year. A further 17 t of sharks and rays was reported to have been landed by 'wetline' methods (i.e. taken by vessels not operating in managed fisheries), which was 8 t less than in 2003/04. The causes of these reductions are varied but, notably, the introduction of bycatch reduction devices in the Pilbara Fish Trawl Fishery has significantly reduced shark and ray catches in that fishery.

The total shark catch by all State-managed sectors in the north coast bioregion during 2004/05 was therefore 1,347 t.

*This includes a reported 45 t of the similar-looking bull shark (*Carcharhinus leucas*), since extensive research has shown that this species does not occur in the fisheries' catch.

Fishing effort/access level

Because longlining is the primary fishing method in the northern shark fisheries, effort has been standardised in terms of hook days, using comparative longline and gillnet catch and effort data from the JANSF to convert gillnet effort into an equivalent longline effort. Effort in the northern shark fisheries is therefore expressed in terms of numbers of hook days (i.e. the number of longline or dropline hooks multiplied by the number of fishing days).

There are 14 licences that are endorsed to fish in the northern shark fisheries, nine in the WANCSF and five in the JANSF. In 2004/05, the total fishing effort was 1.2 million hook days, which was expended by nine vessels (two fewer than in 2003/04). Total northern shark fishing effort was 74% higher than in 2003/04 (Northern Shark Figure 2). Given the continued high value of shark fins, the increasingly full-time operation of vessels and the large amount of latent capacity in the fisheries, longline effort in this fishery is likely to rise further without additional management constraints.

Catch rate

There was a 26% increase in the northern shark fisheries' overall catch rate of sharks in 2004/05. Catch rates of sandbar and blacktip sharks increased by 110% and 11% respectively. Although the overall catch rate of other sharks declined by 66%, catch rates of the four most important secondary target species all increased: tiger sharks by 31%, lemon sharks by 66%, pigeye sharks by 167% and hammerheads by 191%. The interpretation of CPUE trends in the northern shark fisheries is somewhat complicated by the continual redistribution of effort within the extensive fishing area and the high turnover of fishing vessels over the last several years. However, the doubling of sandbar CPUE, together with a relatively low blacktip CPUE and declining CPUE of other sharks in 2004/05, indicates the fleet's more efficient targeting of adult sandbar sharks within the Pilbara and western Kimberley regions.

Recreational component: **Not assessed**

STOCK ASSESSMENT

Assessment complete: **Yes (key species)**

As sandbar shark is the primary target species in the multi-species northern shark fisheries, it has been selected as the indicator species for the fisheries. The life history characteristics of the sandbar shark, i.e. relatively long-lived, slow-growing and low in fecundity, make it a suitably conservative indicator species for the array of other species in the catch.

Stock assessment of the sandbar shark was undertaken using demographic analysis, which is widely used in assessing the status of long-lived shark species. This method has previously been used in Western Australia to assess the status of the related and co-occurring dusky shark, *C. obscurus* (see Demersal Gillnet and Longline Fisheries Status Report, pp. 212–220). The demographic model developed for sandbar sharks estimates the potential capacity (or rate) for the sandbar stock to increase or decrease, using biological information and fishing mortality rates derived from tagging data collected during the recently completed FRDC-funded project. Model results indicated that under zero fishing mortality the sandbar stock had the capacity to grow at only 2.5% per year, making it among the least productive shark populations for which demographic analyses have been conducted.

The model also suggested 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 caused a depletion of the sandbar stock during 2001/02, 2002/03 and 2003/04. The rate of depletion was highest in 2003/04 when, in addition to the 204 t landed by the temperate demersal gillnet and longline fisheries, the reported catch from the northern shark fisheries was 209 t, only a quarter of the catch reported during the current year.

The cumulative effect of fishing on this indicator species, since targeting began in 1997/98, is reflected in the total shark catch rates shown in Northern Shark Figure 2. These data indicate that there was a reduction in CPUE from approximately 2.3 kg/hook day in 1998/99 to 0.8 kg/hook day in 2003/04. Despite the slight increase to 1 kg/hook day in 2004/05, which is believed largely to reflect efficiency increases within the fleet, this trend suggests that total shark biomass is now at about 35% of its level prior to the commencement of full-time northern shark fishing. Furthermore, as a result of the observed concentration of fishing effort into areas where sandbar sharks are most prevalent, recent catch rates are considered to be biased upwards.

Breeding stock levels: Declining

Fishery-independent survey data collected from the area between northern Shark Bay and Eighty Mile Beach, where mature sandbar sharks are prevalent, show a 58% decline in the species' abundance between 2002 and 2005. Furthermore, the full extent of the depletion of mature sandbar sharks has not yet manifested, as previous levels of juvenile fishing mortality in the temperate demersal gillnet and longline fisheries are likely to cause declining recruitment to the breeding stock over the next decade. As the breeding biomass is already likely to be at the minimal acceptable limit reference point of at least 40% of virgin biomass, and continuing to decline due to a period of over-exploitation by the temperate demersal gillnet and longline fisheries, management intervention is urgently required.

NON-RETAINED SPECIES

Bycatch species impact: Low

The fisheries have a small scalefish catch, which is generally retained for sale. There is some discarded bycatch of unsaleable species of sharks, rays and scalefish, which was rated as a low to negligible risk by the ESD risk assessment process.

Protected species interaction: Low

Through the ESD risk assessment process, the northern shark fisheries were rated as having a generally low risk of interacting with these protected species, for the following reasons.

Sharks and rays: Because the northern shark fisheries generally operate some distance offshore, they pose a negligible risk to the speartooth and northern river sharks (*Glyphis* sp. A and C respectively) and the freshwater sawfish (*Pristis microdon*), which have primarily inshore, estuarine and riverine distributions. The white shark (*Carcharodon carcharias*) and the grey nurse shark (*Carcharias taurus*) rarely occur north of North West Cape and the whale shark (*Rhincodon typus*) is extremely unlikely to be caught by longline or pelagic gillnet gear.

Turtles: No turtle captures either been observed or reliably reported in the northern shark fisheries. As the amount of gear used is small relative to the fisheries' operational area, the risk of interaction is low.

Billfish: The limited billfish bycatch in the northern shark fisheries was assessed as being insufficient to impact breeding stocks.

Cetaceans: As almost all northern shark fishery effort in 2004/05 was applied by (mainly demersal) longlines, the risk of interaction with cetaceans is negligible.

ECOSYSTEM EFFECTS

Food chain effects: Negligible

Given the historically small amount of total catch taken by this fishery, which is spread across a large number of species, all of which have broad diets (i.e. a high degree of trophic redundancy), the fishery currently is likely to be having only a negligible impact on trophic interactions within this region. If recent increases in landings of larger species continues, this risk will need to be reassessed.

Habitat effects: Negligible

The principal type of fishing gear (longline) is set so that it is only in intermittent contact with the seabed, and its physical impact on the seabed is therefore minimal.

SOCIAL EFFECTS

Estimated employment in the northern shark fleet during 2004/05 was approximately 35 fishers.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2004/05: $2.9 million

The combined value of the catch from the two managed sectors was approximately $2.9 million (mainly from the estimated value of shark fins). As fishers do not separately identify the weight of fins on their catch returns, fin weight was calculated at an average of 3% of sharks' whole weight and value was estimated using an average price of $45/kg. During the 2004/05 season, shark fins maintained their value of between $25/kg and $120/kg, depending on fin size and species. Categories of shark which do not have saleable fins were excluded from fin valuation.

FISHERY GOVERNANCE

Target catch range:

Current: sandbar sharks < 117 tonnes
Future: sandbar sharks < 20 tonnes

Until the 2004/05 season, the maximum acceptable catch of sandbar sharks in the northern shark fisheries (117 t)

was derived from the mean reported catches from 2000/01 and 2001/02 plus an allowance of 50%, which the previous preliminary stock assessment had indicated was sustainable. However, formal assessment of this stock using empirically derived biological data and fishing mortality rates for Western Australian sandbar sharks has demonstrated that the rapid escalation of fishing effort, efficiency and catches in the northern shark fisheries over the last two years has depleted the breeding stock.

For 2005/06, therefore, the acceptable maximum catch of sandbar sharks has been revised to 20 t, in line with the new management arrangements arising from the formal stock assessment. These arrangements aim to reduce northern shark fishing effort and re-target it towards the more productive blacktip shark complex, making sandbar sharks a minor by-product of the fisheries' catch.

New management initiatives (2005/06)

A new set of management arrangements for the northern shark fisheries was developed in consultation with northern shark fisheries licensees and introduced in June 2005. These arrangements correct long-standing inconsistencies in the previous regulations, incorporate proposals put forward by the Northern Shark Industry Association, and implement responses to the outcomes of the sandbar shark stock assessment and a review of the fisheries' use of shark products. The key elements of these arrangements are:

- closing (i) the area between North West Cape (114° 06´ E longitude) and 120° E, (ii) the area east of 120° E and south of 18° S latitude, and (iii) King Sound;
- limiting access to the remaining area of the WANCSF to 200 days of gillnet fishing and 100 days of longline fishing, with no more than 100 days of fishing in the open area south of Cape Leveque (16º 23´ S latitude) between 1 October and 31 January;
- limiting access to the JANSF to 400 days of gillnet fishing and 200 days of longline fishing;
- restricting gillnets to a maximum length of 2,000 m, with a mesh size of 6.3–7.3 inches (160–185 mm mesh) and a maximum drop of 100 meshes;
- restricting longlines to a maximum of 1,000 hooks;
- introduction of the vessel monitoring system;
- implementation of daily catch and effort log book reporting; and
- introduction of fin to trunk and fillet weight ratios to assist in ensuring compliance with existing anti-finning regulations.

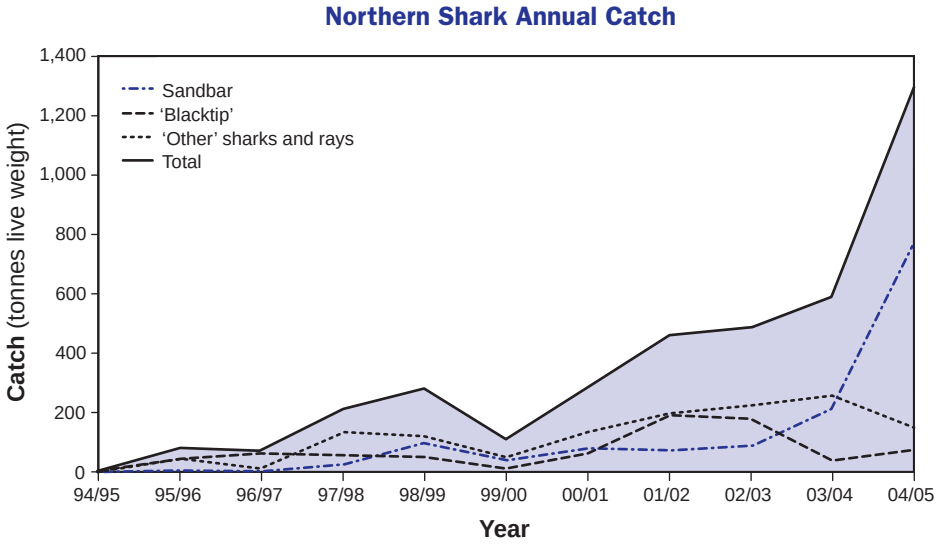
EXTERNAL FACTORS

The northern shark fisheries share their primary target stock of sandbar sharks with the temperate demersal gillnet and longline fisheries, which primarily take juveniles of this stock. Similarly, northern shark species are also incidentally taken by a range of other fisheries in the northern bioregion. 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

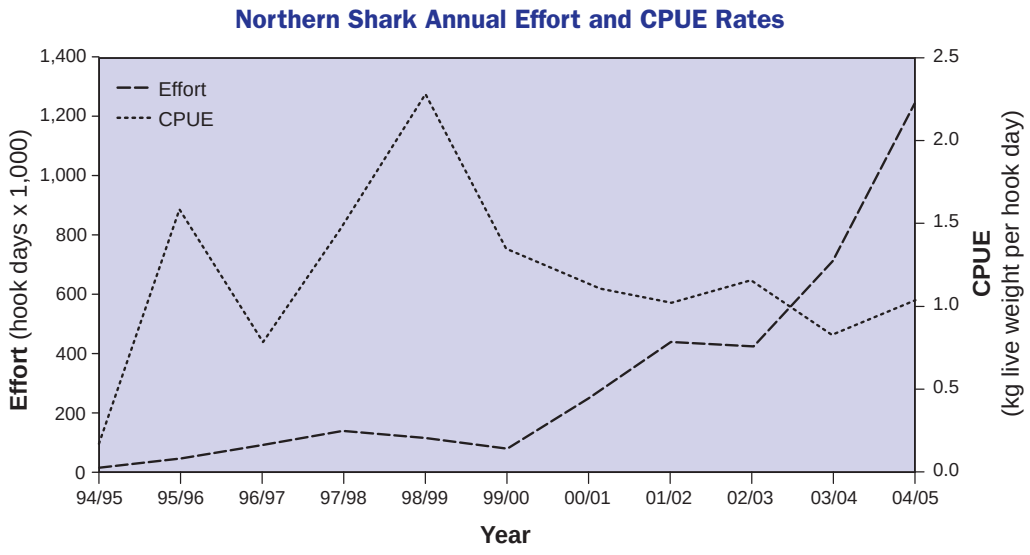
Elasmobranch catch species composition for the northern shark fisheries (WANCSF and JANSF) from 2000/01 to 2004/05.

SPECIES		CATCH (tonnes)			
		2001/02	2002/03	2003/04	2004/05
Sandbar (thickskin) shark	*Carcharhinus plumbeus*	72	88	209	762
Hammerhead shark	Sphyrnidae	43	45	33	114
Pigeye shark	*Carcharhinus amboinensis*	25	32	43	83
Tiger shark	*Galeocerdo cuvier*	37	43	51	81
Blacktip shark	*Carcharhinus* spp.	185	178	40	78
Lemon shark	*Negaprion acutidens*	26	57	24	62
'Bronze whaler' shark	*Carcharhinus obscurus*	6	7	17	36
Shovelnose/fiddler rays	Rhinobatidae, Rhynchobatidae	11	11	8	32
Grey reef shark	*Carcharhinus amblyrhynchos*	6	7	9	8
Other sharks/rays		45	19	156	46
TOTAL		**456**	**490**	**591**	**1,294**



NORTHERN SHARK FIGURE 1

Annual landings for the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2004/05.



NORTHERN SHARK FIGURE 2

Annual effort and catch rate of all sharks and rays for the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2004/05.

Pearl Oyster Managed Fishery Status Report

A. Hart and D. Murphy
Management input from J. Kennedy

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 a drift dive 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
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Pearling Industry Advisory Committee and subcommittees
Department–industry meetings

Boundaries

The fishery is separated into four zones (Pearl Figure 1), as follows:

Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30´ E. There are five licensees in this zone.

Pearl Oyster Zone 2: East of Cape Thouin (118°20´ E) and south of latitude 18°14´ S. The nine 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 two licensees in this zone also have partial access to Zone 2.

Pearl Oyster Zone 4: East of longitude 125°20´ E to WA/NT 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 enabling 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 divided up into individually transferable quotas. There are officially 572 wild-stock quota units (currently, 1 unit = 1,000 shell) and 350 hatchery options/quota units allocated amongst 16 pearling licensees; however, through hatchery-shell substitution agreements in Zone 1 the effective number of wild-stock quota units for management and compliance purposes in that zone has been reduced from 115 to 55, resulting in an overall wild stock ITQ of 512 quota units. The status of wild stocks is reviewed each year by the Department of Fisheries in liaison with the Pearling Industry Advisory Committee to enable the total allowable catch 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 ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of pearl oysters. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Current research is focused on stock assessment using catch and effort statistics and recruitment and length-frequency sampling to estimate the total allowable catch. Since 2004, data on discard rates and quality of pearl shell have been collected to assess the overall heath of the fishery. In addition, the FRDC project entitled 'Management of bioeroding sponges (*Cliona* spp.) in wild stocks of *Pinctada maxima* in Western Australia' officially commenced in 2005. The overall objective is to determine whether the incidence of *Cliona* spp. is increasing in wild stocks over time. Management outcomes from the project may include changes to wild-shell fishing practices, shell treatment and shell discard processes, all of which will ameliorate the economic impact of *Cliona* spp. on the industry and maintain the health of the wild stocks.

The Research Division's Fish Health Unit also provides a comprehensive disease testing program to the industry.

There are several other significant research projects being carried out within the pearling industry focusing on environmental management, pearl oyster health, and improved health and safety for pearl divers. The main aims of this research are to demonstrate that the pearling industry operates in a manner acceptable to public standards for access to the marine environment; to develop a culture of best practice and continuous self-improvement with regard to environmental management and health and safety; and to enhance Australia's reputation for producing the highest quality pearls.

RETAINED SPECIES

Commercial production (season 2005):513,875 oysters

Landings

In 2005 the number of wild-caught pearl oysters was 513,875 (Pearl Tables 1 and 2). The total allowable catch for the pearl oyster fishery was 557,500 oysters (including a 2,000 special quota for tourism purposes). The disparity between the TAC and the oysters caught was due principally to licensees electing for hatchery-produced oysters, rather than their wild-shell quota. In particular, Zone 1 operators caught 25,572 oysters from the wild fishery, and elected to obtain 29,428 of their 55,000 TAC from hatchery production (Pearl Table 2).

The catch in Zone 2 was 458,859 oysters, and 29,444 oysters in Zone 3, totalling 488,303 oysters from a TAC of 502,500 oysters. This TAC increased from 2004 and is the upper level TAC for this region (see 'Stock assessment' section for details).

Fishing effort/access level

Total effort in all zones was 15,891 dive hours (Pearl Tables 1 and 2). The total effort for 2005 in Zone 2/3 was 14,807 dive hours, a 19% increase on the 2004 Zone 2/3 effort of 11,994 dive hours, and corresponding to a 13% increase in catch. The total effort in Zone 1 during 2005 was 1,084 dive hours. Fishing did not occur in Zone 1 in 2004.

Catch rate

The catch rate achieved by the fishery is an indicator of the abundance of the 3- to 6-year-old oysters specifically targeted for pearl production. Year-to-year variations in catch rates reflect changes in recruit abundance, while the long-term trend in CPUE involves an element of effort efficiency change.

The catch rate for the Zone 2/3 pearl oyster fishery was 32.9 shells per dive hour in 2005. This is similar to the catch rate for 2004 (33.8 shells/hr).

For Zone 1, the catch rate was 23.6 shells/hr in 2005, with the majority of the catch extracted from the 'middle sector'. Catch rates have recovered to the levels of the early to mid-1990s after an all-time low of 7.3 shells/hr in 2001, and a period of rest in 2004 following relatively low fishing levels in 2002 and 2003.

Recreational component: **Nil**

STOCK ASSESSMENT

Assessment complete: **Yes**

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2005 fishing season based on catch and effort statistics, recruitment (95,000 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (18,000 shells measured), shell discard rates by size and location, habitat effects on spat settlement, 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 total allowable catch for 2006 was undertaken. Results for each zone, and issues relevant to stock sustainability, were as follows.

Zone 2/3: The pattern in catch rates suggests that the *P. maxima* fishery is characterised by large variability in recruitment, as is the case with most bivalve fisheries. In 2005, CPUE was at the lower end of the range for the past 10 years and was similar to 2004. After five years of collection, the trend in the recruitment index (i.e. piggyback spat abundance) was used to draw the tentative conclusion that shell abundance will rise in 2006 in the main part of the fishery (Zone 2). Based on this analysis, and the fact that the overall TAC was not taken in 2005 due to hatchery substitution, the TAC allocation for 2006 was maintained at the increased level of 502,500. A very high 0+ recruitment was detected in the Zone 2 fishery in 2005, and is expected to enter the commercially fished population over the 2008 and 2009 fishing years

Zone 1: The Zone 1 fishery was fished in 2005 after no fishing in 2004. Research data indicate that the stock is rebuilding, particularly in the middle sector, and after some heavy fishing years in the mid-1990s to early 2000s, the current low level of effort will be beneficial to the stocks. Collection of spat settlement and size-structure data will resume in 2006 after some years with no data while the fishery was rebuilding.

Breeding stock levels: **Adequate**

The externally funded FRDC project 'Mother of pearl (*Pinctada maxima*) shell: Stock evaluation for management and future harvesting in Western Australia', completed in 2003, determined that under normal conditions (average growth and mortality), recruitment into the breeding stock exceeded natural mortality, and hence breeding stocks were 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 6–7 years of age onward, and may live for another 15–20 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 lack of fishing during 2004 following low effort in 2002 and 2003.

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 2005.

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 32 oysters/hr.

Collection of size-frequency data in Zone 1 will resume in 2006, permitting more detailed reporting against the performance measure for this zone.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

Divers have the ability to target pearl oysters of choice (species, sizes and quality of *P. maxima*). Pearl oysters brought to the vessel after hand collection are young and have relatively little epiphytic growth (fouling organisms). Any such organisms are removed from the oyster and put back in the water prior to the oysters being placed in mesh panels. A small number of over-sized or under-sized oysters are returned to the substrate.

Protected species interaction: **Negligible**

There is no interaction between the pearl oyster fishing operation and protected species.

ECOSYSTEM EFFECTS

Food chain effects: **Negligible**

The fishery removes only a small proportion of the biomass of pearl oysters on the fishing grounds, and is considered to have negligible impact on the food chain in the fishing area.

Habitat effects: **Negligible**

Pearl divers have minimal contact with the habitat during fishing operations. The main habitat contact is by pearl oysters held in mesh panels on holding sites following capture. These sites, however, cover a very small proportion of the habitat, and the activity concerned is unlikely to cause any lasting effect.

Similarly, the pearl farming operation, which uses longline systems in areas of high tidal flow to culture pearls, has limited impact on the environment. Physical effects are limited to static anchoring systems in typically sand/mud habitats. Environmental management research (see 'Research summary') is also being undertaken to quantify impacts on habitat and environment.

SOCIAL EFFECTS

Pearl oyster fishing vessels generally operate from the Lacepede Islands north of Broome down 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 6 vessels in 2005, due to increased fleet efficiency and increased reliance on hatchery-produced shells. Each vessel presently operating has 10–14 crew involved with the fishing of pearl oysters between March and June each year. These vessels also support a number of other pearl farm functions throughout the year. Fleet managers are employed by pearling companies to coordinate and support vessel operation. Including the operation of the pearl farms, the industry provides employment for approximately 500 people in the northern coastal regions.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2004/05: **$122 million**

The value of cultured pearls and by-products was considered to be approximately $122 million for the year 2004/05. Estimated value was based on 2003/04 level, with the Department now working with industry to develop a more robust method of calculating the annual GVP for pearling. Precise estimates of the value of product are 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

FISHERY GOVERNANCE

Target effort range: **14,071–20,551 dive hours**

The target effort range relates to the time required to achieve the TAC in the pearl oyster fishery of 557,500 oysters (502,500 oysters in Zone 2/3, and 55,000 oysters in Zone 1). Acceptable effort ranges for individual management zones are 11,456–15,819 dive hours for Zone 2/3 and 2,615–4,732 dive hours for Zone 1.

These ranges are based on the five-year period (1994–1998) following the introduction of 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 488,303 catch (TAC of 502,500) with 14,807 dive hours (Pearl Table 1), which was within the target range.

Zone 1 of the pearl oyster fishery achieved its 25,572 catch (TAC of 55,000) with 1,084 dive hours (Pearl Table 2), which was below the target range, due mainly to the entire quota not being taken, but also to improved catch rates and hence abundance.

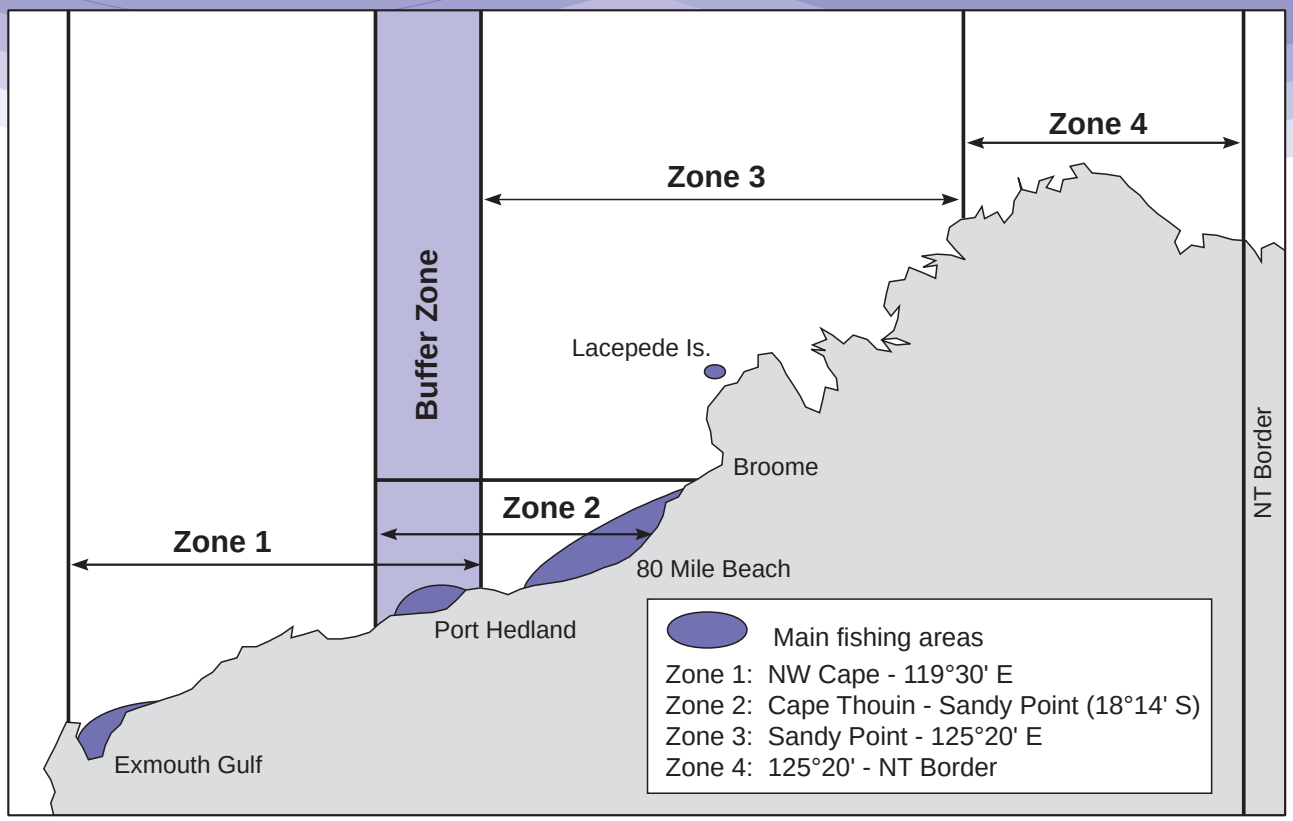
The overall pearl oyster fishery effort of 15,891 hours in 2005 was within the target range.

New management initiatives (2005/06)

A number of new management initiatives are being developed for the pearling industry. At the start of the 2006 season, the vessel monitoring system was introduced into the fishery. A new Pearling Management Bill is in development to replace the existing *Pearling Act 1990*. The Minister recently approved the preparation of a submission to Cabinet seeking permission to commence drafting the new Bill. The Minister also endorsed a review of the hatchery quota policy in May 2006, with the result that growth in first operation seeding of hatchery stock will continue to be regulated to match demand. Finally, the management boundaries between Zone 2 and Zone 3 in the wild fishery are being reviewed and a decision upon whether to retain them will be announced in 2006/07.

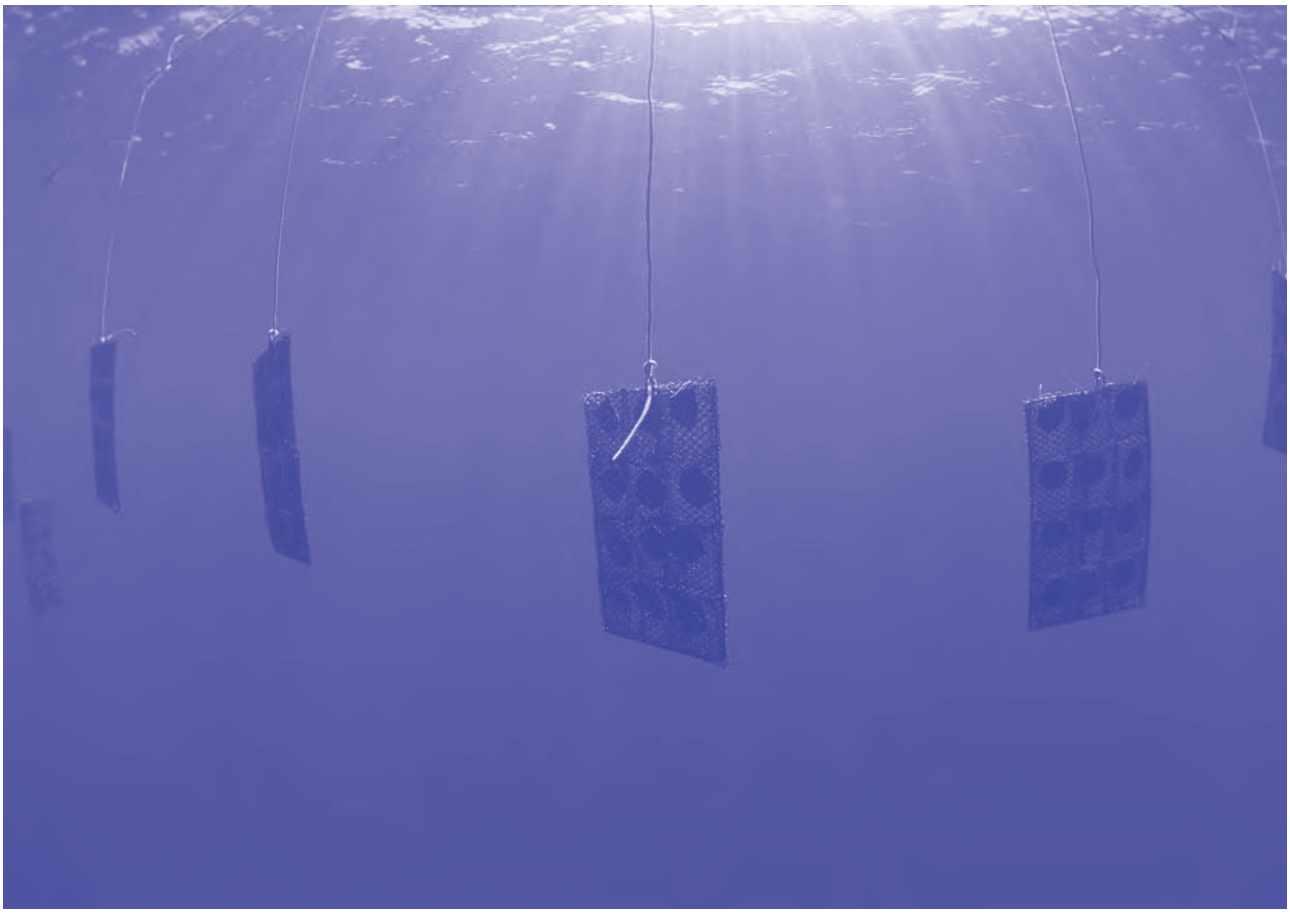
EXTERNAL FACTORS

The pearl oyster stocks underpinning the fishery in Zone 2/3 continue to provide sufficient level of production to support this major Western Australian industry. However, there is a declining trend in number of vessels used to catch pearl shell, which reflects improvements in economic efficiency and the increased use of hatchery-produced oysters. This is most obvious in Zone 1, where minimal fishing has occurred between 2002 and 2005. It is likely, though, that after four years of very minimal effort in this zone, stocks will have recovered and there will be substantial fishing in 2006.



PEARL FIGURE 1

Distribution of pearl oyster stocks and fishing zones in Western Australia.



PEARL TABLE 1

Pearl shell catch and effort – Broome area (Zone 2/3).

YEAR	WILD STOCK QUOTA	NO. OF CULTURE SHELLS	NO. OF MOP SHELLS	TOTAL SHELLS	DIVE HOURS	CULTURE SHELLS/HR	AVERAGE DEPTH FISHED	TOTAL SHELLS/HR
1978		404,952	146,692	551,644	10,583	38.3		52.1
1979		371,806	355,599	727,405	16,068	23.1		45.3
1980		364,502	260,714	625,216	18,568	19.6		33.7
1981		481,193	210,649	691,842	23,320	20.6		29.7
1982	460,000	439,092	132,931	572,023	15,710	27.9		36.4
1983	520,000	365,381	87,049	452,430	19,019	19.2		23.8
1984	375,000	242,828	47,230	290,058	11,615	20.9		25
1985	342,000	272,869	53,831	326,700	12,423	21.0		26.3
1986	360,000	337,566	10,929	348,495	16,478	20.5		21.2
1987	380,000	365,397	0	365,397	17,476	20.9		20.9
1988	445,000	379,657	0	379,657	14,600	26.0		26
1989	445,000	445,364	0	445,364	18,625	23.9		23.9
1990	457,000	453,705	0	453,705	23,263	19.5	15.3	19.5
1991	457,000	460,608	0	460,608	21,657	21.3	16.1	21.3
1992	457,000	461,599	0	461,599	19,455	23.7	13.9	23.7
1993	457,000	457,186	0	457,186	14,733	31.0	15.7	31
1994	457,000	456,832	0	456,832	12,384	36.9	11.4	36.9
1995	512,000	511,633	0	511,633	12,217	41.9	12.4	41.9
1996	512,000	511,756	0	511,756	12,774	40.1	16.8	40.1
1997	512,000	512,314	0	512,314	16,893	30.3	12.9	30.3
1998	457,000	457,266	0	457,266	14,499	31.5	12.6	31.5
1999	457,000	457,842	0	457,842	10,300	44.4	11.6	44.4
2000	502,500	501,419	0	501,419	9,258	54.2	11.2	54.2
2001	502,500	502,484	0	502,484	12,054	41.7	12.1	41.7
2002	479,750	479,562	0	479,562	15,661	30.6	13.4	30.6
2003	457,000	456,988	0	456,988	14,242	32.1	13.6	32.1
2004	457,000	404,984	0	404,984	11,994	33.8	12.3	33.8
2005	**502,500**	**488,303**	**0**	**488,303**	**14,807**	**32.9**	**12.1**	**32.9**
2006	**502,500**							

Note: 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.

PEARL TABLE 2

Pearl shell catch and effort in Zone 1 since 1983.

YEAR	WILD STOCK QUOTA	NO. OF CULTURE SHELLS	NO. OF MOP SHELLS	TOTAL SHELLS	DIVE HOURS	CULTURE SHELLS/HR	TOTAL SHELLS/HR
1983		27,895		27,895	542	51.5	51.5
1984		45,690	4,696	50,386	827	55.3	60.9
1985	55,000	46,009	0	46,009	897	51.3	51.3
1986	55,000	39,663	0	39,663	1,104	35.9	35.9
1987	55,000	46,269	4,634	50,903	1,194	38.7	42.6
1988	55,000	43,046	0	43,046	1,243	34.6	34.6
1989	55,000	52,937	0	52,937	1,010	52.4	52.4
1990	55,000	43,711	0	43,711	1,146	38.1	38.1
1991	55,000	63,774	0	63,774	1,681	37.9	37.9
1992	55,000	53,386	0	53,386	1,266	42.2	42.2
1993	115,000[1]	79,465	0	79,465	2,395	33.2	33.2
1994	115,000[1]	132,316[2]	0	132,316	6,291	21.0	21.0
1995	115,000[1]	121,312[2]	0	121,312	6,247	19.4	19.4
1996	115,000[1]	80,163	0	80,163	5,013	16.0	16.0
1997	115,000[1]	110,348	0	110,348	9,494	11.6	11.6
1998	115,000	108,056	0	108,056	6,094	17.7	17.7
1999	115,000	90,414[3]	0	90,414	4,789	18.9	18.9
2000	115,000	66,772[3]	0	66,772	5,893	11.3	11.3
2001	115,000	68,931[3]	0	68,931	9,480	7.3	7.3
2002	55,000[6]	29,126[3]	0	29,126	2,729	10.7	10.7
2003	45,000[4]	22,131[3]	0	22,131	1,647	13.4	13.4
2004	45,000[4]	0[5]	0				
2005	**55,000[6]**	**25,572[3]**	**0**	**25,572**	**1,084**	**23.6**	**23.6**

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 three new Zone 1 pearl industry licences, and a corresponding increase in TAC of pearl shell in Zone 1 (from 55,000 to 115,000 shell).
2. Management arrangements in 1994 and 1995 allowed fishing of quota a year ahead. Licensees who utilised this option took a quota reduction in subsequent years.
3. Hatchery stock used since 1999 has reduced the need for wild-stock shell.
4. In 2003 and 2004, the 115,000 Zone 1 quota was still maintained, however only 45,000 could be caught from wild stock due to hatchery shell substitution.
5. In 2004, no wild-stock quota was taken as only hatchery oysters were used.
6. In 2002 and 2005, the wild-stock quota for management and compliance purposes is effectively 55,000 due to hatchery substitution rules.

Beche-de-mer Fishery Status Report

A. Hart and D. Murphy

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 target species caught commercially in Western Australia, however 99% of the catch is sandfish (*Holothuria scabra*).

Governing legislation/fishing authority

Fisheries Notice no. 366 – Prohibition for commercial fishers unless otherwise endorsed for shellfish, coral, starfish, urchins and beche-de-mer

Fishing Boat Licence Conditions

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Department–industry meetings

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 six operators holding a fishing boat licence endorsement to take beche-de-mer. Beche-de-mer may only be harvested by hand or diving by licensed commercial fishers who currently hold a permit and who operate from a licensed fishing boat which is endorsed to take beche-de-mer. Aboriginal communities may be granted a non-transferable exemption to fish. There was one Aboriginal community with an exemption to harvest beche-de-mer but they have not been actively collecting and their exemption expired on 30 April 2005.

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 crew (six) 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 echninitis (deep-water redfish)	12 cm
Holothuria atra (lolly fish)	15 cm

A comprehensive ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of beche-de-mer. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Current research is focused on reporting of annual catch and effort statistics. A daily catch and effort log book has been tested and achieved its goals of obtaining species-specific, fine-scale catch and effort data and appropriate environmental information such as depth fished. Analysis of this information indicated that the stocks could be divided into at least three separate sub-stocks for finer-scale reporting, although this would require more detailed spatial catch and effort information than currently exists. Estimates of average size of *Holothuria scabra* caught suggest that a review of LMLs for sandfish in Western Australia is required. Log book implementation is planned in 2007.

RETAINED SPECIES

Commercial production (season 2005): 78 tonnes (live weight)

Landings

In 2005 the total beche-de-mer catch was 78 t live weight (Beche-de-mer Table 1), which was similiar to the 2004 catch of 81 t. Catch has been relatively constant since 2000, after the initial developmental years of the fishery. The maximum catch of 382 t was recorded in 1997 during the early years of the fishery.

Fishing effort/access level

Three licensed vessels fished for beche-de-mer in 2005, one more than in 2004. This represents about half the potential number of vessels that have an endorsement to fish. Total effort was 545 crew days, about 15% higher than the 470 crew days in 2004 (Beche-de-mer Table 1). Effort has been relatively stable (400–600 crew days) since 2000, except for 2003 when 1,019 crew days were expended.

Catch rate

The catch rate for beche-de-mer (diving only) was 150 kg/crew day, which was slightly higher than the 143 kg/crew day in 2004 (Beche-de-mer Table 1). Overall, CPUE shows a slight upward trend since 1999. The highest catch rates occurred in the first three years of the fishery.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Preliminary

Annual catch and effort statistics show that catch rates have been relatively stable since 2000, with a slight increase. This has occurred despite the fishing company reporting difficulty in retaining experienced crews due to the conditions (remoteness and risk of crocodile attack).

The biomass dynamics model for 2005 indicated that the maximum sustainable yield for the currently fished stocks is around 97 t, a slight decline from last year's estimate of maximum sustainable yield as 110 t.

Breeding stock levels: Adequate

Breeding stock levels appear adequately protected by the imposed size limits; however, an analysis of size at maturity is required for sandfish (*Holothuria scabra*) stocks in Western Australia to verify that the size limits are correct.

The initial performance measures for the fishery relate to breeding stock maintenance as indicated by catches remaining in the range 50–150 t and catch rate remaining above 80 kg/crew day. Both measures were met in 2005.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

There are currently no bycatch species known to be taken in this fishery. Given the selective method of fishing used (diving or wading, collection by hand only), the minimal level of interaction with other species is likely to be maintained.

Protected species interaction: Negligible

There are currently no protected species known to be taken in this fishery.

ECOSYSTEM EFFECTS

Food chain effects: Negligible

This fishery harvests only a small amount of sandfish per annum. The effect from this harvesting on the rest of the ecosystem, given that the catch is spread over a wide region, would be insignificant. In addition, predation on the beche-de-mer is relatively infrequent due to the toxins present in their body tissues. It is highly unlikely these animals are a major diet for higher-order predators due to these toxins acting as an effective defence system.

Habitat effects: Negligible

Divers collect beche-de-mer as they drift over the bottom; there is minimal impact on the habitat as divers are highly selective in their fishing effort and no fishing gear or lines contact the seabed. The vessels work during the day and anchor at night, usually further inshore where they are protected from the open ocean which is subject to higher seas and wind. Most fishers are mindful of the habitat they choose to anchor over, so they avoid more diverse bottom habitat.

There are some areas where fishers can access beche-de-mer by wading through the shallow water mangrove lagoons and estuaries. This is a minor component of the fishery. This method may be applied in areas of the Kimberley that are accessible and prone to extreme tidal movements. Wading usually occurs on soft sandy substrates with minimal impact on these habitats.

SOCIAL EFFECTS

Up to 36 fishers can be employed in the fishery, based on 6 endorsements each with a maximum of 6 crew. In 2005 only three vessels with a total of 11 crew were working. Additional individuals are employed for the processing of the product. These activities are mostly located in remote areas of the Kimberley and Pilbara regions.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $622,000

The estimated annual value was $622,000 based on an average product price of $8/kg live weight, compared to $15/kg in 2004.

FISHERY GOVERNANCE

Target catch range: 50–150 tonnes

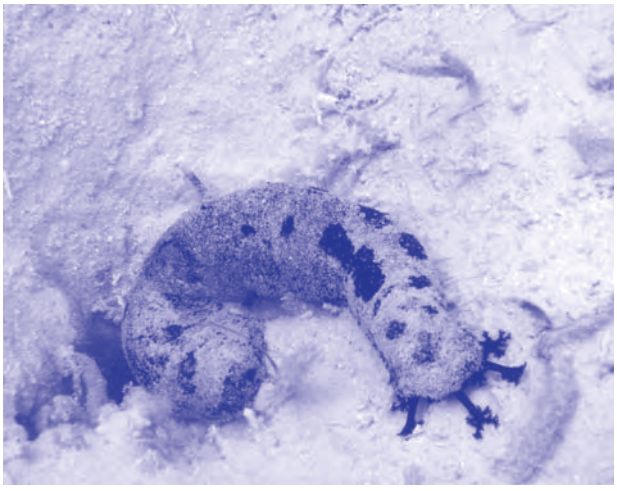
This target catch range is preliminary, noting that this is a developing fishery.

New management initiatives (2005/06)

Trials of a daily log book are continuing, with the intention that ultimately this will replace the compulsory monthly return. Implementation of this is planned to coincide with the 2007 review of the fishery.

EXTERNAL FACTORS

The remoteness of the currently fished stock and the large tidal ranges are natural barriers to uncontrolled expansion of fishing of beche-de-mer. Marine park planning processes may also impact on the potential extent of the fishery in the Pilbara region.



BECHE-DE-MER TABLE 1

Catch, effort and CPUE of sandfish (*Holothuria scabra*) in the beche-de-mer fishery since 1995.

YEAR	LIVE WT (t) (all methods)	CREW DAYS (all methods)	KG/CREW DAY (diving only)
1995	92.7	737	212.0
1996	257.3	945	249.0
1997	382.1	1852	222.2
1998	309.7	2565	135.0
1999	175.7	1757	106.4
2000	82.9	607	134.7
2001	90.1	663	137.6
2002	87.1	535	124.8
2003	122.4	1019	146.2
2004	80.9	470	143.0
2004	**77.7**	**545**	**150.0**

Wetline Fishing

This assessment, which utilised the CAES database, indicates that less than one-fifth (17%) of the state's wetline catch during 2004/05 was reported from this bioregion, which includes waters off both the Kimberley and Pilbara coasts. The top 10 species comprised goldband snapper (*Pristipomoides multidens*) 87 t, Spanish mackerel (*Scomberomorus commerson*) 63 t*, threadfin (*Eleutheroyema* spp.) 43 t, ruby snapper (*Etelis carbunculus*) 42 t, saddletail snapper (formerly scarlet sea perch) (*Lutjanus malabaricus*) 24 t, crimson snapper (formerly red snapper) (*Lutjanus erythropterus*) 15 t, spangled emperor (*Lethrinus nebulosa*) 11 t, trevally (Carangidae) 9 t, red emperor (*Lutjanus sebae*) 9 t and grey-banded cod (*Epinephelus octofasciatus*) 8 t. The next most prominent species were unspecified shark 7 t and cod (*Epinephelus* spp.) 6 t. The majority of threadfin were taken by net fishers south of the Kimberley Gillnet and Barramundi Managed Fishery. Most other species are taken by line fishing off the Pilbara coast. Of some concern is the escalating catch of goldband snapper.

*An interim management plan for the troll fishery for mackerel (details of which are reported on pp. 159–164) commenced in August 2004, precluding mackerel from the wetline catch after that date. The catch reported above was taken during July 2004.

RECREATIONAL FISHERIES

Regional Research Overview

Recreational fishing is a popular activity in the north coast bioregion, where about 7% of the state's recreational fishers were active during 2005/06 (Baharthah 2006).

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

A major project completed in 2004 collected baseline data on the inshore finfish species targeted by recreational anglers across the north coast bioregion. In addition, a parallel collaborative project with Murdoch University has provided biological data on the species subject to shore-based fishing by both recreational and commercial fishers.

A 12-month creel survey of recreational boat-based and shore-based fishing in the Pilbara region of Western Australia was conducted between December 1999 and November 2000 (Williamson et al. 2006). The survey area incorporated the region from Onslow up to and including Broome.

The total recreational catch of all finfish species for the region in 1999/2000 was estimated at 383 t, excluding charter vessel catches. This was approximately one-sixth of the commercial catch (2,442 t) taken in the region during the same period.

The most common species retained by recreational fishers in the Pilbara region were (in order of estimated weight kept) spangled emperor (*Lethrinus nebulosus*) (31 t), narrow-barred Spanish mackerel (*Scomberomorus commerson*) (28 t), golden trevally (*Gnathanodon speciosus*) (26 t), blue-lined emperor (*Lethrinus laticaudis*) (23 t), blue swimmer crabs (*Portunus pelagicus*)

(22 t), blackspot tuskfish (*Choerodon schoenleinii*) (22 t), threadfin salmon (*Eleutheronema tetradactylum, Polydactylus macrochir* and *Polydactylus plebius*) (18 t), green mud crabs (*Scylla serrata*) (17 t), mullet species (13 t), estuary cod (*Epinephelus coioides*) (13 t), black-tip reef shark (*Carcharhinus melanopterus*) (12 t), Queensland and Australian spotted mackerel (*Scomberomorus* spp.) (11 t) and stripey seaperch (*Lutjanus carponotatus*) (11 t). These catches do not include charter boats and therefore understate the total recreational catch for the region.

These data, integrated with the long-run commercial CAES databases and the current fishery-independent projects, provide the basis for ongoing management of the most important recreational stocks in this region.

Fishing and Aquatic Tour Industry

C. Johnson and E. Lai

The north coast bioregion had 103 licensed fishing tour operators plus 19 licensed restricted fishing tour or eco-tour operators at the end of June 2006.

Tour operators were licensed by the Department of Fisheries in 2001, with all licensed operators required to submit daily trip returns. These returns enable data to be compiled on the overall number of tours, number of fishing tours, catch and effort estimates and other statistics.

Data for this bioregion continue to be presented by calendar year as returns indicate that the majority of the total catch is taken between March and October. Catch figures may differ slightly from those reported in previous years as a result of improved analysis of average fish weights and inclusion of some late returns.

Fishing effort

In 2005, 47.5% of tour operators who were licensed to operate on the north coast reported actively using their licence in this bioregion. Operators reported 5,227* tours during 2005, an increase from 5,091 in 2004, 4,340 in 2003 and 3,651 in 2002. Activities conducted on these tours included fishing, diving, snorkelling, wildlife observation and sightseeing.

The total number of 'fishing only' tours on the north coast in 2005 was 3,458* tours compared to 3,606 in 2004, 3,151 in 2003 and 2,965 in 2002. The total fishing effort reported by operators for the north coast bioregion in 2005 was 24,254* fisher days, a slight decline from 25,702 in 2004 but higher than the 20,832 fisher days in 2003 and 18,421 in 2002.

Catch

Catches of the major finfish species for the north coast bioregion between 2002 and 2005 are shown in North Coast Fishing Tours Table 1.

The estimated total finfish catch for 2005 is 81.5* t. Catches on the north coast have remained relatively stable over time.

NORTH COAST FISHING TOURS TABLE 1

Estimated catch of major finfish species reported by tour operators. Catches are calculated by calendar year as the majority of the total catch is taken between March and October.

SPECIES		ESTIMATED CATCH (tonnes) 2002	ESTIMATED CATCH (tonnes) 2003	ESTIMATED CATCH (tonnes) 2004	ESTIMATED CATCH (tonnes) 2005*
Spanish mackerel	*Scomberomorus commerson*	14	8	13.5	10
Spangled emperor	*Lethrinus nebulosus*	6.5	9.5	7.5	7.5
Barramundi	*Lates calcarifer*	7	6	6	5.5
Rankin cod	*Epinephelus multinotatus*	1	5	6.5	5.5
Red emperor	*Lutjanus sebae*	3	8	6	5
Fingermark bream	*Lutjanus johnii*	4	5	3	5
Chinaman fish	*Symphorus nematophorus*	5	7.5	4	4.5
Black snapper (blue-lined emperor)	*Lethrinus laticaudis*	2	2	3.5	4
Saddletail (scarlet) seaperch	*Lutjanus malabaricus*	2	3.5	2.5	3
Mangrove jack	*Lutjanus argentimaculatus*	2	2.5	2	1.5
Other finfish		30.5	35	32.5	30
Total		**77**	**92**	**87**	**81.5**

* Denotes some missing data (~10%)

AQUACULTURE

Regional Research and Development Overview

Aquaculture in the north coast bioregion is dominated by the production of pearls from the species *Pinctada maxima*. This industry utilises both wild-caught and hatchery-reared oysters for the production of cultured pearls. The wild-stock fishery is reported in the commercial fisheries section on pp. 170–175. The Department also has a major role in the management and regulation of pearl hatcheries, seeding activities and pearl oyster farm leases.

The past year has brought considerable progress in a number of policy initiatives identified and commenced in previous years. This period saw the finalisation of the new hatchery policy, development of a revised compliance plan, significant progress in the development of an industry strategy, and the signing of a Memorandum of Understanding between the Western Australian and Northern Territory Fisheries Ministers on comparable and cooperative management and compliance arrangements.

The 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*.

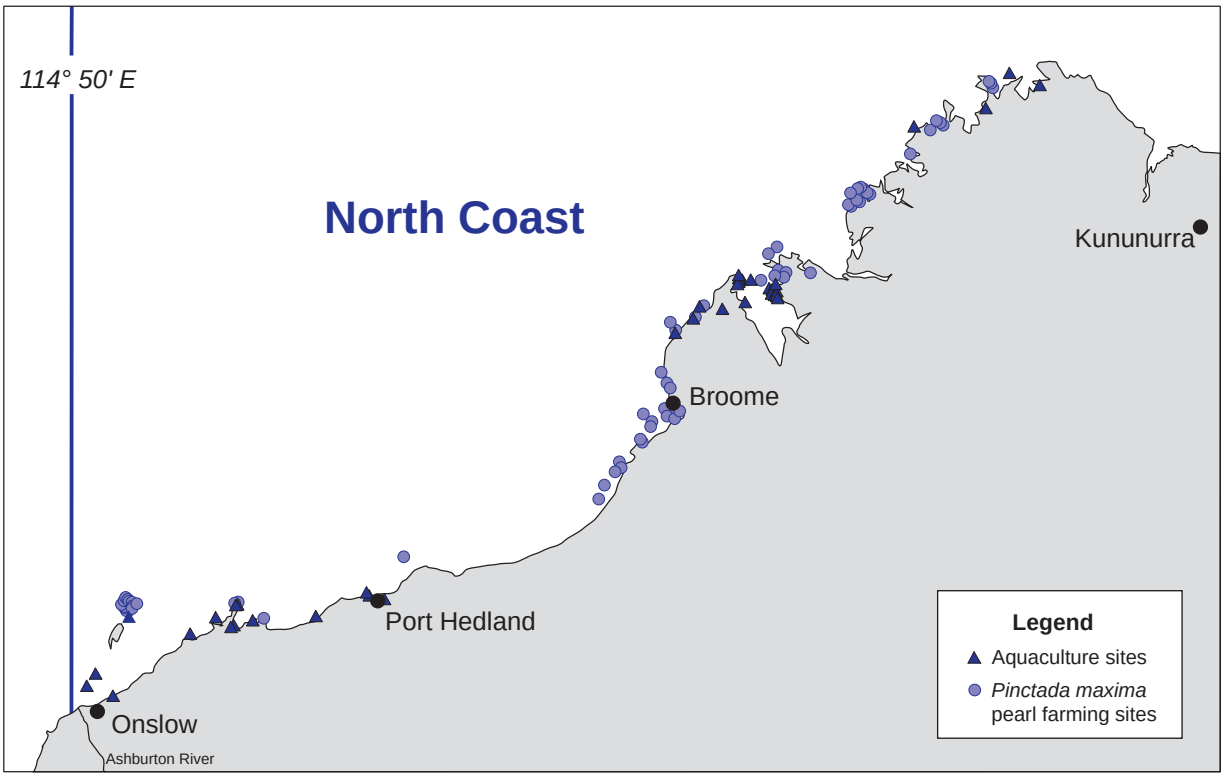
Research staff have been involved in a major Sustainable Regions Program project managed by the Kimberley Aquaculture Aboriginal Corporation, aimed at commercialising black tiger prawn (*Penaeus monodon*) farming in the Kimberley. Broodstock surveys and collection of black tiger prawns have led to successful spawning of disease-free prawns and successful grow-out in commercial ponds.

As part of its process of ESD reporting for aquaculture, the Department is focusing on prawn aquaculture as the second sector to be considered (finfish aquaculture was the first). This process will result in a code of conduct and monitoring program for prawn farmers which should assist industry and government in achieving appropriate environmental outcomes for this sector.

The Department continues to assist the Department of Land Information in negotiations over land tenure associated with the proposed development of a prawn farm at Wyndham.

Sea-cage barramundi farming in the Kimberley grew in 2005/06, with the major operator in the area increasing its permitted production capacity and making application for further expansion within new waters.

The Department is supporting the development of several indigenous aquaculture projects in this region, targeting the aquaculture of barramundi (*Lates calcarifer*) in sea cages and earthen ponds, cherabin (*Macrobrachium rosenbergii*) and edible rock oysters (*Saccostrea* sp.).



NORTH COAST AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture and pearl farming sites of the north coast bioregion. Note that aquaculture operations may also encompass the culture of non-*Pinctada maxima* pearl oysters.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services are delivered across the large and remote north coast bioregion by the Fisheries and Marine Officers working out of the two District Offices at Karratha and Broome, located 800 km apart by road. During 2004/05 the two District Offices maintained a permanent staff of seven Fisheries and Marine Officers, supplemented by a two-officer mobile patrol during peak winter months. Compliance is delivered across commercial and recreational fisheries, pearling, aquaculture, fish habitat and biosecurity areas.

To provide compliance and education services across the Pilbara and Kimberley, FMOs conduct extended remote patrols lasting up to two weeks at a time. Officers utilise specially equipped four-wheel-drive vehicles and a range of vessels for inshore coastal and inland waters, through to large fisheries patrol vessels (23 m in length) for offshore work. Officers in the Northern Region dive team undertake a variety of underwater inspections including pearling, introduced marine pests and habitat monitoring.

In delivering fisheries compliance services throughout the bioregion Fisheries and Marine Officers utilise a risk-based and random approach to perform investigation of complaints and inspection of catches, licences, gear, processing and retail establishments and fish transport. Officers utilise a range of strategies including roadside checks, dive inspections, and land-based and aerial surveillance.

Officers also play a vital role in promoting voluntary compliance by adopting a high profile in the delivery of community education at regional events and through children's fishing clinics and school talks. Officers also coordinate and facilitate Volunteer Fisheries Liaison Officer patrols and VFLOs in turn provide advice to the community.

The International Operations Group (two state officers based at Broome) provides services to the Australian Fisheries Management Authority. Their work focuses on illegal foreign fishing in Australian jurisdictional waters. Their activity is subject to a separate reporting mechanism and is not included in the north coast bioregion statistics.

Activities during 2004/05

During 2004/05, FMOs delivered a total of 11,007 hours to compliance and education services (as presented in North Coast Compliance Table 1), recording 9,661 personal contacts with the community and fishers. This resulted in 40 infringement warnings and 23 infringement notices being issued, with 18 matters resulting in prosecution action.

Operational targeting of commercial netting, recreational netting, bycatch reporting, commercial shark fishing, charter vessel licence compliance and pearl oyster transport and seeding inspections were the identified 2004/05 priorities.

During 2004/05, FMOs delivered 443 hours to the marine safety compliance program within the bioregion. Officers conducted 857 safety inspections on recreational and charter vessels, and 12 at-sea random boarding inspections on commercial vessels. A high level of recreational marine safety non-compliance (17%) was detected, with 65 infringements and 88 warnings and cautions issued. Regionally, the recent addition of marine safety inspections to FMOs' responsibilities will continue to improve community safety outcomes.

Officers also undertook a greater role in contributing to fisheries management review, legal development, policy development and planning to ensure better coordination and practical application of management strategies.

An increased emphasis on community engagement was demonstrated by officers maintaining a presence at the FeNaClNG festival in Karratha, the Nameless Festival in Newman, the Northwest Expo in Broome, King Tide Day in Derby and the Ord Valley Muster in Kununurra, as well as a variety of fishing competitions and community fairs.

Volunteer Fisheries Liaison Officer groups from across the region were supported in training, with many new members being recruited, culminating in a combined Pilbara and Kimberley VFLOs meeting and patrol at Eighty Mile Beach. The VFLOs raised their community profile in a range of locations from Karratha through to the Ord Valley Muster.

Initiatives in 2005/06

The Northern Region's Fisheries and Marine Officers continue to review their risk-based assessment practices to ensure areas at high risk of non-compliance are targeted, with Standard Operating Procedures being developed to maintain consistent standards across fisheries.

2005/06 has seen the introduction of a new Compliance Plan for Pearling, providing for a focus on first operation (saibo) quota management and the transport of pearl oysters throughout the fishery. These changes reflect modern industry operating and management arrangements, which are aimed at maximising the number of first-grade round pearls resulting from first operations within existing industry quotas.

This year has also seen marine parks and the minor commercial fisheries identified as emerging priorities for compliance planning and servicing. Marine park patrols will include the Montebello and Barrow Islands, the Rowley Shoals, Dampier Archipelago and Cape Preston, to ensure compliance with management and environmental objectives.

The mobile patrol unit has concentrated on maximising recreational fishing compliance during peak tourism periods, working with District Officers to provide greater coverage and improved compliance outcomes.

The emphasis on developing and supporting the VFLO program has also continued, with new activities planned to promote the program in the north.

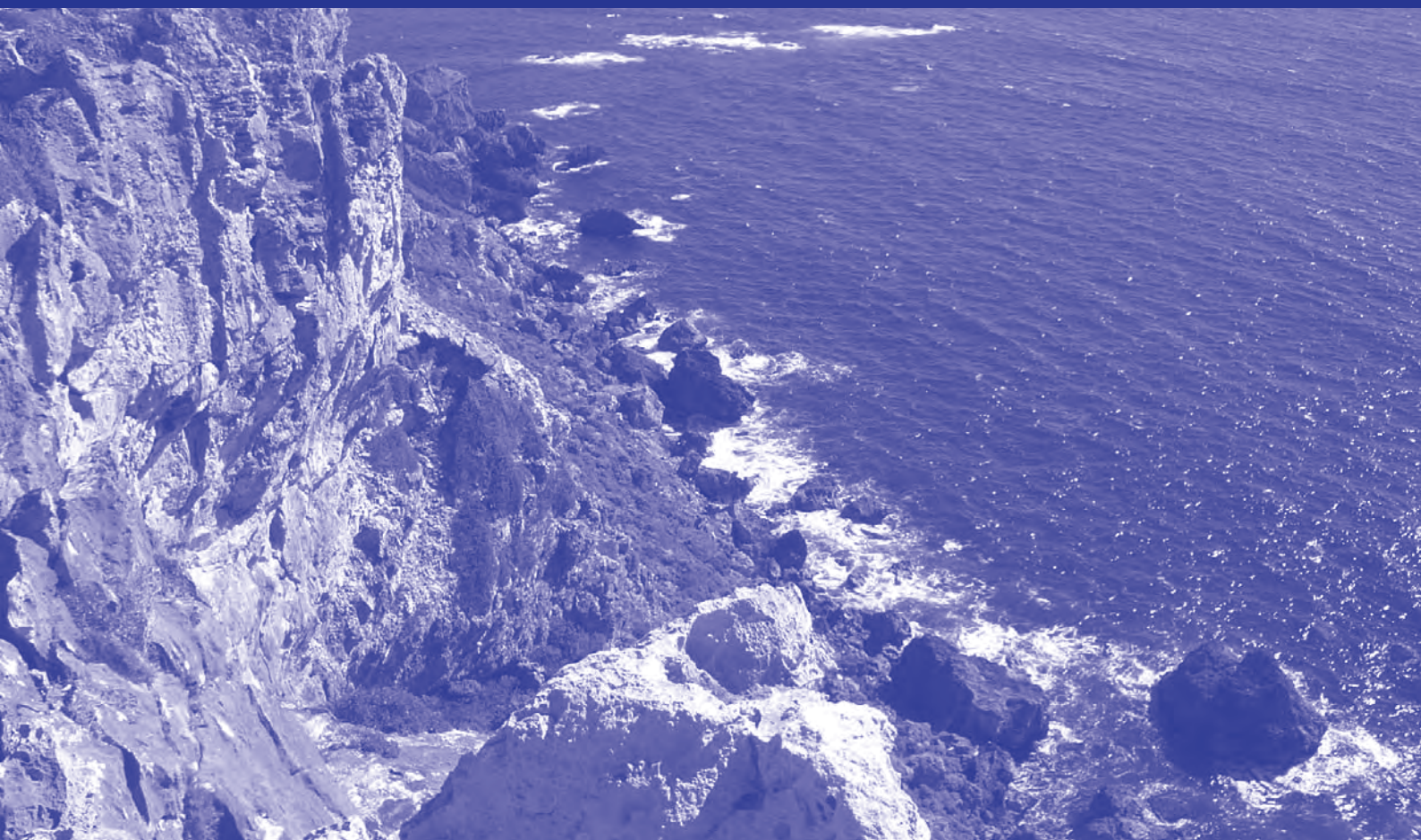
NORTH COAST BIOREGION TABLE 1

Summary of compliance and educative contacts and infringement types within the north coast bioregion during the 2004/05 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	1,307
Fisher field contacts by Fisheries Officers	47
District Office contacts by Fisheries Officers	513
COMMERCIAL OFFENCES DETECTED	
Infringement warnings	4
Infringement notices	9
Prosecutions	11
CONTACT WITH THE PEARLING INDUSTRY	
Hours delivered in the North Coast and Gascoyne bioregions	5,148
Pearling offences detected	
Prosecutions	6
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	4,552
Fisher field contacts by Fisheries Officers	6,553
District Office contacts by Fisheries Officers	2,548
Fishwatch reports*	17*
RECREATIONAL OFFENCES DETECTED	
Infringement warnings	36
Infringement notices	14
Prosecutions	7

* Data for combined recreational and commercial Fishwatch reports, July 2004 – March 2005. The service provider ceased operation in April 2005, and the interim arrangements implemented do not provide reliable statistics for the period April–June.

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 runoff. 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. This effect, particularly west of Albany, limits the winter minimum temperatures away from terrestrial effects along the beaches to about 16–17°C. Fish stocks in the region are predominantly temperate, with many species distributions extending right across southern Australia. The occasional more tropical species found are thought to have been brought into the area as larvae, but are unlikely to form breeding populations.

Under IMCRA, the bioregion has been divided into two meso-scale regions: the WA South Coast and the Eucla.

The south coast is a high-energy environment heavily influenced by large swells generated in the Southern Ocean. The coastline from Cape Leeuwin to Israelite Bay is characterised by white sand beaches separated by high granite headlands. East of Israelite Bay there are long sandy beaches backed by large sand dunes until replaced by high limestone cliffs at the South Australian border. There are few large areas of protected water along the south coast, the exceptions being around Albany and in the Recherche Archipelago off Esperance.

Along the western section of the coastline which receives significant winter rainfall, there are numerous estuaries fed by winter-flowing rivers. Several of these, such as Walpole/Nornalup Inlet and Oyster Harbour, are permanently open, but most are closed by sandbars and open only seasonally after heavy winter rains. The number of rivers and estuaries decreases to the east as the coastline becomes more arid. While these estuaries, influenced by terrestrial runoff, have higher nutrient levels (and some, such as Oyster Harbour and Wilson Inlet, are suffering eutrophication), their outflow to the ocean does not significantly influence the low nutrient status of coastal waters.

The marine habitats of the south coast are similar to the coastline, having fine, clear sand sea floors interspersed with occasional granite outcrops and limestone shoreline platforms and sub-surface reefs. A mixture of seagrass and kelp habitats occurs along the south coast, with seagrass more abundant in protected waters and some of the more marine estuaries. The kelp habitats are diverse but dominated by the relatively small *Ecklonia radiata*, rather than the larger kelps expected in these latitudes where waters are typically colder and have higher nutrient levels.

The major commercial fisheries of the south coast bioregion are the abalone fishery, the purse seine fishery targeting pilchards and other small pelagics, and a demersal gillnet fishery for sharks. Other smaller commercial fisheries are the long-standing beach seine fishery for Australian salmon and herring, a trap fishery targeting southern rock lobsters and deep-water crabs, and the intermittent scallop fishery

in the Recherche Archipelago. There is also a commercial net fishery for finfish operating in a number of south coast estuaries. South coast commercial fishing vessel operators often hold a number of licences to create a viable year-round fishing operation.

As much of the south coast is remote or difficult to access, recreational beach and boat fishing tends to be concentrated around the main population and holiday centres. The major target species for beach and rock anglers are salmon, herring, whiting and trevally, while boat anglers target pink snapper, queen snapper, Bight redfish, shark, samson fish and King George whiting. The third major component of the recreational fishery is dinghy and shoreline fishing of estuaries and rivers, focused in the western half of the bioregion. Here the main angling targets are black bream and whiting (including King George whiting). Recreational netting, primarily targeting mullet, also occurs in these estuaries.

The predominant aquaculture activity undertaken on the south coast is the production of mussels and oysters from Oyster Harbour at Albany. This activity is restricted to this area where there are sufficient nutrient levels related to terrestrial runoff 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.

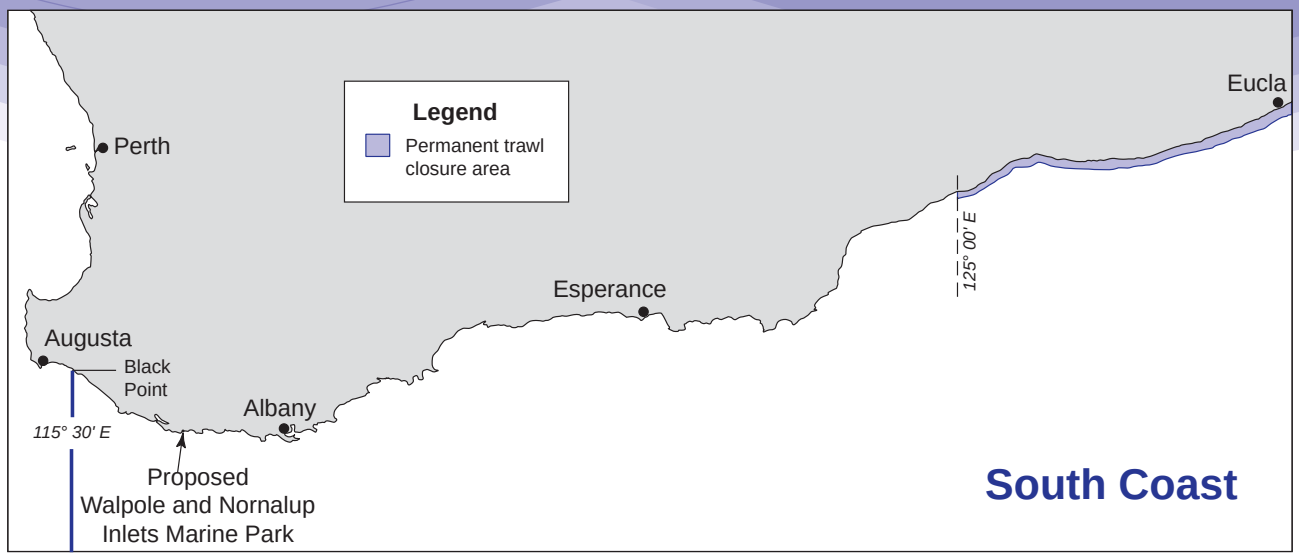
ENVIRONMENTAL MANAGEMENT

Regional Overview

The inshore marine habitats of the south coast are largely unaffected by human activities, the exceptions being some estuaries and marine embayments (e.g. Princess Royal Harbour, Oyster Harbour and Wilson Inlet) where significant eutrophication associated with nutrient inputs from land-based activities has occurred. Fishing methods which can impact on marine habitats are naturally restricted due to the relatively low productivity and abundance of species capable of trawl capture. A small, limited-entry scallop trawl fishery focused in the Esperance region is the only state-managed fishing activity which can have any significant physical interaction with the marine habitat.

Trawling in deep waters off the edge of the continental shelf is managed by the Commonwealth. This area, particularly the western part of the Great Australian Bight, was subject to significant exploratory trawling by locally based and international vessels prior to the 1980s, but is only sporadically fished now. There is a coastal trawling closure of state waters along the western Bight sector, enacted under Commonwealth Government fisheries legislation, to ensure deep-sea trawlers do not venture into sensitive coastal areas (South Coast Habitat Protection Figure 1).

During 2005/06, the Department has continued to provide scientific and management advice in relation to the planning of the proposed Walpole and Nornalup Inlets Marine Park. The management plan for this marine park has been released for public review.



SOUTH COAST HABITAT PROTECTION FIGURE 1

Map showing areas permanently closed to trawl fishing and propsosed areas of protected fish habitat in the south coast bioregion.

COMMERCIAL FISHERIES

South Coast Crustacean Fisheries Status Report

R. Melville-Smith

Management input from J. Froud

FISHERY DESCRIPTION

The 'south coast crustacean fisheries' are pot fisheries which operate from Windy Harbour to the South Australian border. They include the Windy Harbour/Augusta Rock Lobster Managed Fishery, the Esperance Rock Lobster Managed Fishery (ERLF), the rock lobster pot fishery (a Regulation fishery) operating in the Albany and Great Australian Bight (GAB) sectors, and the deep sea crab fishery (a Section 43 Order fishery). The fisheries are multi-species and take southern rock lobsters (*Jasus edwardsii*) and western rock lobsters (*Panulirus cygnus*) as well as deep sea crab species including giant crabs (*Pseudocarcinus gigas*), crystal crabs (*Chaceon bicolor*) and champagne crabs (*Hypothalassia acerba*). Southern rock lobsters comprise the majority of the catch in the eastern areas of the fishery, with crab species becoming more prevalent in the south-western region. Western rock lobsters are a significant component of the catch in the Windy Harbour fishery (not reported here due to confidentiality provisions relating to the small number of licensees).

Governing legislation/fishing authority

Esperance

Esperance Rock Lobster Management Plan 1987
Esperance Rock Lobster Managed Fishery Licence

Windy Harbour/Augusta

Windy Harbour/Augusta Rock Lobster Management Plan 1987
Windy Harbour/Augusta Rock Lobster Managed Fishery Licence

Other south coast endorsements

Fish Resources Management Regulations 1995
Regulation Licence granted under Regulations 125 and 126
Condition 105 on a Fishing Boat Licence

All areas

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Department–industry meetings

Boundaries

Management boundaries for the south coast crustacean fisheries are shown in South Coast Crustacean Figure 1. The 'boundaries' of the deep sea crab component of the fishery (Condition 105) include all the waters of these fisheries excluding those of the ERLF, where crabs may only be taken by the holders of an Esperance Rock Lobster Managed Fishery Licence.

Management arrangements

These fisheries are managed primarily through input controls in the form of limited entry, pot numbers, size limits and seasonal closures.

In 2004/05, two vessels were licensed to fish for rock lobsters in the Windy Harbour/Augusta Rock Lobster Managed Fishery, 11 were licensed to fish in the Esperance Rock Lobster Managed Fishery and 31 vessels were endorsed to fish in the GAB and Albany zones.

The season for fishing for rock lobsters throughout the south coast crustacean fisheries mirrors the Western 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.

A comprehensive ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of southern rock lobsters. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Ongoing research in this sector involves assessing the current status of the stocks based on commercial catch returns and information from south coast rock lobster fishermen.

RETAINED SPECIES

Commercial production (season 2004/05): Southern rock lobster 39 tonnes

Landings

The total catch of southern rock lobsters was 39 t, down from 47 t in 2003/04 (South Coast Crustacean Table 1). A catch of 16 t of southern rock lobsters was taken in the ERLF in 2004/05, a decrease of 30% on the catch taken in the 2003/04 season (23 t). The combined catch for the GAB and Albany southern rock lobster fishery zones in 2004/05 was 23 t, similar to the catch taken in 2003/04. Catches in both the Albany and GAB zones remained the same in 2004/05 as in 2003/04.

As a secondary target of the rock lobster fishery, a total of 20 t of deep sea crabs was caught (South Coast Crustacean Table 1). In the Albany zone this included 3 t of giant crabs, a decrease of 70% over the 2003/04 season, 9 t of champagne crabs, a decrease of 25%, and 1 t of crystal crabs, a decrease of 75% over the 2003/04 season. In the ERLF 5 t of giant crabs were landed, an increase of 25% over the 2003/04 figure of 4 t. A catch of 2 t of giant crab was reported as landed in the GAB.

Fishing effort/access level

Fishing effort directed at southern rock lobsters in the south coast crustacean fisheries is shown in South Coast Crustacean Table 1. It should be noted that effort figures are confounded in the Albany and Esperance zones, because an unknown proportion of the effort recorded may have targeted deep sea crabs rather than lobsters, particularly in the Albany zone.

Catch rate

Catch per unit of fishing effort for southern rock lobsters in the ERLF remained relatively constant at 0.49 kg/pot lift in the 2004/05 season compared to 0.52 kg/pot lift in 2003/04. The combined CPUE for southern rock lobsters in the GAB and Albany zones in the 2004/05 season was 0.2 kg/pot lift, a decrease of 9% compared to the 0.22 kg/pot lift in the 2003/04 season. Catch rates in the Albany zone decreased by 11%, from 0.09 kg/pot lift in 2003/04 to 0.08 kg/pot lift in 2004/05, while in the GAB zone they decreased by 7%, from 0.44 kg/pot lift in 2003/04 to 0.41 kg/pot lift in 2004/05.

Recreational component: 10% (approx.)

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.

STOCK ASSESSMENT

Assessment complete: Yes

It is clear that the south coast crustacean fisheries have experienced significant catch declines in the past few years, especially for southern rock lobsters. It is necessary to determine to what extent the downturn in landings represents a sustainability problem as opposed to a reduction in fishing effort.

Model assessments from earlier years indicated that the ERLF should be stable at 40 t per season and that the 60 t levels experienced in the early to late 1990s (South Coast Rock Lobster Figure 2) were not sustainable.

The decline of 60% in the rock lobster catches over the past five seasons suggests either that the model was over-optimistic, or that there has been an environmental shift which has affected recruitment into the fishery. The response by the fishers has been to decrease fishing effort, with a 52% decrease in the numbers of pots set per season over this period.

Catches in the GAB and Albany zones are small in relation to the vast stretch of coastline that they cover. The annual catch of rock lobsters in the Albany fishery has consistently been low (only about 6 t per season) (South Coast Crustacean Figure 2). Landings in the GAB zone are from a number of shallow-water inshore areas which are dispersed along the coast. As in the ERLF, catches and effort in this zone have decreased by half (52% and 51% respectively) over the last five seasons (South Coast Crustacean Figure 2).

There is currently no information on basic biological characteristics such as growth rates and size at maturity of southern rock lobsters in the Western Australian fishery. Given the small size of this fishery and the costs involved in the collection of data, it is not a high priority for research support. Furthermore, CPUE data are difficult to use because this is a multi-species fishery and catch rates can be biased depending on which species is being targeted. Few fishers complete voluntary log books that would improve these data.

Insufficient information is available to complete a detailed stock assessment for this fishery. The information that is available suggests that there may be long-term sustainability issues and excessive latent effort which could prevent future recovery of the fishery. These issues are to be addressed within the financial constraints available for this small fishery.

Breeding stock levels: Uncertain

Oceanographic modelling work on possible rock lobster larval movements (David Griffin, CSIRO Hobart, pers.

comm.) suggests that the source of southern rock lobster recruitment to WA waters may be from local stock as well as from the Northern Zone in South Australia.

Published assessments for the Northern Zone of South Australia estimate the broodstock to be at around 20% of pristine egg production levels, which is the lowest level on record for that fishery and approaching the minimum level acceptable for rock lobster fisheries. Modelling work based on catch per unit effort suggests that the stock biomass (and therefore by implication the breeding stock) in the ERLF has also declined to its lowest level on record.

These low levels of egg production, combined with the larval source hypothesis, suggest that these fisheries need to be managed more cautiously than has been the case. If the recent downturn in catches continues it could represent a potential case of recruitment over-fishing.

The performance measure for the southern rock lobster fishery is that the catch in the ERLF indicator zone is below 40 t per annum. In 2004/05 the catch was 16 t, due in part to the 25% reduction in effort during this season.

For the secondary retained species, i.e. deep sea crab species, there are management measures (legal minimum sizes, return of females carrying eggs) in place which, based on current information, are considered to offer sufficient protection to the broodstock. Therefore, while the standing stock of these slow-growing and long-lived species may have been depleted by fishing several years ago, their broodstock is considered to have remained at acceptable levels.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

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

Protected species interaction: **Negligible**

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

ECOSYSTEM EFFECTS

Food chain effects: **Negligible**

The rock lobster and crab catches represent a very small biomass for such a vast area of coastline, and any impact of fishing on the general food chain is expected to be minimal.

Habitat effects: **Negligible**

Rock lobster potting has a very low impact on the largely granite habitat over which the fishery operates.

SOCIAL EFFECTS

There are a large number of licensed pots in this fishery, but not a large number of active fishers. The nature of the fishery means that rock lobster and deep sea crab catches cannot support a stand-alone fishery. Most fishers use them to supplement income from other fishing activities, or supplement their fishing income with other non-fishing businesses or employment. In the Albany and GAB zones especially, fishers tend to vary their rock lobster and deep sea crab fishing effort according to the local abundance of stock and market prices. If the management objective were to fish the Albany and GAB zone rock lobster and crab stocks at economically viable levels, then current effort levels would need to be drastically reduced.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2004/05: **$1.4 million**

The beach value of the southern rock lobster fishery was about $1 million in 2004/05, based on a beach price of $25.50/kg. Giant crabs ($31.70/kg), crystal crabs ($13/kg) and champagne crabs ($10/kg) added an additional $420,000 to the catch figure.

FISHERY GOVERNANCE

Target catch range:

Southern rock lobster 50–80 tonnes

The target catch range for the south coast rock lobster stock at 50–80 t is based on the assessment that the Esperance fishery is capable of sustaining production of approximately 40 t per year, with an additional allowance for catches taken from the adjacent fishing grounds discovered in the Albany and GAB zones during the early 1990s. In 2004/05, the south coast catch of 39 t is again below this range, which suggests that a review might be required.

New management initiatives (2005/06)

A comprehensive review of management arrangements in the south coast crustacean fisheries will be undertaken as soon as opportunity allows.

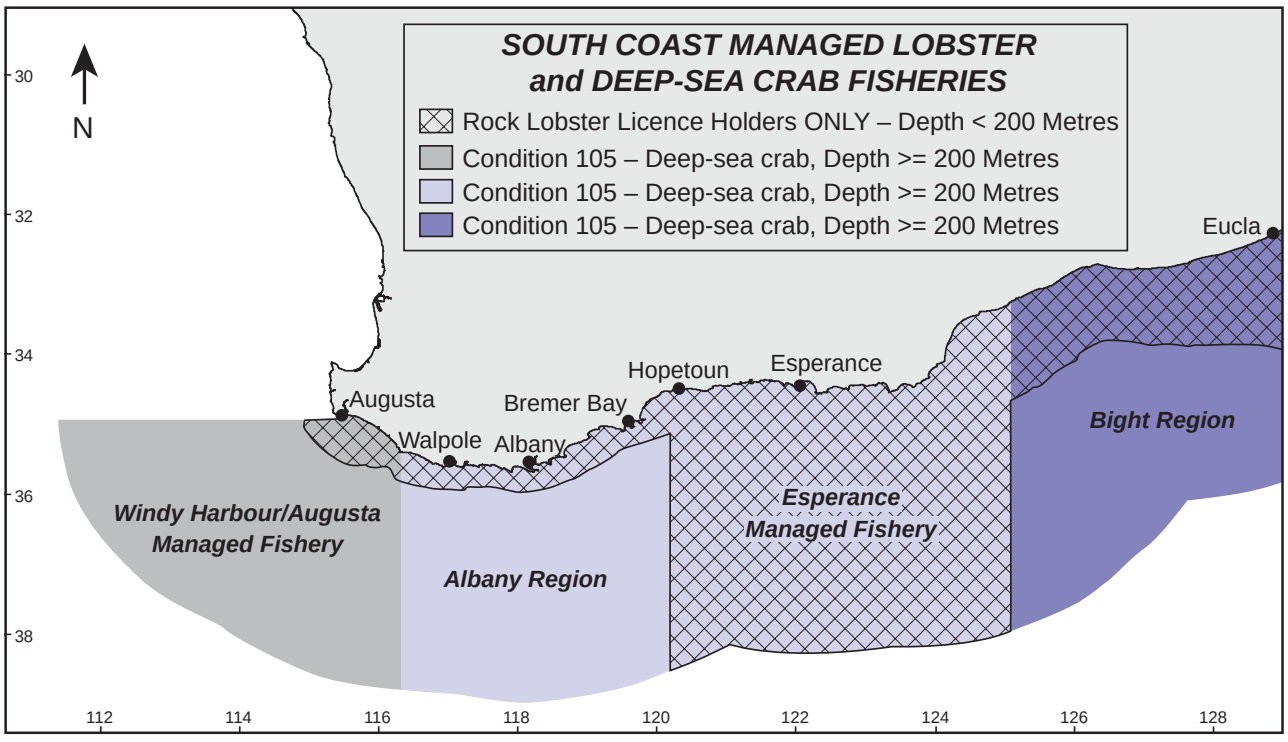
EXTERNAL FACTORS

The recruitment levels may be affected by spawning stock levels in South Australia which have declined in recent years, as well as general environmental fluctuations.

SOUTH COAST CRUSTACEAN TABLE 1

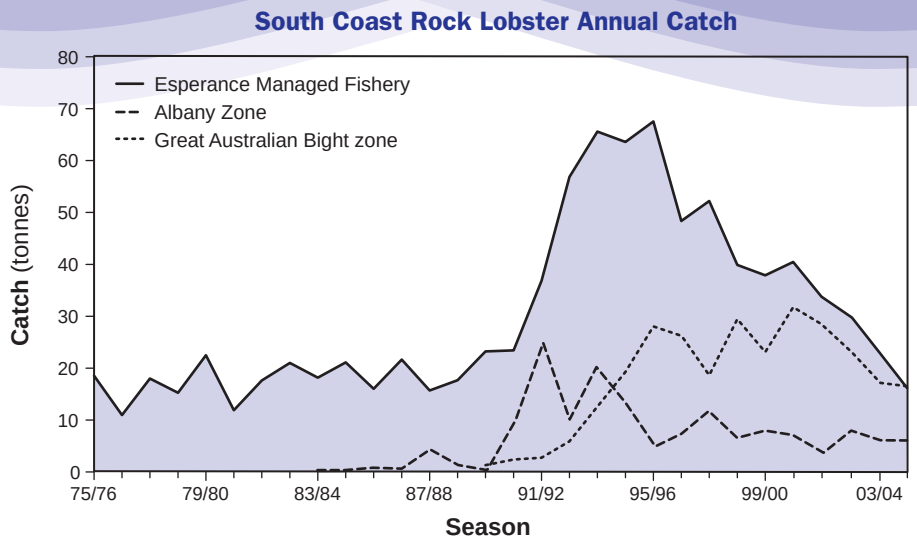
Comparisons of fishing effort and southern rock lobster catch in 2003/04 and 2004/05 in the south coast crustacean fisheries.

MANAGEMENT ZONE	SEASON	POT LIFTS	SOUTHERN ROCK LOBSTER CATCH (tonnes)	DEEP-SEA CRABS CATCH (tonnes)
ERLF	2002/04	44,000	23	4
	2003/05	33,000	16	5
	difference	–25%	–30.4%	+25%
Albany	2002/04	64,000	6	26
	2003/05	73,000	6	13
	difference	+ 14%	0%	–50%
GAB	2002/04	39,000	17	0
	2003/05	40,000	17	2
	difference	+2.5%	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, 1975/76 to 2004/05.

Greenlip and Brownlip Abalone Managed Fishery Status Report

A. Hart and F. Fabris
Management input from J. Kennedy

FISHERY DESCRIPTION

The Western Australian commercial 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 principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) using an abalone 'iron' to prise abalone off rocks. Abalone divers operate from small fishery vessels (generally < 9 m). The fishery targets two species: greenlip abalone (*Haliotis laevigata*), and brownlip abalone (*H. conicopora*).

Governing legislation/fishing authority

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

Consultation process

Abalone Management Advisory Committee
Department–industry meetings

Boundaries

The Abalone Management Plan covers all Western Australian coastal waters, which are divided into eight management areas. Commercial fishing for greenlip and brownlip abalone fisheries is managed in three separate regions from the South Australian border to Busselton Jetty – Areas 1, 2 and 3 (Greenlip/Brownlip Abalone Figure 1).

Management arrangements

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 TACCs, set annually for each species in each area and allocated to licence holders as ITQs. The overall TACC for 2005 was 210.5 t (whole weight) (reduced from 225.5 t following a mid-season review). 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-agreed levels of catch and effort.

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 the breeding stock levels of greenlip and brownlip abalone. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Abalone divers are required to provide daily catch information on the weight and number of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. These data are used to

assist in research, compliance and management matters. Current research is focused on stock assessment using catch and effort statistics, meat weight indices and, where available, length-frequency sampling to estimate fishing mortality. Performance criteria (based on catch, catch rates and meat weights) were negotiated as part of the assessment process, and these are reported (see 'Fishery Governance').

The FRDC project entitled 'Digital video techniques for assessing population size structure and habitat of greenlip and Roe's abalone', which was designed to test the possibility of underwater video for monitoring density and size structure of abalone stocks, was successfully completed in 2005. The industry has accepted the usefulness of this technique and plans are being drawn up to ensure the video monitoring program can provide sufficient data for stock assessment purposes.

Research on stock enhancement and greenlip abalone habitat commenced in 2005, with the principal objectives of investigating habitat effects on growth and survival of hatchery-bred greenlip abalone (from wild stock parents) released back into the wild.

RETAINED SPECIES

Commercial production (season 2005): 208 tonnes (whole weight)

Landings

In 2005 the overall greenlip/brownlip catch was 208 t whole weight (Greenlip/ Brownlip Abalone Table 1), which was 3.5 t (2%) higher than the 2004 catch of 204.5 t. The Area 1 (Nullarbor fishery) exploratory quota remained at 1.2 t.

Greenlip catch at 169.3 t whole weight, from a total quota of 171.8 t, was similar to 2004. The brownlip catch of 38.7 t whole weight for the 2005 season slightly exceeded the quota of 38.5 t (Greenlip/Brownlip Abalone Table 1).

Fishing effort/access level

Continuing the practice introduced in 2002, effort has been divided into main and stunted stocks. Total effort for the main stocks in 2005 was 1,252 days. This was an 8% increase in effort from 2004 (1,154 days), for a 2% increase in total catch.

For a greenlip and brownlip catch of 200 t (main stocks only), the effort of 1,252 diver days was within the fishery governance range (907–1,339 days) set for the season, indicating that overall stocks are within acceptable levels.

Catch rate

The commercial divers' catch rates are an indicator of the abundance of legal-sized abalone and are assessed annually.

In 2005, the catch rate for the combined greenlip stocks was 131 kg whole weight (49 kg meat weight) per diver day. This was very similar to the 129 kg whole weight (48 kg meat weight) per diver day in 2004, and is the second lowest catch rate in 10 years. Performance criteria have been set for Area 2, and the Augusta and Hopetoun sub-areas within Area 3 (see 'Fishery Governance').

Recreational component: 2–7%

The estimate of recreational catch of greenlip and brownlip abalone, based on the telephone diary survey of recreational licence holders in 2004, was between 4 t and 16 t, which was between 2% and 7% of the total (commercial and recreational) catch in the 2004 season. As no telephone diary surveys were undertaken in 2005, these estimates will be updated in the 2006 season.

For details of survey methods see the Licensed Recreational Abalone Fishery Status Report (pp. 67–72.)

STOCK ASSESSMENT

Assessment complete: Yes

A stock assessment of the greenlip/brownlip abalone fishery was undertaken for the 2005 fishing season based on catch and effort statistics, length-frequency and shell morphometry sampling, biological growth studies, and some fishery-independent surveys. These were combined into performance assessments of each major fishery area, i.e. Areas 2 and 3. These performance assessments indicate that the TACC set for Area 2 is within the sustainable range, whereas the greenlip stock levels in Area 3 are approaching the lower end of the sustainable range.

Following assessment of Area 2 against agreed performance criteria, using fishery data from 1 April 2005 to 31 March 2006, all indicators were found to be above the agreed levels (Greenlip/Brownlip Abalone Table 2). This assessment showed the fishery in this area was performing satisfactorily, and TACC for 2006 will be maintained at its long-term average of 31,200 kg (meat weight).

Following assessment of Area 3 against agreed performance criteria, using fishery data from 1 April 2005 to 31 March 2006, most performance indicators for greenlip were found to be below the agreed levels (Greenlip/Brownlip Abalone Table 3). This result was forecast in a mid-year quota review, and resulted in a quota reduction (from 37.5 t to 32 t) prior to the completion of the fishing year. Hence no further reductions were advised for 2006. For brownlip, the assessment showed that a higher TACC was possible, and the TACC for brownlip was raised from 7,500 to 8,000 kg for 2006.

Breeding stock levels: Adequate

Greenlip abalone mature between 80 and 110 mm shell length, and brownlip abalone mature between 90 and 130 mm shell length. Both are below the legal minimum size limit set across the fishery (140 mm shell length), which equates to an average meat weight of 140 g for greenlip and 160 g for brownlip. At these weights, animals are expected to have spawned at least twice. These figures are used as a breeding stock performance measure.

In addition, industry-imposed length limits in excess of the minimum legal limits have been set in areas of fast-growing stocks. In Area 2 there is a general 145 mm minimum length across the fishing grounds. In Area 3, fishers have an imposed a minimum size limit of 153 mm

shell length for the faster-growing portions of the fishing grounds, and 150 mm for the remainder.

The main performance measures for the fishery relate to the maintenance of adequate breeding stocks in each area of the fishery. This is assessed using a combination of measures which reflect the average size of breeding individuals and the overall biomass of breeding stock.

In 2005, the average sizes of greenlip and brownlip caught were 205 g and 273 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 (1,252 days) were within the set range that indicates sufficient biomass of breeding stock for the fishery overall (907–1,339 days – see 'Fishery Governance').

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

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

Protected species interaction: **Negligible**

The only protected species interaction occurring in this fishery is with the great white shark (*Carcharodon carcharias*), which has been known to attack divers. Most divers now use diving cages or electronic shark deterrent devices for their personal protection.

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 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.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $9.7 million

The estimated average price received by fishers was $127/kg meat weight (approx. $48/kg whole weight) for greenlip and $99/kg meat weight (approx. $40/kg whole weight) for brownlip abalone, resulting in a fishery valued at $9.7 million. These prices are comparable to 2004 when average price received by fishers was $126/kg meat weight for greenlip and $100/kg meat weight for brownlip abalone, 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 diver days**

To assess whether the catch quota set is appropriate (sustainable) relative to the stock available, the effort required to take the a full season's quota (210.5 t in 2005) from the main stocks should fall within the effort range (907–1,339 diver days) derived from the five-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 2005 was 1,254 days (main stocks), which is within the governance range and indicates that the fishery as a whole is performing satisfactorily.

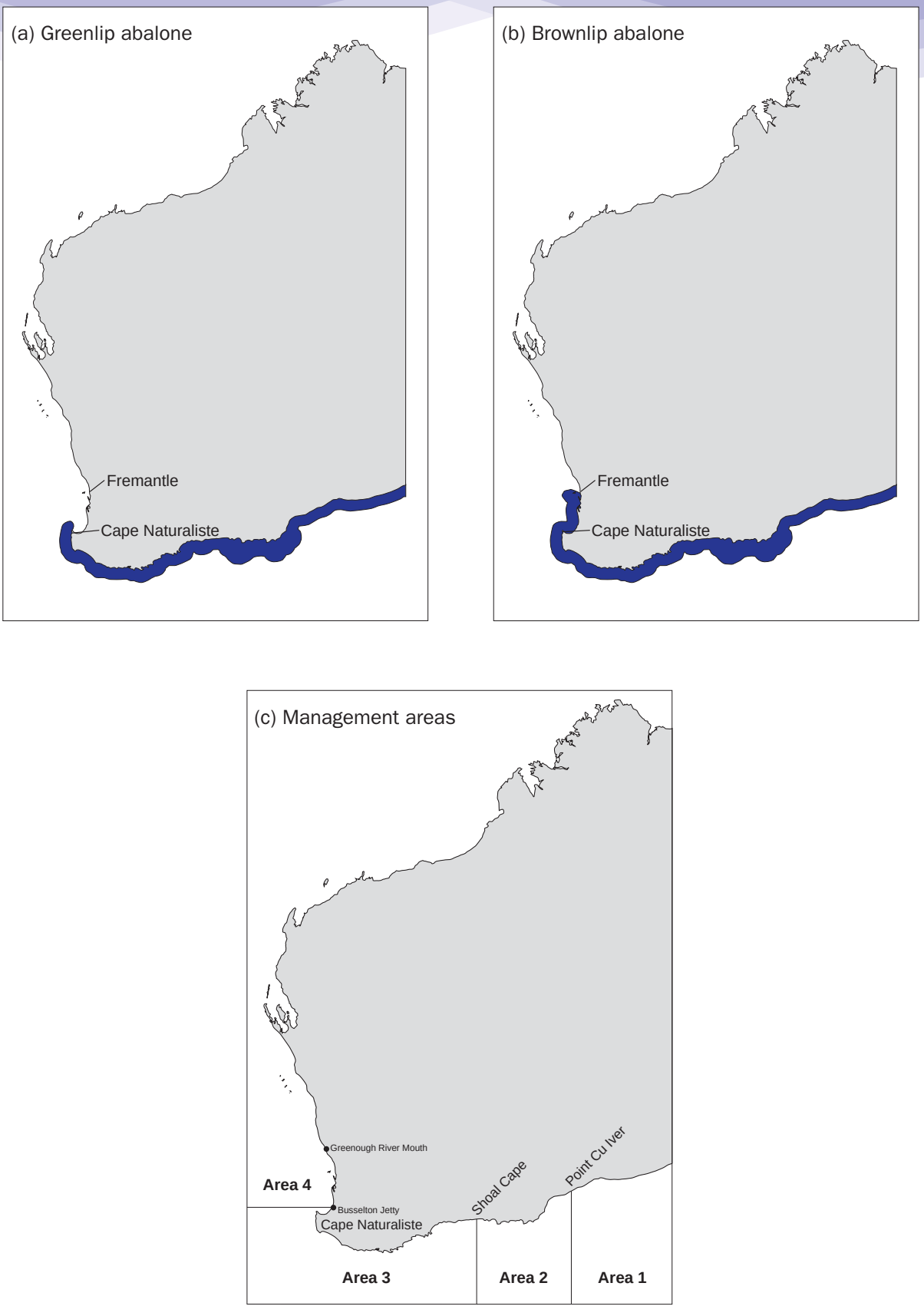
The overall greenlip/brownlip quota for 2006 has increased slightly to 211.5 t whole weight due to small increases in brownlip quota (Greenlip/Brownlip Abalone Table 1).

New management initiatives (2005/06)

There were no new management initiatives introduced in 2005/06, though consultation took place with industry on relatively minor operational changes to the Abalone Management Plan 1992. These matters are currently being progressed.

EXTERNAL FACTORS

In the last few years there have been a number of changes which impact on fishery governance, and particularly on catch rates. Lease divers are becoming more common, industry size limits have been varied substantially above the legal minimum sizes and the value of the abalone has decreased. In addition, environmental effects such as weather conditions, and the effect of technology changes such as the introduction of GPS, motorised underwater scooters and shark protection cages on diver efficiency, are still poorly understood. All these effects will need to be quantified in the future to improve the stock assessment.



GREENLIP/BROWNLIP ABALONE FIGURE 1

Maps showing the distribution of (a) greenlip and (b) brownlip abalone in Western Australia, and (c) the management areas used to set quotas for the commercial fishery.

GREENLIP/BROWNLIP ABALONE TABLE 1

Greenlip and brownlip abalone catch and effort[1] by quota period.

QUOTA PERIOD[2]	GREENLIP TAC kg whole weight	GREENLIP CAUGHT kg whole weight (all stocks)	GREENLIP CAUGHT kg whole weight (stunted stocks)	BROWNLIP TAC kg whole weight	BROWNLIP CAUGHT kg whole weight	COMBINED CATCH kg whole weight	DIVER DAYS (main stocks only)	GREENLIP kg whole (meat) wt per diver day (main stocks only)[4]
1989	–	229,619	20,774	–	36,977	266,596	1,324[3]	158 (59)
1990	126,500	118,395	3,967	–	19,118	137,514	696[3]	164 (62)
1991	148,500	132,194	2,989	–	14,658	146,852	816[3]	158 (59)
1992	192,500	170,608		–	30,404	201,012	1,120	152 (57)
1993	197,450	173,397		–	31,153	204,550	1,238	140 (53)
1994	200,750	171,820		–	32,222	204,042	1,337	129 (48)
1995	187,264	145,467		–	27,061	172,528	1,087	134 (50)
1996	189,750	171,337	11,170	–	21,932	193,269	904[3]	177 (66)
1997	207,350	182,317		–	26,297	208,614	1,059	172 (65)
1998	200,750	181,810	10,922	–	22,197	204,006	1,031[3]	166 (62)
1999	184,023	175,765	7,781	28,000[5]	28,047	203,812	922[3]	182 (68)
2000	194,691	189,511	6,709	34,875	34,179	223,690	1,029[3]	178 (67)
2001	194,691	187,459	22,283	33,075	31,091	218,550	1,002[3]	165 (62)
2002	194,691[6]	166,828	29,110	33,075[6]	27,458	194,286	1,027[3]	134 (50)
2003	202,521[6]	180,730	25,044	37,453[6]	33,449	214,179	1,144[3]	136 (51)
2004	190,520[6]	170,385	21,380	35,000[6]	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**			**39,750**				

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. In prior years, conversion factors for meat weight to whole weight for greenlip abalone were 2.75 prior to 2000 and 2.667 for 2000+. To standardise comparison, we used one conversion factor of 2.667 across all years. The brownlip abalone conversion factor for meat weight to whole weight is 2.5.
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.
6. TACC for greenlip/brownlip after 2001 raised by 4% to reflect changes in processing, but does not represent an increase in actual allowed catch.

GREENLIP/BROWNLIP ABALONE TABLE 2

Assessment against performance criteria in Area 2 for 2005. Note that all weight estimates are in meat weight, not whole weight.

PERFORMANCE INDICATOR	PERFORMANCE CRITERIA	2005 VALUES	ASSESSMENT/COMMENTS
GREENLIP			
Total catch (TACC)	31,200 kg	31,249 kg	Met – 100% of quota caught
Catch rate kg/day (overall)	55 kg per day	53 kg per day	Met – at agreed level
Meat weight*	180 g	189 g	Met – above agreed level
BROWNLIP			
Total catch (TACC)	7,900 kg	7,914 kg	Met – 100% of quota caught
Meat weight	270 g	274 g	Met – above agreed level

* Meat weight is the primary indicator for breeding stock performance.

GREENLIP/BROWNLIP ABALONE TABLE 3

Assessment against performance criteria in Area 3 for 2005. Note that all weight estimates are in meat weight, not whole weight.

PERFORMANCE INDICATOR	PERFORMANCE CRITERIA	2005 VALUES	ASSESSMENT/COMMENTS
GREENLIP			
Total catch	32,000 kg	31,792 kg	Met – 99% of TACC caught
Catch rate kg/day (overall)	60 kg per day	46 kg per day	Not met – below agreed level
Catch rate kg/day (Hopetoun)	50 kg per day	37 kg per day	Not met – below agreed level
Meat weight* (Augusta)	240 g	245 g	Met – above agreed level
Meat weight* (Hopetoun)	200 g	185 g	Not met – below agreed level
BROWNLIP			
Total catch (TACC)	7,500 kg	7,584 kg	Met – 100% of TACC caught
Meat weight	270 g	273 g	Met – at agreed level

* Meat weight is the primary indicator for breeding stock performance.

South Coast Trawl Fishery Status Report

M. Kangas

Management input from J. Froud

FISHERY DESCRIPTION

The South Coast Trawl Fishery principally targets scallops (*Amusium balloti*) and associated by-products, although in years of low scallop catches licensees have an option (rarely exercised) to use other trawl gear to target fish species. The main fishing method is by twin-rig otter trawl. Scallop landings for the fishery have varied dramatically over the years, depending primarily on the strength of recruitment. While the fishery has theoretical access to a large section of the coastal waters, it is effectively restricted to small areas of higher scallop abundance.

Governing legislation/fishing authority

Trawling Prohibition (Whole of State) Notice 1992 (Order)
Surface Trawl Net Fishery (South Coast) Notice 1992
Trawling for Scallops (South Coast) Notice 1992
Condition 73 and/or 79 on Fishing Boat Licences
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Department–industry meetings

Boundaries

There are currently four fishing boat licences that specify conditions intended to constitute 'endorsements' for the purposes of an exception to the governing legislation (orders). These endorsements are defined in two fishing boat licence conditions. Condition 73 provides for the use of trawl nets off the south coast of Western Australia in state waters east of 115° E longitude (Cape Leeuwin). Condition 79 provides for the use of demersal trawl nets for taking scallops within the Recherche Archipelago. All four fishing boat licences have both conditions.

Management arrangements

The South Coast Trawl Fishery is managed primarily under an input control system limiting numbers to only four fishing vessels. There are also seasonal closed areas in certain parts of the fishery.

The Australian Government Department of Environment and Heritage has assessed the fishery under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, and has conditionally granted a special exemption allowing product from the fishery to be exported from Australia until August 2008. Among other conditions, the Department of Fisheries is required to develop and implement an interim management plan for the fishery before March 2007.

RETAINED SPECIES

Commercial production (season 2005): 30 tonnes whole weight

Landings

The scallop catch of 30 t whole weight in 2005 was low compared to catches seen in recent years. Recorded by-products were less than 1 t of bugs (Scyllaridae).

Fishing effort/access level

The annual effort expended in this scallop fishery is affected by scallop recruitment levels which are determined in fishing surveys completed by operators to estimate stock abundance of scallops and likely benefits of continued fishing. As a consequence, the level of effort utilised each year closely

follows stock abundance and catch levels. In 2005, only 40 fishing days were recorded compared to 107 days in 2004, 137 fishing days in 2003 and 425 days in 2002.

Catch rate
Not available.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Not assessed

Exploitation status: Not assessed

Breeding stock levels: Not assessed

NON-RETAINED SPECIES

Bycatch species impact: Low

The large-mesh (100 mm) trawl gear used in scallop fisheries takes minimal bycatch. The areas trawled by the fleet also represent a very small percentage of the fishing area within the legislated boundary, therefore bycatch species impact is considered to be minimal.

Protected species interaction: Negligible

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

ECOSYSTEM EFFECTS

Food chain effects: Low

The extremely variable recruitment and resultant fluctuating biomass of the scallops which occur in this area preclude the fishery having any significant impact on the general food chain in the region.

Habitat effects: Low

Trawling has minimal impact on the benthic sand habitats in this scallop fishery.

SOCIAL EFFECTS

The estimated employment for the year 2005 was 6 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $100,000

FISHERY GOVERNANCE

Acceptable catch range for next season:Not available

New management initiatives (2005/06)
The Minister has approved the drafting of an interim management plan for the South Coast Trawl Fishery. When implemented, the interim plan will include a set of gear restrictions/limits, and will also define a number of temporal and spatial closures in the area of the fishery. The interim plan should be in place before March 2007.

EXTERNAL FACTORS

The level of fishing activity and quantity of catch within the south coast trawl is highly variable. This variability has largely been driven by the level of scallop recruitment to these grounds and also by the product price paid to fishers. Scallop catches in 2005 were low, indicating both low levels of effort and low scallop abundances in the region.

South Coast Estuarine Managed Fishery Status Report

K. Smith, J. Brown and E. Lai
Management input from J. Froud

FISHERY DESCRIPTION

Thirteen estuaries and inlets located between Cape Beaufort and the WA/SA border are conditionally open to commercial fishing as part of the South Coast Estuarine Managed Fishery (SCEF). The SCEF is a multi-species fishery targeting many finfish species, with the main fishing methods being gillnet and haul net.

Governing legislation/fishing authority
South Coast Estuarine Fishery (Interim) Management Plan 2001
South Coast Estuarine Fishery Management Plan 2005
South Coast Estuarine (Interim) Managed Fishery Permit
South Coast Estuarine Managed Fishery Licence

Consultation process
Department–industry meetings

Boundaries
The fishery encompasses '*the waters of all estuaries on the south coast of Western Australia between Cape Beaufort and 129° east longitude, including Princess Royal Harbour and Oyster Harbour, and all the rivers, streams and all the tributaries that flow into those estuaries.*' The areas that are open to commercial fishing are (from west to east) Broke Inlet, Irwin Inlet, Wilson Inlet, Princess Royal Harbour, Oyster Harbour, Waychinicup Inlet, Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Culham Inlet, Jerdacuttup Lakes, Oldfield Inlet and Stokes Inlet.

Management arrangements
The South Coast Estuarine Fishery (Interim) Management Plan 2001 came into effect in July 2002 and ceased on 30 June 2005. The South Coast Estuarine Fishery Management Plan 2005 came into effect on 1 July 2005. Catch and effort

in the fishery is managed by input controls including limited entry, gear controls and spatial and temporal restrictions. These arrangements are designed to ensure that permitted fishing methods and times are well defined, and that the maximum potential effort in the fishery is limited.

Research summary

Monitoring of fisheries and fish stocks in south coast estuaries is primarily based on monthly catch and effort statistics (CAES) provided by commercial fishers. The CAES database provides a valuable and consistent source of information for monitoring estuarine fish, including recreationally important stocks where they are harvested by both sectors. However, levels of commercial fishing activity have been declining since 1992 as a result of voluntary buy-back of commercial access, making this valuable long-term commercial catch and effort data set less useful in assessing the status of certain estuarine species. Consequently, even greater co-operation from the remaining commercial fishers will be required in future to provide more detailed catch and effort data that can be used to derive a CPUE-based index of abundance for target species. A new commercial fishing daily log book to record fine-scale data is being developed in consultation with estuary fishers.

Ultimately, comprehensive assessments of commercial and recreational fisheries in south coast estuaries will also require data from the recreational sector and/or independent surveys. The Research Angler Program and annual research surveys of juvenile fish recruitment (including herring, whiting, mullet and several other species) are among the strategies now being employed by the Department to meet this need.

This report presents specific data for three important estuarine fish stocks, namely cobbler (*Cnidoglanis macrocephalus*), black bream (*Acanthopagrus butcheri*) and King George whiting (*Sillaginodes punctata*).

RETAINED SPECIES

Commercial production (season 2005): 227 tonnes

Landings

The SCEF retains approximately 33 species, including finfish, sharks, rays, molluscs and crustaceans. The majority of landings are finfish including black bream, cobbler, sea mullet (*Mugil cephalus*), Australian herring (*Arripis georgianus*), flathead (Platycephalidae), leatherjackets (Monocanthidae) and King George whiting. In 2005, black bream and cobbler comprised about 50% of the total catch of 226.7 t (South Coast Estuarine Table 1).

After 1980, total annual commercial landings in south coast estuaries steadily increased, from approximately 200 t during the early 1980s to a peak of 466 t in 1992 (South Coast Estuarine Figure 1). Total landings declined sharply between 1992 and 1994, but were then relatively stable until 2003. Total annual landings averaged 282 t between 1994 and 2003. In 2004, the total catch dropped to its lowest level since 1980 before recovering slightly in 2005. The 2005 catch of 227 t was below the 10-year average annual catch (1995–2004) of 274 t.

The increase in total catch between 2004 and 2005 reflected increases in landings of black bream, cobbler, King George whiting, southern sea garfish (*Hyporhamphus melanochir*) and yellowtail scad (*Trachurus novaezelandiae*). Leatherjackets were the only species to experience a substantial decline in catch between 2004 and 2005. Despite a general increase in landings in 2005, the annual catches of many species were still well below the 10-year annual average, including cobbler (17.4 t lower), sea mullet (12.7 t), yellow-eye mullet (*Aldrichetta forsteri*) (10.2 t), blue swimmer crabs (*Portunus pelagicus*) (9.9 t), King George whiting (8.4 t), Australian herring (7.5 t) and leatherjackets (5.8 t). Only black bream and sea garfish landings in 2005 were substantially above their respective 10-year annual averages (37.1 t and 4.6 t higher, respectively).

Of the individual estuaries, Wilson Inlet recorded the highest catch in 2005 (110 t or 49% of total SCEF landings). This catch was similar to the 10-year (1995–2004) average annual catch (115 t) for the estuary. Combined landings from Oyster Harbour, Princess Royal Harbour, Beaufort Inlet, Irwin Inlet and Stokes Inlet contributed a further 48% of total SCEF landings in 2005. Only minor catches were recorded in Broke Inlet, Oldfield Inlet and Gordon Inlet and no catches were reported from Waychinicup Inlet, Hamersley Inlet, Culham Inlet or Jerdacuttup Lakes in 2005.

In 2005, Beaufort Inlet was the only estuary on the south coast to produce commercial landings that were significantly higher than the 10-year annual average for the estuary. The 2005 catch in Beaufort Inlet was 425% higher than the 2004 catch, due to a large increase in the catch of black bream.

Three estuaries (Oyster Harbour, Princess Royal Harbour, Broke Inlet) produced total landings in 2005 that were significantly below their respective 10-year averages. Annual catches have followed a declining trend since 2001 in Oyster Harbour and since the late 1990s in the other two estuaries.

Cobbler: In 2005 the total SCEF cobbler catch was 49.3 t, representing an increase of 9.1 t from the 2004 catch level, but still 17.4 t below the 10-year average catch. The 2005 catch was concentrated in four estuaries, namely Wilson Inlet (76%), Oyster Harbour (11%), Irwin Inlet (9%) and Princess Royal Harbour (4%).

Traditionally, the majority of annual 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 catch declined markedly from 78 t in 2003 to 28 t in 2004. The 2005 catch remained relatively low at 37 t, which was well below the 10-year average catch (52.3 t) in Wilson Inlet.

Black bream: In 2005, the total SCEF black bream catch was 63.5 t, which was significantly higher than the 10-year average catch of 26.3 t and the highest annual catch since the early 1990s (South Coast Estuarine Figure 3). Total bream landings on the south coast peaked at 97 t in 1992 after favourable environmental conditions in Culham Inlet

led to strong recruitment and high catches in that system. In 2005, Beaufort Inlet and Wilson Inlet contributed 71% of total bream landings, while Oyster Harbour and Stokes Inlet contributed a further 28%. The sharp increase in total landings of bream between 2004 and 2005 reflected increases in catches in Beaufort Inlet, Wilson Inlet and Oyster Harbour.

King George whiting: In 2005, the total SCEF King George whiting catch was 11.3 t, most (94%) of which was taken in Wilson Inlet and Irwin Inlet. The 2005 catch from Wilson Inlet was 8.4 t, more than 3.9 t higher than in 2004 but still 7.1 t less than the 10-year average catch in this estuary (South Coast Estuarine Figure 4). However, the 10-year average is inflated by very high catches of whiting from 1997 to 2000, which resulted from high juvenile recruitment into Wilson Inlet by the 1995 year-class. Higher catches of King George whiting also occurred in Broke and Irwin Inlets at this time, indicating a widespread recruitment event.

Other species: The annual SCEF catch of southern sea garfish increased markedly between 2004 and 2005. The 2005 catch (8.8 t) was well above the 10-year average (4.1 t). The 2005 SCEF catch of flathead (11.9 t) was also above the 10-year average catch (8.9 t). The majority of garfish and flathead landings are taken in Wilson Inlet each year.

The 2005 catch of sea mullet (23.4 t) was below the 10-year average catch (36.1 t), and continued the declining trend in sea mullet landings since 1995. Sea mullet is caught in numerous south coast estuaries. The 2005 catch of leatherjackets (11.9 t) was also below the 10-year average catch (17.7 t), mainly due to relatively low catches in Oyster Harbour, where leatherjacket landings have been declining since the late 1990s. Leatherjackets are also caught in Princess Royal Harbour, where landings have been stable over the last 10 years.

Fishing effort/access level

Fishing effort has traditionally been recorded here as the average number of boats fishing per month. This measure of effort gives only a very general indication of effort changes. The number of days fished is also now reported, but it is difficult to determine effort targeted towards individual species from this measure. The number of days fished does, however, show where the effort is concentrated (i.e. in which estuaries) and indicates how that effort has changed over time.

The average number of boats fishing per month peaked at 42.9 in 1992, and has subsequently followed a declining trend. In 2005, the average number of boats fishing per month was 15.8, down from 17.7 boats per month in 2004. Declines in SCEF effort over the past decade reflect a reduction in the number of units of access in the fishery, which fell from 51 in 1994/95 to 25 in 2005.

The total annual reported fishing days also peaked in 1992 at 6,747 days and then progressively declined to a low of 3,365 days in 2004. A slight increase in effort occurred in 2005, when 3,481 fishing days were reported (South Coast Estuarine Figure 1). This increase in reported fishing days between 2004 and 2005 occurred despite the decline over the same period in the average number of boats fishing per month.

In 2005, SCEF fishing effort was focused in Wilson Inlet (61.9% of fishing days), Oyster Harbour (9.8%), Princess Royal Harbour (9.1%) and Irwin Inlet (8.2%). In Wilson, Irwin and Beaufort Inlets fishing effort in 2005 was higher than in 2004 and was above the 10-year average for each estuary. In contrast, Princess Royal Harbour, Oyster Harbour, Stokes Inlet and Broke Inlet each experienced a substantial decrease in reported effort. Lower levels of effort in Oyster Harbour and Princess Royal Harbour may at least partly reflect attempts by fishers to avoid interactions with fur seals, which are problematic because seals can damage gear and remove fish from nets.

Catch rate

Catch per unit effort (CPUE) in this fishery steadily increased after 1980 to reach a peak of 82.2 kg/day fished in 1998 (South Coast Estuarine Figure 1). CPUE has since slowly declined, and was 65.1 kg/day fished in 2005 (South Coast Estuarine Figure 1).

Recreational component: 27% (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, in press).

During the 2000/01 survey, the most commonly reported species in the south coast estuaries were black bream, King George whiting, blue swimmer crabs, pink snapper, skipjack trevally, prawns, western Australian salmon, mullet, Australian herring, mulloway, tailor, squid and tarwhine. The recreational catch of the above-mentioned 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 2000 calendar year.

The 2003 survey included 17 estuaries, including 11 of the 13 estuaries open to commercial fishing (noting that no commercial catches were taken in the remaining two estuaries during the study period). The most commonly reported species were King George whiting, black bream, Australian herring, skipjack trevally and blue swimmer crabs, comprising approximately 83% of all species (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 27% (by weight) of the combined recreational and commercial catch of these species during the survey period.

The total recreational catch (by weight) for all the species caught in south coast estuaries could not be estimated in 2003 due to uncertainties associated with small samples of less abundant species and limited data on the average size of fish in the catch. A total of 48 species were reported in the recreational catch from south coast estuaries.

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.

STOCK ASSESSMENT

Assessment complete: **Preliminary**

The downward trend in commercial catches from south coast estuaries since 1992 mainly reflects a decline in effort due to a buy-back of licences. CPUE has been relatively stable over this period, probably due to the relatively constant total abundance of the suite of species that make up the catch. The catch rates of individual species have, however, been highly variable from year to year.

Cobbler: Wilson Inlet is the state's major cobbler fishery. Trends in cobbler CPUE suggest that abundance increased in Wilson Inlet between 1990 and 2003, when landings peaked at the second highest annual catch on record. In 2004, CPUE declined sharply and the annual catch fell to its lowest level since 1983. In 2005, the catch and CPUE remained low. The rapid decline in CPUE at a time of relatively low and stable fishing effort suggests a decline in stock abundance after 2003, probably due to low recruitment as a result of environmental factors. Assessment of this stock is made difficult by imprecise estimates of effort spent targeting cobbler as a result of multi-species targeting by this fishery and the lack of appropriate fishery-independent monitoring data for Wilson Inlet.

Black bream: Black bream populations are independent and genetically distinct within each south coast estuary. Therefore, 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. Trends in both catch and CPUE suggested that black bream in Beaufort Inlet, Oyster Harbour and Wilson Inlet increased in abundance from the mid-1990s until 2003, then declined slightly in 2004 before increasing significantly in 2005. In Irwin Inlet, catch trends also suggested a large increase in bream abundance in 2005, although abundance in this estuary appeared relatively stable until 2004. Higher catches of black bream are frequently associated with higher rainfall in the estuary catchments. Annual rainfall was very high in 2005 along much of the south coast. High flows after heavy rain can cause fish in tributaries to move downstream into the open fishing waters of estuary basins, where they are vulnerable to capture by commercial fishers. Also, higher flows appear to increase the spawning and recruitment success of bream, although the mechanisms for this are unclear.

Over the last 10 years, Stokes Inlet has provided a high proportion of SCEF black bream landings (42.5%). However, in 2005 Stokes Inlet contributed less than 10% of the total annual bream catch, suggesting lower stock abundance possibly as a result of lower rainfall in the catchment of this estuary.

King George whiting: In 2005, over 74% of the south coast commercial catch of King George whiting was taken in Wilson Inlet. This estuary provides a critical, local nursery habitat for individuals of this species to an age of approximately 3 years. Successful recruitment to the 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. High catches in Wilson Inlet from 1997 to 2000 were most likely related to a substantial increase in recruits entering the estuary, and not to 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 2005, King George whiting catches were at the more typical pre-1997 levels.

Breeding stock levels: **Adequate**

Cobbler: Catch trends suggest cobbler abundance in Wilson Inlet has declined since peaking in 2003 but is currently stable, albeit at a lower level. The breeding stock for the cobbler fishery in Wilson Inlet is contained within the estuary. The length at maturity in Wilson Inlet is approximately 425 mm, which is attained at an age of 3–4 years (Laurenson et al. 1993a) and is very close to the legal minimum length (430 mm total length). Although cobbler exhibit different growth rates in different estuaries, the size at maturity in each estuary is generally less than the legal minimum length of 430 mm, thus affording some protection to each breeding stock. This important species is also afforded some additional protection by a closed fishing area in Wilson Inlet. With the introduction of the interim management plan in 2002, special regulations specific to the targeting of cobbler were introduced to protect spawning aggregations and spawning areas in a number of estuaries.

Black bream: In both south coast and west coast estuaries, black bream exhibit different growth rates and attain maturity at different sizes in each estuary. In all cases, the size at maturity is lower than the legal minimum length (250 mm total length), affording some protection to each breeding stock. Trends in catch and CPUE suggest that breeding stock levels are adequate to maintain recruitment in each estuary. In fact, bream abundance appears to be increasing in several south coast estuaries.

King George whiting: King George whiting are spawned in ocean waters and recruit as juveniles into nursery habitats within Wilson Inlet and other estuaries. These recruits belong to the same stock as fish 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 fishery employs selective fishing methods, including specific mesh sizes. As a result, bycatch levels in this fishery have historically been low.

Protected species interaction: **Negligible**

The SCEF has occasional interactions with New Zealand fur seals and Australian sea lions. These animals are primarily open ocean foragers and only occasionally enter estuaries. However, the abundance of fur seals on the south coast has steadily increased over the last 15 years, resulting in an increasing level of interaction with fishers especially in the Albany region (R. Campbell, Department of Fisheries, 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 in south coast estuaries can vary markedly and is primarily recruitment-driven, independent of fishing within each estuarine system. Food chain effects due to fishing are likely to be insignificant compared to the effects of recruitment-driven variations in fish abundance.

Habitat effects: Low

The operation of the nets used is unlikely to have any significant impact on the benthic habitats in these estuaries. Gillnets are hung in open water and do not interact with benthic habitats. Haul nets may be deployed over bare sand or low- to medium-density seagrass. Haul nets tend to 'roll' over the surface of seagrass beds without removing attached leaves or uprooting plants. At times, haul nets may collect floating vegetation including seagrass leaves or algae.

SOCIAL EFFECTS

Catches from the SCEF are an important source of fresh local fish to regional centres. During the 2005 fishing season, the SCEF employed an average of 26 fishers per month and generated additional regional employment in associated industries such as fish processing.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $1.1 million

FISHERY GOVERNANCE

Target catch range: 200–500 tonnes

To determine a target catch range, annual SCEF catches from 1983 to 1998 were subject to double exponential smoothed forecasting. The range was then derived from the difference between the predicted catch and reported catch in each year. The confidence intervals were set at 80%. The resulting target catch range was 200–500 t (rounded to the nearest 50 t).

The total catch in 2005 of 226 t was within lower part of the target range. This was consistent with the continuing trend of reduced effort (and hence catch) in this fishery, mostly due to buy-backs funded through the Voluntary Fisheries Adjustment Scheme. The target catch range will need to be recalculated as this trend continues.

New management initiatives (2005/06)

Following a period of consultation with industry, a full management plan for the SCEF was effected on 1 July 2005, replacing the interim management plan which had been in force since 2002. Consideration is now being given to making a number of small amendments to the management plan that will enable Fisheries and Marine Officers to more efficiently ensure that industry members are complying with fishery rules.

EXTERNAL FACTORS

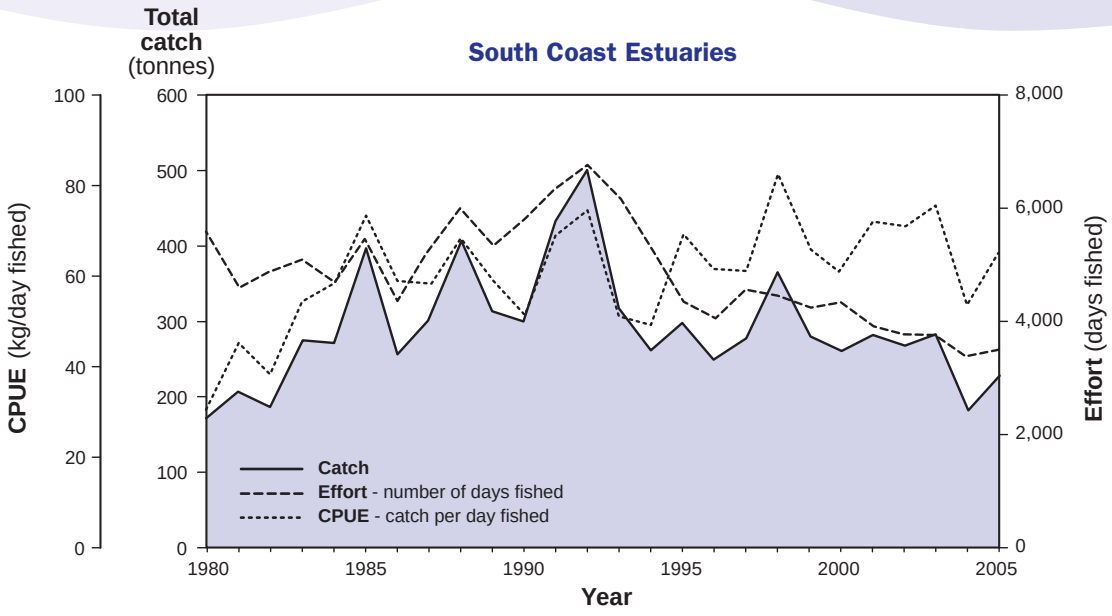
Variation in the abundance of target species in south coast estuaries is largely driven by environmental factors, independent of fishing. These factors, which are outside the control of the Department of Fisheries, often have a dominant influence on the commercial catch and effort from year to year. For example, high annual rainfall probably contributed to higher catches of black bream in several estuaries in 2005. Catchment processes, such as clearing of vegetation, flow regulation and nutrient input, can have major downstream effects on estuary 'health' and on fishery production. Attempts to quantify the influence of environmental factors on fishery production are difficult in the absence of complementary biological and environmental monitoring programs in 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 2005.

SPECIES	SCIENTIFIC NAME	CATCH (tonnes)
Black bream	*Acanthopagrus butcheri*	63.5
Cobbler	*Cnidoglanis macrocephalus*	49.3
Sea mullet	*Mugil cephalus*	23.4
Australian herring	*Arripis georgianus*	15.4
Flathead	Platycephalidae	11.9
Leatherjacket	Monocanthidae	11.9
King George whiting	*Sillaginodes punctata*	11.3
Southern sea garfish	*Hyporhamphus melanochir*	8.8
Yellowtail scad		5.2
Silver bream	*Rhabdosargus sarba*	4.1
Other species		21.9

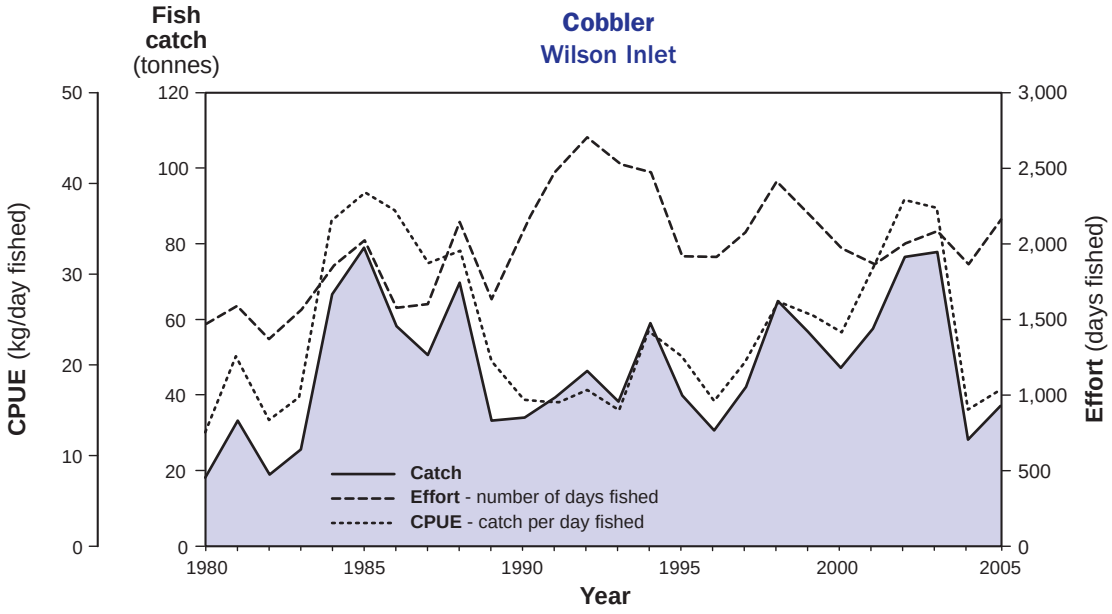


SOUTH COAST ESTUARINE FIGURE 1

The annual catch, effort and catch per unit effort (CPUE) for the South Coast Estuarine Fishery over the period 1980–2005.

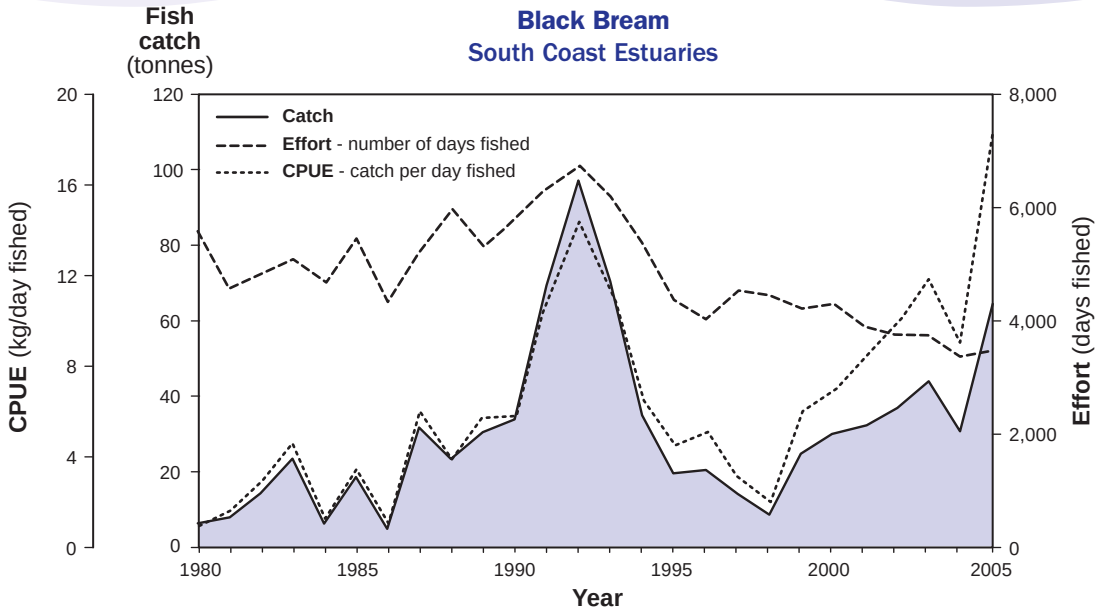
Note 1: Prior to 1993, the south coast estuarine catch figures included King George Sound, which was not part of the SCEF. From 1993, when a separate fishing block was created for Princess Royal Harbour, the catch figures include Princess Royal Harbour but not King George Sound.

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.



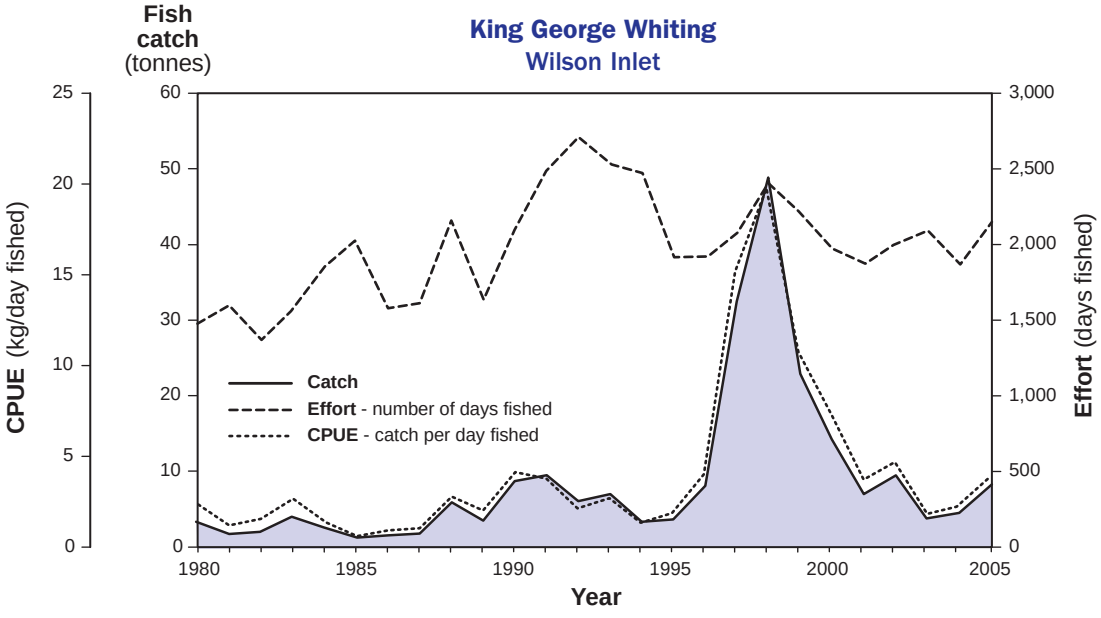
SOUTH COAST ESTUARINE FIGURE 2

The annual catch, effort and catch per unit effort (CPUE) for the cobbler (*Cnidoglanis macrocephalus*) fishery of Wilson Inlet over the period 1980–2005.



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 1980–2005.



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 1980–2005.

Australian Salmon Managed Fisheries Status Report

K. Smith and J. Brown
Management input from J. Froud

FISHERY DESCRIPTION

The western species of Australian salmon (*Arripis truttaceus*) is targeted in Western Australian waters by two commercial fisheries, the South Coast Salmon Managed Fishery and the South-West Coast Salmon Managed Fishery. Fishers target schools of migrating salmon as they move west along the southern coastline of WA during the late summer and autumn. Fishing operations are conducted by teams of fishers setting beach seine nets using either rowboats or small jet-powered boats.

Governing legislation/fishing authority

South Coast

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

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)

Consultation process

Department–industry meetings

Boundaries

The boundaries of the South Coast Salmon Managed Fishery are '*Western Australian waters below high water mark from Cape Beaufort to the waters up to the eastern boundary of the State on the south coast of Western Australia*'.

In the South-West Coast Salmon Managed Fishery the boundaries are '*Western Australian waters from the eastern boundary of the State on the north coast of Western Australia to Cape Beaufort on the south-west coast of Western Australia*'.

Management arrangements

The two managed salmon fisheries are controlled through limited entry and spatial and gear restrictions.

The South Coast Salmon Fishery management plan provides for licence holders to operate from assigned beaches between Shoal Cape and Cape Beaufort, with each fishing team having access to a single nominated beach.

In the South-West Coast Salmon Fishery, operating west and north of Cape Beaufort, licence holders can operate from any beach within the area of the fishery and share the use of beaches amongst themselves under priority of netting rules specified in the Fish Resources Management Regulations 1995. In practice, only a few beaches are fished.

A small number of fishers have a condition on their fishing boat licence or commercial fishing licence which has traditionally been interpreted as allowing them to fish for salmon between Busselton Jetty and Tim's Thicket, near Mandurah.

These three categories are the only fishers with authority to land and sell Australian salmon in WA.

Industry members are being encouraged to investigate ways of improving fish handling and value-adding techniques to improve the net value of the fishery. As salmon is considered a prime recreational species, resource-sharing issues are likely to be a major consideration in future management of these fisheries.

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

Research summary

Information to monitor the stock of this important commercial and recreational target species is obtained from compulsory monthly commercial fishing returns and voluntary commercial fisher log books. These are analysed in conjunction with the substantial amount of biological information available for this species. In future, catch rates from the recreational angler daily log book program, which commenced in 2004, will also provide an ongoing index of stock abundance on the south and west coasts, to complement that provided by commercial catch rates.

Annual surveys of juvenile salmon recruitment are conducted at six sites along the south and lower west coasts of WA. These fishery-independent data are used to generate an overall index of salmon recruitment, which is then used to forecast fishery catches 3–4 years later.

RETAINED SPECIES

Commercial production (season 2005): 1,474 tonnes

Landings

The total state catch of Australian salmon for the 2005 season was 1,474 t, which was 909 t less than in 2004 and 418 t less than in 2003 (Salmon Figure 1). The 2005 catch was well below the average catch of 2,529 t for the past 10 years (1995–2004). The catch did however still fall within the long-term catch range for this fishery (1,200–2,800 t).

The 2005 south coast commercial catch of salmon was 680 t, which was 974 t less than in 2004. This is the lowest recorded catch in this region for the past 40 years. Traditionally, almost the entire south coast catch (approximately 97%) is taken between February and May, which coincides with the time of the spawning run along the south coast. However,

in 2005, only 60% of the total catch was taken during this period, with the remainder being taken during the 'back run' (June–December).

The south coast catch was mainly taken from designated salmon beaches, with a minor catch component from estuaries. The central (Albany to Cape Riche) and western (Windy Harbour to Albany) regions of the fishery contributed similar proportions (50.4% and 45.8% respectively) to the total south coast catch. A small proportion (3.8%) was taken from the eastern sector of the fishery (from Cape Riche eastwards).

The south-west coast catch for 2005 was 794 t, which was 66 t more than in 2004 and 237 t above the 10-year average (1995–2004) for the south-west coast. This is the first year in the history of the WA commercial salmon fishery that the south-west coast catch has exceeded the total south coast catch. The Geographe Bay region contributed the majority (56%) of the south-west coast catch.

Fishing effort/access level

In 2005 there were 18 south coast and 12 south-west coast fishing teams, plus 3 licensees with access only from Busselton Jetty to Tim's Thicket. This is the same number that operated during the previous year. Their method of operation (i.e. beach-based netting on a restricted number of beaches) includes a considerable amount of time spent observing ('spotting' or searching for fish), which enables the number of beaches occupied through each season to be used as a general measure of the annual fishing effort applied to the stock.

Catch rate

In 2005, the average annual catch per fishing team was 37.8 t on the south coast (down from 91.9 t in 2004), and 52.9 t on the south-west coast (slightly up from 48.5 t in 2004). The 2005 catch rates were markedly different from the 10-year (1995–2004) average regional catch rates of 104.5 t for the south coast and 39 t for the south-west coast.

Recreational component: **6% (approx.)**

The most recent recreational fishing survey to include salmon was a national survey, conducted between May 2000 and April 2001 (Henry and Lyle 2003), which estimated a total Western Australian recreational catch of 136 t for Australian salmon. Most of this catch came from the south coast (111 t from the ocean and 6 t from estuaries) and the remainder from the west coast (17 t from the ocean and 2 t from estuaries).

The recreational component is estimated to be approximately 6% of the total salmon catch (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 8–16% of the west coast catch.

STOCK ASSESSMENT

Assessment complete: **Yes**

Outputs from a preliminary biomass dynamics model indicate that the long-term catch of Australian salmon from both sectors (recreational and commercial) can be sustained at an average of about 2,500 t per year. Recent total landings have been below this level and are considered sustainable.

Breeding stock levels: **Adequate**

Commercial and recreational fishers in WA target mature salmon during the spawning run, and so fishery catch rates are essentially an index of breeding stock abundance. Commercial catch rate trends indicate that the breeding stock is currently at an acceptable level.

A declining trend in total catch since the mid-1990s is considered to be a result of market forces and environmental factors affecting catchability, and does not reflect a decline in stock level.

Australian salmon is inherently vulnerable to over-exploitation due to the 'gauntlet' nature of the fishery – that is, most migrating schools of pre-spawning salmon pass close to shore along each of the fishing beaches, where they are highly vulnerable to capture by commercial and recreational fishers, given the right conditions. There is also the potential for a significant reduction in recruitment due to unusual environmental effects. Without appropriate management, one or both of these factors could take the stock below an acceptable biological reference point of 30% of virgin spawning biomass.

The performance measure for the fishery relates to annual salmon catch, which is taken predominantly during the spawning season and is therefore an indicator of breeding stock levels. In 2005, the catch was within the target range, indicating that the breeding stock level was adequate in that year.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

The fishery uses beach seine nets to specifically target schooling salmon, primarily during the annual late summer–autumn spawning migration. As a result of the fishing method, the design of the gear used and the way it is operated, the fishery captures minimal bycatch. A small quantity of other finfish species is caught with the salmon, but the risk to these species is regarded as negligible.

Protected species interaction: **Negligible**

Occasionally seals are surrounded by a beach seine net, but they are released immediately by the fishers. This is possible because seine netting is a labour-intensive operation and the fishing team will immediately notice a seal in the net. Fishers are able to release seals from their seine net soon after capture and without injury to the seal.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Salmon are only one of a number of top-end predatory species in the marine food chain of the lower west and south coasts. The fishery has some potential to reduce the mortality of prey species. However, given the high natural variability in the salmon biomass, the impact of the fishery is likely to be similar in magnitude to other environmental factors

contributing to the recruitment of the prey species. Overall, the ecological impact of the fishery is assessed as low.

Habitat effects: Negligible

These fisheries operate at a very small number of beaches along the Western Australian coastline. The fishing operators 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 shoot their nets few times in a season. Finally, the beach seining method when operated over the sandy beach environments in these high-energy areas does not impact significantly upon these habitats.

SOCIAL EFFECTS

During the 2005 fishing season there were approximately 64 fishers involved in the south coast fishery and 36 in the south-west coast fishery.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $589,000

The price paid to south coast fishers for Australian salmon remained at an average of $400/t in 2005.

FISHERY GOVERNANCE

Target catch range: 1,200–2,800 tonnes

In 2005, the target catch range for this fishery was reduced from 1,200–3,350 t to 1,200–2,800 t.

Prior to 2005, the catch range for this fishery was derived by applying an autoregressive moving average quality control procedure to 37 years of annual catches up to the year 2000. This followed a standard methodology that is applied routinely to fisheries in Western Australia. Although the previous upper catch limit of 3,350 t was considered adequate to ensure the sustainability of the fishery, a more precautionary upper catch limit of 2,800 t was introduced to satisfy recommendations by the Australian Government Department of Environment and Heritage, to maintain the fishery's permit to export under the *Environment Protection and Biodiversity Conservation Act 1999*.

The 2005 total catch level was within the new target range.

New management initiatives (2005/06)

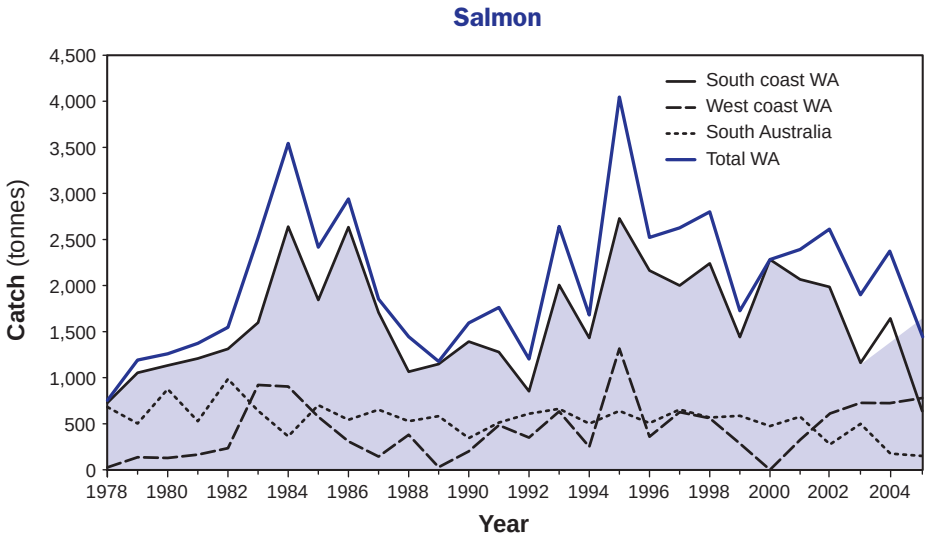
A Voluntary Fisheries Adjustment Scheme remains in progress for the South-West Coast Salmon Managed Fishery. Three licences have recently been removed from the south-west fishery under the scheme, leaving nine managed fishery licences remaining as at February 2006. The scheme has now been extended until March 2008.

The Department is currently replacing Designated Fishing Zone signs at all relevant beaches in the South Coast Salmon Managed Fishery and the South-West Coast Salmon Managed Fishery. The Department also intends to produce a brochure that will explain the purpose of Designated Fishing Zones in Western Australia.

EXTERNAL FACTORS

The cyclic nature of salmon catches, with peaks at intervals of about a decade, is likely to reflect changes in abundance that are related to variations in recruitment success linked to large-scale environmental influences such as the flow of the Leeuwin Current.

Fluctuations in salmon catches can also occur due to the influence of environmental factors without a change in stock level. For example, water temperature and the strength of the Leeuwin Current can affect the distribution and movement of spawning-run fish and their catchability for beach-based fishers. Low market demand can also result in reduced targeting and catch levels, as has been the case on the south coast in recent years.



SALMON FIGURE 1

Australian salmon catches for Western Australia and South Australia for the period 1978 to 2005.

Australian Herring Fishery Status Report

K. Smith and J. Brown
Management input from J. Froud

FISHERY DESCRIPTION

Commercial fishing for Australian herring (*Arripis georgianus*) is primarily undertaken using herring trap nets (also known as 'G' trap nets). This takes place on a limited number of beaches along the south coast of Western Australia, principally during the autumn migration of this species.

Along the west coast, the Cockburn Sound (Fish Net) Managed Fishery and the West Coast Beach Bait Managed Fishery undertake most of the commercial fishing for Australian herring. Australian herring are also taken by wetline fishers and some estuarine licensed fishers on both the south and west coasts.

Governing legislation/fishing authority

Fisheries Notice no. 478 of 1991 (Section 43 Order)
(Herring 'G' nets)
Fishing Boat Licence Condition 42 (Herring 'G' nets)

Consultation process

Department–industry meetings

Boundaries

Australian herring can be taken commercially by holders of an unrestricted fishing boat licence along the lower west and south coasts, which is the distributional range of this species in WA. The use of trap nets is restricted to holders of fishing boat licences with Condition 42, who operate at 10 specific beaches along the south coast.

Management arrangements

The Herring Trap Net Notice (Order 478 of 1991) prohibits the use of herring trap nets, except by licensed 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 salmon migration season along the south coast.

Australian herring may also be commercially caught by beach seine and set net 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.

As Australian herring is considered a prime recreational species, resource-sharing issues are a major consideration in future management arrangements for this fishery, particularly on the west coast.

Research summary

The status of this fishery is assessed annually based on trends in commercial catch coupled with the known biological characteristics of the species. In addition, annual surveys of juvenile herring recruitment are conducted at six sites along the south and lower west coasts of WA. These fishery-independent data are used to generate an overall index of herring recruitment, which is then used to forecast fishery catches 2–3 years later.

Several research projects are currently underway that will provide additional data about Australian herring. A 12-month creel survey of boat-based recreational fishing in the west coast bioregion commenced in July 2005 and will yield estimates of the annual herring catch by this sector. Plankton samples taken in coastal waters off Perth in 2005 are currently being analysed to determine the distribution of herring larvae in this region. Samples of herring donated by recreational fishers in 2005 are being analysed to determine the age structure of west coast landings. The recreational angler daily log book program commenced in 2004 and these recreational catch rates will provide an ongoing index of stock abundance on the south and west coasts, in addition to that provided by commercial catch rates.

RETAINED SPECIES

Commercial production (season 2005):
State 228 tonnes
South coast 144 tonnes

Landings

In 2005, the total commercial catch of Australian herring reported for the state was 227.9 t. This was a continuation of the general decline in catches that has been occurring since the early 1990s. The total state catch of herring peaked at 1,537 t in 1991, followed by a period of lower, but stable, annual catches of approximately 800–1,000 t during the mid-1990s. Since 2000, the total annual catch has steadily declined each year (Herring Figure 1). In 2005, the total annual catch was well below the 10-year (1995–2004) average of 747.6 t.

In 2005 the south coast catch was 144 t, which was 63% of the total state catch. This was the third consecutive year in which the south coast catch was below the target catch range for this region (475–1,200 t). These relatively low catches are partly attributable to the recent low marketability of this species, resulting in lower effort expended by fishers. Only 4 of the 11 licensed trap net teams reported fishing for herring in 2005.

Approximately 85% of the 2005 south coast catch was caught using trap nets, with 9% caught using gillnets and 3% using beach seine nets. The majority of south coast landings (128 t or 89%) were from ocean waters, with the remainder from estuaries and embayments. The south coast catch to the end of May 2005 (traditionally the end of the trap net fishing season and the main spawning run for this species) was 132.3 t, or 92% of the annual south coast catch.

In 2005, the west coast catch of herring was 84 t. The majority (71%) of these landings were from embayments (Geographe Bay and Cockburn Sound), with the remainder from ocean waters (18%) and from estuaries (11%). The 2005 west coast catch was 24.6 t below the 10-year (1995–2004)

average but was still within the target catch range (70–185 t) for this region.

Fishing effort/access level

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. Since the mid-1990s, trap net fishing effort has been reduced by 47% through a series of Government buy-back initiatives. The most recent reduction was in 2000, when three units (or 23% of the effort) were removed.

In 2005, 11 teams (most of whom are also Australian salmon fishers) were entitled to take Australian herring using trap nets set on 10 nominated south coast beaches. However, only four teams recorded effort during the season. This was a reduction from the six active teams in 2004. These low effort levels were in response to the lack of markets and low wholesale prices paid for herring.

Catch rate

A slight downward trend in the south coast catch rate is evident between 1997 and 2005, although the longer-term trend is relatively stable (Herring Figure 2). In 2005, the average catch per south coast trap net fishing team was 30.7 t, which was below the 10-year (1995–2004) average annual catch rate of 46.1 t per team.

Trends in commercial catch rates since 1990 are difficult to interpret because of the significant reduction in effort and changes in targeting practices by commercial fishers over this period. Environmental factors also cause annual fluctuations in catch rates.

Recreational component: **40% (approx.)**

Using data from the most recent recreational fishing survey, which was conducted between May 2000 and April 2001 (Henry and Lyle 2003), the recreational share of the total WA herring catch (i.e. the recreational catch combined with the commercial catch from the calendar year 2000) is estimated to be approximately 40%. However, there are marked differences in catch shares between regions. On the west coast, the recreational share of the herring catch is estimated to be 80%, whereas on the south coast it is estimated at 11%. Data from earlier recreational fishing surveys in 1994 and 1995 (Ayvazian et al. 1997) indicated that the recreational catch shares in those years were approximately 60% and 10% on the west and south coasts respectively.

STOCK ASSESSMENT

Assessment complete: **Yes**

Australian herring occur from Shark Bay, WA, to the Gippsland Lakes, Victoria. Evidence from studies of otolith microchemistry, tagging and genetics indicates that herring form a single breeding stock across this range. Spawning occurs on the west and south coasts of WA. Larvae are then dispersed to juvenile nursery areas in WA and South Australia. The South Australian herring fishery catch is composed of WA-spawned juveniles that are caught prior to their migration back to WA to spawn.

WA landings are believed to comprise a mixture of recruits from South Australian and Western Australian nursery areas. For the west coast sector especially, it is believed that protected local habitats such as Geographe Bay are important nursery areas and a source of recruitment. However, there was a significant correlation between west coast catches and south coast catches from 1976 to 2005, suggesting that west coast catches are supplemented by recruitment of maturing fish from southern regions.

Available data suggest that a major review of the management of this important resource is warranted. A declining trend in the fishery-independent recruitment index suggests that declining fishery catches and catch rates since the mid-1990s are not solely the result of declining effort and market forces, but rather do reflect declining rates of recruitment of herring over the past decade. In a period of declining recruitment, relatively high recreational catches, especially on the lower west coast, are of concern. The total recreational catch level for Australian herring is essentially unconstrained under current management arrangements.

Breeding stock levels: **Adequate**

As is the case with Australian salmon, virtually the entire commercial Australian herring catch in WA consists of mature individuals, with peak seasonal catches being taken during the annual autumn spawning migration. Hence, fishery catch rates are likely to be a reasonable indicator of breeding stock level. The Australian herring populations in all regions appeared to be at satisfactory levels when assessed in the late 1990s, and above a conservative biological limit reference point of 40% of the total virgin biomass. However, recent declines in commercial catch and recruitment in each region suggest a decline in the breeding stock level, and a reassessment of the status of the stock is now underway.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The main south coast fishery operates primarily through fixed trap nets on a maximum of 10 beaches during the main autumn fishing season. Overall, the ecological effect of this fishery is assessed as low.

Protected species interaction: **Negligible**

While there is occasionally some interaction with protected species such as fur seals and sea lions, the operation of the fishing gear allows these animals to be removed and returned to the water safely and hence does not result in a negative impact on these species.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The fishing methods used in this fishery do not impact on the habitat.

SOCIAL EFFECTS

Approximately 17 fishers participated in trap net fishing in 2005. Numerous other fishers participate in the capture of Australian herring using other fishing methods, such as estuarine haul and gillnets, but the quantities caught by other methods are minor compared to the trap net fishery. Additional employment is created in the processing and distribution networks and retail fish sales sectors.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $91,000

The estimated value to fishers of the total state commercial catch for the year 2005 is $91,000.

FISHERY GOVERNANCE

Target catch range: South coast 475–1,200 tonnes West coast 70–185 tonnes

Target catch ranges for the south coast herring trap net fishery and the west coast commercial fishery were derived by applying an autoregressive moving average control quality procedure to the annual catches from 1976 to 2000. The confidence intervals are obtained by estimating the variation of the observations compared with the variation of the predictions from 1983 to 2000. Where consecutive values occur outside of the target range, management changes to protect the stock may need to be considered.

In 2005, the south coast catch was 144 t. This was the third consecutive year in which the south coast catch was below the target catch range (475–1,200 t) for this region. The relatively low catches reflected the low effort expended by fishers, with only four of the 11 licensed trap net teams fishing for herring in 2005. The target catch range assumes that all licensees participate in the fishery each year.

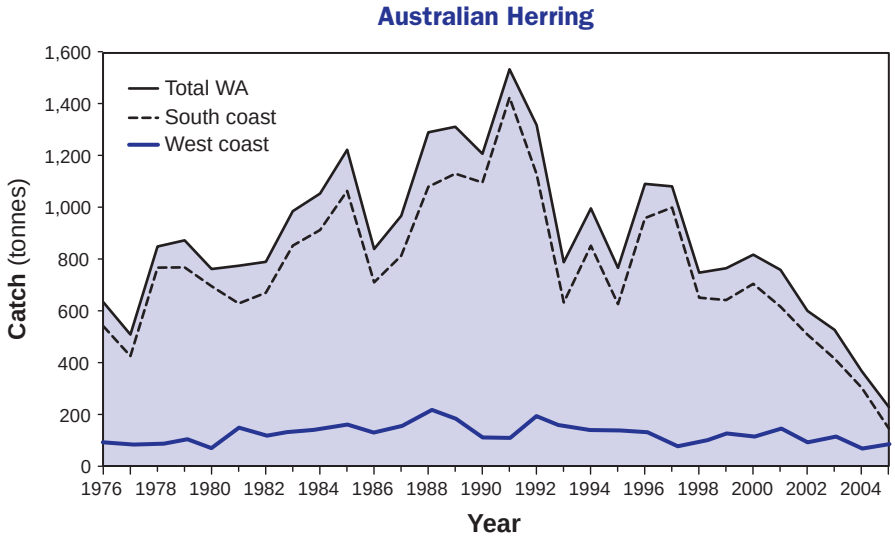
In 2005, the west coast commercial fishery catch was 84 t, which was within the target catch range (70–185 t) for this region.

New management initiatives (2005/06)

The Minister has approved the drafting of a new Order to regulate the use of herring 'G' trap nets. The new Order will list operators in the fishery in the schedule to the Order, and remove the need for fishing boat licence Condition 42.

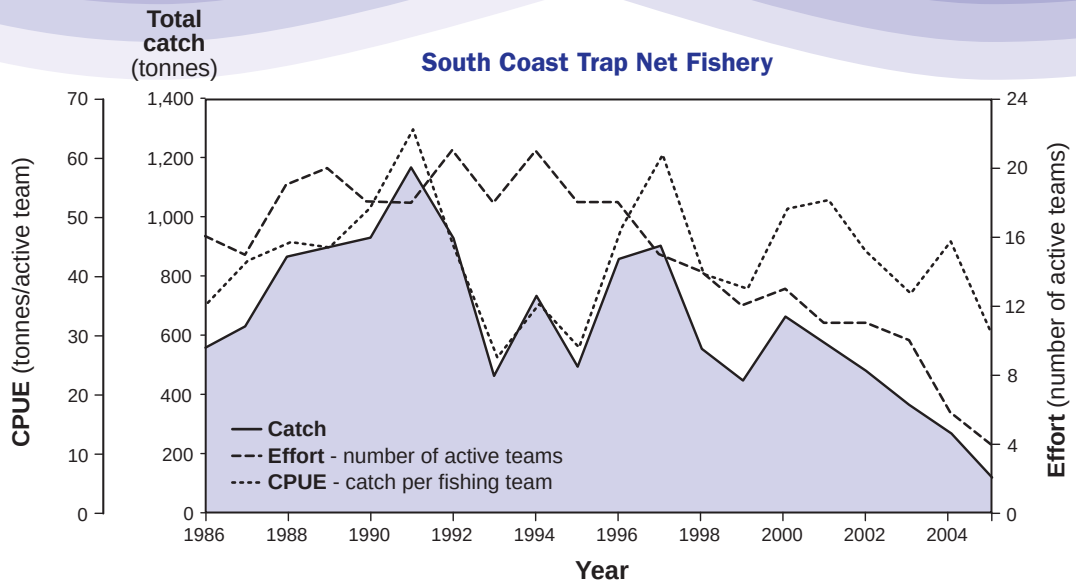
EXTERNAL FACTORS

It is likely that factors other than fishing (especially the strength of the Leeuwin Current) significantly influence the migration patterns of pre-spawning adults, the distribution of spawning and the dispersal of larvae. These factors will then affect juvenile recruitment success and the catchability and abundance of adult fish in each region, which ultimately determine the total breeding stock level.



HERRING FIGURE 1

Australian herring catches from the south and west coasts, and the total Western Australian catch, for the period 1976 to 2005.



HERRING FIGURE 2

Catch, effort and CPUE for Australian herring catches from the south coast trap net fishery for the period 1986 to 2005.

South Coast Purse Seine Managed Fishery Status Report

D. Gaughan and T. Leary

Management input from R. Gregor

FISHERY DESCRIPTION

This fishery is based on the capture of pilchards (*Sardinops sagax*) by purse seine nets in the waters off the south coast of Western Australia between Cape Leeuwin and the WA/SA border. However, the management plan also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus teres*).

Governing legislation/fishing authority

South Coast Purse Seine Management Plan 1994
South Coast Purse Seine Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Purse Seine Management Advisory Committee
Department–industry meetings

Boundaries

The South Coast Purse Seine Managed Fishery consists of three primary management zones. The Albany zone extends from Point D'Entrecasteaux to Cape Knob. The King George Sound zone is a subset of this area and the two zones are reported together. The Bremer Bay zone extends from Cape Knob to longitude 120° E, and the Esperance zone from 120° E to the WA/SA border. A further zone exists between Cape Leeuwin and Point D'Entrecasteaux but has not been significantly fished to date.

Management arrangements

This fishery is primarily managed through output controls in the form of individually transferable quota 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. The total quota units allocated across each of the five zones in the fishery amount to 890. The quota season for the South Coast Purse Seine Managed Fishery runs from 1 July to 30 June each year.

Research summary

Research in 2005 consisted of completing estimates of spawning biomass for the south coast regions, using data from fishery-independent surveys carried out in 2004. A further spawning biomass survey for Albany and Bremer Bay was undertaken in July 2005, with the analyses expected to be completed in 2006. Monitoring of catches from each region is undertaken monthly to provide age-composition data, from which relative recruitment strengths can be inferred. The estimates from the biomass surveys and the age-composition data are integrated via an age-structured model to provide a more robust estimate of pilchard biomass in each of the three management regions. The model outputs,

along with analyses of catches, together allow the annual review of stocks in each major zone.

An FRDC project undertaken by the Research Division's Fish Health Unit to assess any future threat from the virus disease which decimated pilchard stocks in the 1990s is nearing completion.

A collaborative research project with Murdoch University, to examine the extent of interactions between the fishery and wildlife and potential mitigation methods, commenced in 2005.

RETAINED SPECIES

Commercial production (season 2004/05): 1,645 tonnes

Landings

Following the apparent recovery of the pilchard stocks from the 1999 mass mortality, pilchard TACs have been stabilised at 1,500 t for each of the three regions of the south coast. Landings of pilchards for the 2004/05 season were:

Albany zone:	1,020 t
Bremer Bay zone:	481 t
Esperance zone:	136 t

These figures represent a small catch increase for Albany over the previous year, a large (70%) increase for Bremer Bay over the same period and a significant decrease (69%) in landings for Esperance. The presence of only variable-sized or small fish, and concomitant lack of consistent markets, inhibited significant landings in the Albany region in some months, but periodic influxes of larger fish allowed increased landings in other months. The Bremer Bay fishery was similarly constrained by inconsistency in the presence of large pilchards in the fishing grounds. Consistently small fish in the Esperance region have led to low demand for product from that region.

Catches of other small pelagic species, at 8 t, were again a minor component of the catch in 2004/05.

Fishing effort/access level

Fishing effort in the south coast purse seine fishery was again constrained by low availability of suitably sized fish at times when the market was receptive, and then by competition from the rival South Australian fishery. The Albany fleet fished 14% fewer days than last year. Likewise, Bremer Bay and Esperance vessels fished 4% and 6% fewer days respectively than the previous season.

Albany zone: The recorded number of CAES days in 2004/05 was 1,027 compared to 1,181 in 2003/04.

Bremer Bay zone: The recorded number of CAES days in 2004/05 was 276 compared to 286 in 2003/04.

Esperance zone: The recorded number of CAES days in 2004/05 was 94 days compared to 100 in 2003/04.

Catch rate

The catch rate was slightly higher than the previous year in Albany, much higher in Bremer Bay and significantly lower in Esperance. Given the avoidance of small fish by vessels in each region, the year-to-year changes in catch rate, when measured as kg/day, are difficult to interpret with any certainty and are unlikely to be accurately reflecting fish abundance.

Albany zone: The 2004/05 catch rate for the Albany zone was 999 kg/day compared to 830 kg/day in 2003/04.

Bremer Bay zone: The 2004/05 catch rate for the Bremer Bay zone was 1,731 kg/day compared to 969 kg/day in 2003/04.

Esperance zone: The 2004/05 catch rate for the Esperance zone was 1,446 kg/day compared to 2,320 kg/day in 2003/04.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

The fishery-independent estimates of spawning biomass and the age-composition data for each zone are analysed together within a population simulation model that provides a forecast of mature biomass. The age composition data 'feeds in' recruitment levels, the recognised primary influence on stock size, while the fishery-independent survey provides a point estimate of spawning biomass to ensure that the model outputs are as robust as possible. The most recent assessment indicated that the spawning biomass in each region, and the lower and upper bounds for the estimate, were:

Albany zone:	23,100 t (15,100–31,100 t)
Bremer Bay zone:	24,700 t (17,700–31,700 t)
Esperance zone:	43,700 t (30,400–57,000 t)

Breeding stock levels: Adequate

The south coast population of pilchards is considered to consist of a single breeding stock, but with functionally distinct adult assemblages at Albany, Bremer Bay and Esperance. At the end of 2005 the model indicated that the spawning biomass (i.e. the breeding stock) of pilchards in each of the three primary management zones was at adequate levels.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

This fishery specifically targets schools of pilchards, so unwanted bycatch is insignificant. Other similar-sized pelagic fish that may be caught in small quantities and marketed include yellowtail scad, maray, anchovies and blue mackerel.

Protected species interaction: Under review

A number of protected species, including seabirds, seals, dolphins and sharks, are attracted to pilchard fishing operations to feed on the fish. Occasionally, seabirds, and to a much lesser extent dolphins, become entangled in the nets. The impact of these incidental captures has the potential to be a significant issue for the fishery. A new research project to examine the extent of wildlife interactions and potential mitigation actions commenced in late 2005.

ECOSYSTEM EFFECTS

Food chain effects: Moderate

Ecosystem structure and function is reliant on flows of energy within an interconnected 'web'. Small pelagic fish occupy a pivotal role as a conduit between primary (phytoplankton) and secondary (zooplankton) production and the higher trophic levels. The characteristics of small pelagics mean they are available as food for a number of populations of larger animals including predatory fish, pinnipeds, cetaceans and bird species. Catches of small pelagic fish on the south coast are carefully constrained so as to leave a large majority of the estimated biomass available to predators. The quota for pilchards and other small pelagic species is set at a maximum of 10% of the spawning biomass, leaving more than 90% of the total biomass available to natural predators.

Habitat effects: Negligible

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

SOCIAL EFFECTS

There were 10 vessels fishing in Albany in 2004/05 for at least part of the year, providing income for 26 crew members. Local factories employ about 15 casual and full-time staff to process and package pilchards. Fewer vessels worked in Bremer Bay and Esperance, with concomitantly fewer onshore employees. In total there were approximately 60 people directly employed in this industry, a reduction from the 2003/04 tally of 80 persons.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2004/05: $1.37 million

The total catch value calculated for 2004/05 was $1.37 million. Prices paid differ amongst processors depending on the quality of the fish and the end market, and whether the licence holder has interests in the plant or vessel. Being able to supply the right sized product, in the right quantity at the right time is crucial.

The different product types for each zone are shown in South Coast Purse Seine Table 1. The recreational bait market remains the most common destination for south coast pilchards, mainly in block/tray form, with some individually quick frozen (IQF) fish finding interstate markets for human consumption. (The potential exists for local processing for human consumption, but this requires a steady supply of appropriately sized fish.) Tuna grow-out feed, commercial trap bait and, to a lesser extent, pet food accounted for the remainder of the catch.

FISHERY GOVERNANCE

Target effort range: Not available

Catches are governed by changes in the TAC for each of the primary management zones. For the 2005/06 season, the TAC for each of three zones remains at 1,500 t, giving a maximum expected catch for the fishery of 4,500 t. The fleet and infrastructure for this fishery remain in a state of flux due to irregular availability of market-sized fish, particularly in Bremer Bay and Esperance, which will influence how much of the TAC is caught. Furthermore, the schooling behaviour of pilchards makes it difficult to detect meaningful patterns in catch rates. These factors, combined with the variability in unit holdings within the fishery and resultant variability in fishing behaviour by different operators, mean that it is currently difficult to estimate a target effort range for the fishery.

New management initiatives (2005/06)

Following reports of deaths of some seabirds and confirmed deaths of some dolphins resulting from interactions with the purse seine fishing operations, the Department has instigated a working group to examine this issue. This group, which will provide advice to the Purse Seine Management Advisory Committee, is developing a process to ensure that any wildlife interactions are recorded and reported as required.

In November 2005, the Australian Government Department of Environment and Heritage declared the South Coast Purse Seine Fishery a Wildlife Trade Operation under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a number of conditions, this certification allows product from the fishery to be exported from Australia for a period of three years before reassessment.

EXTERNAL FACTORS

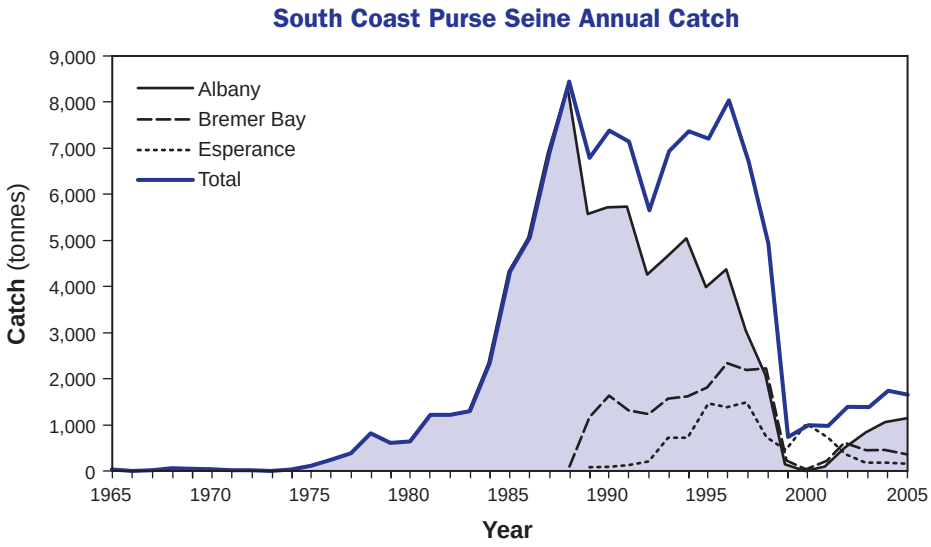
Market competition, particularly from the South Australian pilchard fishery, continues to negatively impact this fishery, and this is exacerbated by the unpredictable availability of market-size fish in this region. Consequently, it cannot be predicted when the fishery, as opposed to the resource, might recover to a point where the TAC of 1,500 t can be consistently achieved in each zone.

Previous research has shown that environmental factors such as variations in the Leeuwin Current flow are also likely to be affecting both the distribution and the biology of the species. Recent research on oceanographic variability undertaken by the University of Western Australia and Murdoch University appears to confirm that there is significant variability in phytoplankton productivity, even within the regions on the south coast. Any variations in recruitment and stock size that might occur as a result of environmental effects are already accommodated within the management system. The possibility of longer-term changes, on a time scale unrelated to inter-annual environmental variations, cannot be discounted.

SOUTH COAST PURSE SEINE TABLE 1

Processing details (in tonnes) for pilchards from Albany, Bremer Bay and Esperance for 2004/05.

PRODUCT	ALBANY	BREMER BAY	ESPERANCE	TOTAL SOUTH COAST
Trays	601.5	234.0	116.4	951.9 (58.1%)
IQF	142.2	212.4	16.3	370.9 (22.7%)
Pet food/other	276.0	34.7	3.3	314.0 (19.2%)
TOTAL	**1,019.7**	**481.1**	**136.0**	**1,636.8**



SOUTH COAST PURSE SEINE FIGURE 1

Annual catches of pilchards along the south coast, by fishing zone.

Demersal Gillnet and Longline Fisheries Status Report

R. McAuley

Management input from R. Gould

FISHERY DESCRIPTION

The Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF) and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) employ demersal gillnets and demersal longlines with power-hauled reels along the south and lower west coasts. The majority of operators use demersal gillnets and the fisheries primarily target sharks, with a scalefish component in the catch. The main shark species targeted by fishers on the south coast are the gummy shark (*Mustelus antarcticus*) and dusky whaler shark (*Carcharhinus obscurus*), while on the west coast fishers primarily target the dusky whaler shark and sandbar shark (*Carcharhinus plumbeus*). The whiskery shark (*Furgaleus macki*) is also an important component of the catch of both fisheries. The two fisheries are reported together here because extensive past research indicates that they share these key unit stocks.

Governing legislation/fishing authority

South Coast

Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992

Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery License

West Coast

West Coast Demersal Gillnet and Demersal Longline (Interim) Management Plan 1999

West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery Permit

Consultation process

WA Demersal Net and Hook Fisheries Management Advisory Committee

Department–industry meetings

Boundaries

The Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery covers the waters from latitude 33° S to the

WA/SA border. For the purposes of management, the fishery is effectively composed of two zones. Zone 1 extends from latitude 33° S around the coast as far as longitude 116°30´ E, and Zone 2 from 116°30´ E to the WA/SA border (129° E).

The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery extends north from latitude 33° S to a line drawn north of North West Cape (114°06´ E). However, shark fishing has been prohibited between Steep Point (26°30´ S) and North West Cape since 1993.

Management arrangements

The south and west coast fisheries are regulated through two similar management plans.

The JASDGDLF was declared a limited entry fishery in 1988 and is managed under a joint authority with the Commonwealth Government. This fishery is managed primarily through effort controls in the form of time/gear units, which allow fishers to use one 'net' or an equivalent number of hooks for one month. Unit values have undergone a series of adjustments since 1992 in response to concerns about the sustainability of key shark stocks (see *State of the Fisheries Report 2000/01*). All JASDGDLF units now permit the use of either 270 m of demersal gillnet (15 or 20 mesh-drop) or 90 demersal longline hooks for one month.

The WCDGDLF is currently managed as a limited entry fishery, under an interim management plan introduced in 1997. Under the interim plan, the fishery is managed using effort controls in the form of time/gear units, with each unit allowing a net length of 540 m or 180 hooks. Implementation of the full management plan is currently awaiting the outcomes of legal challenges to the proposed unit allocation.

Both fisheries' management plans will be revised in 2006/07 to reduce high levels of latent effort, set explicit effort ceilings for each management zone and address remaining sustainability concerns for key stocks. These new management arrangements will be complemented by regulations for improved management of shark catches in non-target fisheries.

Research summary

Major FRDC-funded studies of the shark fishery on the south and west coasts of Western Australia, undertaken over the period 1993–2004, have provided a detailed basis for managing the fishery. The extensive biological and fishery information gained from these studies have been reported in three FRDC final reports and the data incorporated into the Department of Fisheries' research records. These data have been used to develop stock assessment models for the fisheries' key target stocks, to determine their likely responses to current levels of exploitation and to test alternative harvest regimes.

Research monitoring of the fishery involves analysis of CAES data and biological sampling of commercial catches. In 2002/03 the computer program that validates CAES records, standardises fishing effort and reapportions incorrectly reported catches from earlier seasons was rewritten using modified criteria to account for improved species identification and reporting in recent years. Thus, catch and effort data provided in status reports since 2002/03 are not comparable to those given in previous years. Variations from previous years' catches of the key species are described below under 'Stock Assessment'.

These research data are used to provide the status report on the fishery.

RETAINED SPECIES

Commercial production (season 2004/05):

Managed shark fisheries:

All sharks (and rays) 1,305 tonnes

Key species 1,062 tonnes

Other fisheries: 148 tonnes

Landings

All total shark catches given in this report include rays, unless otherwise specified. The total shark catch of 1,305 t from these fisheries in 2004/05 comprised 881 t from the JASDGDLF and 424 t from the WCDGDLF, made up as follows:

SPECIES	JASDGDLF	WCDGDLF
Dusky whaler	163 t	118 t
Gummy shark	460 t	12 t
Whiskery shark	119 t	34 t
Sandbar shark	13 t	143 t
Other shark	125 t	118 t
Total sharks and rays	**881 t**	**424 t**

In addition to the shark catch, between 11% and 23% of the total demersal gillnet and longline catch from each zone was composed of scalefish (teleost) species that were retained for sale. In 2004/05, scalefish landings totalled 149 t in the JASDGDLF and 130 t in the WCDGDLF. For a detailed breakdown of the species composition of catches in the two south coast zones and the west coast fishery, see Demersal Gillnet and Longline Tables 1 and 2. The historical annual catches of the key target shark species are shown in Demersal Gillnet and Longline Figure 1 (for sandbar shark, also see Northern Shark Figure 1).

Sharks are also caught off the south and west coasts in a variety of other commercial fisheries and these catches are summarised here to provide a complete report on shark catches in the area. During 2004/05, vessels operating in other managed fisheries in the same overall area (i.e. between North West Cape and the South Australian border) reported catches of sharks totalling 13 t. An additional 135 t catch of sharks was taken by vessels using 'wetline' methods.

Fishing effort/access level

There were 57 licences in the JASDGDLF in 2004/05, 24 in Zone 1 and 33 in Zone 2. However, only 6 Zone 1 vessels (two fewer than in 2003/04) and 18 Zone 2 vessels (one less than in 2002/03) reported active fishing returns during the year. There were 26 licences in the WCDGDLF in 2004/05, although only 15 (one less than in 2003/04) reported active fishing returns during the year.

The effort expended in 2004/05 was:

JASDGDLF: 174,127 km gn hr
(Zone 1: 45,450; Zone 2: 128,677)
WCDGDLF: 69,018 km gn hr

As gillnetting is by far the dominant method employed in the fisheries, effort is expressed in standardised units of kilometre gillnet hours (km gn hr) by converting the historically small amount longline effort into the equivalent gillnet effort on the basis of comparative longline and gillnet catch and effort data (Demersal Gillnet and Longline Figure 2). On this standardised basis, effort in the JASDGDLF decreased by 6% in 2004/05, while that in the WCDGDLF decreased by 18%.

While combining gillnet and longline effort into a single standardised measure of effort will continue, increased use of longlines on the west coast has altered the composition of the fisheries' overall effort. Therefore, the trends in catch and effort by each method are also provided separately in this report (Demersal Gillnet and Longline Figures 3 and 4).

Gillnet shark catches and fishing effort peaked during the late 1980s and early 1990s, before successive unit reductions steadily reduced effort to 42% (in 2001/02) of its peak level. However, since 2001/02, gillnet effort has increased by a total of 9%. Total shark catches by gillnet fell by 27% in 1993/94, before stabilising at between 1,100 t and 1,300 t. Throughout most of the 1990s, total shark catches have largely reflected the levels of fishing effort being applied. While these figures demonstrate that the overall level of shark catch in the gillnet sector can be adequately managed via effort controls, it should be noted that the contribution of individual species to the total catch has varied considerably, according to changes in their relative abundances.

Longline fishing effort peaked in 1993/94 at just over 1,129,000 hook days, before declining rapidly to just 59,000 hook days in 2002/03. Despite the relatively high levels of longline effort during the mid-1990s, longline shark catches during this period were relatively low at less than 50 t per year. By contrast, between 1979/80 and 1981/82 over 175 t of sharks were caught with between 675,000 and 775,000 hook days. Prior to 2003/04, demersal longline effort was targeted at the same shark and scalefish stocks as targeted by gillnets. However, during 2003/04, the majority of the 324,240 longline hook days was targeted towards adult sharks, resulting in a total shark catch of 186 t. Although longline effort decreased by 46% to 176,218 hook days in 2004/05, longlines caught 121 t of sharks, highlighting the potential for increasing exploitation (particularly of larger sharks) through existing gear conversion arrangements.

Catch rate

See 'Stock Assessment' below.

Recreational component: **< 5%**

The estimated recreational catch between Augusta and Kalbarri, from a Department of Fisheries recreational trailer-boat survey conducted in 1996/97 (Sumner and Williamson 1999), was 3,700 sharks, with a further 3,500 released. This total catch included wobbegong species, of which 1,000 were kept. Assuming that the remaining species caught recreationally were similar to those taken by the commercial fishery, at an average weight of 5 kg per shark, then the west coast recreational take of sharks at the time of the survey would have been about 15–20 t, or approximately 4% of the west coast commercial shark catch in that year. Recreational effort on the west coast has increased since 1996/97 so it is likely that the catch of shark has also increased. A recreational fishing survey of the west coast region that commenced in 2005 will determine whether the catch of sharks and rays has increased since 1996/97.

STOCK ASSESSMENT

Assessment complete: **Yes (key species)**

Stock assessment is carried out for the four main shark species caught by the fishery. A summary for three of these species is presented here, with that for sandbar shark presented in the Northern Shark Fisheries Status Report (pp. 165–169).

Dusky whaler: The total catch of dusky shark (which is recorded as 'bronze whaler') in the JASDGDLF and WCDGDLF during 2004/05 was 281 t, 19% lower than last year. The catch in Zone 1 of the southern fishery was 92 t (19% less than last year) and in Zone 2 was 74 t (20% less than last year). These were the lowest 'bronze whaler' catches in Zones 1 and 2 of the JASDGDLF since 1979/80 and 1983/84, respectively. After two consecutive years of rapid growth in dusky shark catches in the WCDGDLF, caused by the expansion of longline effort, catch fell by 14% in 2004/05, to 118 t. Despite this slight decline, the west coast dusky shark catch remains substantially higher than the six-year average of 69 t, for the period between the introduction of the WCDGDLF (interim) management plan in 1997 and the expansion of longline effort in the fishery in 2003.

Catch rates decreased by 6% in Zone 1 and by 17% in Zone 2 of the JASDGDLF, and increased by 5% in the WCDGDLF. The best available index of dusky shark abundance is the mean annual gillnet catch rate in the area corresponding to this species' distribution within the fishery. Between 2003/04 and 2004/05, this 'effective area' catch rate declined by 6% to its lowest ever level of 0.74 kg/km gn hr, less than one-third of its rate during the late 1970s (Demersal Gillnet and Longline Figure 5).

The status of the Western Australian dusky shark stock has been reassessed using revised demographic modelling techniques and updated biological and fishing mortality parameters developed during the recently completed FRDC-funded project.

The new demographic analysis has indicated that although catches of sharks born in 1994 and 1995 were likely to have been sustainable, the stock is less productive than previously thought. While the model indicates that the population has the capacity to offset demersal gillnet fishing mortality of primarily first-year (neonate) and second-year sharks, it also indicates that fishing mortality of as low as 1–2% per year

in older sharks (greater than 10 years of age) would cause stock recruitment to decline. Although this analysis was still based on age-specific mortality rates experienced by sharks born in 1994 and 1995, these results nonetheless provide a valuable reference for analysing recent catch rate trends. However, analysis of CPUE data for this species has become complicated, since the relative contribution of neonates to the fisheries' catch appears to have declined and catches of older juveniles have increased during recent years. Similarly, the increased targeting of large dusky sharks for their fins by hook methods, both within and outside the managed shark fisheries, is biasing CPUE estimates. The reported 'wetline' catch of dusky shark outside the target fisheries has also doubled since the mid-1990s and it is believed that a significant proportion of demersal gillnet vessels' large hook-caught sharks might have been included within the reported gillnet catch. These factors are likely to have caused an overly optimistic trend in the CPUE for recent years. Nonetheless, the overall trend in effective area CPUE still indicates that the stock is in decline.

Whiskery shark: The combined catch of whiskery sharks in the JASDGDLF and WCDGDLF during 2004/05 was 153 t, a 17% reduction from the previous year. Landings in Zones 1 and 2 were, respectively, 38% and 6% lower than in 2003/04, and at 34 t the WCDGDLF catch was identical to last year. Although the whiskery shark effective area catch rate decreased by 10% in 2004/05, the CPUE trend has remained relatively steady over the last 13 years (Demersal Gillnet and Longline Figure 5). Regionally, catch rates decreased by 29% (to their lowest ever level of 0.95 kg/km gn hr) in Zone 1 and by 3% in Zone 2, but increased by 23% in the WCDGDLF.

The most recent assessment of the whiskery shark stock using the age-structured population model was conducted in 2004 (based on 2002/03 data). This assessment indicated that although the whiskery shark stock had been depleted during the 1980s, subsequent management measures (effort reduction) had caused the stock to stabilise at about 35% of its total virgin biomass. The model also estimated that the mature female biomass had been increasing at between 1% and 1.6% per year since 2001/02. Based on these and previously reported model results, constraining whiskery shark catches at around their 2001/02 levels (12% more than in 2004/05) should be adequate to maintain their current biomass. However, further measures are still required to ensure and accelerate the recovery of this stock.

Gummy shark: The total catch of gummy sharks increased by 8 t in 2004/05 to 472 t, the second highest in the fisheries' history (after 500.7 t in 1991/92). While the gummy shark catch was outside of the acceptable range (350–450 t) for the second consecutive year, the steady increase in catches since 1999/00 (when effort reductions were completed) appears indicative of a healthy stock. This conclusion is supported by the fact that, for the last four years, effective area catch rates of gummy shark have been at their highest levels since 1977/78, at over 2 kg/km gn hr. Nonetheless, there is a possibility that increased targeting of effort towards this species may be providing an overly optimistic interpretation of the trends.

Previous age-structured modelling indicated that, at 42.7% of its virgin level, the Western Australian gummy shark stock was above its target level in 1998. However, despite recent catch and CPUE trends indicating little cause for concern, this principal target stock has not been comprehensively assessed since 1997/98 and a new model that incorporates recent catch and effort data needs to be developed.

Breeding stock levels: **Dusky whaler declining**
Whiskery shark increasing
Gummy shark adequate
Sandbar shark declining

Dusky whaler: As 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 whalers in the gillnet sector that the breeding stock biomass is continuing to decline.

Whiskery shark: Model results indicate that mature female biomass has been stable and possibly increasing marginally since 1999/2000.

Gummy shark: As the catch of gummy sharks is primarily comprised of adults, the increasing trend in CPUE suggests that the breeding biomass is increasing.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The catch composition of the fishery has been examined in detail for the period 1994 to 1999 (McAuley and Simpfendorfer 2003). There is some discarded bycatch of unsaleable species of sharks, rays and scalefish. During the ESD risk assessment of these fisheries, all impacts on stocks of bycatch species were determined to be low risk.

Protected species interaction: **Low–negligible**

The rates of capture of protected species were very low throughout the fishery (McAuley and Simpfendorfer 2003). Marine mammals were caught at a rate of just over 1 per 10,000 km gn hr, seabirds at 4 captures per 100,000 km gn hr and turtles at 1 capture per 100,000 km gn hr. It should be noted that demersal gillnet and longline fishing are not permitted between Steep Point (26°30´ S) and a line drawn north of North West Cape (114°06´ E), or within 3 nautical miles of the Abrolhos Islands baselines, where populations of turtles and dugongs are present.

The numbers of white sharks (*Carcharodon carcharias*) and grey nurse sharks (*Carcharias taurus*) caught were small (< 20/yr and < 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 is assessed as very low.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Negligible**
The level of effort is such that the gear is deployed infrequently over approximately 40% of the fisheries' area and the physical impact of the gear on the bottom is minimal.

SOCIAL EFFECTS

Estimated employment during 2004/05 was 60 skippers and crew in the JASDGDLF and 37 in the WCDGDLF.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003/04: $6 million

JASDGDLF:	$3.5 million (shark and scalefish)
	$600,000 (shark fins)*
WCDGDLF:	$1.6 million (shark and scalefish)
	$400,000 (shark fins)*

* As fishers do not specify the value of fins on their catch returns, fin values were calculated at an average of 3% of sharks' whole weight and value was conservatively estimated using a price of $35/kg. Categories of shark which do not have saleable fins were excluded from fin valuation.

FISHERY GOVERNANCE

Target catch range:
Current: Key species 725–1,175 tonnes
Future: Key species 725–1,095 tonnes

Target catch ranges for the key species in 2004/05 were as follows:

Gummy shark	350–450 t
Dusky whaler	200–300 t
Whiskery shark	175–225 t
Sandbar shark	< 200 t

Catches of gummy shark in 2004/05 were marginally above the upper limit of their target range for the second consecutive year, but acceptable as they were apparently due to increasing abundance.

The catch of dusky whaler was within the target range for 2004/05, primarily due to a decline in catches by longlines in the WCDGDLF. The apparent decline in the dusky whaler breeding stock is attributed to additional external sources of mortality of older sharks (see 'External Factors' below). As updated demographic analysis has confirmed that a gillnet catch of 200–300 t is sustainable, the target catch range for next season has not been revised.

Whiskery shark catches were below the target catch range during 2004/05 and are expected to decline further following the implementation of new management strategies in 2006/07 (see below). When the resulting reductions in whiskery shark catches can be quantified, the target catch range will be adjusted accordingly.

Sandbar shark catches were within the acceptable limits (< 200 t) set for 2004/05 for these southern shark fisheries; however, the acceptable limit for next season has been adjusted (to < 120 t) to reflect the lower sustainable harvest levels of sandbar shark predicted by the demographic model (see Northern Shark Fisheries Status Report).

For 2005/06, therefore, the overall target catch range for the key species in these fisheries will be 725–1,095 t.

New management initiatives (2005/06)

The new management arrangements for the JASDGDLF and WCDGDLF, and for the statewide management of sharks in all commercial fisheries, that were foreshadowed in last year's status report were not finalised in time for implementation at the start of the 2005/06 season. However, following further discussion of management options with stakeholders and consideration by the Management Advisory Committee, the Minister for Fisheries announced a package of management measures to be implemented by the start of the 2006/07 season. The key elements of this package are:

- conversion of existing monthly gear units to daily gear units;
- explicit caps on potential fishing effort within each zone equal to their 2001/02 levels;
- a two-month closure in the temperate shark fisheries (waters between Steep Point and Albany) inshore of the 200 m isobath to aid the recovery of whiskery shark stocks;
- implementation of the vessel monitoring system in the temperate shark fisheries;
- implementation of daily catch and effort log book reporting;
- a prohibition on the possession of sharks and rays by commercial fishers outside the state's four shark fisheries;
- a prohibition on the use of wire traces in all commercial fisheries under state jurisdiction (except the northern shark fisheries);
- a statewide commercial maximum size limit for dusky sharks of 1.5 m; and
- a significant increase in penalties for illegally possessing sharks or rays.

To support and assess the success of these management changes, there will need to be increased monitoring of these fisheries, with a focus on catch size composition and tagging to update harvest rates, particularly for dusky whaler and sandbar sharks.

EXTERNAL FACTORS

There are a number of factors outside of the control of the fishery which are impacting on the performance of key temperate shark stocks. These include targeted gummy shark fishing by Commonwealth-managed vessels to the east of Zone 2, and incidental catches of dusky whaler, sandbar and gummy sharks in offshore Commonwealth-managed fisheries and overlapping WA-managed fisheries. For the sandbar population particularly, the overlap with the northern shark fisheries which target the breeding stock further complicates the situation. The ongoing mortality of older juvenile and adult dusky sharks from entanglement in plastic packing straps is also compromising future recruitment to this stock. These outside influences need to be taken into account in the stock assessment process for these species and accommodated in the management strategy.

DEMERSAL GILLNET AND LONGLINE TABLE 1

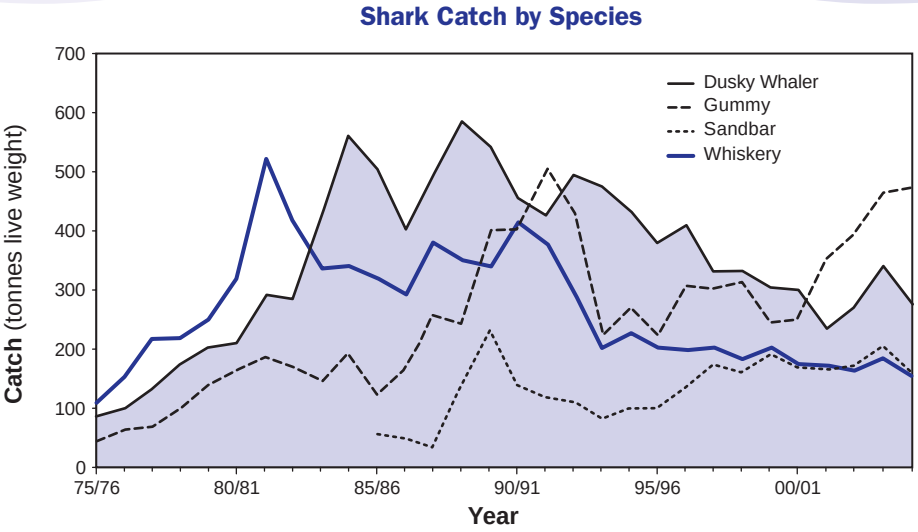
Shark catch species composition for the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF), 2004/05.

SPECIES		CATCH (tonnes)				
		JASDGDLF			WCDGDLF	FISHERY TOTAL
		Zone 1	Zone 2	Total		
Gummy	*Mustelus antarcticus*	55	405	460	12	472
Dusky	*Carcharhinus obscurus*	92	71	163	118	281
Sandbar (thickskin)	*Carcharhinus plumbeus*	5	8	13	143	156
Whiskery	*Furgaleus macki*	43	76	119	34	153
Hammerhead	Sphyrnidae	14	20	34	31	65
Wobbegong	Orectolobidae	19	7	25	21	46
Blacktip	*Carcharhinus* spp.	2	1	3	23	26
School	*Galeorhinus galeus*	0	14	14	0	14
Shovelnose rays	Rhinobatidae, Rhynchobatidae	0	0	0	10	10
Other sharks and rays		29	20	49	32	81

DEMERSAL GILLNET AND LONGLINE TABLE 2

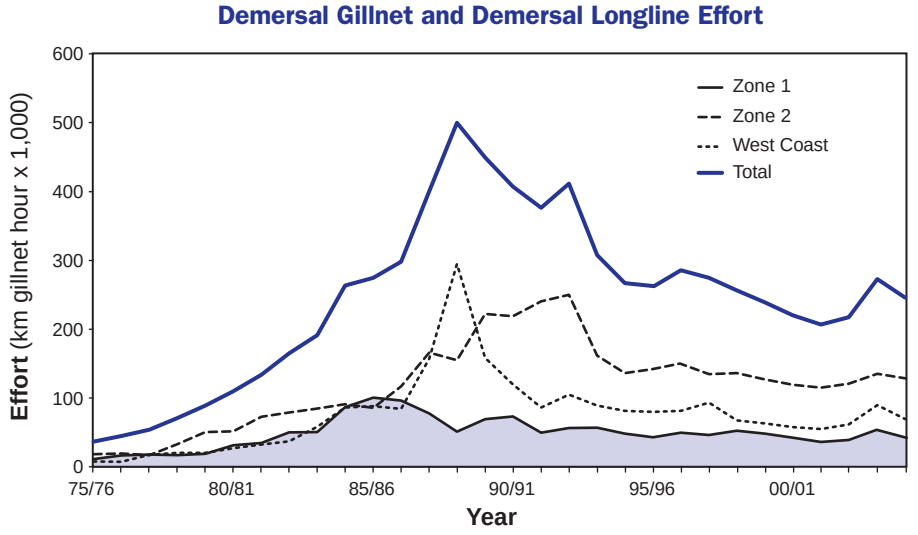
Scalefish catch species composition for the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF), 2004/05.

SPECIES		CATCH (tonnes)				
		JASDGDLF			WCDGDLF	FISHERY TOTAL
		Zone 1	Zone 2	Total		
Queen snapper	*Nemadactylus valenciennesi*	10	24	33	7	40
Blue groper	*Achoerodus gouldii*	12	17	29	5	34
Samson fish	*Seriola hippos*	2	2	4	24	29
Pink snapper	*Pagrus auratus*	1	8	9	18	27
Dhufish	*Glaucosoma hebraicum*	7	1	8	17	25
Sweetlip emperor	*Lethrinus miniatus*	0	0	0	20	20
Mulloway	*Argyrosomus hololepidotus*	0	4	4	10	14
Parrotfish	Scaridae	0	0	0	6	6
Baldchin groper	*Choerodon rubescens*	2	0	2	4	6
Other scalefish		41	18	59	18	78



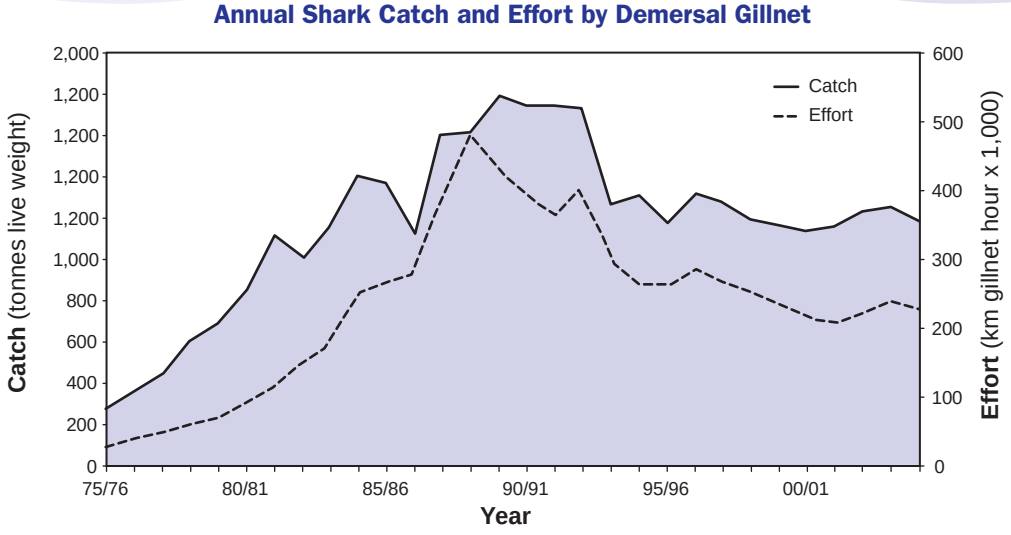
DEMERSAL GILLNET AND LONGLINE FIGURE 1

Annual catches of target shark species in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2004/05.



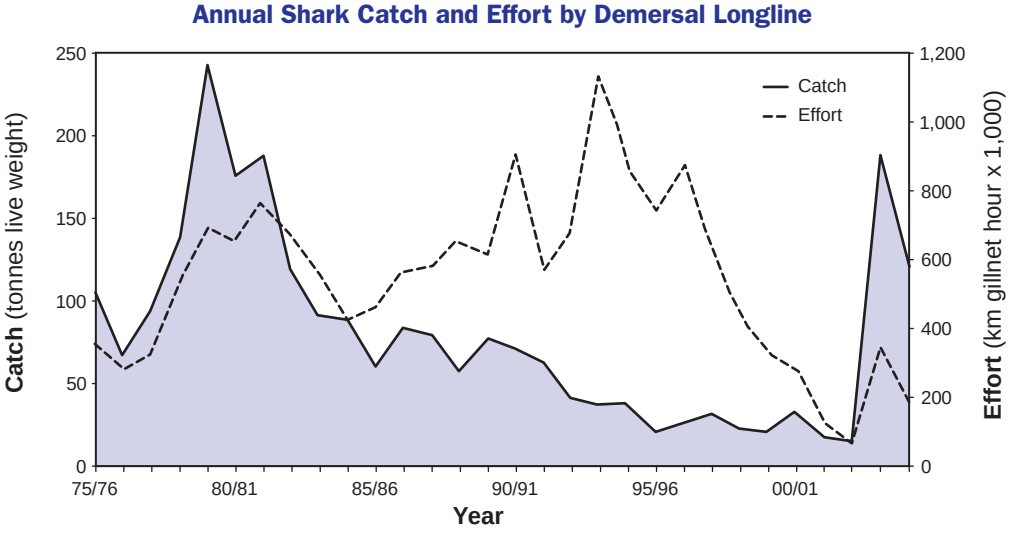
DEMERSAL GILLNET AND LONGLINE FIGURE 2

Effort in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2004/05.



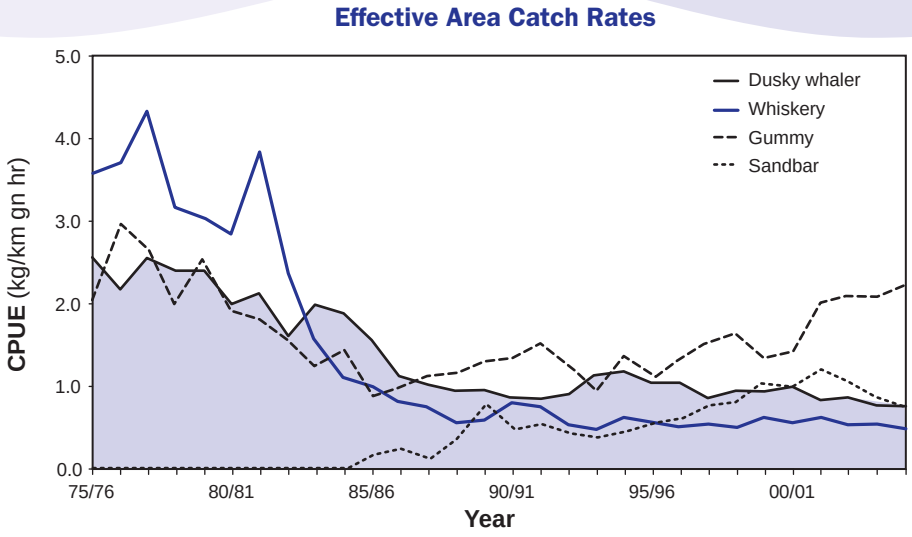
DEMERSAL GILLNET AND LONGLINE FIGURE 3

Catch and effort by demersal gillnet in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2004/05.



DEMERSAL GILLNET AND LONGLINE FIGURE 4

Catch and effort by demersal longline in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2004/05.



DEMERSAL GILLNET AND LONGLINE FIGURE 5

Effective area catch rates for four target species of the demersal gillnet and longline fisheries for the period 1975/76 to 2004/05.

Wetline Fishing

The CAES database indicates that a small proportion (8%) of the wetline catch in 2004/05 continues to be reported from the south coast bioregion. The top ten species comprised pink snapper (*Pagrus auratus*) 35 t, redfish (*Centroberyx* sp.*) 33 t, hapuku (*Polyprion oxygeneios*) 20 t, samson fish (*Seriola hippos*) 10 t, wobbegong (*Orectolobus* spp.) 10 t, Australian herring (*Arripis georgianus*) 9 t, copper shark (*Carcharhinus brachyurus*) 6 t, West Australian dhufish (*Glaucosoma hebraicum*) 6 t, sea garfish (*Hyporhamphus melanochir*) 5 t, and cod (*Epinephalus* spp.) 5t.

Fishing along the south coast is concentrated off the ports of Albany, Bremer Bay and Esperance. Hapuku and redfish are targeted in deeper waters at the edge of the continental shelf. West Australian dhufish has appeared in the top-10 list for the first time.

*Expected to be Bight redfish (C. *gerrardi*).

RECREATIONAL FISHERIES

Regional Research Overview

The south coast is the second most heavily used bioregion in terms of recreational fishing. During 2005/06, about 15% of recreational fishers reported fishing in this region (Baharthah 2006).

An extensive scientific knowledge of key recreational target species in the south coast estuarine sector has been developed from research undertaken by the Department of Fisheries since the 1970s (e.g. Lenanton and Hodgkin 1985, Lenanton and Potter 1987). In addition, a number of collaborative research projects have been undertaken since the 1980s by the Department of Fisheries with Murdoch University postgraduate students, particularly on recreationally important species in Wilson and Walpole/Nornalup Inlets (e.g. Potter et al. 1993, Potter and Hyndes 1994).

These studies, supported by and utilising the commercial fisheries database, have provided a good basic knowledge of the key species black bream (*Acanthopagrus butcheri*), cobbler (*Cnidoglanis macrocephalus*) and King George whiting (*Sillaginodes punctata*). Relevant abundance information and stock status for these recreational/commercial stocks are reported on pp. 196–202.

For the south coast beach fishery the major target species of salmon (*Arripis truttaceus*) and herring (*Arripis georgianus*) are similarly known from historical and recent FRDC-funded research projects. These data, combined with long-run commercial fisheries databases for overall measures of abundance, breeding stocks etc., provide a strong basis for recreational fishing management of this key sector. Specific data to assess the impact of recreational fishing on these key stocks was provided by a survey of shore-based fishers to estimate the recreational catch of herring and salmon, completed in 1995 (Ayvazian et al. 1997). Other species targeted by beach fishers included garfish (*Hyporhamphus melanochir*), skipjack trevally (*Pseudocaranx dentex*), western sand whiting (*Sillago schomburgkii*), southern school whiting (*Sillago bassensis*) and King George whiting.

A 12-month survey of recreational boat- and shore-based fishing in estuaries of the south coast bioregion was conducted between December 2002 and November 2003 (Smallwood and Sumner, in press). There were 17 different estuaries and inlets surveyed, from Broke Inlet in the west to Bandy Creek in the east. The overall recreational catch (excluding cockles, mussels and razor clams) for all the south coast estuaries combined was estimated at 211,316 fish retained and 201,710 fish released. The highest catches and greatest diversity of species occurred in the permanently open systems of Walpole/Nornalup Inlet (57,366 fish kept), Oyster Harbour (70,809 fish kept) and Princess Royal Harbour (31,993 fish kept). For all surveyed locations combined, the most frequently retained recreational species (excluding catches from charter vessel and recreational netting) were King George whiting (66,244 fish or 12.2 t), black bream (46,216 fish or 21.9 t), Australian herring (32,930 fish or 4.2 t), skipjack trevally (20,951 fish or 7.1 t) and blue swimmer crabs (10,545 crabs or 2.5 t).

There are gaps in the biological data in this region relating to the offshore boat angling species such as trevally (Carangidae), queen snapper (*Nemadactylus valenciennesi*), redfish (*Centroberyx* spp.), blue groper (*Achoerodus gouldii*) and samson fish (*Seriola hippos*), the exception being the more abundant shark species (gummy shark, *Mustelus antarcticus*, and dusky whaler, *Carcharinhus obscurus*) which have been extensively researched under FRDC-funded projects. First estimates of recreational catches for these species are available from the National Recreational Fishing Survey (Henry and Lyle 2003).

Research for managing all three of the south coast bioregion's recreational sectors (estuarine, beach and boat) will rely heavily on the long-run commercial fisheries databases coupled with recreational creel survey data and the national recreational database.

Fishing and Aquatic Tour Industry

C. Johnson and E. Lai

The south coast bioregion has the smallest number of licensed tour operators in the state, with 24 licensed fishing tour operators plus 5 licensed restricted fishing tour or eco-tour operators at the end of June 2006.

Tour operators were licensed by the Department of Fisheries in 2001, with all licensed operators required to submit daily trip returns. These returns enable data to be compiled on the overall number of tours, number of fishing tours, catch and effort estimates and other statistics.

Starting from the current report, data for this bioregion have been presented by financial year (rather than by calendar year as previously), as returns indicate that the majority of the total catch is taken between September and March. Catch estimates have been enhanced through improved analysis of average fish weights and inclusion of late fishing returns.

Fishing effort

In 2004/05, 40% of tour operators who were licensed to operate on the south coast reported actively using their licence in this bioregion. Operators reported 359 tours during 2004/05, a substantial decline from 667 in 2003/04 and 715 in 2002/03. Activities conducted on these tours included fishing, diving, snorkelling, wildlife observation and sightseeing.

The total number of 'fishing only' tours on the south coast in 2004/05 also decreased to 323 from 394 in 2003/04 and 340 in 2002/03. The total fishing effort reported by operators for the south coast bioregion increased to 2,905 fisher days in 2004/05 compared to 2,386 fisher days in 2003/04, but was still lower than the 3,037 fisher days reported in 2002/03.

Catch

Catches of the major finfish species for the south coast bioregion in 2002/03, 2003/04 and 2004/05 are shown in South Coast Fishing Tours Table 1.

The estimated total finfish catch for 2004/05 was 21.5 t.

SOUTH COAST FISHING TOURS TABLE 1

Estimated catch of major finfish species reported by tour operators. Catches are calculated by financial year as the majority of the total catch is taken between September and March.

SPECIES		ESTIMATED CATCH (tonnes) 2002/03	ESTIMATED CATCH (tonnes) 2003/04	ESTIMATED CATCH (tonnes) 2004/05
Bight redfish	*Centroberyx gerrardi*	8	8.5	5.5
Swallowtail	*Centroberyx lineatus*	1	2	2
Samson fish	*Seriola hippos*	3	3	2
Queen snapper	*Nemadactylus valenciennesi*	3	2.5	1.5
Breaksea cod	*Epinephelides armatus*	1.5	1.5	1.5
Skipjack trevally	*Pseudocaranx dentex*	1.5	2	1
Pink snapper	*Pagrus auratus*	2	2	1
Sea Sweep	*Scorpis aequipinnis*	0.5	0.5	0.5
Dhufish	*Glaucosoma hebraicum*	0.5	1	0.5
Other finfish		5	5.5	6
Total		**26**	**28.5**	**21.5**

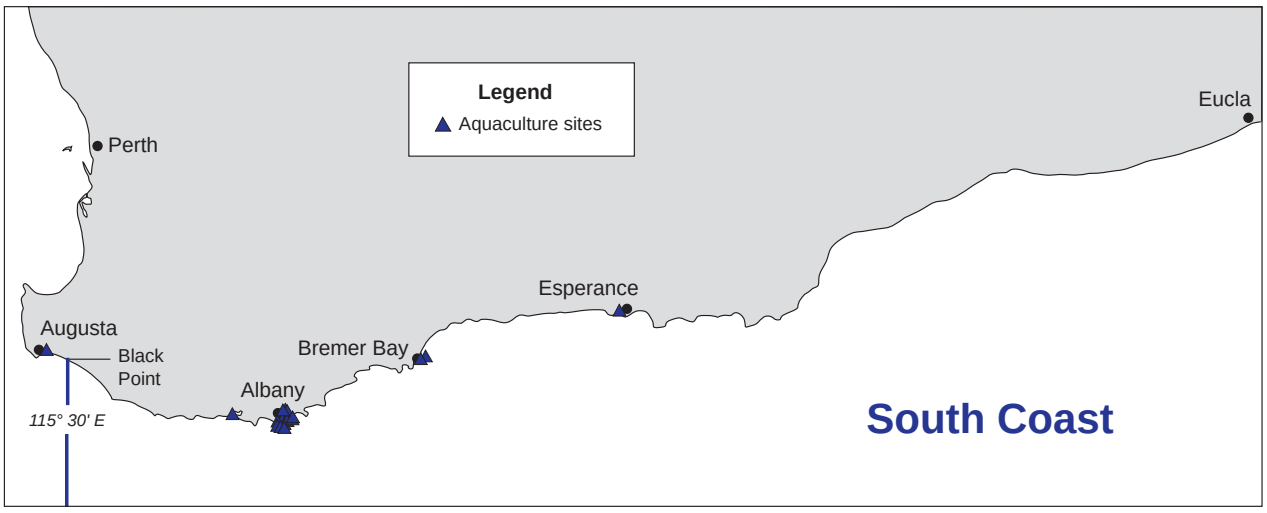
AQUACULTURE

Regional Research and Development Overview

Abalone continues to be a key aquaculture species and investigations around the development of this species have been a priority in this period for the Aquaculture Development Council.

On-farm experimental work funded by the FRDC has been finalised, and abalone stock derived from the experimental work were moved to the new WAFMRL facility at Hillarys in October 2005 (see west coast bioregion, pp. 76–77).

Joint abalone aquaculture research by the Department and Murdoch University has shown that specific red algae can be utilised in commercial abalone nurseries, particularly if they are used as juvenile growth forms and in combination with the common sea lettuce (Ulva spp.). Juvenile abalone as small as 4–5 mm can utilise fragments of the algae and growth rates are very promising. Departmental researchers have also demonstrated that these algal species can easily be grown with existing infrastructure from a commercial abalone farm and growth rates of 10% per day can be maintained. The results of this research have allowed farmers to delay weaning juvenile abalone on to formulated feeds for several months, thus improving growth and survival rates, particularly during the warmer months when feeding formulated diets is problematic and high mortalities are encountered on farms.



SOUTH COAST AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture sites of the south coast bioregion.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance with commercial and recreational fishery management arrangements in the south coast bioregion is monitored by Fisheries and Marine Officers based at Albany and Esperance. These officers undertake a variety of compliance activities including land-based and at-sea inspection of vessels, catches, fishing gear and marine safety equipment, and verification of licences.

Activities during 2004/05

Owing to the variety of commercial and recreational fisheries, the expanse of coastline and the variable and seasonal weather conditions, FMOs employ a risk-management-driven approach to prioritise and plan compliance activities.

Overall, FMOs delivered a total of 6,646 hours of compliance activities during 2004/05, as summarised in South Coast Compliance Table 1.

Officers delivered 3,652 hours of compliance services targeted at commercial fisheries, with a total of 155 contacts with commercial fishers. The majority of the compliance effort was directed towards the abalone fishery. Only minor breaches were detected by licence holders within the fishery, mainly in terms of quota management and incorrect completion of catch and disposal records. However, illegal (unlicensed) abalone operations continue to be a major concern for the sustainability of the commercial and recreational abalone fishery in the south coast bioregion.

The remainder of the commercial fishery compliance hours were dedicated to the wide range of minor commercial fisheries operating in the bioregion. Particular attention was paid to spot checks of net lengths in the commercial shark fishery, at-sea inspections of deep sea crab gear and quota checks in the purse seine fishery.

During the year 6 infringement warnings and 5 infringement notices were issued and a further 17 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 delivered a total of 2,994 hours of compliance services to recreational fisheries and achieved 2,192 contacts with recreational fishers. During 2004/05, 31 infringement warnings and 20 infringement notices were issued and 31 prosecutions were instigated against recreational fishers.

Compliance patrols in recreational fisheries principally involve checks to ensure that fishers are adhering to size and bag limits and complying with restrictions that apply in the recreational net fishery. The areas of highest risk of non-compliance with the management arrangements were considered to be abalone, cockles, marine finfish and estuarine netting. There continues to be a growing awareness of the open season and availability of abalone on the south coast, which will require increased compliance services.

During 2004/05, FMOs delivered 200 hours to the marine safety compliance program within the bioregion. Officers conducted marine safety checks on recreational and commercial vessels. Regional marine safety checks are unfunded and are conducted together with fisheries compliance checks.

A review of the recreational fishing management arrangements for the south coast was conducted during the year, with consultative workshops held in Walpole, Albany and Esperance and discussion papers distributed throughout the community.

The education program in this bioregion is supported by Volunteer Fisheries Liaison Officers. In 2004/05 the VFLO program involved 10 volunteers in the Albany and Denmark areas and 5 in Esperance, accounting for 546 contacts during the year. Community education activities conducted in the bioregion included attendance and presentations by FMOs and VFLOs at primary and secondary schools, regional shows and festivals, community group meetings and fishing competitions.

Initiatives in 2005/06

The outcomes of the South Coast Regional Recreational Fishing Review were implemented on 1 January 2006. Extensive changes occurred, including a new bag and category limit regime, increases in the minimum size limits for redfish and tarwhine, the banning of recreational set netting in ocean waters and new management arrangements for recreational netting in estuarine waters.

In response to these changed management arrangements, a comprehensive community education strategy was implemented across the bioregion in 2005/06. Compliance efforts took a far more educative approach in relation to the changes, while still enforcing pre-existing regulations. A multi-lingual pamphlet was produced for the Albany cockle season to explain the change from 2 litres to 20 shellfish and emphasise that the practice of collecting bag limits for others not actively fishing is illegal.

Education initiatives for the south coast have previously been overseen by the Department's southern region Community Education Officer, based in Busselton. However, a funding application through the South Coast Regional Initiative Planning Team Inc (SCRIPT), a natural resource management body, has been successful in securing Natural Heritage Trust funding for an Albany-based Volunteer and Education Activity Coordinator position, which was established in October 2005. Since the establishment, the VFLO program in the south coast has doubled from 15 to 30 volunteers and has resulted in higher community contact levels.

SOUTH COAST BIOREGION TABLE 1

Summary of compliance and educative contacts and infringement types within the south coast bioregion during the 2004/05 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	3,652
Fisher field contacts by Fisheries Officers	155
District Office contacts by Fisheries Officers	805
COMMERCIAL OFFENCES DETECTED	
Infringement warnings	6
Infringement notices	5
Prosecutions	17
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	*NUMBER*
Hours delivered in bioregion	2,994
Fisher field contacts by Fisheries Officers	2,192
District Office contacts by Fisheries Officers	1,264
Fisher field contacts by VFLOs	546
Fishwatch reports*	18*
RECREATIONAL OFFENCES DETECTED	
Infringement warnings	31
Infringement notices	20
Prosecutions	31

* Data for combined recreational and commercial Fishwatch reports, July 2004 – March 2005. The service provider ceased operation in April 2005, and the interim arrangements implemented do not provide reliable statistics for the period April–June.

NORTHERN INLAND BIOREGION

Northern Inland Bioregion

ABOUT THE BIOREGION

The northern inland bioregion, encompassing the northern half of the state, is predominantly a desert area, with few permanent water bodies. As a result of occasional summer cyclones, the various river systems flow at flood levels for short periods before drying out to residual waterholes. The only exceptions to this are man-made dams which trap rainfall for water supply purposes and irrigation.

The only significant fishable water body in the region is Lake Argyle, created by damming the Ord River. The continuous release of water from the dam has resulted in the Ord River maintaining its freshwater fish populations year-round, as does the lake where some freshwater native fish populations have expanded. Populations of reptiles, such as the protected freshwater crocodile, are supported by the expanded food chain of native fish, and are thought to have expanded significantly from their original billabong-based populations.

The creation of Lake Argyle has produced a unique inland aquatic environment which is now home to various fishing and tourism-related activities. The lake supports the state's only commercial freshwater fishery, for the silver cobbler or catfish, together with a processing facility supplying predominantly Western Australian and interstate markets. The lake and its associated river system also support recreational fishing for the freshwater component of the barramundi stock and cherabin (freshwater prawns).

Aquaculture development operations in the region have included a significant production of barramundi from a cage operation in Lake Argyle and a small but growing pond production of redclaw crayfish in the Ord River irrigation system around Kununurra. Production of aquarium fish using bore water in the southern Gascoyne region is also being explored.

ENVIRONMENTAL MANAGEMENT

Regional Overview

Influences on freshwater bodies and habitats in the northern inland bioregion are largely terrestrial and outside the control of Fisheries legislation. While fishing activities in this region do not cause any significant environmental impact, the Department has supported a number of studies into the native fish fauna and their habitats in northern river systems.

In Lake Argyle, the development of the barramundi aquaculture industry is subject to environmental management under the Department's licensing arrangements. Monitoring to ensure maintenance of water and benthic quality standards

is undertaken by the industry, and research has been carried out by the Department to assess the nutrient dynamics and carrying capacity of the lake in relation to barramundi. Water quality standards are set in consultation with the Water Corporation, Department of Water and the Department of Environment and Conservation.

COMMERCIAL FISHERIES

Lake Argyle Silver Cobbler Fishery Status Report

S. Newman and C. Skepper
Management input from A. Bain

FISHERY DESCRIPTION

The only commercial freshwater fishery in Western Australia is in Lake Argyle in the north-eastern Kimberley. This gillnet fishery specifically targets the silver cobbler or shovel-nosed catfish (*Arius midgleyi*).

In previous *State of the Fisheries Reports*, this fishery has been referred to as the Lake Argyle Freshwater Catfish Fishery. From this year, however, in response to requests from industry, the name has been changed to Lake Argyle Silver Cobbler Fishery. This change reflects the marketing name now commonly used for this species throughout Australia, as well as the move toward an Australian Standard for fish names.

Governing legislation/fishing authority

Fisheries Notice no. 665 (Section 43 order)
Condition 55 on a Fishing Boat Licence

Consultation process

Department–industry meeting

Boundaries

The Lake Argyle Silver Cobbler Fishery (LASCF) is contained in the impounded waters of the Ord River at Lake Argyle.

Management arrangements

This fishery is managed by input controls in the form of a set of licensing conditions. It is a limited entry fishery. For each licensee there is a gillnet length restriction of 1,500 m and all nets must be suitably marked with licence identification. While there is no mesh size restriction, the fishers have adopted a code of practice that states that nets should have a mesh size not less than 6¼ inches (150 mm) and a drop length of 30 meshes. All fishers are prohibited from taking any fish whatsoever by means of nets during the period from 1 November to 31 December in any year. Fishers in the LASCF are not permitted to take barramundi (*Lates calcarifer*).

Since 2000, operators have voluntarily reduced effort in the fishery and hence the levels of catch.

In response to concerns from charter operators, the general public and conservation groups, Lake Argyle Silver Cobbler Fishery endorsement holders developed an industry code of practice to minimise the incidental capture of freshwater crocodiles. The code was implemented in 2001 and specifies the accepted means of operation in the fishery, and outlines contingency procedures for fishing gear that has been lost or abandoned.

Future management measures for this fishery include a review of the latent effort present within the fishery and a possible shift in the seasonal closures to better accommodate the wet-season breeding period for the target species.

Research summary

Data for assessing the status of the silver cobbler stock in Lake Argyle are derived from the catch and effort returns provided by industry. These data are compiled annually and used as the basis for this assessment. Biological data on the species' specialised reproductive behaviour and low fecundity are used to interpret these assessments.

RETAINED SPECIES

Commercial production (season 2005): 131 tonnes

Landings

The target species in the fishery is the silver cobbler or shovel-nosed catfish. The fishery first developed in 1979 with increasing catches reported until 1988 (138 t). Catch levels then fluctuated between 90 t and 145 t until 1997 (Lake Argyle Silver Cobbler Figure 1), after which they increased to a peak of 231 t in 2000. Owing to voluntary reductions in effort, catches declined in both 2001 and 2002. In 2003, the level of catch and effort increased again, with a reported catch of 165 t in 2003 being above the target range for the fishery. The catch dropped in 2004 to 147 t and in 2005 is again lower at 131 t, with both these values falling within the target catch range for the fishery (Lake Argyle Silver Cobbler Figure 1).

Fishing effort/access level

Nominal effort in this gillnet fishery is calculated as the total number of fishing days by all boats multiplied by the average daily total net length fished per boat divided by 100 to give '100 m net days'. During 2005, four vessels were active in the fishery and generated an effort of 6,472 units (100 m net days), similar to the effort of 6,632 units reported in 2004 (Lake Argyle Silver Cobbler Figure 1).

Catch rate

The catch rates achieved in the fishery from 2000 to 2002 were similar to those achieved in 1993 and 1994. The much higher catch rate achieved in the fishery in 2003 is similar to that reported in the fishery in 1990 (Lake Argyle Silver Cobbler Figure 1). The factors contributing to the increase in CPUE in 2003 are not known. The catch rate in 2004 declined to similar levels to those reported in the period from 2000 to 2002. The catch rate in 2005 is lower than that reported in 2004 and is similar to levels reported within the fishery in the late 1990s (Lake Argyle Silver Cobbler Figure 1).

Recreational component: **Not assessed**

Limited data are currently available. The reported charter boat catch for Lake Argyle from 2002 to 2005 was less than 1 t of silver cobbler per annum.

STOCK ASSESSMENT

Assessment complete: **Yes**

The catch and effort data provided by industry are used to develop stock assessment models for the fishery. The modelling approach used in the following assessment of the fishery requires a number of assumptions related to catchability, age and growth, and the available data are not sufficiently detailed to determine whether or not these assumptions are reasonable. This creates a high degree of uncertainty around the results generated from the models. The only way to reduce this uncertainty is to allocate more resources to the gathering of the necessary data from the fishery, and to gain an understanding of some key characteristics of both the fishery and the biology of the species.

The fishery was last formally assessed in 2001 when a process error model and an observational error model replaced the biomass dynamics model previously used. The results of this assessment work indicated that the stock was either fully fished or over-fished. Both models indicated that the catch levels of 180–230 t reported by the fishery during the period 1998–2000 were unlikely to be sustainable.

The reduced effort applied by the fishery after 1999 has brought catches back into the acceptable range. These lower catches have generated a slight upward trend in CPUE since 1999 suggesting that stock abundance may be increasing (Lake Argyle Silver Cobbler Figure 1). The simultaneous increase in catch and catch rate in 2003 appears to reflect either the short-term use of a smaller mesh size within the fishery or an increase in recruitment, before returning to the general trend line in 2004 and 2005.

Breeding stock levels: **Adequate**

The assessment completed in 2001 indicated that the fishery was probably over-exploited and the breeding stock may not have been sufficient to maintain existing recruitment to the fishery if fishing had continued at the catch levels seen during the years 1998–2000. The significant reductions in catch that occurred in 2001 and 2002 appear to have assisted in the recovery of the breeding stock. That is, the upward trend in CPUE as a measure of adult abundance since 1999 indicates that the breeding stock has recovered and it is now considered adequate.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Minimal fish by-catch occurs in this fishery as a result of the large mesh size used relative to the species present in the lake.

Protected species interaction: **Low**

There is an incidental capture of freshwater or Johnston's crocodiles (*Crocodylus johnstoni*) and some tortoises by the silver cobbler fishery in Lake Argyle. Although Lake Argyle is an artificially created aquatic environment it is now designated as a wetland of international importance under the Ramsar Convention. While the crocodile population has probably increased in response to the creation of the dam in an otherwise arid environment, there are no assessments of the current size of the population, nor of the proportion of the population being captured incidentally by the fishery. In the absence of this information, but on the basis of the fishers' anecdotal information of low levels of capture, the incidental capture of crocodiles is considered to be of minimal ecological significance. In addition, fishers in Lake Argyle are also attempting to reduce the incidental capture of non-target species.

In 2005, Lake Argyle Silver Cobbler Fishery endorsement holders trialled the use of fish traps as a method of mitigating bycatch. Early indications suggest that this gear type is ineffective for harvesting silver cobbler. Further trials of other gear types and bycatch mitigation strategies are planned for 2006–2007.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The surface gillnets used have minimal impact on the habitat.

SOCIAL EFFECTS

During 2005, four vessels fished in the LASCF with an average crew level of two people per vessel, indicating that 8 people were directly employed in the fishery. Additional employment occurs throughout the fish processing and distribution networks.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2005: $347,000

The LASCF landed a total of 131 t of fish in 2005 for a catch value of over $347,000. This estimate is based on the landed weight of silver cobbler recorded in the CAES system and the 2003/04 average price per kilogram of whole weight of silver cobbler as supplied by fish processors.

FISHERY GOVERNANCE

Target catch range: **95–155 tonnes**

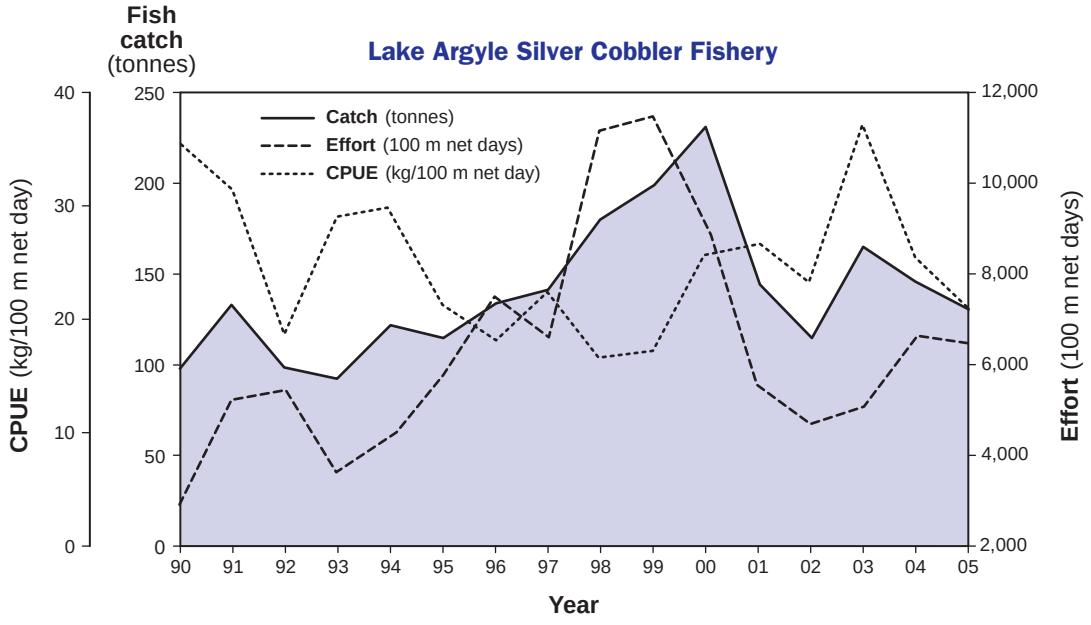
The target catch range under the current management regime is 95–155 t of silver cobbler. Applying an autoregressive moving average control quality procedure to the annual catches from 1990 to 2002 has derived this range. The confidence intervals are obtained by estimating the variation of the observations compared with the variation of the predictions using the 13 years of catch data. The catches from 1998 to 2000 exceeded this range (Lake Argyle Silver Cobbler Figure 1) and were driven by the utilisation of latent effort. The 2001 and 2002 catches were within the target catch range as a result of voluntary decreases in effort in this fishery. The catch in the fishery in 2004 and 2005 has again been within the target catch range.

New management initiatives (2005/06)

The 2006 annual management meeting for the fishery is expected to focus on bycatch issues, particularly in relation to interactions with protected species. It is expected that this meeting will lead to new management initiatives for the fishery including formalisation of current industry codes of practice and further trialling of alternative gear types.

EXTERNAL FACTORS

The variations in catch and catch rate seen from year to year are possibly related in part to the unknown catchability dynamics and demographic characteristics of the silver cobbler, each of which may be affected by variations in environmental conditions within the Lake Argyle system. Another factor which may be affecting the population size and growth of the silver cobbler stock is the development of barramundi farming within the lake, which indirectly provides some additional (waste) food utilised by the silver cobbler and its prey species. Fishermen head and gut the silver cobbler for transport to Perth markets in order to reduce freight costs, making it difficult to cost-effectively sample the size and age composition of the catch. The remote location of this fishery also means that it is a costly exercise to use observers to gain a better understanding of the catchability of this species.



LAKE ARGYLE SILVER COBBLER FIGURE 1

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for the Lake Argyle Silver Cobbler Fishery over the period from 1979 to 2005.

RECREATIONAL FISHERIES

Regional Research Overview

Around 1% of the state's recreational fishers reported fishing in the fresh waters of the Kimberley during 2005/06 (Baharthah 2006).

Scientific information for the management of northern freshwater species, particularly barramundi (*Lates calcarifer*), has been provided by historical Department of Fisheries research projects. Some abundance data for the estuarine component of the stock can be obtained from the commercial catches recorded in the CAES system and reported on pp. 138–143. In addition to barramundi, Lake Argyle silver cobbler (*Arius midgleyi*) and cherabin or freshwater prawns (*Macrobrachium rosenbergii*) are also taken in this inland bioregion. Catch and abundance data for the silver cobbler stocks are available via the commercial fishery statistics, but no data are available for cherabin, which are not taken commercially.

Research has recently been carried out with a view to formalising recreational fishing for the introduced redclaw crayfish (*Cherax quadricarinatus*) in Lake Kununurra. Researchers from the Department of Fisheries, in collaboration with the East Kimberley Region Recreational Fishing Advisory Committee and the East Kimberley Sport and Game Fishing Club, conducted trials to identify the most appropriate fishing gear to catch this feral species. The most efficient gear was found to be commercially available 'opera house' traps, with a metal or plastic ring not exceeding 70 mm in diameter incorporated in the entrance funnel to minimise bycatch. The Minister has approved the drafting of legislation that would allow the use of such traps to catch redclaw in Lake Kununurra. This is expected to be introduced in 2007.

AQUACULTURE

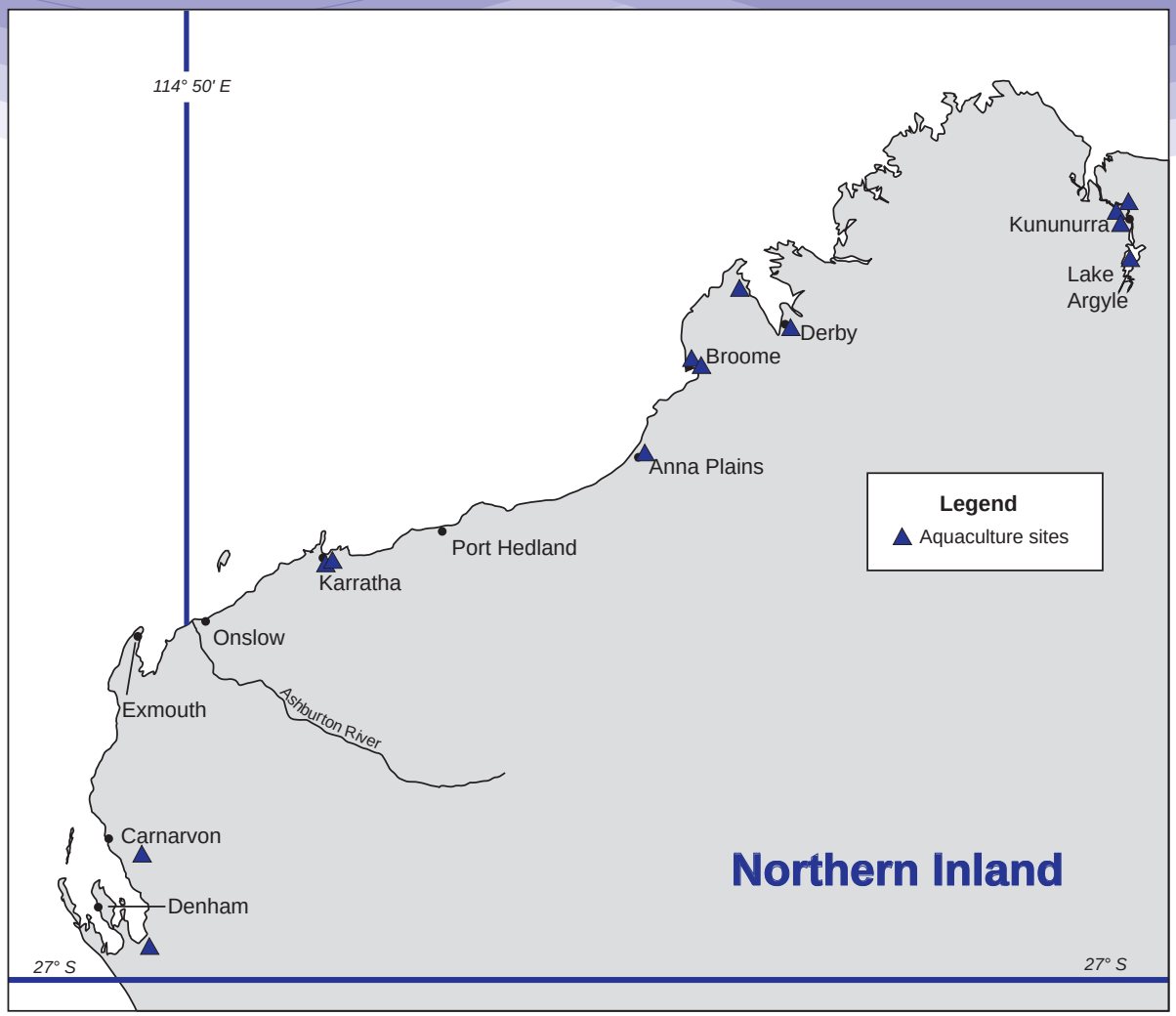
Regional Research and Development Overview

During 2005/06, Research and Regional Services staff in this region have assisted a variety of mainly indigenous proponents with interest in inland aquaculture species including barramundi (*Lates calcarifer*), redclaw crayfish (*Cherax quadricarinatus*), cherabin (*Macrobrachium rosenbergii*) and live-bait fish.

The Department was involved in assessing a range of potential sites in areas occupied by local indigenous communities interested in aquaculture projects. Staff have progressed the identification of an aquaculture lease area in Lake Argyle for the Mirriuwung Gajjerong Aboriginal Corporation in accordance with requirements for the Ord Stage II final agreement. Progress has also been made on developing an indigenous model farm for the aquaculture of barramundi and redclaw crayfish near Kununurra, with commissioning of the site expected in 2006/07.

Research and Regional Services staff have also been assisting the Department of Planning and Infrastructure in identifying a new land-based aquaculture area for Lake Argyle to support the mid- to long-term expansion of aquaculture in the lake.

Two large externally funded research projects have helped underpin the sustainability of barramundi aquaculture development in the Kimberley. These projects have been funded from the Fisheries Research and Development Corporation, Sustainable Regions Program and Australian Centre for International Agricultural Research. Major issues resolved include the development of disease management strategies to limit spread of diseases in Lake Argyle; the development of techniques to reduce and remove 'muddy' flavour taint in fish farmed in Lake Argyle; the development of a national testing centre for flavour taint issues; and the refinement of a production and feed management model. This model is being further refined in work at the WA Fisheries and Marine Research Laboratories, at Hillarys in Perth.



NORTHERN INLAND BIOREGION FIGURE 1

Map showing the major licensed aquaculture sites of the northern inland bioregion.

Barramundi Farming Status Report

C. Lawrence and S. How

INDUSTRY DESCRIPTION

Production methods

Barramundi (*Lates calcarifer*) can be farmed in cages in lakes or coastal areas, in inland saline ponds, or in intensive recirculating culture systems using fresh water, inland saline water or seawater. In Western Australia the majority of barramundi production is from fresh water, particularly cages or intensive recirculating systems.

Production areas

Barramundi is currently produced in cages in Lake Argyle or intensively in recirculating systems in the southern half of the state.

Management arrangements

To undertake barramundi farming, an aquaculture licence from the Department of Fisheries is required. A water quality monitoring program that is to the satisfaction of the Department of Environment and Conservation must also be developed and maintained.

AQUACULTURE PRODUCTION

Production current year (2004/05): 289 tonnes

Number of producers for year 2004/05: 16

This represents a drop of one in the number of farms producing, by comparison with 2003/04.

Production projection next year (2005/06): 300 tonnes

After a 60% growth in barramundi production in 2003/04, production decreased by 4% in 2004/05 (Barramundi Farming Figure 1).

Future production levels may be affected by:

- appropriate management during periodic fluctuations in water quality in Lake Argyle;
- intense competition (particularly from Northern Territory and Queensland farms) that can depress market prices; and
- development of new farms.

The effect upon market prices of intense competition among growers resulted in a 32% reduction in the value of WA barramundi production in 2004/05.

ECOSYSTEM EFFECTS

With correct management, barramundi farming is considered to present a moderate risk to the environment. Even within protected coastal areas and lakes, cages can be operated with low environmental impact if appropriately located in deeper water with adequate current flow to remove nutrients. Native fish present around the cages can also be expected to consume a significant amount of waste material (uneaten feed and faeces), thus reducing the overall impact on the environment.

Monitoring of the major farm in Lake Argyle in 2002/03, as part of the requirements of the Department of Environment and Conservation, indicated minimal environmental impact.

Land-based farms producing more than 1 t of fish are required to minimise their environmental impact and are subject to discharge licensing, which includes monitoring of water quality.

SOCIAL EFFECTS

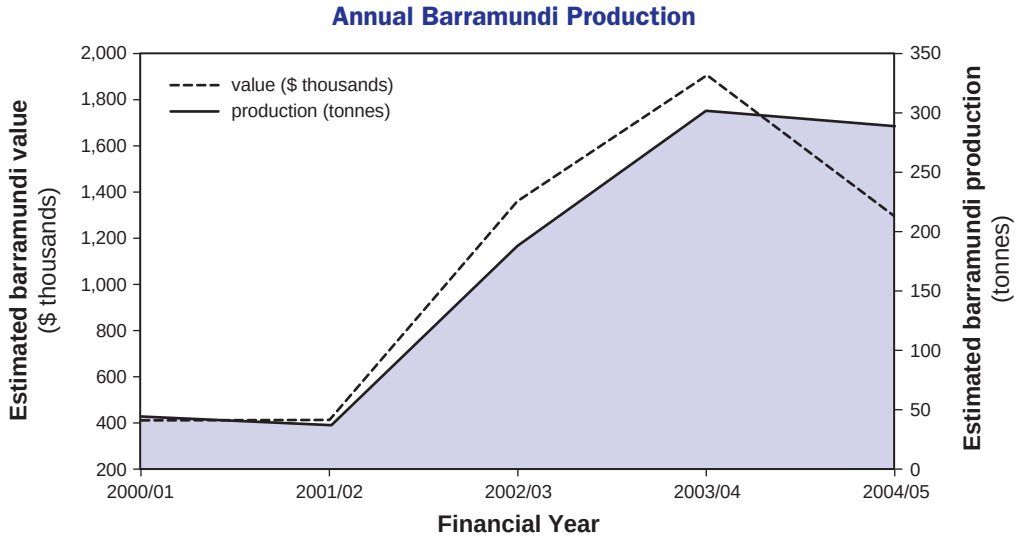
This industry has grown rapidly over the past five years and has the potential to become a valuable source of regional employment and local tourism opportunities at Lake Argyle.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2004/05: $1.3 million

EXTERNAL FACTORS

Competition from farms in the Northern Territory and Queensland, combined with the rapid increase in production from Western Australia, may result in depressed prices for barramundi. To address this issue a greater emphasis on export markets may be required. To compete with imported product, WA producers will need to implement marketing strategies that emphasise the benefits of local produce.



BARRAMUNDI FARMING FIGURE 1

Estimated barramundi production and value from 2000/01 to 2004/05.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and education activities for the freshwater systems in the north focus on habitat protection, translocation inspections of non-endemic freshwater species, protected species interaction, monitoring of introduced fish species, aquaculture lease and licence compliance, localised depletion of barramundi as a target recreational species, cherabin catches and the impact of the commercial fishery in Lake Argyle.

Owing to the large number of campers and fishers accessing the inland Kimberley rivers during the peak tourism period from May to October, and the area-specific barramundi size and possession limit legislation, patrols continue to focus on the Fitzroy and Ord Rivers. (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 2004/05

During 2004/05, Fisheries and Marine Officers recorded 260 hours and 331 personal contacts with the community and commercial sector across the northern inland bioregion. FMOs focused on freshwater fishing compliance in areas of known high visitation or local complaints regarding non-compliant netting.

Officers also worked with the Department of Environment and Conservation and crocodile park owner Malcolm Douglas to free crocodiles, barramundi and sawfish from drying billabongs and relocate them to permanent water.

Compliance and education was also undertaken in the Lake Argyle area, where FMOs inspected commercial silver cobbler fishers and aquaculture sites to ensure that management, protected species interaction and environmental objectives were being met.

Initiatives in 2005/06

Compliance service delivery continues to target any areas of complaint and locations with high recreational fishing pressure, as identified during the annual risk assessment processes.

Improved levels of engagement with children, through fishing clinics and school presentations promoting ‘fish for the future’ messages, have been undertaken this year in regional towns and remote Aboriginal communities.

SOUTHERN INLAND BIOREGION

Southern Inland Bioregion

ABOUT THE BIOREGION

This region contains the state's only natural permanent freshwater rivers, which are fed by rainfall through winter and spring. These permanent rivers are restricted to the high-rainfall south-west corner of the state and flow through the significant native forest areas. Some of the rivers are more saline in their upper reaches owing to the effects of agricultural clearing of native vegetation in more inland areas.

Across the remainder of the southern inland bioregion, rivers flow primarily during the three months of winter rainfall, with very occasional summer flows from inland rain-bearing depressions resulting from decaying cyclones. Permanent fresh water bodies are essentially all man-made irrigation, water supply or stock-feeding dams. Some natural salt lakes also occur but generally dry out over summer each year.

The few natural freshwater rivers and man-made lakes support a small native fish fauna and create an environment, particularly in forest areas, which is highly valued by the community for a variety of recreational pursuits.

While there are no commercial fisheries in the southern inland bioregion, it provides significant recreational fishing opportunities. The major species fished recreationally are native marron, trout (both rainbow and brown trout) stocked by the Department of Fisheries into public dams and rivers, and feral redfin perch, an introduced, self-perpetuating stock. The native freshwater cobbler is also taken in small numbers, as are black bream artificially stocked into some inland impoundments.

Aquaculture development in the southern inland bioregion is dominated by the farm-dam production of yabbies, which can reach about 200 t annually depending on rainfall and market demand. Semi-intensive culture of marron in purpose-built pond systems provides around 50 t per year and has the potential to expand significantly.

Trout have historically been the mainstay of finfish aquaculture production in this region, originating from heat-tolerant stocks maintained at the Department's Pemberton Freshwater Research Centre. Recent developments have focused on the short-term winter growout of trout in inland saline waters. Silver perch are also grown in purpose-built ponds in the warmer northerly areas to supply local markets, while intensive closed-circuit systems are being used to produce barramundi for the metropolitan restaurant trade.

ENVIRONMENTAL MANAGEMENT

Regional Overview

The conservation of the 13 species of freshwater native fish which exist in Western Australia is a growing issue for the Department of Fisheries. Some of these species are endemic to Western Australia, and therefore their survival depends on proper environmental management. Most of these fish are under pressure because of deteriorating environmental conditions. Therefore the Department of Fisheries is working with other agencies and institutions to undertake research on the distribution and life history of these animals to obtain the information required to protect them. Further, the Department has an approval process in place for assessing proposals to translocate fish into and within Western Australia, to minimise the risks associated with movement of fish which may impact on endemic species.

The identification of the 'hairy' marron in the Margaret River catchment as a separate species or sub-species has focused attention on the decline of this stock. Specific management actions to recover this unique stock and remove competing 'smooth' marron species from the catchment are underway. A captive breeding program to support this initiative has also been implemented at the Department's Pemberton Freshwater Research Centre.

RECREATIONAL FISHERIES

Regional Research Overview

The state's most popular freshwater fishing area is the southern inland bioregion, where two licensed recreational fisheries target marron (freshwater crayfish) and certain native and introduced freshwater fish species. In 2005/06, around 23,000 licences were issued for these two activities; however, this includes a large number (13,000) of 'umbrella' licences (covering all licensed recreational fisheries), which generally correlates with a lower participation rate than the number issued implies.

Research for managing and enhancing the fisheries for marron and the non-native trout (both rainbow and brown trout) has been largely undertaken by the Department of Fisheries. In addition, collaborative university projects have provided data on the non-native redfin perch and native freshwater cobbler and their relationship to the small native freshwater species of the southern inland bioregion.

Additional research is now underway to assist the recovery of the critically endangered Margaret River or 'hairy' marron, which until 2002 formed part of the recreational marron fishery.

Licensed Recreational Marron Fishery Status Report

M. de Graaf
Management input from C. Syers

FISHERY DESCRIPTION

Marron (*Cherax tenuimanus**) are endemic to Western Australia and are the third largest crayfish in the world. Recreational fishing for marron occurs in freshwater dams and rivers using scoop nets, drop nets and snares.

*It should be noted that the nomenclature of marron is currently under review by the International Committee for Zoological Nomenclature; case number 3267.

Governing legislation/fishing authority

Fish Resources Management Regulations 1995 and subsidiary legislation
Recreational Fishing Licence

Consultation process

Recreational Freshwater Fisheries Stakeholder Subcommittee of the Recreational Fishing Advisory Committee

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 is closed to the public and monitored by the Water Corporation.

The Margaret River catchment above Ten Mile Brook Junction (the key area for the survival of the 'hairy' marron) has been closed to fishing since late 2002.

Management arrangements

This fishery is managed through input controls of licences, closed seasons and gear restrictions, and the output controls of size and bag limits. A Ministerial Review of the fishery in late 2002, aimed at ensuring the long-term sustainability of the stocks, resulted in changes in the management arrangements for the 2003 season, most notably the reduction of the fishing season from 55 days to 16 days. The reduced length of the fishing season (16 days) was maintained in the 2005 season.

All marron fishers require a recreational fishing licence (either a specific marron licence or an 'umbrella' licence covering all licensed recreational fisheries). Licensed fishers were permitted to fish for marron from 7 to 23 January 2005. Three types of legal gear exist: scoop nets, drop nets and snares. Only a single scoop net or snare, or six drop nets, may be used at any one time, and some waters, including all dams, have been declared 'snare only'. In most waters there is a minimum size of 76 mm carapace length and a bag limit of 10 marron per day. However, Harvey Dam is managed as a 'trophy water' with a minimum legal size of 90 mm carapace length and a daily bag limit and possession limit of 5 marron.

Research summary

Detailed research on the marron stocks in south-west rivers has been undertaken since the 1970s. Ongoing research involves the annual scientific monitoring of stock levels, surveys of catches taken by recreational licence holders and volunteer log book holders, and joint sampling with individual catchment groups. These data enable trends in stock levels to be monitored and recommendations to be made for adjustments to fishery management when necessary. The following status report is based on these research findings.

A major FRDC research project, due for completion in 2007, aims to quantify the various factors that are influencing the marron fishery, and redesign long-term monitoring so as to provide better management advice to sustain this important fishery for the future. This project is focused mainly on:

- determining the reproductive characteristics (size at maturity and fecundity) of marron throughout their range;
- development of a fishery-independent abundance index in 8–12 main rivers and dams;
- development of a tagging program to provide information on long-term growth and mortality throughout the marron range; and
- development of a recruitment monitoring program to predict future catches.

RETAINED SPECIES

Recreational catch estimate (season 2005): 13.6 tonnes

Landings

The total catch for the 2005 season was estimated at approximately 60,600 ± 5,460 marron or 13.6 ± 1.2 t of marron (average weight of marron 225g*, based on log book data). This is a decrease compared to the previous season

(2004: 64,200 ± 13,200 marron or 14.4 ± 3.0 t). The decrease in catch is due to a decrease in CPUE as fishing licence usage and effort increased and season length did not differ between 2004 and 2005.

*It should be noted that the *State of the Fisheries Report* prior to 2004/05 used an assumed weight for marron of 125 g, and is therefore considered to have under-estimated the annual tonnage landed by a factor of approximately 1.8.

Fishing effort/access level

A large number of recreational marron licences are sold annually. For the 2005 season, a total of 20,075 licences were sold, including umbrella licences (13,035). This represents an increase from the 18,708 licences in 2004.

Total effort for the 2005 season was estimated from telephone surveys at around 15,200 days. Fishing effort increased significantly compared to the previous season (2004: 12,400 days). This was due to an increase in the number of participating licensed fishers (from 4,000 in 2004 to 5,400 in 2005), as the number of fishing days per fisher decreased from 3.1 in 2004 to 2.8 in the 2005 season. The season length for both the 2004 and 2005 season was just 16 days.

Catch rate

The CPUE recorded by fishers, based on telephone surveys, was lower in 2005 at approximately 4 marron per fisher per day compared to 5.2 marron per fisher per day in 2004.

Commercial share: **Nil**

STOCK ASSESSMENT

Assessment complete: **Yes**

Current assessment involves the research surveys of stock levels at several indicator sites, surveys of catches taken by recreational licence holders and volunteer log book holders, and joint sampling with catchment groups. These data enable trends in stock levels to be monitored and recommendations to be made for adjustments to fishery management when necessary.

Analysis of the data from the 2005 season showed that effort increased by 22% but CPUE decreased by 22%. As the estimated total catch in 2005 (60,600 marron) was similar to 2004 but with increased effort, it indicates that a slightly reduced stock was available at the start of the season. The absence of the higher stock levels expected in 2005 as a result of the substantial reduction in the duration of the season in 2003 and 2004 might be due to the poor winter rains in 2004.

Future catches may be affected by rainfall. Briefly, higher rainfall increases the volume of rivers and dams, allowing marron to spread out, reducing competition and allowing more energy to be allocated to growth and reproduction. Further, higher rainfall washes more leaf litter and nutrients into waters, increasing the productivity and thus growth and reproductive rates.

Breeding stock levels: **Adequate**

The fishery operates over a number of river catchments and dams which contain a large number of essentially separate stocks. From the small number of indicator stocks surveyed, the current breeding stock levels appear adequate (based on typical size at maturity). Size at maturity seems to be well below the minimum legal size of 76 mm rostrum carapace length (RCL) for the majority of marron stocks in the south-west (e.g. Warren River ~56 mm RCL, Murray River ~54 mm RCL, Waroona Dam ~63 mm RCL, Wellington Dam ~54 mm RCL). Present size restrictions appear to adequately protect the majority of the female breeding stocks; however, further information on size at maturity from other catchments throughout the marron range needs to be obtained in the near future.

The exception to the above is the stock in Harvey Dam, where a larger female size at maturity of about 85 mm occurs, and a larger minimum legal size of 90 mm RCL has been introduced to protect the breeding stock. Recent studies have revealed that female size at maturity in the Hutt River, 600 km north of Perth, is also significantly larger (at about 95 mm RCL) than the minimum legal size of 76 mm RCL.

While reduced recruitment is generally due to poor environmental conditions, the impacts of fishing pressure following low recruitment can lead to a reduced spawning stock. Thus the spawning stock needs to be monitored continually.

Projected catch next season (2006): **12.5 tonnes**

This projected catch is based on rainfall in the previous season (2005). As rainfall in 2005 was higher than for 2004 (by 19%), the projected catch for 2006 is higher than the catch which was projected for the 2005 season (10.2 t). The predicted catch for 2006 is 12.5 t or 55,675 marron, assuming effort levels similar to those in the period 2003–2005.

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 smaller crayfish are not targeted by marroners and tend to be released.

Protected species interaction: **Negligible**

This fishery does not interact with protected species. However, a second species of marron has been identified (the Margaret River or 'hairy' marron), which is threatened mainly by the extension in range of the more common 'smooth' marron that forms the basis of the recreational marron fishery. In late 2002, recreational marron fishing above Ten Mile Brook Junction 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 this species.

ECOSYSTEM EFFECTS

Food chain effects: Low

The removal of legal-sized marron from freshwater rivers is unlikely to have a significant effect, noting that the bulk of the marron biomass is below legal size and that marron of all sizes have similar food and habitat requirements. Marron taken from man-made dams do not 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

The marron fishery in the 2005 season involved approximately 5,400 licence holders and their families undertaking about 15,200 fishing days, and provided a major recreational activity in regional areas of the south-west of the state.

ECONOMIC EFFECTS

The equivalent commercial value of the 2005 season recreational marron catch was in the approximate range of $182,000–$327,000 (based on an average sale price of marron from aquaculture farms of approximately $24/kg and the estimated average size of marron captured as calculated from log book returns). Revenue from licence sales was estimated at approximately $290,000, which is used to support recreational fishery management, research and compliance. In addition, the estimated 15,200 days of marroning in regional locations provided a significant economic boost to regional towns in the south-west.

FISHERY GOVERNANCE

The primary management control on the catch of marron stocks is currently the duration of the fishing season.

The expected 2006 catch of approximately 55,675 marron or 12.5 t, estimated from the rainfall–catch relationship, was calculated on the assumption that the short season (16 days) would be maintained and that fishing effort would remain in the low range, i.e. ~12,000 days as seen over the past few years.

New management initiatives (2005/06)

Owing to the refurbishment of Waroona Dam, this water body has been closed to the recreational marron fishery between 2002 and 2005. A highly successful breeding and restocking program was conducted in order to enhance marron stock levels in the dam. Waroona Dam will be reopened to recreational marron fishers in the 2006 season, and will be managed as a 'trophy water', with a minimum legal size of 90 mm carapace length and a daily bag limit and possession limit of 5 marron.

A Recreational Freshwater Fisheries Stakeholder Subcommittee (RFFSS) of the Recreational Fishing Advisory Committee was established in 2004 to develop a five-year strategy for the management of the state's south-west recreational freshwater fisheries and provide advice on ongoing monitoring and adaptive management of the marron and trout fisheries. The RFFSS reviewed the current management arrangements for the recreational marron fishery during 2005/06, and in 2006 a discussion paper was released containing future management options for the fishery. The Minister for Fisheries has determined that the following adjustments to the existing management arrangements will be implemented from the start of the 2007 season.

- The minimum legal size will be increased from 76 mm to 80 mm.
- The bag limit of 10 marron per day (or 5 marron in trophy waters) will be retained, but a possession limit of 20 legal-sized marron per licensed fisher will be introduced.
- The season will be increased from 16 to 23 days.
- Hutt River will be managed as a 'trophy water', with a minimum size limit of 90 mm and a bag and possession limit of 5 marron per licensed fisher.
- The 'snare-only' requirement within the Warren National Park will be removed.
- In the Donnelly River downstream of Boat Landing, fishers will be permitted to carry marron drop nets and scoop nets by boat in order to access these relatively inaccessible sections of the river.
- The Shannon River will be closed to marron fishing.

These management arrangements will be subject to ongoing review.

EXTERNAL FACTORS

The three main external factors which affect the marron fishery are winter rainfall, access to dams, and introduced species.

Winter rainfall plays a major role in marron reproduction, growth and survival. Rainfall increases the quality of areas for marron by transporting leaf-litter into streams (providing food sources for marron growth and reproduction) and by maintaining water volume and quality. It may also affect the ease with which fishers can access the water bodies, reducing pre-season illegal fishing.

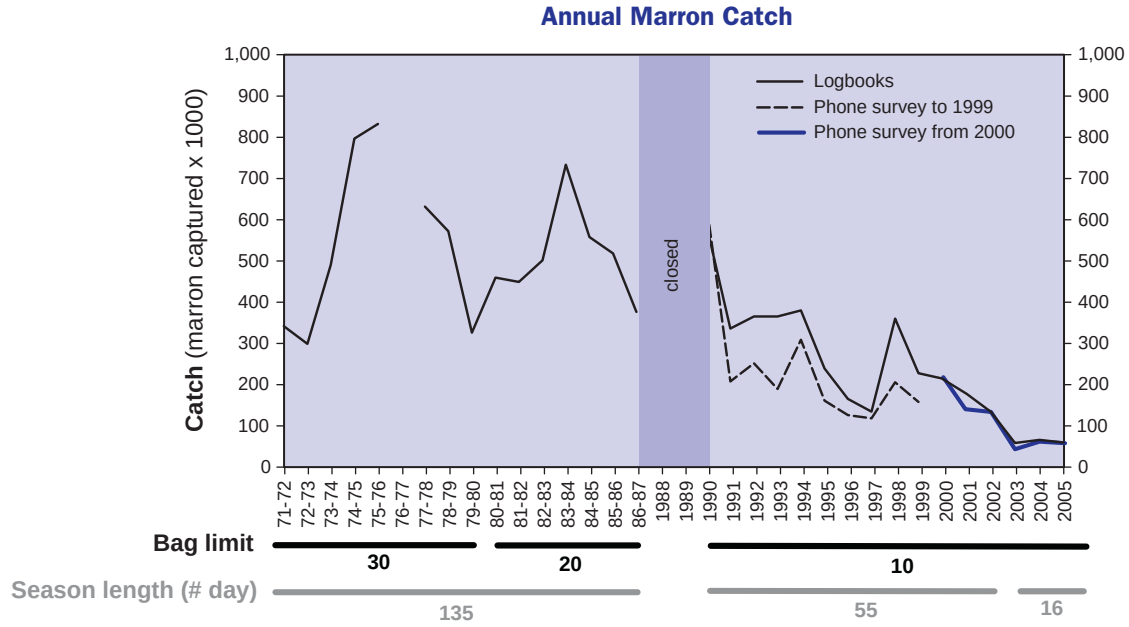
A second major issue in this fishery is continuing access to irrigation dams. The Water Corporation closed access to Stirling Dam in 2001 owing to the diversion of this water to the metropolitan water supply, and there is a strong possibility of limitations to fishing in Logue Brook and Wellington Dams in the near future. Waroona Dam was closed for several seasons for refurbishment, reopening to marron fishing in 2006. Drakesbrook Dam, the next in line for improvements, is expected to be unavailable for recreational marron fishing in 2008, 2009 and possibly 2010. The Department of Fisheries is working closely with the Water Corporation to ensure that refurbished and refilled irrigation dams will provide a high-quality marron fishery by

installing refuges, adding marron and controlling introduced species. Trials in Waroona Dam have shown that the rock walls provide an important refuge for juvenile marron.

The major introduced species that impact on the marron fishery are redfin perch (*Perca fluviatilis*), trout (*Oncorhynchus mykiss* and *Salmo trutta*) and yabbies (*Cherax albidus*). Redfin perch, which predate heavily on small marron, have been illegally stocked into most rivers and irrigation dams in the south-west. Redfin perch may be of greatest concern in irrigation dams, which generally have all structure (e.g. tree stumps) removed prior to filling and provide little shelter or protection for marron. Redfin perch control has been attempted at Waroona Dam as part of the refurbishment process.

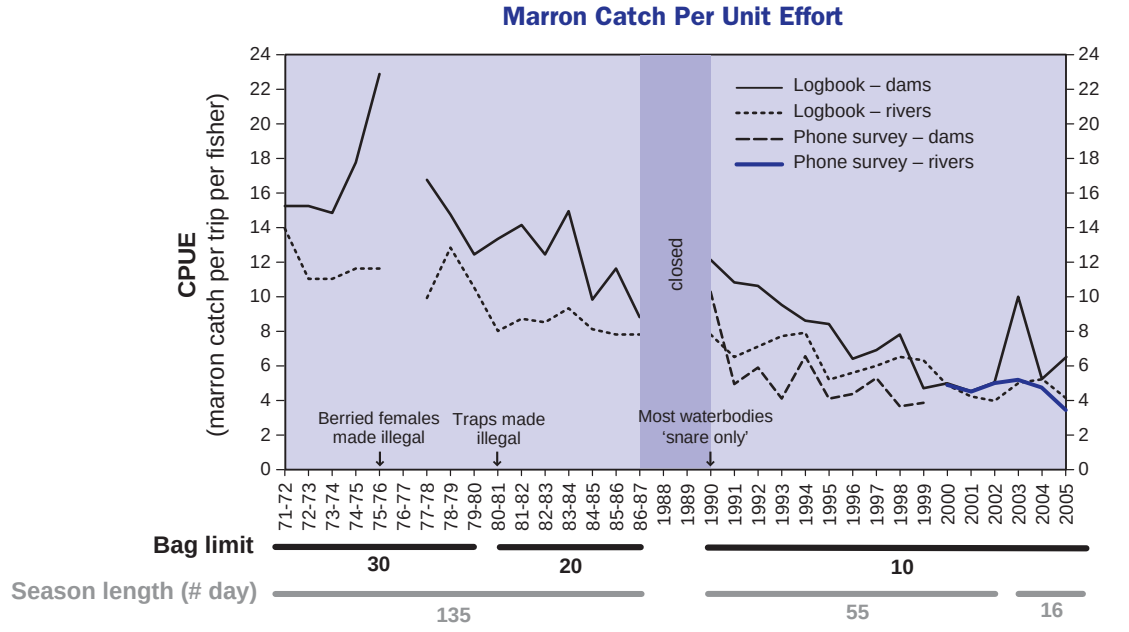
Trout also predate on marron, but to a much lesser extent than redfin perch due to the wider diet of trout, particularly rainbow trout, which prey predominantly on freshwater insects.

Yabbies, a direct competitor and a potential threat to marron, have been recorded from a number of areas within the marron recreational fishery, but at low abundances.



RECREATIONAL MARRON FIGURE 1

Estimated total catch in the recreational marron fishery from 1971 to 2005.



RECREATIONAL MARRON FIGURE 2

Catch per unit effort in the recreational marron fishery from 1971 to 2005.

Licensed South-West Recreational Freshwater Angling Status Report

M. de Graaf
Management input from C. Syers

FISHERY DESCRIPTION

The south-west recreational freshwater fishery is focused primarily on angling for rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), which are the subject of an annual controlled stocking program by the Department of Fisheries. In addition, anglers take the native freshwater cobbler (*Tandanus bostocki*) and an exotic species, redfin perch (*Perca fluviatilis*). Redfin perch were previously released in the south-west and now occur as self-breeding populations in most water bodies.

Licensed anglers may only use a single rod, reel and line or single handline to fish for these species.

Governing legislation/fishing authority

Fish Resources Management Regulations 1995 and subsidiary legislation
Recreational Fishing Licence

Consultation process

Recreational Freshwater Fisheries Stakeholder Subcommittee of the Recreational Fishing Advisory Committee

Boundaries

The south-west freshwater angling licence authorises anglers to fish for freshwater fish species (excluding crustaceans) in all inland waters of Western Australia south of latitude 29° S (Greenough) and above the tidal influence including all lakes, dams, rivers and their tributaries.

Management arrangements

Access to this fishery is controlled by licence, seasonal closures, minimum sizes and bag limits. All anglers in south-west fresh waters, except those under 16 years of age, require a recreational fishing licence (either a specific angling licence or an 'umbrella' licence covering all licensed recreational fisheries).

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 Serpentine, Murray, Blackwood, Donnelly and Warren Rivers, but is prohibited on the streams, brooks and tributaries flowing into these rivers. 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 and brown trout, together with a minimum legal size limit of 300 mm.

A daily bag limit of 40 applies to freshwater cobbler. No minimum legal size limit applies to this species. No bag limit or size limit applies to redfin perch, 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 native fauna and trout fry.

To improve the quality of the trout fishery, Waroona Dam and Logue Brook Dam are 'artificial lure only' (no bait). Reduced bag limits (2 trout per day) have also been established in these selected waters. This has had the effect of improving the quality of the trout fishery over the spring period.

The trout stocking program, administered by the Department of Fisheries in consultation with the Recreational Freshwater Fisheries Stakeholder Subcommittee, focuses on public waters where trout have been stocked or occurred since the 1930s. All trout stocked into public waters are produced at the Department's Pemberton Freshwater Research Centre.

Research summary

The Research Division of the Department of Fisheries produces and distributes trout fry, yearlings and excess broodstock to support the recreational trout fishery. In 2005 approximately 400,000 rainbow and 16,000 brown trout fry, 27,000 rainbow trout yearlings, and 2,200 rainbow and 460 brown trout broodstock, were stocked in selected public waters.

A limited survey of licence holders was performed for the 1998/99 season to obtain information on catch and effort within the fishery. Subsequently, an annual telephone survey commenced in 2001 and continues to provide regular information about this important recreational fishery.

In 2005/06 a small-scale trial log book program was initiated to provide more detailed catch and effort data for the different catchments in the south-west. In cooperation with recreational anglers, rainbow and brown trout were collected for diet analysis.

Research information from these projects and the annual report from the manager of the PFRC have been used to compile the following status report.

RETAINED SPECIES

Recreational catch estimate (season 2004/05): 37.9 tonnes

Landings

An estimated 37.9 ± 10.1 t of fish were landed in this fishery by recreational anglers in the 2004/05 season, including 31.3 t of retained fish (89,000 fish) and 6.6 t of captured and released fish (36,700 fish). The estimated catch was composed of 12,800 rainbow trout (3.5 t), 2,700 brown trout (0.7 t), 86,700 redfin perch (29.2 t), 2,400 native freshwater cobbler (0.8 t) and 21,100 black bream (3.7 t).

The reported catch is significantly higher (~150%) than for the previous season, when it was 15.1 t. The sharpest increase was observed in redfin perch, with landings of this species rising by over 200% compared to the previous season. Unfortunately the numbers of this harmful feral species returned to the water also increased by 170%.

Fishing effort

A large number of freshwater angling licences are sold annually. For the 2004/05 season, a total of 17,000 licences were sold, including umbrella licences (13,531). This represents little change from the 16,781 licences in 2003/04.

Estimates of fishing effort are based on telephone surveys of licence holders. Total effort was estimated at 28,000 days, a sharp increase (~37%) from the previous season (20,500 days).

Catch rate

A catch rate of 4.5 fish of all species per day was estimated for the 2004/05 season. This included 3.19 retained fish and 1.31 released fish per angler per day. This is significantly higher (~50%) than for the 2003/04 season (2.43 fish per angler per day, being 1.67 retained fish and 0.76 released fish per angler per day).

Commercial share: Nil

STOCK ASSESSMENT

Assessment complete: Preliminary

Survival of rainbow trout stocked as fry and yearlings has been assessed in Waroona Dam. Results indicated that survival of fry is negligible in the presence of moderate redfin perch densities, whereas survival rates of yearlings can be very high. The 2004/05 data indicate that the stock levels of both rainbow and brown trout, as indicated by catch rates and catches, improved compared to 2003/04.

Breeding stock levels: Not applicable

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 are dominant in all fresh waters. Little is currently known about the biology and abundance of the native freshwater cobbler; however, in 2006 the management arrangements for this species will be reviewed based on historical and recent scientific data.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

Protected species interaction: Low

Currently, only one species of south-west native fish, the western trout minnow (*Galaxias truttaceus hesperius*), is protected (Wildlife Conservation Notice 2005, Schedule 1: Fauna that is rare or is likely to become extinct). In areas where issues concerning the interaction of trout and native fish have been raised, trout stocking has ceased (Margaret River 1998, Bancell Brook 2004). The likely effects of trout and redfin perch on the endemic fishes of the south-west are discussed under 'Food chain effects' below. Recent research data indicate that redfin perch have the biggest impact on native fishes and crayfishes.

ECOSYSTEM EFFECTS

Food chain effects: Moderate

The major environmental risk in this fishery relates to the spread of the introduced redfin perch. Redfin perch consume juvenile trout, native fishes and crayfishes (including marron). Further, redfin perch breed throughout the fishery and are the most dominant fish in this region, leading to stunted fish with little or no angling value in many water bodies. While the release of redfin perch is not illegal, the Department of Fisheries' education program strongly encourages anglers to retain any redfin perch caught, regardless of size. Telephone survey data indicate that the release rates of redfin by licensed anglers have been low in recent years, suggesting angler support for this initiative. However, in 2004/05 the number of released redfin perch increased sharply from 2,500 in 2003/04 to 6,700. This undesirable increase justifies an enhanced educational campaign to increase the awareness among recreational fishermen that redfin perch have a negative impact on native fish and crayfish (especially marron) stocks.

Rainbow and brown trout are also introduced species but have much broader diets than redfin. For example, rainbow trout consume many species of aquatic insects. Further, the reproduction of trout in the wild in Western Australia is minimal due to lack of suitable spawning sites. The numbers of trout can therefore be controlled by regulating the quantities of hatchery-produced fish stocked. Currently, trout are stocked in only 25 locations and not throughout the entire range of fresh waters in the south-west. Thus, although trout are also predatory fishes, the lack of natural reproduction and their broader diet means they are more controllable than redfin perch and are thus more acceptable as an introduced recreational species. Furthermore, the majority of stocked systems also contain redfin perch populations.

Habitat effects: Negligible

The impact of this fishery on the aquatic habitat is negligible.

SOCIAL EFFECTS

Recreational angling in 2004/05 involved approximately 3,500 licence holders undertaking 28,000 days of fishing, and provided an important recreational activity in south-west regional areas.

ECONOMIC EFFECTS

The fishery operates in the south-west and is a significant tourist attraction for the region, generating valuable income for regional centres. There are also a number of pay-for-fishing operators who target the tourist market. The licence sales contributed approximately $230,000 of revenue, which is used to support breeding, stocking, research, management and monitoring activities.

FISHERY GOVERNANCE

New management initiatives (2005/06)

A Recreational Freshwater Fisheries Stakeholder Subcommittee (RFFSS) of the Recreational Fishing Advisory Committee was established in 2004 to develop a five-year strategy for the management of the state's south-west recreational freshwater fisheries and provide advice on ongoing monitoring and adaptive management of the trout and marron fisheries. The RFFSS has assumed the role of the former trout stocking committee in the development of trout stocking strategies for the fishery.

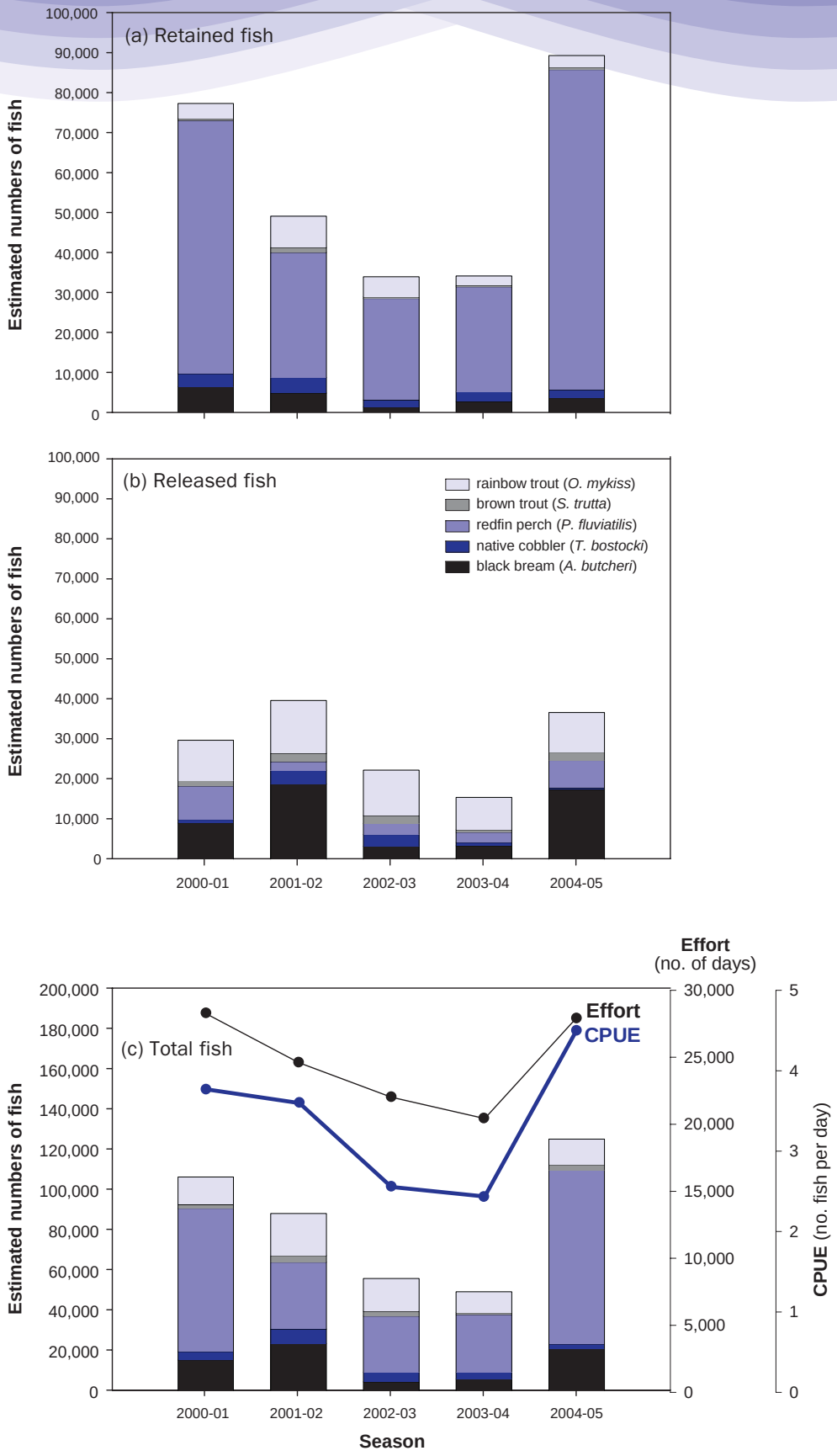
The RFFSS will commence a review of the management arrangements for freshwater angling in the state's south-west in 2006. One focus of this review will be the management arrangements (size limits, bag limits etc.) for the native cobbler based on the available historical and recent scientific data.

EXTERNAL FACTORS

The extent and success of the freshwater angling fishery in the south-west is dependent mainly upon availability of high-quality fresh water for stocking. The degraded nature (e.g. increased salinity) of many freshwater streams and rivers, coupled with the effects of climate change (e.g. low rainfall leading to reduced flow and water levels), are having a strong negative influence on the fishery.

A further issue is continuing access to irrigation dams, as the management objectives of these waters change from irrigation and recreation to irrigation and/or public drinking water supply. The Water Corporation closed access to Stirling Dam in 2001 owing to the diversion of this water to the metropolitan water supply, and there is a strong possibility of limitations to fishing in Logue Brook and Wellington Dams in the near future. Waroona Dam underwent refurbishment and stocking commenced in 2004 to provide angling opportunities for the 2004/05 season. Drakesbrook Dam, the next in line for improvements, is expected to be unavailable for recreational angling for at least one season. The Department of Fisheries is working closely with the Water Corporation to reduce the impacts to recreational fishing by enhancing stocks in refurbished and refilled irrigation dams.

The intermittent flow and general condition of most rivers make many areas in the south-west unsuitable for trout. Livestock access, cleared banks and de-snagging of streams all reduce the quality of the stream for trout and other aquatic species. Rehabilitation projects in the USA have produced better stream quality and better angling, and similar initiatives may be considered in Western Australia, particularly in irrigation dams.



FRESH WATER ANGLING FIGURE 1

Estimates of the total numbers of fishes retained (a) or released (b) in the south-west freshwater angling fishery since 2000/01, and the development of total catch, effort and CPUE (c).

AQUACULTURE

Regional Research and Development Overview

The three key areas of aquaculture research in this region are FRDC-funded marron husbandry and selective breeding research; captive breeding programs for conserving endangered native fish and crayfish; and evaluation of the use of grains in aquaculture feeds.

The FRDC-funded marron research program, involving some of the largest aquaculture experiments undertaken by the Department of Fisheries, was completed successfully this year. Researchers worked with commercial farmers in WA and South Australia to conduct 44 commercial farm grow-outs involving over 147,000 animals grown from juveniles through to sexual maturity and harvest size. Combined with experiments at the Department's research facilities at Pemberton and Shenton Park, this project demonstrated the commercial viability of marron farming and increased the growth rate of marron by 100% through selective breeding.

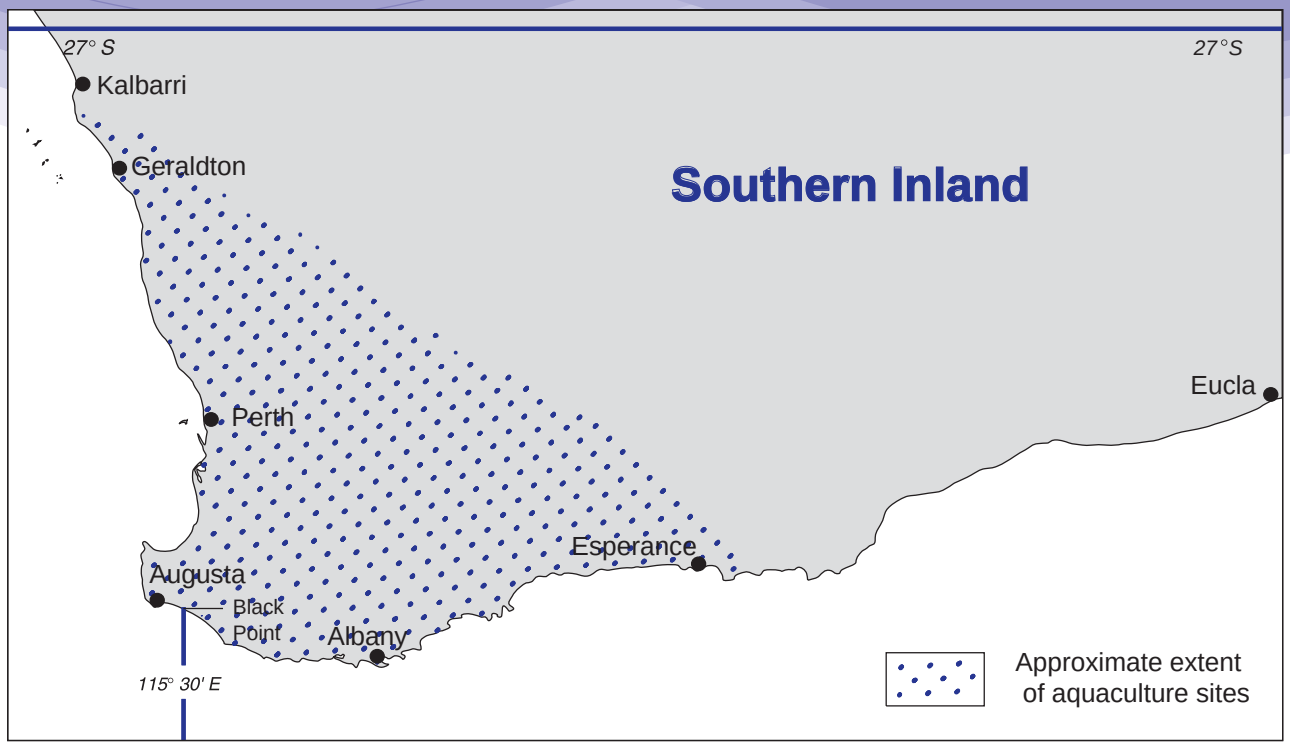
Research Division staff worked with industry, university collaborators, FRDC and external funders to develop a rapid, low-cost commercialisation strategy. This resulted in over 10,000 elite breeding stock being distributed to industry by the Department via a tender process within six months of the project's conclusion.

Industry uptake of the technology developed through this project has also been enthusiastic, largely due to the ongoing extension role of the Research Division staff. In 2005/06 this has included providing staff expertise for industry workshops, demonstrating techniques at field days, conducting industry research seminars and open days, providing advice to new farmers, and working with existing farmers to develop software for farm data management.

The Department's captive breeding program to conserve native fish and crayfish biodiversity in the southern inland bioregion successfully bred the critically endangered Margaret River marron in research ponds at the Pemberton Freshwater Research Centre. The progeny from this project, funded by the Natural Heritage Trust through the South West Catchments Council, will be reared to sexual maturity, spawned, and their progeny used to restock the Margaret River. In addition, the Department established captive populations of other endangered and vulnerable native fish and crayfish at PFRC and Shenton Park Aquaculture Laboratory. Aquaculture techniques that have previously been used to produce commercial species are now being applied by this research group to prevent extinction of key freshwater species in Western Australia.

A major collaborative project in association with the Department of Agriculture and Food, the University of Western Australia and feeds production and grain processing companies, with funding support from the Grains Research and Development Corporation, has continued the quality assessment of local agricultural products such as lupins and canola in aquaculture feeds. Much of the product evaluation work is being conducted at the Pemberton Freshwater Research Centre in a purpose-built, temperature-controlled finfish nutrition research system. Rainbow trout continues to be used as the main test species to fast-track the quality assessment process, which is part of a major national R&D program led by the Department of Fisheries. Complementary research, funded by the FRDC, is being conducted with interstate researchers using Atlantic salmon (*Salmo salar*) and black tiger prawns (*Penaeus monodon*), as there are larger aquaculture industries for these species in Australia. As well as undertaking feeding trials, considerable effort has gone into assessing the influence of feed grains on the aquaculture feed extrusion manufacturing process, as well as their physical processing properties such as milling, storage and transport characteristics. Considerable promotional work to the domestic and international markets has also been undertaken to encourage industry adoption of these feed grains.

The Aquaculture Development Council has commenced a project aimed at identifying suitable sites for inland aquaculture in Western Australia. The outcomes of this project will provide significant insight into the potential for such an industry as well as guidance for potential aquaculturists with an interest in this type of aquaculture.



SOUTHERN INLAND AQUACULTURE FIGURE 1
Map showing the approximate extent of aquaculture sites in the southern inland bioregion.

Marron Farming Status Report

C. Lawrence and S. How

INDUSTRY DESCRIPTION

Production methods

The majority of marron (*Cherax tenuimanus*) farming occurs in purpose-built earthen ponds. These ponds average 1,000 m2 in surface area and each pond is equipped with aeration, water supply and a drain to facilitate harvesting. Research by the Department of Fisheries has established the criteria essential for optimising production from commercial marron farms. These correctly designed, well constructed and professionally managed farms are responsible for the majority of marron production, with over 50% of WA marron production coming from the most productive 10% of marron farmers. Some gully dams are also used for farming marron, however these can only sustain much lower feed rates, stocking densities and yields.

Production areas

Licensed purpose-built farms for marron extend from Esperance to Hutt River north of Geraldton. The majority of farms are, however, concentrated in the higher-rainfall south-west coastal areas. Potential exists to expand production by the utilisation of irrigation dam water in transit to agricultural farms on the south-west coastal plain.

Management arrangements

Licence approvals are required to farm marron. Two types of marron licence are available.

- An Aquaculture Licence (Marron) allows the holder to sell marron of any size to any person. Applicants must demonstrate that they own or occupy private property with a minimum of 2,500 m^2 of impounded water available for marron aquaculture purposes.
- An Aquaculture Licence (Marron Limited) allows the licence holder to sell marron of 76 mm carapace length or greater to the holder of a Fish Processor's Licence or an Aquaculture Licence (Marron).

AQUACULTURE PRODUCTION

Production current year (2004/05): 56 tonnes

Number of producers for year 2004/05: 189

Production projection next year (2005/06): 60 tonnes

Marron production increased by 12% in 2004/05 (Marron Farming Figure 1). This was due to an additional 13 new farms commencing production during the year. Supply of marron is still insufficient to meet market demand, resulting in a 23% increase in the price received by producers.

A significant number of purpose-built marron farms have been developed, and other existing farms have constructed more ponds. This should progressively contribute to

expansion in state production, as will ongoing improvements in husbandry and selective breeding to improve growth rates. However, while some farmers have recognised the need for better stock management and feeding practices, production may not improve at some farms unless efficient aeration techniques are used to support increased pond biomass. Commercialisation of faster growing marron from Department of Fisheries selective breeding research will address the industry problem of poor broodstock selection which has led to a steady decline in growth rates.

ECOSYSTEM EFFECTS

Marron farms present a low risk to the environment because there is relatively little water discharged from these facilities. The nutrient input from feeds, per unit pond area, is also relatively low because of the use of efficient feeding strategies and feeds of relatively low nutrient content, particularly nitrogen and phosphorus. The Department of Fisheries recommends treating discharge water using settlement and reed ponds to improve the quality of this water for discharge or reuse on the farm. A demonstration facility including settlement and reed ponds has operated well at the PFRC and this technology is now being adopted by industry.

As marron farms currently experience few disease problems, they pose little immediate threat to the health of wild stocks.

SOCIAL EFFECTS

There are more marron farms than any other type of licensed aquaculture venture in Western Australia. The industry has the potential to provide significant regional employment as production increases. Increasingly, marron farms are being constructed to allow diversification of farm usage away from other, sometimes unprofitable or less profitable, agricultural uses.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2004/05: $1.3 million*

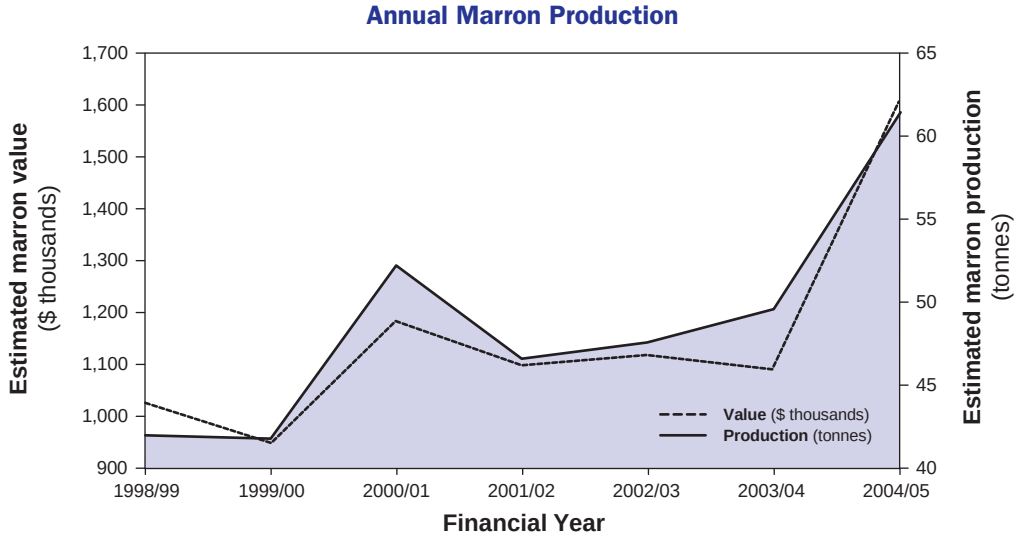
Even though there has been considerable competition with other luxury crustacean products, ex-farm market price for marron has risen to an average farm gate value of $24/kg in 2004/05 (Marron Farming Figure 1).

* Note that this estimate excludes ornamental marron.

EXTERNAL FACTORS

Development of a new farm to full production usually requires around three years and, for most farms, production is influenced by rainfall. The reliance upon often inconsistent rainfall to fill dams on commercial farms has contributed to renewed interest in both the utilisation of irrigation dam water on the south-west coastal plain for marron farming and the use of water reuse systems.

An external factor of concern to the marron industry is the potential for agricultural chemicals, applied by aerial spraying or use of ground-based misters, to impact on adjacent marron farms or natural waterways. The rapid expansion of tree farms and vineyards in the southern inland bioregion has heightened these concerns. A literature search by research staff has indicated limited relevant information on the toxicity of the chemicals used, particularly alpha-cypermethrin, to freshwater crayfish. Joint codes of conduct are needed with such industries to help minimise the risks.



MARRON FARMING FIGURE 1

Estimated marron production and value from 1998/99 to 2004/05.

Yabby Farming Status Report

C. Lawrence and S. How

INDUSTRY DESCRIPTION

Production method

Yabbies (*Cherax albidus*) are farmed in stock watering dams. In these dams yabbies require minimal management other than supplementary feeding and harvesting by baited traps. Although yields per dam are relatively low, the combined production from a large number of farmers results in a significant form of farm diversification.

Production areas

Yabbies are an introduced species and so for translocation reasons, the licensed commercial yabby farming industry is restricted to the drier inland agricultural areas of the south-west. Commercial yabby farming is only permitted to the north and east of the 'yabby boundary', which approximately follows the direct line from Perth to Albany.

Management arrangements

Licence approvals are required for yabby processors and commercial harvesters. Agricultural farms may sell yabbies without a licence to licensed farmers/processors.

AQUACULTURE PRODUCTION

Production current year (2004/05): 73 tonnes

Number of producers for year 2004/05: 14

This number refers to licensed farmers or processors. Note most farmers do not require licences.

Production projection next year (2005/06): 75 tonnes

While yabby production has not recovered from the major decline in 2001/02 that coincided with low rainfall and high commodity prices, it has stabilised at a level of around 70–80 t/year (Yabby Farming Figure 1).

ECOSYSTEM EFFECTS

Yabby farming presents a low risk to the environment because negligible amounts of water are discharged from farm dams, whose primary purpose is the provision of water for stock. Nutrient inputs into dams are also very low because of the low feed rates used. Because the yabby farming industry is located away from the marron zone, it poses little threat to marron fisheries, which are more at risk from landholders within the marron zone stocking yabbies in dams on a non-commercial basis. Research has also shown that the current commercial yabby stocks are not destructive burrowers, but rather build shallow burrows. However, yabbies can suffer from the microsporidian *Thelohania* and this may pose a risk to native freshwater crayfish stocks if they escape from farm dams.

SOCIAL EFFECTS

On-farm management of yabby stocks is generally undertaken by women and teenagers who, through yabby harvesting, generate a small but valuable income for a large number of agricultural households. Yabby processors also provide useful regional employment.

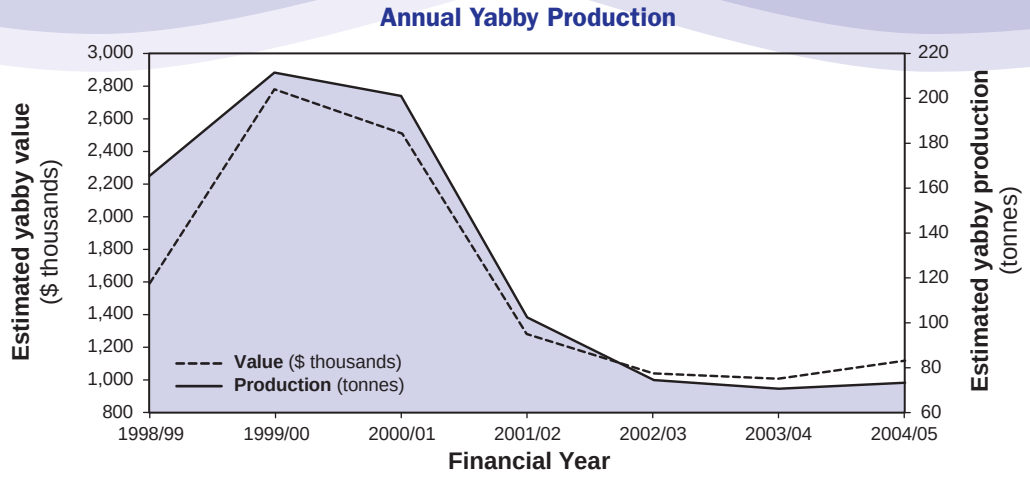
ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2004/05: $1.1 million

Even in the presence of competition from other luxury crustaceans, the market price for yabbies has increased to an average farm gate value of $15/kg, most likely due to a combination of reduced supply and the farming of larger and therefore more valuable yabbies. Farmers have continued to harvest yabbies through the winter, resulting in a more even distribution of production throughout 2004/05.

EXTERNAL FACTORS

Commodity prices for alternative products from wheatbelt farms have a significant influence upon yabby production. Drought is also a key issue as most farmers rely on surface runoff to fill stock watering dams. Owing to the lower farm gate value for yabbies ($15/kg compared to $24/kg for marron), few purpose-built yabby ponds are used. As dam volumes decline, more intensive management can sustain yields, but eventually the yabbies are forced to use the dam floor in shallow water where organic matter accumulates and creates an unfavourable environment for their survival, particularly on warm days.



YABBY FARMING FIGURE 1
Estimated yabby production and value from 1998/99 to 2004/05.

Trout Farming Status Report

C. Lawrence and S. How

INDUSTRY DESCRIPTION

Production methods

Two species of trout are produced in Western Australia. Rainbow trout (*Oncorhynchus mykiss*) are farmed in purpose-built ponds and tanks for the food market. In addition, both rainbow trout and brown trout (*Salmo trutta*) are stocked in large gully dams and ponds for pay fishing by recreational fishers and tourists. More recently, some farmers located in salt-affected regions have trialled trout production in ponds supplied with saline groundwater or installed floating cages on saline waterbodies.

Production areas

Intensive culture of trout is confined to the lower south-west by summer water temperatures and limited by the need for a large throughput volume of water. Potential exists to expand production by the utilisation of irrigation dam water in transit to agricultural farms on the south-west coastal plain. In addition, inland farmers with saline water are evaluating the performance of rainbow trout, stocked as yearlings and grown out in dams, ponds or cages during cooler months.

Management arrangements

An aquaculture licence is required by trout producers, though not by small inland saline farmers. Translocation approval can also be a requirement.

AQUACULTURE PRODUCTION

Production current year (2004/05): 22 tonnes

Number of producers for year 2004/05: 13

Production projection next year (2005/06):30 tonnes

In 2004/05 trout production increased by 37% (Trout Farming Figure 1). This increase in production can be partially attributed to three new farms commencing production during the year, but is more likely a sign of industry recovery following the 44% decrease in production in 2003/04.

ECOSYSTEM EFFECTS

Trout farming is considered to present a low to medium risk to the environment. Farms producing more than 1 t of fish annually require discharge licensing including monitoring of water quality. The Department of Fisheries recommends use of swirl separators to improve the quality of this discharge prior to release or reuse. A demonstration facility, including a swirl separator, settlement pond and reed pond for stripping nutrients, has operated well at the PFRC. Inland saline trials usually involve little discharge. However, farms developed in the future to utilise high flow rates of pumped underground saline water for rearing trout in ponds or raceways can use swirl separators to improve water quality prior to reuse or discharge.

Trout farms pose a low risk to public waterways as inadvertent release of large numbers of fish from land-based farms is unlikely and there are few localities in Western Australia where escapees could reproduce.

SOCIAL EFFECTS

Recreational pay fishing for trout is a significant contributor to the tourism industry in the south-west region. Inland saline trout production may have potential for improving returns from salt-affected land, but production is still highly dependent on rainfall.

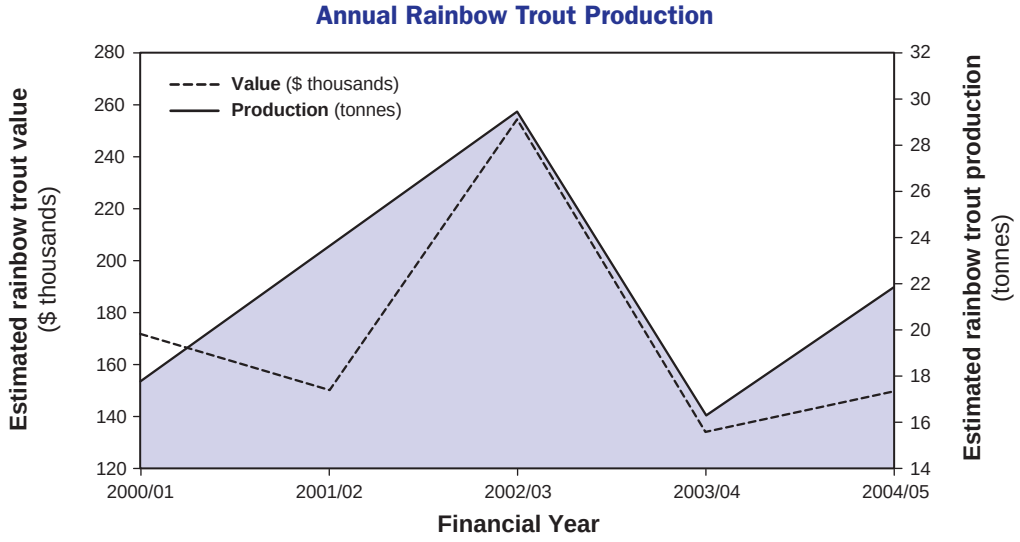
ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2004/05: $149,000*

Internationally, prices for farmed trout and salmon (salmonids) are being depressed by massive increases in production, particularly in Norway and Chile. Domestic trout prices, particularly for frozen product, are restricted by competition from large-scale producers, especially by those in Victoria. Nonetheless, distance from other producers provides some degree of protection for the Western Australian industry from national and global suppliers.

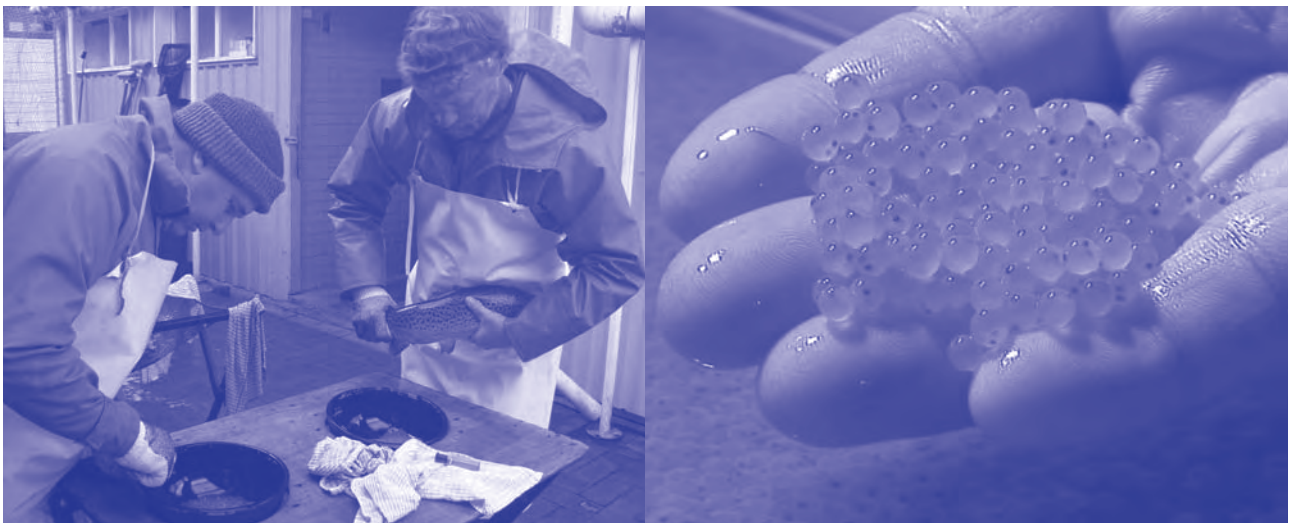
The PFRC trout hatchery provides support for the commercial trout farming industry as a by-product of producing trout fry for recreational stocking programs. Fry and yearlings are also supplied to private buyers who stock private dams within tourist complexes. Trout sold via tourist fishing ventures do not usually appear within the commercial production records, although they add significant commercial benefits to that sector and the regional economy. There is a trend for major trout producers to move towards tourist fishing ventures, effectively 'adding value' to the trout grown in these systems. While there is no reliable method of estimating the value of this sector, its tourism value within the south-west may exceed that of the trout grown for the general fish market trade.

* Note this estimate includes the value of yearlings provided to inland saline farmers but not production by these farmers, as the smaller farms are not licensed and hence do not provide aquaculture



TROUT FARMING FIGURE 1

Estimated rainbow trout production and value from 2000/01 to 2004/05.



returns.

Silver Perch Farming Status Report

C. Lawrence and S. How

INDUSTRY DESCRIPTION

Production method

Silver perch (*Bidyanus bidyanus*) are farmed in purpose-built earthen ponds. These ponds are equipped with aeration, water supply and a drain to facilitate harvesting.

Production areas

Silver perch is an introduced species from the Murray–Darling region and so for translocation reasons, the licensed commercial silver perch farming industry is restricted to individually approved sites.

Management arrangements

A licence is required to farm silver perch and approval is based on assessment of individual sites, particularly in relation to risk of escape into natural waterways.

AQUACULTURE PRODUCTION

Production current year (2004/05): 20 tonnes

Number of producers for year 2004/05: 10

Production projection next year (2005/06): 30 tonnes

While the industry was limited by availability of imported juveniles in earlier years, local juvenile production has now increased to meet demand. This is largely due to the adoption by industry, with the assistance of the Department of Fisheries, of spawning techniques developed by researchers in New South Wales.

After several years of consistent growth, silver perch production decreased by 48% in 2004/05 (Silver Perch Farming Figure 1). This decrease in production may be partially attributed to three farms ceasing production during the year.

ECOSYSTEM EFFECTS

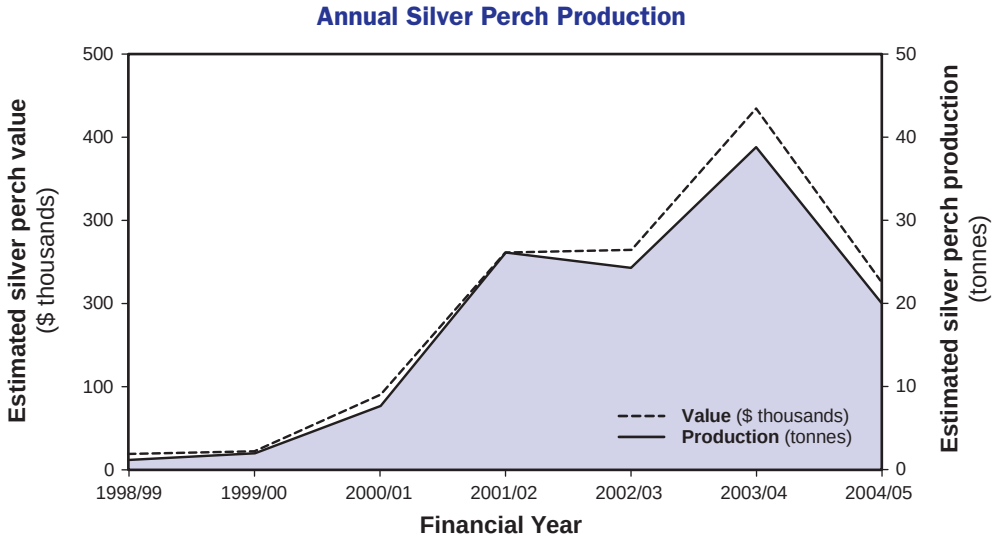
Silver perch farming presents a low risk to the environment as much less water is discharged from these farm dams than from an intensive trout farm. Farms producing more than 1 t of fish annually require discharge licensing including monitoring of water quality. The Department of Fisheries recommends use of swirl separators to improve the quality of this discharge prior to release or reuse. A demonstration facility, including a swirl separator, settlement pond and reed pond for stripping nutrients, has operated well at the PFRC. Silver perch may pose a risk to native fauna stocks if they escape from farm dams and for this reason individual site inspections can be required prior to licensing a farm.

SOCIAL EFFECTS

Silver perch farming allows diversification of farm usage away from other, sometimes unprofitable, agricultural uses.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year



SILVER PERCH FARMING FIGURE 1

Estimated silver perch production and value from 1998/99 to 2004/05.

2004/05: $225,000

Ornamental Fish Farming Status Report

C. Lawrence and S. How

INDUSTRY DESCRIPTION

Production methods

Dedicated small ponds and aquaria are used to breed ornamental finfish and crustaceans and rear juveniles for live sales.

Production areas

Production occurs throughout the state, but is mainly focused in metropolitan areas adjacent to the main markets. Both native and non-native species are produced.

Management arrangements

Specific licence approvals are needed for commercial production.

AQUACULTURE PRODUCTION

Production current year (2004/05): 126,600 fish

Number of producers for year 2004/05: 25

Production projection next year (2005/06): 100,000–300,000 fish

Annual commercial production recorded for this sector indicates considerable volatility in production and prices for major aquarium fish groups (Ornamental Fish Farming Figure 1). This year production of ornamental native fish continued to decrease (down 62%), with a parallel decline in ornamental non-native fish (down 65%). In contrast, goldfish production increased by 15%, koi carp increased by 64% and ornamental crustaceans increased by 40%. Such fluctuations can result from the production and marketing strategies of individual farms. Larger farms interstate may compete intensively with local producers, or if interstate production is depressed for key species, an interstate marketing opportunity is created for local producers. Since 2001/02, ornamental marron have been included in this production sector, and these are now a significant component of the total value of production for the sector.

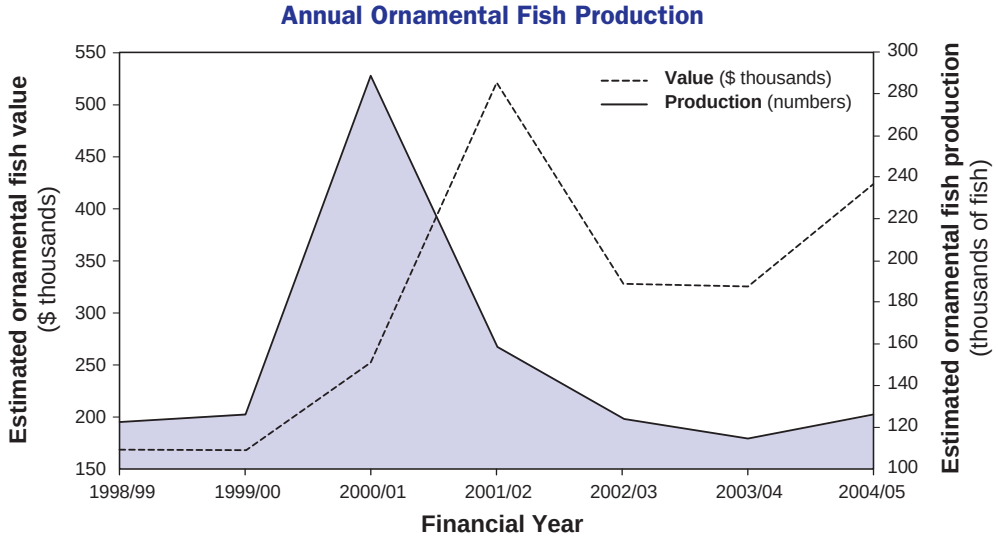
ECOSYSTEM EFFECTS

Ornamental fish farming is considered to present a low risk to the environment because there is relatively little water discharged from ornamental fish farms. Operators are required to ensure that stock does not escape into natural waterways.

SOCIAL EFFECTS

This industry provides part-time employment for numerous small-scale producers and has potential as a form of farm diversification for future entrants to the industry.

ECONOMIC EFFECTS



ORNAMENTAL FISH FARMING FIGURE 1

Estimated ornamental fish production and value from 1998/99 to 2004/05. (The ornamental fish category includes ornamental native and non-native fish, koi carp and goldfish. Ornamental crustaceans are included in the production years 2001/02 to 2004/05.)

COMPLIANCE AND COMMUNITY EDUCATION

Fisheries and Marine Officers based in Geraldton, Dongara, Jurien, Lancelin, Hillarys, Fremantle, Rockingham, Mandurah, Bunbury, Busselton, Albany and Esperance conduct recreational fishing compliance and education activities in the southern inland bioregion.

The Volunteer Fisheries Liaison Officer program is a vital education mechanism in the southern inland region. Although the program is based in major coastal centres, the program is particularly utilised prior to and during the marron season to conduct peer-to-peer education. However, as the records of VFLO contacts do not differentiate between coastal and inland activities, their statistics have been included in the table for the south coast bioregion.

The highest risk of non-compliance in the southern inland bioregion is within the recreational marron fishery. As the open season lasts for just 16 days, the risk of illegal fishing during the closed season (February–December) is extremely high. Increasingly, dams and catchment areas once open to marroning are being closed by the Water Corporation, which presents further challenges to ensure compliance in these areas. During the open marron season illegal activities such as the use of scoop and drop nets in 'snare only' waters, the taking of under-size marron, and exceeding possession limits in trophy waters such as Harvey Weir, are a focus of compliance activities.

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 licence, and the taking of trout during the closed season.

Activities during 2004/05

During 2004/05 Fisheries and Marine Officers delivered 1,652 hours of compliance services to recreational fisheries in the bioregion (Southern Inland Compliance Table 1), achieving 1,717 field contacts with recreational fishers. Officers conducted patrols throughout the region in vehicles, dinghies and canoes.

During the year 18 infringement warnings and 15 infringement notices were issued and 9 prosecutions were instigated. The marron fishery continues to be the major focus for the compliance and education program in this bioregion. The recreational mobile patrol in this region again greatly assisted with service delivery to this fishery. Officers continued to conduct joint patrols with police to address the issue of the theft of marron from dams on private property and licensed aquaculture dams.

During this year the Community Education Officer was appointed a member of the Margaret River Marron Recovery Team. In consultation with Departmental research staff, other government agencies, and the Cape-to-Cape Catchments Group, a community fish-out event was conducted in February 2005 and a field identification guide was produced distinguishing between 'smooth marron' and Margaret River marron.

Initiatives for 2005/06

For the 2006 marron season, compliance activities were developed from an enhanced risk assessment process which was used to identify non-compliant 'hot-spots'. The interpretive program for marron has also been expanded, with workshops conducted by the regional Community Education Officer in Margaret River and Nannup involving 60 community participants.

To support the conservation of the Margaret River marron, new signage has been developed and installed in the upper reaches of the catchment which are closed to marroning. Departmental staff have also met with representatives from the Water Corporation and the Department of Environment and Conservation to discuss and coordinate compliance issues in this area.

SOUTHERN INLAND COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types within the southern inland bioregion during the 2004/05 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	*NUMBER*
Hours delivered in bioregion	1,652
Fisher field contacts by Fisheries Officers	1,717
District Office contacts by Fisheries Officers	2,241
OFFENCES DETECTED	
Infringement warnings	18
Infringement notices	15
Prosecutions	9

Statewide Fisheries

COMMERCIAL FISHERIES

Marine Aquarium Fish Managed Fishery Status Report

S. Newman and M. Cliff
Management input from S. Brand-Gardner

FISHERY DESCRIPTION

The Marine Aquarium Fish Managed Fishery (MAF) targets more than 250 species of fish under the management plan. By way of endorsement, fishermen also take coral, algae, 'live rock' (rock with live marine organisms growing on it), 'live sand' (sand containing live organisms), 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.

Governing legislation/fishing authority

Marine Aquarium Fish Management Plan 1995
Marine Aquarium Fish Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Department–industry meetings

Boundaries

The MAF operates in Western Australia's state waters spanning the coastline from the Northern Territory border in the north to the South Australian border in the south. The effort is spread over a total gazetted area of 20,781 km. Over the past few years the fishery has been active in waters from Esperance to Broome with popular areas being Perth to Busselton, Karratha to Port Hedland, the Gascoyne region and Albany.

Management arrangements

This fishery is managed primarily through input controls in the form of limited entry to the fishery and permanent closed areas. There are 13 licences in the fishery and in most years all licences are actively used.

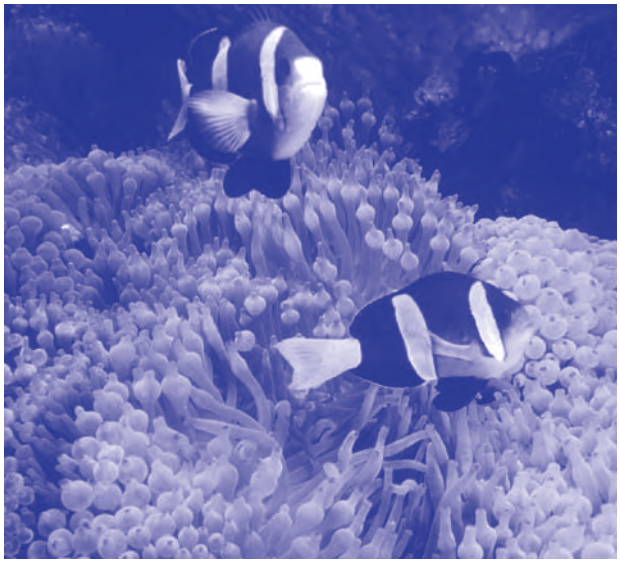
Licensees are not permitted to operate within any waters closed to fishing (e.g. Rowley Shoals, Reef Observation Areas, sanctuary zones in marine parks). Fishing is also prohibited on Cleaverville Reef to exclude the take of coral and associated organisms. The fishery is permitted to operate in general-purpose zones of marine parks for the collection of fish and some invertebrates (usually excluding coral and live rock).

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 species from the syngnathid family (seahorses and pipefish), which are listed under the *Environment Protection and Biodiversity Conservation Act 1999*, up to an annual limit of 750 (all species) set by the Australian Government Department of Environment and Heritage. However, there is a total ban on the take of leafy seadragons (*Phycodurus eques*).

Research summary

Information provided by the fishery in the form of statutory monthly catch and effort returns is used as the basis to provide research advice for fisheries management. Statutory catch and effort reporting at the fine spatial scale of 10 minutes of latitude and longitude commenced in September of 2004.



RETAINED SPECIES

Commercial production (season 2005): 28,936 fish

Landings

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 2005 levels of catch is provided in Marine Aquarium Fish Table 1. The reported landings of aquarium fish for 2005 are lower than the previous year. This reduction is partially explained by a change in the suite of species targeted by some of the fishers.

Fishing effort/access level

Effort in the fishery has been relatively stable over the past three years at an average of 862 days fished, with nearly all licensees reporting some level of activity. Effort in the fishery is concentrated in discrete areas adjacent to the limited number of boat landing sites along the Western Australian coastline.

Given that the specimens are collected for a live market, licensees are restricted in terms of the quantities that they can safely handle and transport (for example, by boat to shore, by vehicle to the holding facility and then on to the retailer) without impacting on the quality of the product. The size of the holding facility and access to regular freight and infrastructure services (such as airports, particularly in the remote northern locations of WA) restricts the levels of effort that can be expended in the fishery at any given time.

Catch rate

Not applicable.

Recreational component: **Not assessed**

There is no documented recreational fishery. If members of the public wish to collect specimens for their own private aquariums they are permitted to do so, but are restricted to normal recreational bag limits and, for some species, size limits. There is a complete ban on the recreational take of coral and totally protected fish such as leafy seadragons.

STOCK ASSESSMENT

Assessment complete: **Not assessed**

Breeding stock levels: **Adequate**

The operating extent of the fishery is low relative to the widespread distribution of the plethora of species targeted. No other fisheries exploit these species and therefore there is no potential for impact on breeding stocks.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

Divers in the MAF use hand-held nets to capture desired target species. As a result of these highly selective fishing methods, there is no bycatch in this fishery.

Protected species interaction: **Negligible**

The MAF is permitted to take syngnathids (excluding leafy seadragons) up to an annual limit of 750. The reported catch of syngnathids in 2005 was 480.

The fishery has retained at least fourteen species of syngnathids, although only five are generally targeted: the Western Australian seahorse (*Hippocampus elongatus*), the western spiny seahorse (*Hippocampus angustus*), common or weedy seadragon (*Phyllopteryx taeniolatus*), knobby seahorse (*Hippocampus tuberculatus*) and spotted pipefish (*Stigmatopora argus*). These species are widely distributed in Western Australian waters and occur in both shallow and deep waters in both urban and remote locations. It is estimated that 80% of populations occur in areas that receive little to no impact from fishing. While in general, some species of syngnathids may be vulnerable to over-fishing because they reproduce relatively slowly, have low rates of dispersal and are highly habitat-dependent, there is no evidence of decline for any syngnathid species retained by the MAF (Pogonowski et al. 2002).

ECOSYSTEM EFFECTS

Food chain effects: **Negligible**

Habitat effects: **Negligible**

There is a small risk of localised depletion of some hard coral species in one northern area. However, the risk to any one species is very small because the area involved represents much less than 1% of the total distribution of these species groups. Moreover, the natural impacts on these corals from frequent storms are likely to be far greater than any impact resulting from collection by the fishery. Overall, the risks to the habitat from this fishery are assessed as negligible.

SOCIAL EFFECTS

Under clauses 9 and 10 of the Marine Aquarium Fish Management Plan 1995, a licensee (or his nominated operator) may fish with two nominated divers, thus permitting up to three persons to fish on each licence at any one time. While most licensees dive alone, some like to use the full complement of crew, indicating that anywhere from 13 to 39 people are directly employed in the fishery. Another aspect to the social effects of this fishery is increased awareness of marine ecosystems through the provision of specimens for public and private aquariums.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2004: **Not assessed**

FISHERY GOVERNANCE

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

New management initiatives (2005/06)

The management plan for the MAF is currently under review. Among the changes under consideration is more equitable

access for all licensees to collect invertebrates, coral and 'live rock'.

As an interim measure, through a Ministerial Exemption granted on 29 April 2005, all licensees have been given access to a restricted list of, and restricted numbers of, invertebrates including sea slugs, sea cucumbers, clams, sea stars, brittle stars, sea squirts, anemones, crabs, shrimps, worms and algae.

In October 2005, the Australian Government Department of Environment and Heritage declared the fishery a Wildlife Trade Operation under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a number of conditions, this certification allows product from the fishery to be exported from Australia for a period of three years before reassessment.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Managed Fishery and associated endorsements in 2005.

COMMON NAME	QUANTITY (numbers)	WEIGHT (kg)
Fish	28,936*	
Hermit crabs	166,377	
Invertebrates	105,325	
Algae		7,774
Coral		10,575
Living rock, living sand, soft coral, sponge, other		15,449

* Includes 480 syngnathids

Specimen Shell Managed Fishery Status Report

A. Hart and M. Cliff

Management input from R. Gould and S. Brand-Gardner

FISHERY DESCRIPTION

The Specimen Shell Managed Fishery (SSF) is based on the collection of individual shells for the purposes of display, collection, cataloguing, classification and sale. Up to 550 different species are collected by hand by 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. The primary controls in the fishery are natural: depth, time and tide.

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

Department–industry meetings

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 primarily through input controls in the form of limited entry, gear restrictions and permanent closed areas.

There are 33 licences in the fishery, though some of these are completely inactive and many more are fished only rarely. Boats must be 8 m or less, there is a maximum of two divers per boat, and specimens may only be collected by hand.

There are a number of closed areas where the SSF is not permitted to operate, for example within various marine parks and aquatic reserves and other closed waters such as Reef Observation Areas and Fish Habitat Protection Areas. Much of the west side of North West Cape and the Ningaloo Marine Park are prohibited areas for the fishery. The exclusion of Marmion Marine Park in the Perth metropolitan area is also important for its populations of two cowrie species.

Some molluscs, such as abalone, mussels, scallops and pearl oysters, form the basis of commercial fisheries and are subject to separate management plans. The SSF is not permitted to take any species for which separate management arrangements exist.

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

Some minor-scale collection of dead shells is also undertaken above the high water mark by collectors operating under the authority of a commercial fishing licence, mainly for sale into the souvenir, pet supply and hobby craft markets. However, this does not form part of the Specimen Shell Managed Fishery.

Research summary

Current fishery-dependent data collection systems monitor the catch (species-specific), effort and catch rates for the fishery. Fishers within the SSF provide monthly returns under the statutory catch and effort system (CAES). These returns contain information on catch (species, numbers and spatial area), and days and hours fished by month and year. In August 2004, fishermen commenced reporting using 10 x 10 nm 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 eight species identified as potentially 'vulnerable.' These data are used as the basis to provide research advice for fisheries management.

RETAINED SPECIES

Commercial production (season 2005): 16,324 shells*

Landings

In 2005 the total number of specimen shells collected was 16,324, distributed over a wide range of species. In the past five 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 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 16% of all shells collected between 2000 and 2005. 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 33 licences in the fishery, only six of these are regularly active. Effort has been stable over the past five years at an average of around 1,200 days fished. In 2005, 1,274 days were fished.

Catch rate

During the 2005 season the catch rate was approximately 13 shells per day (excluding *Trochus hanleyanus*).

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: **Not assessed**

Breeding stock levels: **Adequate**

Ponder and Grayson (1988) examined the specimen shell industry on a nationwide basis, rating vulnerability to over-exploitation on the basis of species biology, accessibility to collection, and rarity. Species collected in Western Australia which were identified by Ponder and Grayson as potentially vulnerable comprised six cowries and two volutes (*Amoria* spp.).

'Shell sighting' is a new abundance category reported on for the first time this year. It is a measure of the population of vulnerable shells that is observed, but not taken, and provides evidence for the breeding stock being conserved each year. Of the eight vulnerable species, an overall average of approximately 47% of shells sighted in 2005 were harvested.

The reporting of catch and effort on the finer spatial scale of 10 x 10 nm blocks from August 2004 is also providing more accurate information on the distribution of certain species.

All species collected in Western Australia, including the eight prized species, occur over wide geographic ranges (hundreds or thousands of kilometres) and wide depth ranges (up to 200 m) where a substantial portion of the population cannot be collected. Even in shallow waters, many localities cannot be fished because of the lack of access to the beach and the small boats used, and collecting is prohibited in many of the more easily reached areas which are now in marine parks and reserves. Additional protection is afforded by the fact that collectors will ignore any specimens with slight visual imperfections, but their reproductive potential in the population remains undiminished. In summary, it is considered that the fishery has very little likelihood of impacting on breeding stocks.

The performance measures for the fishery relate to the maintenance of breeding stocks as indicated by catch levels and catch rates. In 2005, the catch level of approximately 16,000 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 2005. 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 five or six 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 2005: **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 (2005/06)

The management plan for the SSF is currently under review. Among the changes under consideration is the use of two assistant fishers, to address safety concerns of the licensees; and the use of an additional boat, though only one boat may be used at any one time.

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APPENDIX 1

Stock status and catch ranges for major commercial fisheries

(Appendix 5 from Annual Report 2005/06[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	12,138	2004/05	Yes	The above-average catch was due to good puerulus settlement 3-4 years previously. A 15% reduction in effort will be undertaken in the northern zone next season to ensure the breeding stock remains at adequate levels.
Roe's abalone	Yes	Adequate	112.7 (Q) (679-914 days)	96.5 (665 days)	2005	Yes	Poor weather restricted access to remote regions, hence full quota not taken. The improved abundance in the metropolitan area has resulted in a further review of the quota for this area next season.
Abrolhos Islands and Mid West trawl	Yes	Adequate	95-1,830	6,470	2005	Yes	The annual recruitment (and therefore catch) of scallops is highly variable depending upon environmental conditions. The high catch in 2005 was anticipated due to strong recruitment. Although the reported catch is significantly higher than the target catch, given the nature of scallop stocks and variable recruitment, there are no resultant sustainability concerns
South West trawl	NA	NA	Not available	Prawns 14 Scallops 3	2005	NA	
Cockburn Sound crab	Preliminary	Adequate	200-350	84	2004/05	No	Several years of reduced catch have led to concerns about stock, particularly factors affecting recruitment. Breeding stock and recruitment levels will be reviewed to assess possible causes and future target catch ranges.
Deep sea crab	Yes[3]	Adequate	100-300 (crystal crabs)	207 (crystal crabs)	2005	Yes	
Estuarine fisheries (west coast)	NA	NA	75-220 (Peel/Harvey only)	197 (Peel/Harvey)	2005	Yes	Includes fish and crustaceans. Recent annual catches have been stable, but lower than in previous years due to reductions in the number of commercial fishers operating in estuaries. An assessment of the various stocks has been planned.

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 beach bait	Yes[3]	Adequate	60-275 (whitebait only)	158	2005	Yes	Yearly fluctuations in whitebait stocks due to environmental conditions.
West coast purse seine	Yes	Adequate	3,000 (Q)	379	2005	NA	Low catch is due to a combination of irregular availability of fish and low activity levels by fleet. Acceptable effort level not available.
GASCOYNE COAST BIOREGION							
Shark Bay prawn	Yes	Adequate	1,501-2,330	1,628	2005	Yes	Tiger and endeavour prawns were within target catch limits and king prawns just below the target range due to targeting of larger sized prawns.
Exmouth Gulf prawn	Yes	Adequate	771-1,276	1,068	2005	Yes	All three major prawn species were within target catch limits.
Shark Bay scallop	Yes	Adequate	1,250-3,000	1,925	2005	Yes	
Shark Bay beach seine & mesh net	Yes[3]	Adequate	235-335	263	2005	Yes	The total catch and the catches for two of the four indicator species were within target ranges. Yellowfin bream catch was higher (due to strong recruitment in 1999) but tailor was lower than expected, which requires additional investigation.
Shark Bay snapper	Yes	Inadequate	338.3 (Q) (425-558 days)	304.2 (620 days*) *June-July	2005	No	The recovery of this stock does not appear to be progressing at the expected rate. A further review of management arrangements will be completed when the age-based stock assessment has been updated.
NORTH COAST BIOREGION							
Onslow prawn	Yes	Adequate	60-180	85	2005	Yes	All major prawn species were within target catch limits.
Nickol Bay prawn	Yes	Adequate	90-300	84	2005	Yes	A low catch of banana prawns was expected due to poor rainfall levels, which also resulted in a reduced catch of king prawns from the low levels of effort used.
Broome prawn	Yes	Adequate	55-260	47	2005	Yes	Both species (king and coral prawns) were below target catch ranges, with fishing effort down considerably due to small prawn sizes and low catch rates. The exploitation rate was still <40% and catches are expected to return to normal levels.

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 (CONTIUED)							
Kimberley prawn	Yes	Adequate	240-500	265	2005	Yes	Banana prawn catches within expected range for observed rainfall. Other species also within target catch ranges.
Kimberley gillnet & barramundi	Yes[3]	Adequate	25-40 (barramundi)	36 (barramundi)	2005	Yes	Reduced catch of barramundi in 2005 was related to the lower effort used in the fishery. Catch is within target range.
Northern demersal scalefish	Yes	Adequate	Total 600-1,000 (goldband <261) (red emperor <138)	Total 922 (goldband 429) (red emperor 192)	2005	No	Catches of goldband snapper and red emperor both remain above the target range and a reduction in effort is required. An initial review of the fishery has also indicated the need to remove latent effort.
Pilbara fish trawl	Yes	Adequate	2,000- 2,800	2,371	2005	Yes	Catches of lower-value species decreased.
Pilbara demersal trap & line	Yes	Adequate	160-360 (trap) 50-115 (line)	408 (trap) 226 (line)	2005	No	Trap catches were again above upper limit. Line catch, especially of goldband snapper, is considered unsustainable and revised management is needed.
Mackerel	Yes[3] (Spanish mackerel)	Adequate (Spanish mackerel)	246-410 (all except grey mackerel)	334 (all except grey mackerel)	2005	Yes	Catches declined in all areas of the fishery due to the seasonal closures which are part of the new management arrangements.
Northern shark	Yes[3]	Declining	< 117 (sandbar only)	762 (sandbar only)	2004/05	No	The catch of sandbar sharks is used as an indicator species to monitor the fishery. The target catch range will be lowered to < 20 t to reflect new management arrangements aimed at arresting sandbar depletion.
Pearl oyster	Yes	Adequate	557,000 oysters (Q) (14,071-20,551 dive hours)	513,875 oysters (15,891 dive hours)	2005	Yes	Substitution of hatchery stock for wild catch in Zone 1, and to a lesser extent in Zone 2, resulted in total quota not being taken.
SOUTH COAST BIOREGION							
South coast crustacean	Yes[3]	Uncertain	50-80 (southern rock lobster)	39 (southern rock lobster)	2004/05	No	Includes Esperance, GAB and Albany management zones. Downturn in lobster fishery may be a result of recruitment overfishing in both SA and WA. Management of this fishery is under review.
Abalone (greenlip/ brownlip)	Yes	Adequate	210.5 (Q) (907-1,339 days)	208 (1,252 days)	2005	Yes	Mid-year review resulted in quota reduction from 225.5 to 210.5 t.

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
Estuarine fisheries (south coast)	Preliminary	Adequate	200-500	227	2005	Yes	Catch includes finfish and invertebrates. Catch is back within target range due to small increases in black bream catches.
Australian salmon	Yes	Adequate	1,200-2,800	1,474	2005	Yes	Low catches in recent years are due to limited market demand. Catch levels can also be influenced by environmental factors (e.g. Leeuwin Current) that affect recruitment. The target catch range has been adjusted downward as a result of the EPBC assessment process.
Australian herring	Yes	Adequate	475-1,200 (south coast)	144 (south coast)	2005	Yes	South coast catch again below target due to limited market demand. More detailed assessment particularly of the lower west coast will be conducted this year
Albany/King George Sound purse seine	Yes	Adequate	1,500 (Q)	1,028	2004/05	NA	Quotas are adjusted annually. Target effort levels not yet available.
Bremer Bay purse seine	Yes	Adequate	1,500 (Q)	478	2004/05	NA	Quotas are adjusted annually. Target effort levels not yet available. The low catches this season are due to a scarcity of market-size fish in the traditional fishing grounds.
Esperance purse seine	Yes	Adequate	1,500 (Q)	136	2004/05	NA	Quotas are adjusted annually. Target effort levels not yet available. The low catches this season are due to a scarcity of market-size fish in the traditional fishing grounds.
Southern & west coast demersal gillnet & longline	Yes[3]	Declining	725-1,175[3]	1,062[3]	2004/05	Yes	Breeding stocks of two of the four indicator species (dusky whalers and sandbar sharks) have declined and are of concern. Target catch range will be lowered (to 725-1,095t) following updated stock assessments for these species.
NORTHERN INLAND BIOREGION							
Lake Argyle catfish	Yes	Adequate	95-155	131	2005	Yes	Catch levels are within the target range.

1 The information in this table is also used in Appendix 5 of the Department of Fisheries' Annual Report 2005/06, 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.

3 For key species only.

NA Not assessed.

Q Quota management.

APPENDIX 2

Fisheries Research Division staff publications 2005/06

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APPENDIX 3

Table of catches from fishers' statutory monthly returns for 2004/05

This table contains the landed[1] and estimated live weight[2] of species recorded in the compulsory catch and fishing effort returns provided by fishermen 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. 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 to a single species, and must be reported as 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*	10,178	10,178
Barramundi (giant perch)	*Lates calcarifer*	32,045	46,246
Bass groper	*Polyprion americanus*	9,098	9,098
Bigeye (not tuna)	Priacanthidae	50,415	50,415
Boarfish	Pentacerotidae	3,524	4,176
Bonito	*Sarda australis*	3,530	3,530
Bream, black	*Acanthopagrus butcheri*	63,598	63,598
Bream, monocle	*Scolopsis* spp.	15,555	15,555
Bream, Robinson's	*Gymnocranius grandoculis*	40,943	40,943
Bream, silver (tarwhine)	*Rhabdosargus sarba*	6,187	6,187
Bream, western yellowfin	*Acanthopagrus latus*	27,633	27,633
Catfish, sea (golden cobbler)	Ariidae	7,288	7,438
Chinaman fish (not cod)	*Symphorus nematophorus*	11,774	11,774
Cobbler	*Cnidoglanis macrocephalus*	30,234	41,773
Cobbler, silver	*Arius midgleyi*	89,069	150,845
Cod	Serranidae	81,854	82,201
Cod, bar (grey-banded, 8-bar)	*Epinephelus octofasciatus*	72,122	72,122
Cod, breaksea	*Epinephelides armatus*	8,154	8,683
Cod, chinaman	*Epinephelus rivulatus*	4,633	4,634
Cod, radiant/comet	*Epinephelus radiatus/morrhua*	1,000	1,000
Cod, Rankin	*Epinephelus multinotatus*	130,976	132,369
Cod, spotted	*Epinephelus microdon/areolatus/bilobatus*	67,654	67,694
Dhufish, West Australian (jewfish)	*Glaucosoma hebraicum*	212,594	227,331
Emperor, blue-lined (grass; black snapper)	*Lethrinus laticaudis*	2,042	2,042
Emperor, blue-spot	*Lethrinus hutchinsi*	635,674	635,674
Emperor, red	*Lutjanus sebae*	390,329	390,860
Emperor, red-spot (snapper)	*Lethrinus lentjan*	82,566	82,566
Emperor, spangled	*Lethrinus nebulosus*	109,689	110,103
Emperor, sweetlip	*Lethrinus miniatus*	168,468	169,105
Emperor, yellow-tailed	*Lethrinus atkinsoni*	1,008	1,008
Flagfish (Spanish flag)	*Lutjanus vitta, L. uinquelineatus, L. carponotatus, L. lutjanus*	217,578	217,578
Flathead	Platycephalidae	12,834	12,838
Flounder	Bothidae	4,932	4,944
Garfish, sea	*Hyporhamphus melanochir*	38,068	38,068

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
FISH (CONTINUED)			
Groper, baldchin	*Choerodon rubescens*	38,611	43,047
Groper, blue	*Achoerodus gouldii*	29,248	36,951
Groper (wrasses)	Labridae	10,876	10,946
Halibut	*Psettodes erumei*	2,376	2,376
Hapuku	*Polyprion oxygeneios*	42,276	42,303
Herring, Australian	*Arripis georgianus*	219,587	219,587
Herring, Perth	*Nematalosa vlaminghi*	8,515	8,515
Javelin fish	*Pomadasys* spp.	37,211	37,211
Jobfish (goldband snapper) *see* snapper, goldband			
Jobfish, rosy *see* snapper, rosy			
Jobfish (sharptooth snapper) *see* snapper, sharptooth			
Kingfish, black (cobia)	*Rachycentron canadum*	32,127	32,770
Kingfish, yellowtail	*Seriola lalandi*	1,040	1,172
Knifejaw	*Oplegnathus woodwardi*	3,101	3,182
Leather jacket	Monacanthidae	31,501	45,256
Mackerel, blue	*Scomber australasicus*	1,031	1,031
Mackerel, grey (broad-barred)	*Scomberomorus semifasciatus*	15,694	19,582
Mackerel, other	Scombridae	7,434	8,417
Mackerel, scaly	*Sardinella lemuru*	1,672,142	1,672,142
Mackerel, shark (salmon)	*Grammatorcynus bicarinatus*	517	569
Mackerel, Spanish	*Scomberomorus commerson*	247,872	346,291
Mangrove jack	*Lutjanus argentimaculatus*	20,526	20,537
Maray	*Etrumeus teres*	63,459	63,459
Morwong	Cheilodactylidae	2,453	2,963
Mullet, red	Mullidae	74,931	74,931
Mullet, sea	*Mugil cephalus*	249,228	249,242
Mullet, yellow-eye	*Aldrichetta forsteri*	46,505	46,505
Mulloway	*Argyrosomus hololepidotus*	28,224	30,043
Mulloway, northern (black jew)	*Protonibea diacanthus*	3,475	3,760
Parrot fish	Scaridae	20,279	20,830
Perch, darktail sea (maroon sea) *see* snapper, maroon			
Perch, Moses *see* snapper, Moses			
Perch, pearl	*Glaucosoma buergeri*	61,244	61,269
Perch, red *see* snappers, other	*Lutjanus* spp.		
Perch, scarlet sea (saddletail sea) *see* snapper, saddletail			
Perch, yellowtail	*Amniataba caudavittatus*	1,866	1,866
Perches, other *see* snappers, other			
Pike, sea	*Sphyraena novaehollandiae*	1,144	1,144
Pilchard	*Sardinops sagax ocellatus*	1,827,823	1,827,823
Pomfret, black	*Parastromateus niger*	2,046	2,056
Queenfish	*Scomberoides commersonnianus*	564	1,867
Redfish	*Centroberyx* spp.	77,067	79,054
Redfish, Bight	*Centroberyx gerrardi*	41,247	41,868
Salmon, western Australian	*Arripis truttaceus*	1,230,945	1,244,459
Samson fish (sea kingfish)	*Seriola hippos*	87,776	94,610
Sawfish	Pristidae	451	1,669
Sawfish, narrow	*Anoxypristis cuspidata*	447	1,042

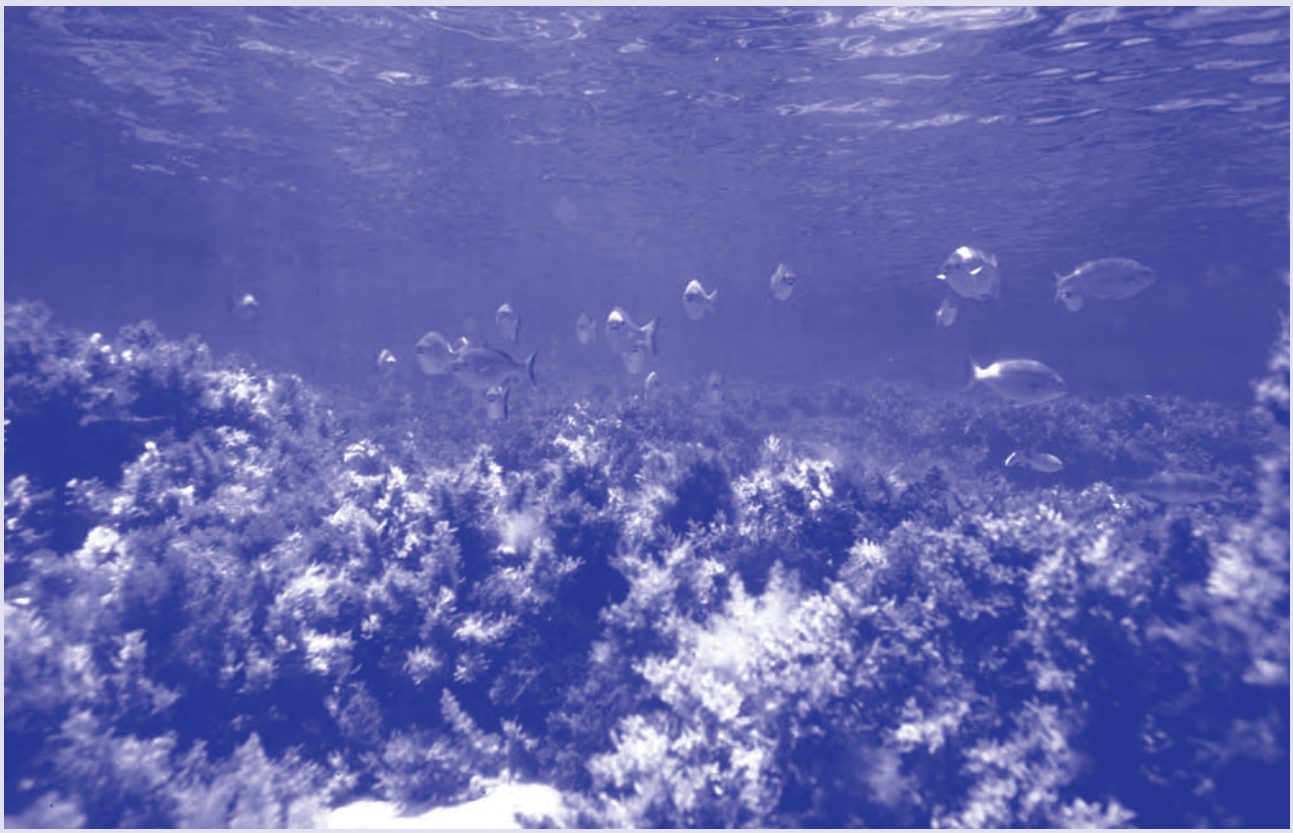
COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
FISH (CONTINUED)			
Scad, yellowtail	*Trachurus novaezelandiae*	10,058	10,058
Scorpionfishes	Scorpaenidae	8,816	8,816
Shark, blacktip	*Carcharhinus* spp.	69,550	109,454
Shark, bronze whaler (dusky whaler)	*Carcharhinus obscurus*	217,373	343,187
Shark, bull (river whaler)	*Carcharinus leucas*	34,427	54,607
Shark, eastern school	*Galeorhinus galeus*	9,530	15,153
Shark, golden (copper whaler)	*Carcharhinus brachyurus*	18,622	29,479
Shark, grey reef	*Carcharhinus amblyrhynchos*	4,928	7,836
Shark, gummy	*Mustelus antarcticus*	301,883	476,130
Shark, hammerhead	Sphyrnidae	114,422	181,721
Shark, lemon	*Negaprion acutidens*	38,898	61,848
Shark, mako (shortfin)	*Isurus oxyrinchus*	3,436	5,463
Shark, pencil	*Hypogaleus hyugaensis*	1,101	1,746
Shark, pigeye	*Carcharhinus amboinensis*	17,980	28,588
Shark, saw	*Pristiphorus* spp.	1,638	3,767
Shark, silky	*Carcharhinus falciformis*	2,130	3,387
Shark, silvertip	*Carcharhinus albimarginatus*	660	1,049
Shark, sixgill	Hexanchidae	380	604
Shark, southern saw	*Pristiophorus nudipinnis*	255	594
Shark, spot-tail	*Carcharhinus sorrah*	2,215	3,486
Shark, spurdog	Squalidae/Oxynotidae	1,415	1,963
Shark, thickskin (sandbar)	*Carcharhinus plumbeus*	574,268	912,691
Shark, tiger	*Galeocerdo cuvier*	58,217	91,090
Shark, whiskery	*Furgaleus macki*	104,134	155,507
Shark, wobbegong	Orectolobidae	61,862	97,952
Shark, other		79,450	133,162
Shovelnose (fiddler rays)	Rhinobatidae & Rhynchobatidae	12,826	42,678
Skates and rays, other		10,521	19,059
Smelt (hardyhead)	Atherinidae	1,047	1,047
Snapper, bullnose (variegated emperor)	*Lethrinus ravus*	3,253	3,253
Snapper, crimson (formerly red snapper)	*Lutjanus erythropterus*	387,589	387,589
Snapper, frypan	*Argyrops spinifer*	46,374	46,374
Snapper, goldband	*Pristipomoides multidens*	732,367	733,391
Snapper, lenko (deep sea)	*Dentex tumifrons*	27,161	27,161
Snapper, long nose	*Lethrinus olivaceus*	23,341	23,341
Snapper, maroon (formerly maroon sea perch)	*Lutjanus lemniscatus*	19,493	19,493
Snapper, Moses (formerly Moses perch)	*Lutjanus russelli*	62,689	62,689
Snapper, nor-west	Lethrinidae	55,738	57,413
Snapper, nor-west (large)	*Lethrinus* spp.	10,687	10,687
Snapper, nor-west (small)	*Lethrinus lentjan, L. choerorhynchus* etc.	4,591	4,591
Snapper, pink	*Pagrus auratus*	666,061	680,191
Snapper, queen	*Nemadactylus valenciennesi*	41,151	49,822
Snapper, rosy (formerly rosy jobfish)	*Pristipomoides filamentosus*	87,654	87,654
Snapper, ruby	*Etelis* spp.	76,872	77,021
Snapper, saddletail (formerly scarlet sea perch)	*Lutjanus malabaricus*	208,342	208,358
Snapper, sharptooth	*Pristipomoides typus*	15,809	15,809
Snapper, tang's	*Lipocheilus carnolabrum*	829	829
Snappers, other	Lutjanidae	3,587	4,020
Sole	*Ammotretis rostratus*	655	655
Sprat, blue	*Spratelloides robustus*	16,109	16,109

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
FISH (CONTINUED)			
Sweep	*Scorpis aequipinnis*	1,162	1,172
Sweetlip	Haemulidae	105,849	108,931
Tailor	*Pomatomus saltatrix*	25,671	25,671
Threadfin	Polynemidae	26,041	26,647
Threadfin bream (butterfish)	Nemipteridae	254,155	254,155
Threadfin, giant (king salmon)	*Eleutheronema tetradactylum*	83,859	88,670
Trevalla, deepsea	*Hyperoglyphe antarctica*	14,479	14,948
Trevally, golden	*Gnathanodon speciosus*	3,217	3,224
Trevally, other (skippy)	Carangidae	223,721	223,895
Trevally, skipjack	*Pseudocaranx dentex*	4,938	4,938
Tripletail	*Lobotes surinamensis*	3,129	3,205
Trout, coral	*Plectropomus maculatus*	17,008	17,752
Trout, spotted (duskytail groper)	*Epinephelus bleekeri*	12,518	12,518
Trumpeters	Terapontidae	2,656	2,656
Tuna, other	Scombridae	10,453	10,645
Tuna, yellowfin	*Thunnus albacares*	1,067	1,108
Tuskfish, bluebone	*Choerodon* spp.	25,403	25,404
Wahoo	*Acanthocybium solandri*	460	500
Whitebait	*Hyperlophus vittatus*	233,339	233,339
Whiting, golden-lined	*Sillago analis*	9,288	9,288
Whiting, King George	*Sillaginodes punctata*	18,040	18,045
Whiting, other	Sillaginidae	2,152	2,152
Whiting, western sand	*Sillago schomburgkii*	157,354	157,354
Other fish varieties		87,791	91,061
Total fish		**14,462,249**	**15,808,402**
CRABS			
Crab, blue swimmer (blue manna, sand)	*Portunus pelagicus*	1,033,771	1,033,771
Crab, champagne (spiny)	*Hypothalassia acerba*	9,695	9,695
Crab, crystal (snow)	*Chaceon bicolor*	213,072	213,072
Crab, giant (king)	*Pseudocarcinus gigas*	11,841	11,841
Crab, mud	*Scylla serrata*	753	753
Other crabs		135	135
Total crabs		**1,269,267**	**1,269,267**
PRAWNS			
Prawn, banana	*Penaeus merguiensis*	335,559	335,559
Prawn, brown tiger	*Penaeus esculentus*	1,188,733	1,188,733
Prawn, coral	*Metapenaeopsis* spp.	202,586	202,586
Prawn, endeavour	*Metapenaeus endeavouri*	298,792	298,792
Prawn, western king	*Penaeus latisulcatus*	1,514,179	1,514,179
Other prawns	Penaeidae	1,347	1,347
Total prawns		**3,541,196**	**3,541,196**
LOBSTERS			
Bugs	Scyllaridae	26,605	31,166
Rock lobster, southern	*Jasus edwardsii*	40,100	40,100
Rock lobster, western	*Panulirus cygnus*	12,262,163	12,262,163
Total lobsters		**12,328,868**	**12,333,429**
MOLLUSCS			
Abalone, brownlip	*Haliotis conicopora*	14,521	36,303
Abalone, greenlip	*Haliotis laevigata*	61,890	164,292
Abalone, Roe's	*Haliotis roei*	86,794	103,540

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
MOLLUSCS (CONTINUED)			
Cuttlefish	Sepiidae	69,538	69,593
Octopus	*Octopus* spp. (mainly *O. tetricus*)	122,220	236,875
Scallop, saucer	*Amusium balloti*	1,234,025	6,161,989
Squid	*Sepioteuthis* spp., *Loligo* spp.	73,720	73,720
Other molluscs		122	122
Total molluscs		**1,662,830**	**6,846,434**
OTHER CLASSES			
Beche-de-mer	Holothuridae	30,175	90,525
Total other classes		**30,175**	**90,525**
GRAND TOTAL		**33,294,585**	**39,889,253**

1. Landed weight: refers to the mass (or weight) of a product at the time of landing, regardless of the state in which it is landed. That is, the fish may be whole, gutted or filleted etc. This unit is of limited use for further analysis except where it is known that the product is very homogenous in nature. Where more detailed analysis of the data is required the landed weight is generally converted to a more meaningful measure, the most frequently used being termed live or whole weight or 'nominal catch'.
2. Live weight: refers to the landings converted to a live weight basis. This is often referred to as the 'live weight equivalent of the landings', shortened to the 'live weight'. Although live weight may be the preferred unit it is rarely obtained as a direct measure. This is because it would usually have to be made on board a fishing vessel where the practical difficulties associated with the working conditions render it impossible. Live weight has to be derived and this is usually done by applying a conversion factor to the landed weight.

More information may be obtained from the 'CWP Handbook of Fishery Statistical Standards' at the website http://www.fao.org/figis/servlet static?dom=ontology&xml=sectionB.xml.



APPENDIX 4

Pemberton Freshwater Research Centre activities 2005/06

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 on Thomson's Flat. The hatchery site contains 10 earthen ponds, 22 concrete ponds, trout hatching and larval rearing troughs, a 48-tank trout nutrition facility and a training centre. The Thomson's Flat component features 25 earthen ponds ranging in size from 150 m2 breeding ponds to 1000 m^2 commercial scale grow-out ponds, 28 tanks and a post-harvest handling facility. There is also an area on Thomson's Flat leased to the Pemberton Aquaculture Producers for marron processing and marketing.

PFRC staff are responsible for the maintenance and production of trout, native fish and crayfish at the facility, as well as stocking trout into public waters and packing trout and marron for sale to commercial farmers. As the efficient operation of a production and research facility on this scale requires a high level of expertise, PFRC staff are able to provide an important regional extension service to aquaculture, recreational fishing and conservation client groups.

PFRC provides facilities, expertise and stock to support research and industry development in the three key areas of conservation, recreational freshwater fisheries and aquaculture. Key PFRC projects in 2005/06 are briefly discussed below.

Trout production and research

Trout production at PFRC provides fingerlings and yearlings for recreational fishing, aquaculture and research. Brown trout (*Salmo trutta*) are produced for recreational fishing and rainbow trout (*Oncorhynchus mykiss*) for both recreational fishing and aquaculture.

In 2005/06 PFRC produced 648,000 fry and eyed ova, comprising 632,000 rainbow trout fry and eyed ova and 16,000 brown trout fry. The majority of production (64%), comprising 400,000 rainbow trout fry and 16,000 brown trout fry, were stocked into public waterways to support recreational fishing. A further 95,000 rainbow trout (15%) were sold to individuals and clubs for stocking private farm dams for recreational fishing and tourism.

PFRC has established a reputation amongst commercial trout farmers for consistent hatchery production of quality fry and eyed ova. In 2005/06 commercial farmers purchased 50,000 fry and 50,000 eyed ova from the Centre, representing 15% of PRFC trout production.

The remaining 6% of trout produced were retained for future broodstock for PFRC, yearling stocking, trout nutrition research, and sales in July 2006 to Challenger TAFE to stock an FRDC-funded project to evaluate commercial trout production using a semi-intensive floating tank system in inland saline water bodies.

To improve management of the recreational trout fishery, Department of Fisheries freshwater fisheries scientists conducted monthly sampling of trout at PFRC during 2005/06. The aim of this work was to examine the formulation of annualis within the otoliths to assist in interpreting field data on trout growth.

In late 2005/06 the Department commenced a review of two key factors associated with trout production at PFRC, namely brown trout egg viability and rainbow trout broodstock selection strategies.

Brown trout egg viability is sub-optimal. However, prior to disposing of this valuable line that is highly regarded by recreational fishers, a study is being undertaken to confirm the extent of the problem and determine the contributing factors. Factors being investigated include poor sperm motility, water quality and climate change. Once the problem has been quantified and contributing factors identified, a decision can be made to either implement measures to resolve the issues or discontinue production.

The current breeding strategy for both rainbow and brown trout at PFRC is based on random selection of broodstock. However, the two main client groups (recreational fishers and aquaculturists) have different objectives which may ideally require fish with differing characteristics. Discussions have begun with both major client groups to establish and prioritise breeding objectives, to ensure that broodstock selection strategies at PFRC in coming years will produce trout that specifically meet the needs of clients.

The genetic line of rainbow trout at PFRC is unique and has been shown to have superior temperature tolerance compared with most domesticated lines elsewhere. Discussions with trout farmers and fishers have already established that broodstock selection to further increase upper temperature tolerance and growth of the trout stock at PFRC would be desirable, particularly if combined with triploid production to produce sterile progeny. With climate change resulting in major losses on trout farms overseas, this breeding strategy could have a major benefit for Western Australia through export sales of eyed ova that can tolerate the warmer water temperatures being recorded on commercial farms internationally.

Aquaculture feeds development

The Australian Aquaculture Feed Grains Program has been led since 2002 by the Department of Fisheries, working in close coordination with the Department of Agriculture and Food and major grain processing and aquaculture feed processing companies throughout Australia. The final stages of the program entailed a series of seven separate experiments at PFRC from July 2005 to June 2006. This work has been instrumental in the development of new export markets for West Australian feed grains, the development of quality assurance criteria, and the assessment of new grain varieties for the Department of Agriculture and Food. Some of these new grain varieties are now being released commercially, and are likely to command premium prices from the aquaculture feeds market because of their superior attributes.

Sales of WA feed grains (lupins) to the aquaculture market worldwide have risen from < 100 t in 2000 to over 40,000 t in 2005. This now represents a $10–12 million market for Western Australia annually, and is still growing.

Native fish and crayfish conservation and biodiversity research

In response to a declining abundance of native fish in the south-west, the PFRC in 2005/06 established a broodstock population of pygmy perch (*Edelia vittata*). The aim is to develop large-scale production techniques for this species, to enable stocking of public and private water bodies. It is thought that the falling numbers of native fish are related to the spread of introduced gambusia (*Gambusia affinis*). Although gambusia were originally introduced to control mosquito populations, it has been shown that the native pygmy perch consumes 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.

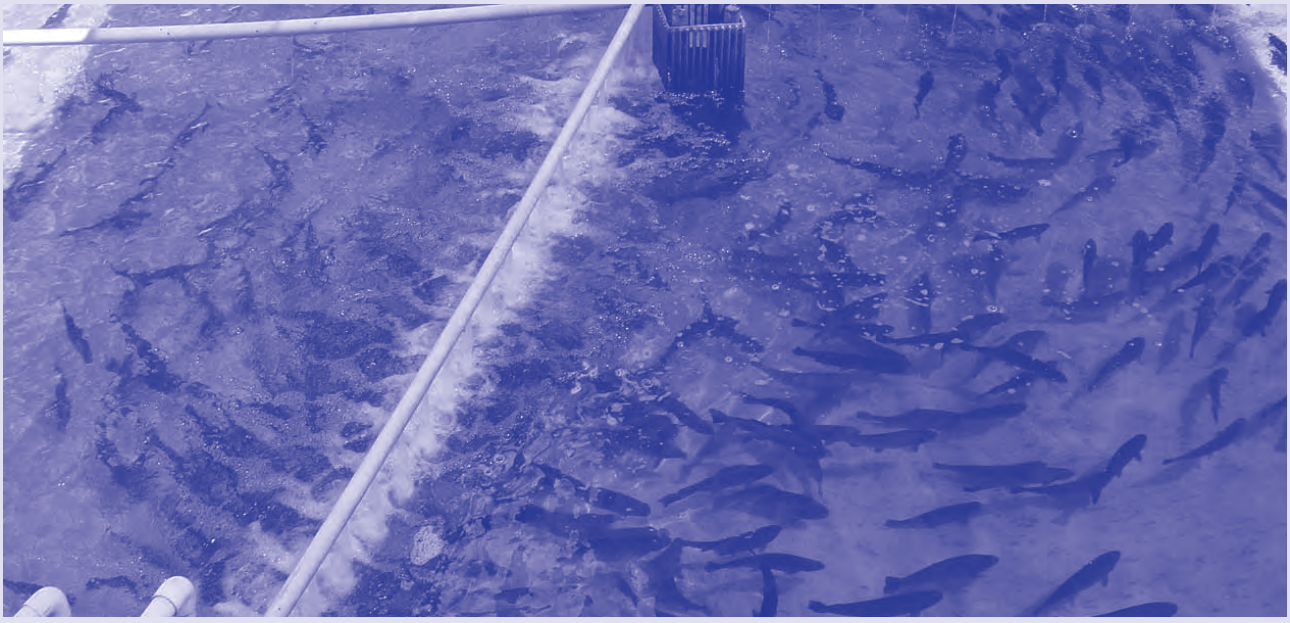
A captive breeding program to conserve marron biodiversity has also been established at PFRC, with a major focus on the critically endangered Margaret River marron. The South West Catchments Council provided funding to the Department of Fisheries and UWA to develop a molecular genetic test which would distinguish 'pure' marron from hybrids. This resulted in the establishment of the only 'pure' broodstock population of the Margaret River marron at PFRC. These broodstock produced over 1,200 juveniles in the first year of the project. These juveniles will be reared to sexual maturity at PFRC, and their progeny will be available for restocking the Margaret River catchment.

In addition, captive breeding populations from three other river systems were established during 2005/06. These broodstock represent the genetic biodiversity of the northern, central and eastern marron populations found in Western Australia. Each genetic line was spawned in 2005/06, and again the juveniles will be reared to sexual maturity at PFRC and their progeny will be available for restocking both catchments and farm dams in each of the three regions.

Freshwater fisheries scientists have undertaken research at PFRC in 2005/06 to develop a tool to predict future marron stocks using a juvenile abundance index based upon habitat preference. This has involved determining the preference of juvenile marron (0+) for different types of similar-sized artificial habitats (hollow bricks, PVC tubes, onion mesh, tenikalon fibre). Results of these initial trials will be used to develop appropriate 'abundance samplers' which, it is hoped, will permit stock prediction in the same way rock lobster stocks are predicted from the abundance of puerulus settling on 'puerulus collectors' made from tenikalon fibre.

Marron aquaculture research and development

In 2005/06 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 broodstock selection, where farmers sell their largest marron and breed from the remaining slower-growing animals, had reduced the growth rate of marron on many commercial farms. To address this the Research Division staff initiated a selective breeding program that resulted in a 100% improvement in growth rate. Over 10,000 marron from the selective breeding program were sold to juvenile marron producers for mass production and sale of progeny to commercial farmers. A repository population of the better-performing genetic lines was retained at PFRC for future selective breeding and sale of progeny to industry.



APPENDIX 5

Fish Health Unit activities 2005/06

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 and Food. The unit is staffed by one full-time and two part-time fish pathologists, one research scientist, one laboratory manager and one technical officer.

The unit is accredited to ISO 17025 and provides a diagnostic service to the fishing and aquaculture industry in Western Australia, investigates fish kills, provides input into 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 2005/06 were as follows.

- The laboratory continued in its role as one of six Regional Resource Centres for Aquatic Animal Health within the Network of Aquaculture Centres in Asia-Pacific. Diagnostic assistance was provided to Vietnam to identify a problem in Babylonia (gastropod snail) culture.
- The fish health laboratory received a total of 206 diagnostic cases during 2005/06, about 14% down on the previous year. This was due to a reduction in the number of applications for export health certificates for yabbies and marron, down 36% on 2004/05. During the year the notifiable disease viral encephalopathy and retinopathy was again detected in farmed barramundi, resulting in quarantining and sterilisation of the affected premises. Ongoing testing continued following the discovery of the notifiable prawn disease gill-associated virus in *Penaeus monodon* from the Joseph Bonaparte Gulf during 2004/05, but no further cases of have been detected in Western Australia this year. Cases of the endemic notifiable disease epizootic ulcerative syndrome continue to be reported from estuarine fish in the south-west river systems. This disease is considered established in wild populations and is monitored for international reporting purposes only. In addition, 30 pearl translocation certificates were provided and 6 pearl diagnostic cases were investigated.
- In collaboration with staff from the Department of Environment and Conservation, 10 reports of fish kills throughout the state were investigated. These were all found to be due to natural environmental causes or to algal blooms in the Swan and Canning River systems.
- In collaboration with the Department of Agriculture and Food and Murdoch University, work continued on a project funded by FRDC and the Australian Government Department of Agriculture, Forestry and Fisheries to develop Australian standard diagnostic techniques for the endemic notifiable disease epizootic ulcerative syndrome and the exotic disease crayfish plague (both caused by fungi of the genus *Aphanomyces*). Crayfish plague has not been recorded in Australia and development of a standard diagnostic technique is a precautionary step. The unit also developed the capability to test imported frozen prawns for white spot syndrome virus and Taura syndrome virus. These internationally reportable viruses, which are not killed by freezing, are commonly detected in imported frozen prawns from Asia.
- Work was completed on the Western Australian component of an FRDC-funded national survey of wild and farmed abalone for parasites and disease. This showed that Western Australia is relatively free of serious diseases of abalone, including *Perkinsus olseni* and abalone herpesvirus, both of which are found in eastern Australia.
- Work was completed on an FRDC-funded project in collaboration with the Australian Animal Health Laboratory of CSIRO and the University of Sydney to develop techniques to detect pilchard herpesvirus in local and imported pilchards. This showed, using new tests developed in the Fish Health Unit, that the herpesvirus, which caused the massive mortalities of pilchards in 1995 and again in 1998 is now endemic in the pilchard population, and that future mortalities on the scale seen in past years are unlikely to recur.
- Work was completed on an FRDC-funded project to develop a national translocation policy using abalone and prawns as templates for other aquatic species.
- The Fish Health Unit won a tender to manage a national Biosecurity Australia project investigating the health of certain groups of quarantined ornamental fish.
- The expertise of the Fish Health Unit is frequently sought by the national Aquatic Animal Health Committee and Biosecurity Australia. Western Australia currently holds the chair of the National Aquatic Animal Health Technical Working Group. This also reflects the greater emphasis on national coordination and consultation in aquatic animal health issues.

APPENDIX 6

Annual performance for commercial fisheries subject to export approval under the Commonwealth 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 2004/05 season or the calendar year 2005. The performance of fisheries which received export approval during the current year (2005/06) will be reported in next year's document.

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 2004/05 OR 2005*	*COMMENT*
Fishery: **Abalone** *Date of certification:* August 2004 *Approval type:* Export exemption *Expiry date*: September 2009	Greenlip/brownlip abalone Areas 2/3 (spawning stock)*	Effort range 907–1,339 diver days; minimum meat weight 140 gm greenlip, 160 gm brownlip	Acceptable	In order to optimise yield, regional performance criteria are used to maintain local stock levels well above those required for ongoing sustainability. This has resulted in small changes to greenlip and brownlip quotas
	Roe's abalone Area 1 (spawning stock)	Effort range 14–43 diver days; total catch 9,900 kg	Acceptable	No fishing in Area 1 due to adverse weather conditions
	Roe's abalone Area 2 (spawning stock)*	Effort range 80–106 diver days; total catch 19,800 kg	Acceptable	
	Roe's abalone Area 5 (spawning stock)	Effort range 100–140 diver days; total catch 20,000 kg	Acceptable	
	Roe's abalone Area 6 (spawning stock)	Effort range 80–127 diver days; total catch 12,000 kg	Acceptable	
	Roe's abalone Area 7 (spawning stock)	Effort range 175–215 diver days; total catch 36,000 kg	Acceptable	
	Roe's abalone Area 8 (spawning stock)	Effort range 140–200 diver days; total catch 15,000 kg	Acceptable	72% of quota taken in Area 8 due to adverse weather
Fishery: **Abrolhos Islands and Mid West Trawl** *Date of certification:* 17 March 2005 *Approval type:* Wildlife Trade Operation *Expiry date*: 17 March 2008	Scallops (spawning stock)	The residual stock index determines a predicted catch that should set the length of the season	Acceptable	

FISHERY DETAILS	ISSUE/SPECIES	PERFORMANCE MEASURE	CURRENT PERFORMANCE IN 2004/05 OR 2005	COMMENT
Fishery: **Beche-de-mer** *Date of certification:* December 2004 *Approval type:* Wildlife Trade Operation *Expiry date*: January 2008	Beche-de-mer species (spawning stock)	The preliminary acceptable catch range is 50–150 t; catch rate above 80 kg/ crew-day fished	Acceptable	
Fishery: **Broome Prawn** *Date of certification:* August 2004 *Approval type:* Export exemption *Expiry date:* August 2009	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any one year	Acceptable	
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–90 t (7-year catch range)	Acceptable	Catch slightly below range due to low effort
Fishery: **Exmouth Gulf Prawn** *Date of certification:* March 2003 *Approval Type:* Export exemption *Expiry date*: February 2008	Tiger prawn (spawning stock)	Catch rate above 8–10 kg/hr	Acceptable	
	King prawn (spawning stock)	Total catch within acceptable range of 350–500 t	Acceptable	
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 120–300 t	Acceptable	
	Banana prawn (spawning stock)	Total catch within acceptable range of 10–60 t for years with significant rainfall and 0–2 t for years with low rainfall	Acceptable	No recorded catch correlates to low rainfall
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–100 t	Acceptable	
	Discarded fish (abundance)	The major species of bycatch are found in significant numbers outside of the trawled areas	Acceptable	
	Impact to mud/shell (habitat)	< 40% of mud/shell habitat in Exmouth Gulf trawled	Acceptable	
	Discarding fish (provisioning)	Reduction in amount of discards and ratio of discards to target catch from levels prior to introduction of BRDs	Acceptable	
Fishery: **Kimberley Prawn** *Date of certification:* November 2004 *Approval Type:* Export exemption *Expiry date*: November 2009	Banana prawn (spawning stock)	Total catch within acceptable range of 200–450 t	Acceptable	

FISHERY DETAILS	ISSUE/SPECIES	PERFORMANCE MEASURE	CURRENT PERFORMANCE IN 2004/05 OR 2005	COMMENT
	Brown tiger prawn (spawning stock)	Total catch within acceptable range of 15–60 t	Acceptable	
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 7–80 t	Acceptable	
	Coral prawns (spawning stock)	Total catch within acceptable range of 0–6 tonnes (10-year catch range)	Acceptable	
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–1 t	Not applicable	Catches typically too low to be recorded as a separate category in landings
	Squid (spawning stock)	Total catch within acceptable range of 1–50 t	Acceptable	Catches insufficient to be recorded accurately in landings
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	Kimberley and Pilbara catches within target ranges. Gascoyne/West Coast catch below target range, however this is not a significant spawning area
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 acceptable	Catches have exceeded trigger points. Allowable effort has been reduced in the main area of the fishery for 2006, and a new stock assessment is being undertaken.
	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; new system of catch reporting implemented by January 2005	Not acceptable	As for red emperor and goldband snapper (above).
Fishery: **Onslow and Nickol Bay Prawn** *Date of certification:* November 2004 *Approval Type:* Export exemption *Expiry date*: November 2009	Banana prawns (spawning stock)	Nickol Bay: total catch in high rainfall areas within acceptable range of 40–220 t; in low rainfall areas within acceptable range of 0–40 t. Onslow: total catch within acceptable range of 2–90 t	Nickol Bay: acceptable Onslow: below but acceptable	Decision taken not to fish banana prawns in Onslow fishery to protect breeding stocks
	Brown tiger prawn (spawning stock)*	Status of stock assessed by whether catches remain within the acceptable catch ranges of Nickol Bay 2–40 t and Onslow 10–120 t	Acceptable	
	Western king prawn (spawning stock)	Status of stock assessed by whether catches remain within the acceptable catch ranges of Nickol Bay 20–70 t and Onslow 10–55 t	Nickol Bay: below but acceptable Onslow: acceptable	Catch below target range in Nickol Bay due to low effort
	Endeavour Prawn (spawning stock)	Total catch within acceptable ranges of Nickol Bay 1-10 t and Onslow 5-20 t.	Acceptable	

FISHERY DETAILS	ISSUE/SPECIES	PERFORMANCE MEASURE	CURRENT PERFORMANCE IN 2004/05 OR 2005	COMMENT
	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 Zone 1 not applicable	Collection of size-frequency data in Zone 1 will resume in 2006
Fishery: **Pilbara Trap** *Date of certification:* November 2004 *Approval type:* Wildlife Trade Operation *Expiry date*: November 2007	Long-lived target species (spawning stock) – includes Rankin cod, red emperor, scarlet perch, goldband snapper, red snapper, spangled emperor	Spawning biomass of Rankin cod and red emperor should remain above minimum limit of 40% of virgin spawning biomass; Annual trap catch should not increase > 20% above average catch of previous 4 years; No decrease in annual trap catch rates in > 2 consecutive years	Acceptable Not acceptable Acceptable	Catch trigger exceeded for three species. Review of effort levels may be necessary. Stock assessment will be updated
Fishery: **Pilbara Trawl** *Date of certification:* November 2004 *Approval type:* Wildlife Trade Operation *Expiry date*: December 2007	Long-lived target species (spawning stock) – includes Rankin cod, red emperor, scarlet perch, goldband snapper, red snapper, spangled emperor	Spawning biomass of Rankin cod and red emperor should remain above minimum limit of 40% of virgin spawning biomass; annual trawl catch should not increase > 20% above average catch of previous 4 years; no decrease in annual trawl catch rates in > 2 consecutive years	Acceptable	
	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	Industry implementation of escape grids has improved performance
	Bycatch of protected species – turtles	Number of turtles caught should be reduced by 50% of 2002 level following implementation of mitigation devices; number of turtles released alive should be greater than or equal to 72% of total captures per year; all skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	

FISHERY DETAILS	ISSUE/SPECIES	PERFORMANCE MEASURE	CURRENT PERFORMANCE IN 2004/05 OR 2005	COMMENT
	Bycatch of protected species – syngnathids	Number of pipefish caught and released alive should be < 500/yr; number of seahorses caught and released alive should be < 60/yr; all skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	
	Bycatch of protected species – sawfish	Number of sawfish caught should be < 120/yr; number of sawfish released alive should be increased to 50% of captures by 2008; all skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	
	General ecosystem – large epibenthos	The total area of the Pilbara demersal fish fishery (encompassing both trawl and trap fisheries) that is closed to trawling is 80%; the total area of the Pilbara demersal fish fishery between depths of 30 m and 120 m should remain at or below the current level of 60%	Acceptable	
Fishery: **Salmon** *Date of certification:* November 2004 *Approval type:* Export exemption *Expiry date*: November 2009	Western Australian salmon (spawning stock)	Expected catch range under the current management regime is 1,200–2,800 t	Acceptable	
Fishery: **Shark Bay Experimental Crab Fishery** *Date of certification:* November 2004 *Approval type:* Wildlife Trade Operation *Expiry date*: November 2007	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Acceptable	
Fishery: **Shark Bay Prawn** *Date of certification:* February 2003 *Approval type:* Export exemption *Expiry date*: January 2008	Tiger prawn (spawning stock)	Level of spawning stock present during the spawning season above 2 kg/hr, preferred level between 3 and 4 kg/hr	Acceptable	
	King prawn (spawning stock)	Total catch within historical acceptable range of 1,100–1,600 t, given no change in effort	Slightly below but acceptable	Lower catch due to targeting of large prawns for economic value
	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	Coral: acceptable Endeavour: below but acceptable	Low prices for small prawns and lack of targeting can limit the landings of these species

FISHERY DETAILS	ISSUE/SPECIES	PERFORMANCE MEASURE	CURRENT PERFORMANCE IN 2004/05 OR 2005	COMMENT
	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-bycatch reduction device levels	Acceptable	
Fishery: **Shark Bay Scallop** *Date of certification:* February 2003 *Approval type:* Export exemption *Expiry date*: January 2008	Scallop (spawning stock)	Monitoring of recruits/ residual stock to ensure the start date of the season is set so that there is adequate level of breeding stock present when spawning commences	Acceptable	
	Loggerhead turtles (captures)	90% of turtles captured from non-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	Catch rate in 2005 slightly improved but below performance measure	Quota reductions made in 2004 maintained for 2006. Further quota reductions under consideration
Fishery: **South Coast Crustacean** *Date of certification:* September 2004 *Approval type:* Wildlife Trade Operation *Expiry date*: September 2007	Southern rock lobster (spawning stock)	Catch to remain below 40 t for Esperance fishery	Acceptable	Management of south coast crustacean fisheries is to be reviewed
Fishery: **Specimen Shell** *Date of certification:* 25 May 2005 *Approval type:* Export exemption *Expiry date*: 25 May 2010	Specimen shell species (spawning stock)	Preliminary acceptable catch range is from 10,000–25,000 shells; acceptable catch rate 10–40 shells per day	Acceptable	

FISHERY DETAILS	ISSUE/SPECIES	PERFORMANCE MEASURE	CURRENT PERFORMANCE IN 2004/05 OR 2005	COMMENT
Fishery: **Western Rock Lobster** *Date of certification:* August 2002 *Approval Type:* Export exemption *Expiry date*: September 2007	Western rock lobster (spawning stock)	Spawning biomass at Abrolhos Islands and coastal regions to remain above 22% of unfished level	Acceptable	Precautionary management measures to increase breeding stock levels, particularly in B Zone, introduced for 2005/06 season
	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	Technology to reduce access to pots by sea lion pups is being finalised
	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
Fishery: **West Coast Deep Sea Crab** *Date of certification:* March 2004 *Approval type:* Wildlife Trade Order *Expiry date*: March 2007	Champagne crab (spawning stock)	Catch to remain below historical high of 50 t per annum	Acceptable	
	Snow Crab (spawning stock)	Catch to remain within range 100–300 t per annum	Acceptable	

* Indicates that an adjustment to the performance measure has been made this year.

GLOSSARY OF ACRONYMS

AIMWTF	Abrolhos Islands and Mid West Trawl Managed Fishery
BPF	Broome Prawn Fishery
BRD	bycatch reduction device
CAES	catch and effort statistics
CAP	Commercial Access Panel
CPUE	catch per unit effort
CW	carapace width
DEC	Department of Environment and Conservation (formerly Department of Conservation and Land Management)
DEH	(Australian Government) Department of Environment and Heritage
EPBC	(Commonwealth) Environment Protection and Biodiversity Conservation (Act 1999)
ERLF	Esperance Rock Lobster Managed Fishery
ESD	ecologically sustainable development
FED	fish escapement device
FHPA	Fish Habitat Protection Area
FMO	Fisheries and Marine Officer
FRDC	Fisheries Research and Development Corporation
GAB	Great Australian Bight
GSMH	Great Southern Marine Hatcheries
IBSS	independent breeding stock survey
IFAAC	Integrated Fisheries Allocation Advisory Committee
IFM	Integrated Fisheries Management
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IQF	individually quick frozen
ITE	individually transferable effort
ITQ	individually transferable quota
JANSF	Joint Authority Northern Shark Fishery
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
KGBF	Kimberley Gillnet and Barramundi Managed Fishery
KPF	Kimberley Prawn Managed Fishery
LASCF	Lake Argyle Silver Cobbler Fishery
LML	legal minimum length
MAF	Marine Aquarium Fish Managed Fishery
MOP	mother-of-pearl
MPA	marine protected area
MPP	Management Planning Panel
MSC	Marine Stewardship Council
NBPF	Nickol Bay Prawn Managed Fishery
NDSF	Northern Demersal Scalefish Managed Fishery
NPF	Northern Prawn Fishery
PER	Public Environmental Review
PFRC	Pemberton Freshwater Research Centre
PFTF	Pilbara Fish Trawl (Interim) Managed Fishery
RCL	rostrum carapace length
RFAC	Recreational Fishing Advisory Committee
RFFSS	Recreational Freshwater Fisheries Stakeholder Subcommittee
ROA	Reef Observation Area
SBBSMNF	Shark Bay Beach Seine and Mesh Net Managed Fishery
SBSF	Shark Bay Snapper Managed Fishery
SCEF	South Coast Estuarine (Interim) Managed Fishery
SFD	standard fishing day
SHL	sustainable harvest level
SLED	sea lion exclusion device
SMFG	size management fish ground
SRR	spawning stock–recruitment relationship
SSF	Specimen Shell Managed Fishery
TAC	total allowable catch
TACC	total allowable commercial catch
TAE	total allowable effort
TAFE	Technical and Further Education
TL	total length
TPSA	tiger prawn spawning area
VFLO	Volunteer Fisheries Liaison Officer
VMS	vessel monitoring system
WAFMRL	WA Fisheries and Marine Research Laboratories
WANCSF	WA North Coast Shark Fishery
WCBBF	West Coast Beach Bait Managed Fishery
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
WCEF	West Coast Estuarine Managed Fishery
WCRLF	West Coast Rock Lobster Managed Fishery