State of the Fisheries Report

2003/**04**

Government of Western Australia

Department of **Fisheries**

Fish for the Future

State of the Fisheries Report 2003/**04**

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Produced by the Fisheries Research Division based at the WA Marine Research Laboratories

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Cover photo: Rock lobster fishing camps at the Abrolhos Islands. Photo Bill Bachman.

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OVERVIEW FROM THE Executive Director

The *State of the Fisheries Report* is published annually to provide an additional level of detailed reporting of the management of fish stocks and their environment undertaken by the Department of Fisheries. A summary report from the document is included in the Department's Annual Report to Parliament, which includes the Department's non-financial (fishery) performance indicators.

By summarising management changes, compliance activities and research data including stock assessments and breeding stock levels, this document provides a valuable reference point for Western Australian fisheries of major importance to the commercial and recreational sectors, and the developing aquaculture sector.

This year's *State of the Fisheries Report* takes the next step in the Department's development of a full ecologically sustainable development (ESD) approach to managing the state's fisheries and aquatic environments. That is, the report structure now deals with fisheries and fishing-related activities on a bioregional basis, enabling ecosystem-based fisheries management to be more efficiently considered. An outline of the management processes the Department undertakes to manage the impact of fishing on the aquatic environment now prefaces the fishery reports in each bioregion, further emphasising the Department's long-standing commitment to protecting the habitats which support our fish stocks and aquatic tourism industries.

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. In contrast, the stocks of the state's larger sharks, particularly the longer-lived species such as dusky whalers, are under excessive pressure from fishing. Management of fisheries targeting these vulnerable stocks is being reviewed to address this decline.

Also of concern is the degradation of many of the state's rivers and estuaries and its impact on fish stocks and fisheries, particularly in the lower west coast estuaries.

On the positive side, it is pleasing to note that the tiger prawn stocks in Exmouth Gulf have recoved from the effects of Cyclone Vance, and that the state's south coast pilchard fisheries have now returned to a healthy state following the exotic virus episodes of the late 1990s. The report also shows that ongoing Departmental action to manage snapper fishing in inner Shark Bay has been effective.

These examples of the varied challenges facing both fisheries and coastal aquatic environments highlight the increasing need for scientific monitoring and proactive management of all fishing activities. The development of a system of Integrated Fisheries Management (IFM), funded in the 2004 Budget, is now central to achieving the Government's goal of long-term sustainability for our fish stocks. Under IFM, all fishing sectors – commercial, recreational and customary – will be allocated explicit shares within a total allowable catch for each fishery. This direct approach to managing the inevitable resource-sharing issues now arising is crucial to meeting ESD goals for the state's fisheries, and will involve some refocusing of the Department's research and field compliance activities.

The restructuring of *State of the Fisheries* to reflect the needs of future reporting has been a major but necessary undertaking. I would like to take this opportunity to express my appreciation to all Departmental staff who contribute to this important annual performance review of our fish stocks. Fishers throughout the state are also to be commended for their positive support for the Department's research and management programs, without which sustainability cannot be achieved.

Peter P. Rogers
EXECUTIVE DIRECTOR

EDITOR'S Introduction

The *State of the Fisheries Report 2003/04* represents the first significant departure from the structure first adopted in 1994 when this current series began. This change, to a bioregional reporting structure, has been undertaken to align the fishery reports with the Department's now fully implemented ESD management focus, which involves management of both the individual fisheries and their aggregate effects on regional environments. The work of the Fish and Fish Habitat Protection Program, which provides overall environmental coordination for the Department's fisheries management activities and habitat reserves, now provides the lead-in for each bioregion.

State of the Fisheries reports in detail on the activities and impacts of fishing across each of the state's four marine bioregions and two inland (freshwater) bioregions, so readers can now more easily see the linkages and overlaps between fisheries and fishing-related activities within each bioregion. The revised structure also reflects the Department's new initiative in Integrated Fisheries Management and resource-sharing necessary to ensure ongoing sustainability of the state's fisheries resources. For convenience, however, within the overall bioregional structure the individual reports remain grouped by stakeholder interest and follow the Department's program structure.

A second aspect of the restructure has been to limit the overlap between *State of the Fisheries* and the Department's Annual Report to Parliament. For detailed information on the operation of the Department's four programs (Commercial Fisheries, Recreational Fisheries, Pearling and Aquaculture, and Fish and Fish Habitat Protection), and performance measures of fisheries management, readers should refer to the Annual Report, available online at www.fish.wa.gov.au/annualreport/index.html.

During 2003/04, the Department's major focus on ESD and biodiversity conservation has continued, with significant resources being devoted to the completion of full fishery environmental risk assessments and the submission of applications to the Australian Government Department of Environmental and Heritage for environmental certification under the *Environment Protection and Biodiversity Conservation Act 1999*. All of the state's major export fisheries were successful in receiving this certification by 30 June 2004. Applications for the majority of the state's smaller exporting fisheries have also been completed and have been lodged for assessment in the coming year.

The focus on environmental aspects of fishing has also extended to the provision of scientific advice to Government in relation to the planning for new marine parks and reserves and revisions to existing marine parks. Although marine parks are not under the Department's direct legislative controls, the management of fishing within marine parks is actively undertaken by the Department. Similarly, the need for the Research Division to provide expert advice for marine park management results from the mobile nature of fish stocks and aquatic species generally, which does not allow marine protected areas to operate in isolation.

In addition to the regular status reports on commercial and recreational fisheries and aquaculture industries, and information on marine protected areas, this year's report for the first time includes detailed information on the state's developing aquatic charter industry. This sector numbered 252 licensed fishing tour operators and 36 licensed restricted fishing tour or eco-tour operators at the end of 2003. Catch and effort data from the charter fleet, which supports the recreational sector, will provide a valuable supplement to the information from commercial operators.

The information provided by fishers, particularly through detailed voluntary log books, continues to provide the critical long-run time series of data necessary to determine sustainable harvest levels across the state. The increasing numbers of volunteers in commercial, recreational and charter vessels, and through the Volunteer Fisheries Liaison Officer program, are adding substantially to the research efforts of the Department. In effect, the state now has hundreds of volunteer vessels contributing to the knowledge of fish stocks and the marine environment of Western Australia. This level of cooperation and active collaboration between all fishing sectors and the Department's staff continues to be a major factor in our ability to monitor the health of the state's fish resources and set sustainable harvest levels.

The state's aquaculture research and development program also benefits greatly from the active collaboration provided by aquaculturists, who provide access to farms and facilities for the research necessary for sustainable expansion of this important sector of the industry.

While *State of the Fisheries* is designed to meet the Department's reporting requirements, the volume also provides the general public and interested fishers with a ready reference source. The report is directly accessible on the Department's website (www.fish.wa.gov.au/sof/index.html), where users are free to download relevant sections for personal use. If quoting from the document, please give appropriate acknowledgment using the citation provided on p. 2.

Readers will be aware that this volume is being published later than normal in the annual cycle. This has been unavoidable due to the additional commitments of the editorial team, who have been heavily involved in the development of the Department's new, world-class fisheries and marine research centre at Hillarys Boat Harbour. This centre, to be commissioned during 2005, will be the first in Australia to combine research and community education facilities to make fisheries and marine science information and activities directly accessible to the WA public.

I would like to thank all of my Departmental colleagues who assisted with the difficult task of restructuring their reports while providing the comprehensive information contained within them. Special thanks are also due to my editorial team members, Dr Rick Fletcher and Ms Fran Head, who have had to take on an increased share of the substantial work involved in editing the restructured document, and to Mrs Sandy Clarke who has again expertly converted it into a quality printed volume.

Dr J.W. Penn
DIRECTOR – FISHERIES RESEARCH

How to use

THIS VOLUME

To obtain full benefit from the information provided, readers need to understand various terms and headings used in the text and summarised in Appendix 1 (which 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 new, 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 generally follow 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.

Exploitation status

Fully exploited: relates to stocks where harvesting is in the optimal range of 'maximum sustainable yield', which is defined as the greatest catch that can be removed each year without reducing the capacity of the fish stock to renew itself.

Under-exploited: relates to fish stocks which are being harvested at a level less than the maximum sustainable yield.

Over-exploited: relates to stocks where the harvest is above the maximum sustainable yield, and measures to reduce the catch should be considered. Typically, over-exploitation is first characterised by 'growth over-fishing', where the fish are being caught at less than optimal size. In rare cases, growth over-fishing becomes 'recruitment over-fishing', where the average number of recruits declines due to insufficient parental biomass.

Breeding stock status

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

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

Decreasing: reflects situations where fishing pressure (catch) has been excessive and parental biomass is falling to a level 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 effects on the food chain and the habitat, and an assessment of ecological risk (negligible, low, medium or high) is provided.

Acceptable catch (or effort) range

Acceptable 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.

Acceptable 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.

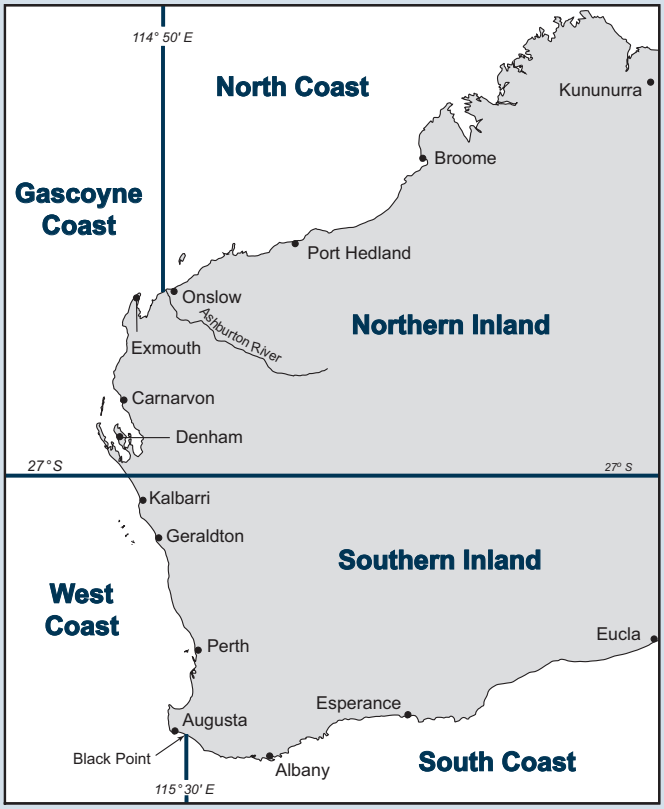
External factors

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 generally refer to the financial year 2002/03 or the calendar year 2003. Similarly, the statistics on compliance and educational activities are also for 2002/03, following analysis of data submitted by Fisheries 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 2004.



INTRODUCTION FIGURE 1

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

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. The fish stocks of the region are typically temperate, in keeping with the shelf 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 ENSO 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 tonnes 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 (*Mytulis edulis*) and marine algae (*Dunaliella salina*) for beta carotene production, and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands.

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

During 2003/04, the Department of Fisheries has provided extensive scientific and management advice to Government in relation to the planning for the proposed Capes Marine Park between Busselton and Augusta. It has also been working on the preparation of orders under the *Fish Resources Management Act 1994* in order to modify fisheries regulations in accordance with the final Jurien Bay Marine Park Management Plan.

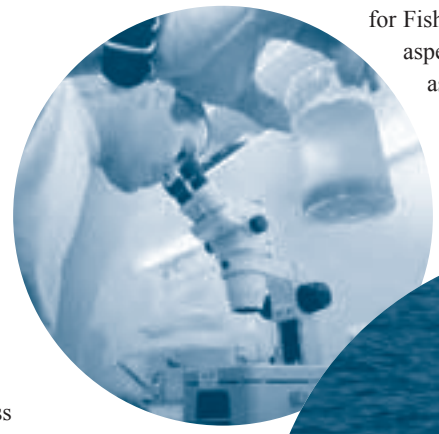
Following the release for public comment of the draft management plan for the proposed Blue Holes Fish Habitat Protection Area at Kalbarri, a final management plan is being prepared for Ministerial approval.

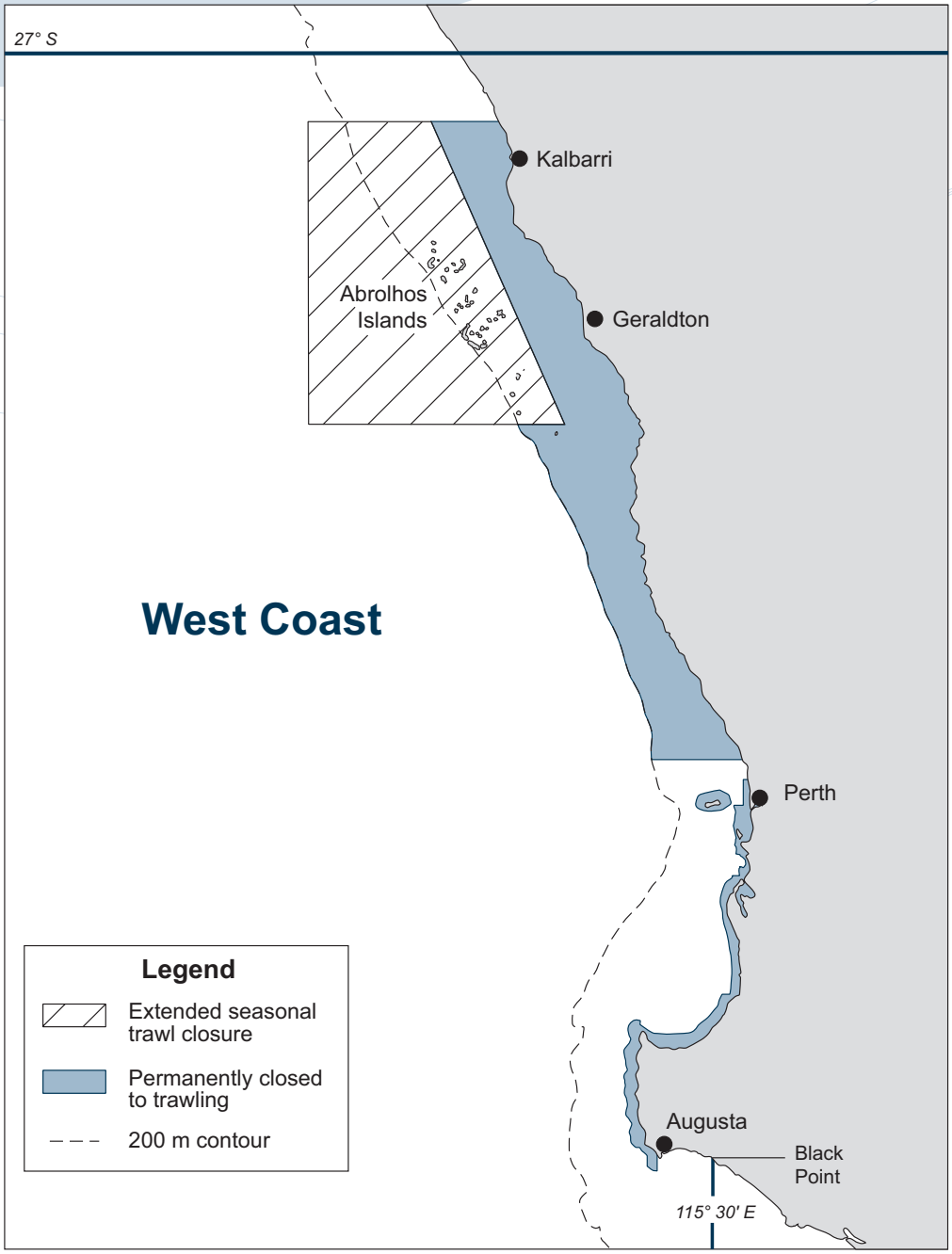
Recommendations for the development of a land-based tourism facility at the Abrolhos Islands, contained within Fisheries Management Paper no. 146 (the sustainable tourism plan for the islands), were implemented during 2003/04. When a preferred respondent has been selected, they will work with a Departmental working group to satisfy state and federal requirements before environmental approvals are granted. A licence to develop the Long Island site in the Wallabi Group will not be approved by the Minister for Fisheries until all environmental and other aspects of the proposed development are assessed as practical and suitable for this unique marine ecosystem.

ENVIRONMENTAL MANAGEMENT

Regional Overview

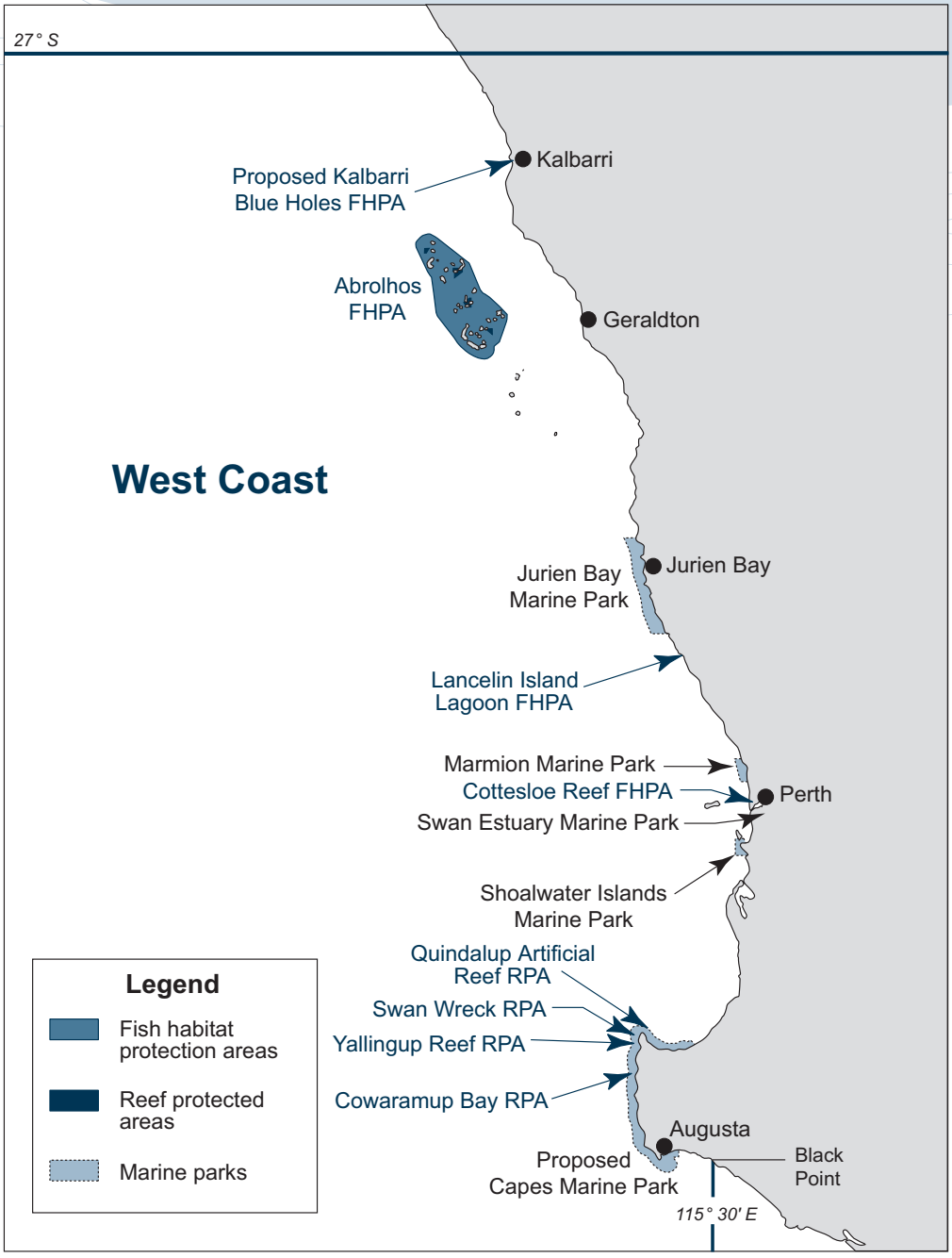
On the west coast, marine habitats are largely protected from any physical impact of commercial fishing by extensive closures to trawling, the only permitted fishing method which can significantly affect marine habitats. These closures, introduced in the 1970s and 1980s, protect essentially all seagrass 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 Protected Areas and marine parks in sensitive areas (West Coast Habitat Protection Figure 2). These protective management measures ensure that the marine habitat and biodiversity have remained in good condition. The exception to this, and the major threat to biodiversity and fish habitats in the west coast bioregion, is from coastal development and environmental degradation from terrestrial runoff impacting estuaries and some protected near-shore waters.





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

Prepared by M. Rossbach and R. Melville-Smith, with management input by S. Anderson

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). Its annual production, which averages in excess of 11,000 t, makes it 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*

Consultation processes

Rock Lobster Industry Advisory Committee 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 76,623 in the late 1980s, and since 1993/94 a usage rate of 82% has operated to keep the TAE at a sustainable level.

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, a variable minimum carapace length and a maximum female carapace length. 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.

During 2002/03, the Australian Government Department of Environment and Heritage (DEH) certified the fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a number of conditions, certification allows product from the fishery to be exported from Australia for a period of five years before reassessment.

Research summary

Research activities continue to focus on the core business activities 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 is used for modelling and stock assessment. An update of the stock assessment of the fishery was undertaken during 2003/04 with particular emphasis on the northern coastal zone where industry and the Department had concerns over the status of the stocks.

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. A new project to investigate the ecosystem effects of rock lobster fishing in deep water has also been developed.

The following status report summarises the research findings for this fishery.

RETAINED SPECIES

Commercial production (season 2002/03): 11,387 tonnes

Landings

Trends in the annual catches from the West Coast Rock Lobster Managed Fishery are shown in West Coast Rock Lobster Figure 2. The 2002/03 catch in the WCRLF was forecast from puerulus settlement 3–4 years previously to be

10,600–11,700 t. The catch from the WCRLF for the 2002/03 season was 11,387 t, 5.3% greater than the long-term average catch of 10,820 t and 27% greater than the previous season's 8,966 t. In 2002/03, the catches in A Zone, B Zone and C Zone were 1,722 t, 3,245 t and 6,420 t respectively, with A Zone 4.3% higher, B Zone 15.9% higher and C Zone 42.2% higher than the previous season.

The total catch of western rock lobster from this fishery (commercial and recreational) was approximately 12,277 t, 29% higher than the previous season's catch of 9,510 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 0.035 octopus per pot lift was recorded in the 2002/03 voluntary research log book data. This was 16.6% above the average of 0.03 per pot lift over the period 1985/86 to 2001/02. This translates to an estimated 270,000 octopus caught in the fishery during 2002/03. Octopus catches in B Zone were about 34% greater than those in C Zone, with those in A Zone estimated at approximately 32,000.

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. Under legislation introduced in 2000/01, new WCRLF licences could be created if a minimum pot holding of 63 was demonstrated. In addition, licensees could redistribute all pots by lease or sale down to a holding of a single pot on a licence, which then was considered dormant. Under this scenario, 145 vessels in A Zone, 137 in B Zone and 281 in C Zone actually fished for lobster in 2002/03. The number of dormant licences increased from 6 to 7 in A Zone, from 7 to 11 in B Zone and from 17 to 20 in C Zone. Thus, in comparison to the 570 active boats in 2001/02, a fleet of 563 vessels fished in 2002/03.

The nominal fishing effort was 10.18 million pot lifts, 1.5% lower than the 10.33 million pot lifts for 2001/02 (West Coast Rock Lobster Figure 2). The 2002/03 nominal effort for the A, B and C Zones of the WCRLF was 1.16, 3.66 and 5.35 million pot lifts respectively, which was 4.1% less, 3.2% more and 0.3% more 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 3) provides a broad indicator of the abundance of the stock. The downward trend from the 1950s to the 1980s reflects the increasing effort (and utilisation of pots) during this period (West Coast Rock Lobster Figure 2) 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) and specific protection for breeding females, both designed to increase the abundance of breeding stocks.

Shorter-term fluctuations in abundance (West Coast Rock Lobster Figure 3) represent the cyclical nature of puerulus settlement which is reflected in abundance (CPUE) three to four years later.

The increase in CPUE to 1.1 kg/pot lift in 2002/03 (around 29% more than the previous year) relates directly to the levels of puerulus settlement recorded previously.

Recreational component: 7%

On the basis of the 2002/03 mail survey, an estimated 7% of the total rock lobster catches were taken recreationally. (See Licensed Recreational Rock Lobster Fishery Status Report, pp. 55-57.)

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 fully exploited 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 Figure 4).

Nominal fishing effort fell in the 1993/94 season as a result of management changes and there has been an slight increase since then. Most of the decline in fishing effort occurred in the 0–10 fathom depth zone, particularly in Zones A and B. Over the period 1989 to 2003, the proportion of effort in 0–10 fathoms has declined from 50–60% to around 50% in A and B Zones, while in C Zone shallow-water effort has remained stable at an average of about 55%. The proportion of effort in deeper water (20–30 fathoms) increased in the mid- to late 1990s, but absolute numbers of pot lifts have remained relatively stable since 1993/94. Previous studies have indicated significant increases in effective effort in deep water during the 'reds' fishery due to the introduction of improved fishing technology such as colour echo sounders and GPS during the 1980s and early 1990s.

A new stock assessment approach using depletion estimates was completed during 2003/04 which provided good estimates of exploitation rates and residual biomass in the three zones of the fishery. This analysis showed that exploitation rates in A Zone have reduced marginally since 1993/94. In B and C Zones, a reduction in exploitation was noted after 1993/94 but an upward trend has been re-established, particularly in B Zone where the exploitation rate has risen back to the levels of the early 1990s, mainly due to increases in efficiency of the fleet. Exploitation rates for the shallow (< 20 fathoms) and deeper (> 20 fathoms) sectors are now being investigated.

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 2002/03 were below average at all sampling sites (West Coast Rock Lobster Figure 6). These results reflect the El Niño conditions (affecting the strength of the Leeuwin Current) which commenced in early 2002 and continued well into January 2003. Fluctuations in commercial catches are due

primarily to variations in puerulus settlement three and four years prior to the season in which the catch is taken. These lower 2002/03 settlements will first impact during the 'reds' of 2005/06 and then as a poor 'whites' throughout the fishery in 2006/07. The consensus forecast from international climate experts is for near-neutral conditions for the remainder of 2003 but with a possible return to El Niño in 2004 which, if correct, may lead to average to slightly below-average settlement within the next settlement period.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Hall and Chubb (2001) assessed the impact of the current management package on the WCRLF and concluded that the sustainability of the fishery was assured at the current rate of exploitation. The modelling confirmed that overall egg production levels were then well above those before the 1993/94 package was introduced. This modelling approach has been updated in 2003 to assess the current status of stocks and to explore management options to reduce the level of exploitation in the northern part of the fishery where breeding stock levels have trended downwards.

A three-year moving average (smoothing) is now 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 Figure 4. The Abrolhos Islands index from the IBSS is presented in West Coast Rock Lobster Figure 5.

Following the introduction of the management arrangements in 1993/94, the coastal egg production indices of breeding stock increased quite dramatically and within three years had returned to target levels. Successive years of very high levels of recruitment (predicted from puerulus settlement and reflected in the high catches) increased egg production above target levels during the early 2000s, but these levels have fallen off in the northern zone of the fishery in recent years (West Coast Rock Lobster Figure 4). The Abrolhos Islands breeding index (West Coast Rock Lobster Figure 5) has also declined, but this is not of concern since approximately 70% of the egg production there comes from sub-legal-sized lobsters. Catches at the Abrolhos Islands (West Coast Rock Lobster Figure 5) are a reasonable representation of the breeding stock as the size at maturity is much smaller than on the coast. The decline in egg production in the northern coastal region is of more concern. The current levels of egg production in the north coastal region are still marginally above the target levels set in 1993/94 (West Coast Rock Lobster Figure 4), but their sharp downward trend over the last two years has led to management discussions aimed at introducing management measures to reverse these trends.

More recent research modelling of the ratios of egg production in the fishery now, compared with back-calculated estimates of virgin levels, suggests that current egg production levels for A, B and C Zones respectively are about 22%, 8.5% and 30% of the unfished levels, compared to 20%, 2% and 18% prior to the introduction of the 1993/94 management package. Overall the stock is considered to be still above the minimum reference point level of approximately 25% used for the fishery.

Projected catch next season (2003/04): 13,450–13,750 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 6). Catch estimates for C Zone also are forecast from combined puerulus settlement figures from a number of C Zone puerulus collection sites. These additional forecasts, for the most part, are not dissimilar to the predictions based on Alkimos settlement alone. Seasons 2003/04 and 2004/05 are expected to produce commercial catches of around 13,450–13,750 t and 12,650–12,850 t respectively, resulting from above-average puerulus settlement in 1999/2000 and 2000/01 (West Coast Rock Lobster Figure 6). A decline in catch is forecast for the 2005/06 and 2006/07 seasons to about 10,300 t and 9,600 t respectively due to the lower puerulus settlement in recent years.

NON-RETAINED SPECIES

Bycatch species impact: Low

Fishery-independent monitoring 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*, in a limited way with the accidental drowning of an apparently small number of sea lion pups in rock lobster pots as the pups attempt to rob the traps of either bait or rock lobsters (West Coast Rock Lobster Figure 1). Such incidents appear to be infrequent and restricted to one or two isolated areas where sea lion pups forage. In the formal ecological risk assessment conducted as part of the MSC certification and DEH assessment processes, the interaction between the WCRLF and the Australian sea lion populations on the west coast was assessed as being a moderate risk due to their very low numbers since the start of the twentieth century.

A report is being compiled by the Department of Fisheries which assesses the historical abundance and distribution of this species throughout Western Australia. Management actions being proposed to minimise or eliminate the incidental mortality of sea lions include modifying existing pots with some form of sea lion exclusion device. Further work is being conducted to estimate the levels and areas of interaction through analysis of databases and phone interviews with commercial fishermen. A scientific reference group including independent experts has been established to advise on all the issues associated with this research and management program.

WEST COAST ROCK LOBSTER FIGURE 1

A juvenile Australian sea lion with a rock lobster it has removed from a fishing pot. Photo Richard Campbell.

Turtle deaths as a direct result of interaction with the lobster fishery appear to be rare. Six turtle species occur in the waters of the western rock lobster fishery, and species identification by fishers for reporting purposes is an issue. Only the entanglement of leatherback turtles (*Dermochelys coriacea*) was identified as a moderate risk by the risk assessment, and data are being collected to establish the level of interaction with rock lobster fishing. There are occasional reports of a whale entangled with ropes, but this is rare.

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

ECOSYSTEM EFFECTS

Food chain effects: Low

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 and significant proportion of the biomass (> 80%), which remains from year to year, and the catch, particularly in inshore areas, is less than the annual varability in biomass due to natural recruitment cycles. The western rock lobster is an opportunistic omnivore feeding on a wide range of food items from coralline algae to molluscan and crustacean fauna, the populations of which have high productivity and short life cycles. With current knowledge, the overall effect of the fishery on the wider ecosystem is assessed to be minimal. A low risk was assigned to this fishery impact during the ecological risk assessment. A proposal for research to determine whether lobster abundance has any detectable influence on the ecology of deep-water reefs inhabited by lobsters has been developed.

Habitat effects: Low

The legislated design of rock lobster pots, the materials they are made from and the strict control of replacement pots prevent 'ghost fishing' problems arising. A study of human impacts (including rock lobster fishing) on the marine environments of the Abrolhos Islands, funded by the Fisheries Research and Development Corporation (FRDC), estimated that potting might impact on between 0.1% and 0.3% of the surface area of fragile habitat (corals) at the Abrolhos. Fishing in this zone is only allowed in three and a half months of the year. Generally, throughout the coastal fishery, rock lobster fishing occurs on sand areas around limestone reef habitat 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 $278 million. Employment is seasonal, the fishing season covering seven and a half months from 15 November to 30 June. A total of 563 vessels and 1,576 people were engaged directly in fishing for rock lobster in 2002/03. This equates to one skipper and an average of 1.8 deckhands per vessel. During the year, 11 processing establishments engaged between 150 employees in the closed season and about 1,000 employees during the fishing season. The processing establishments' receival depots or trucks serviced practically every location where fishing occurred, whilst the factories were located in the Perth metropolitan area (5), Jurien (1), Cervantes (1), Dongara (1) and Geraldton (3). Rock lobster fishing has been responsible for the establishment of, and is a critical element in the economic survival of, many towns along Western Australia's west coast from Mandurah to Kalbarri.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002/03: $278 million

The price fishermen received for the western rock lobster in 2002/03 was an estimated average of $24.45/kg in all zones of the fishery. This was a 27.6% decrease on the $33.75/kg paid in 2001/02. This substantial decrease in price can be attributed to several factors, including the impacts of SARS and the Iraq war on overseas markets, and most notably the strengthening of the Australian dollar (from 55–56¢ US at the start of the season to 67¢ US by June 2003). Thus, despite the increase in catch, the overall value of the fishery fell from approximately $300 million in 2001/02 to $278 million in 2002/03. The bulk of the product was exported to Japan, Taiwan, Hong Kong/China, and the United States and Europe.

FISHERY GOVERNANCE

Acceptable catch range for next season: 8,166–14,523 tonnes

Between 1974/75 and 2000/01, fishing effort levels exceeded 10 million pot lifts. During this 27-year period, commercial catches ranged from 8,166 t in 1985/86 to 14,523 t in 1999/2000. The average catch was 10,820 ± 587 t (95% confidence limits of the mean). The variation in catches results primarily from variable levels of recruitment, driven by the environmental conditions experienced by western rock lobster larvae and post-larvae, and levels of fishing effort. As fishing

effort has been reduced and now has stabilised around the current levels, catches are expected to fall within the above range.

New management initiatives (2003/04)

To assist the Rock Lobster Industry Advisory Committee and its subordinate committees and reference groups in developing management advice for the Minister, a fisheries management decision rules framework for the western rock lobster fishery has been developed. This decision framework is currently in draft form but will be implemented by the commencement of the 2004/05 season.

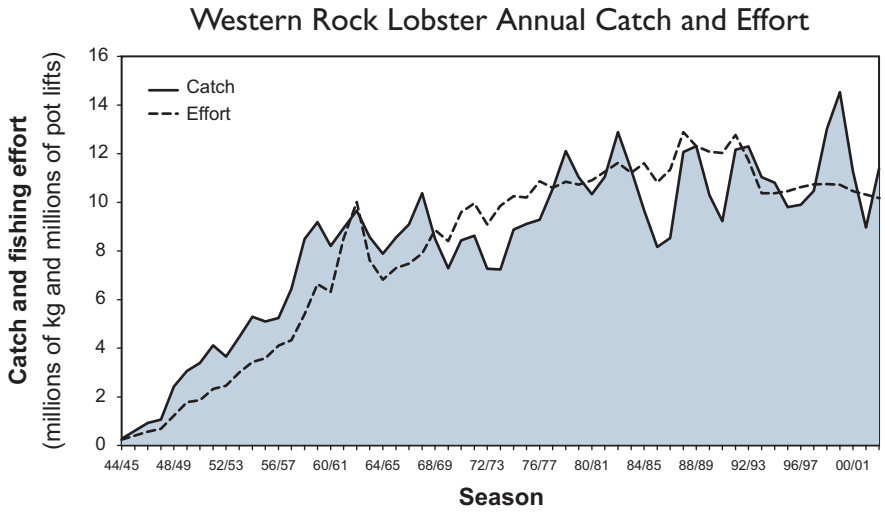
A review of the fishery's management system is currently underway to assess the relative benefits of alternative management models in the context of ESD. The review will compare the current input control system, a transferable time/effort system and a transferable quota management system. The outcomes of this process are to be reported to Government by the end of 2006, ensuring that Government meets its commitments to the National Competition Council.

A three-year FRDC-funded project commencing in July 2004 will involve a large-scale socio-economic study of the fishery, to be undertaken by the University of Western Australia in conjunction with industry. This study will assist in determining which of the above management systems can provide the best mix of social and economic benefits to the Western Australian community.

During 2003/04, the Department has been developing a unit register system for the commercial fleet to capture the detail of the number of units affected by a security interest and the financial limit of the charge. This register will also assist the Department in identifying third parties who have interests in the fishery so that they may be invited to be fully involved in consultation on issues that may affect their investment.

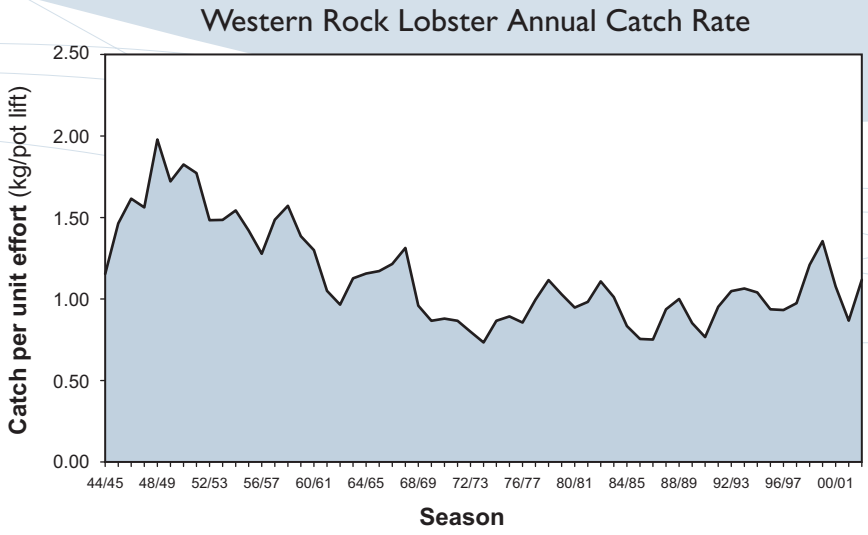
EXTERNAL FACTORS

The variations in western rock lobster catches are 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. Catches are also dependent upon the environmental conditions at the time of fishing.



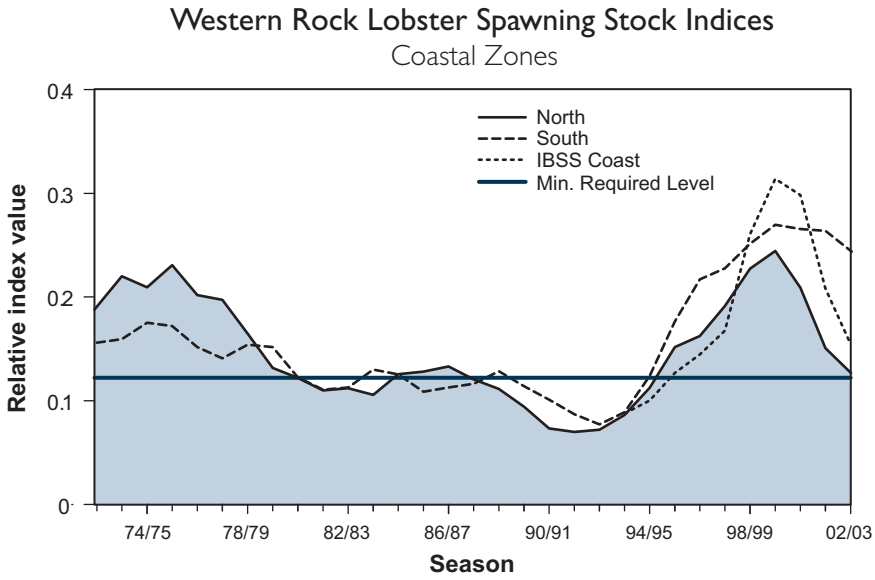
WEST COAST ROCK LOBSTER FIGURE 2

Annual catch and nominal fishing effort from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2002/03.



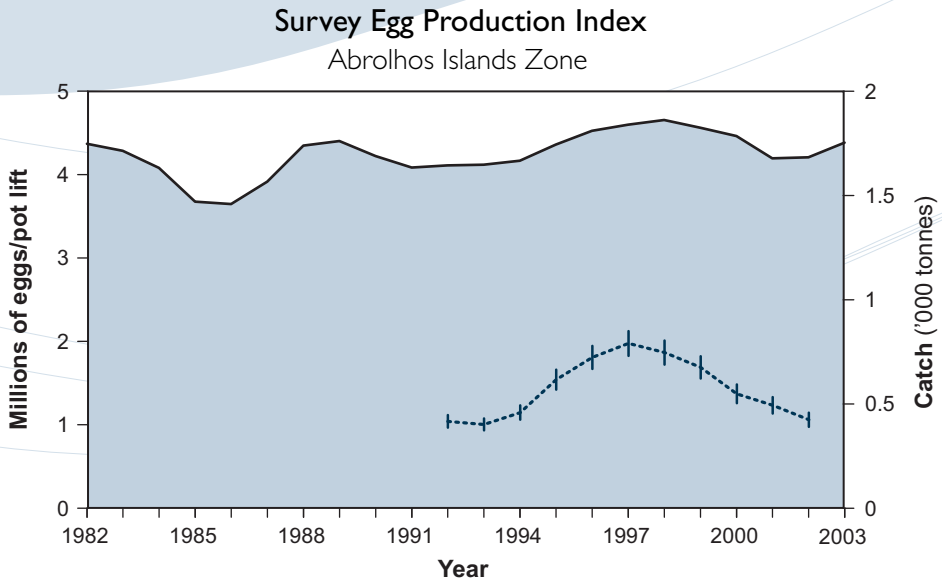
WEST COAST ROCK LOBSTER FIGURE 3

Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2002/03.



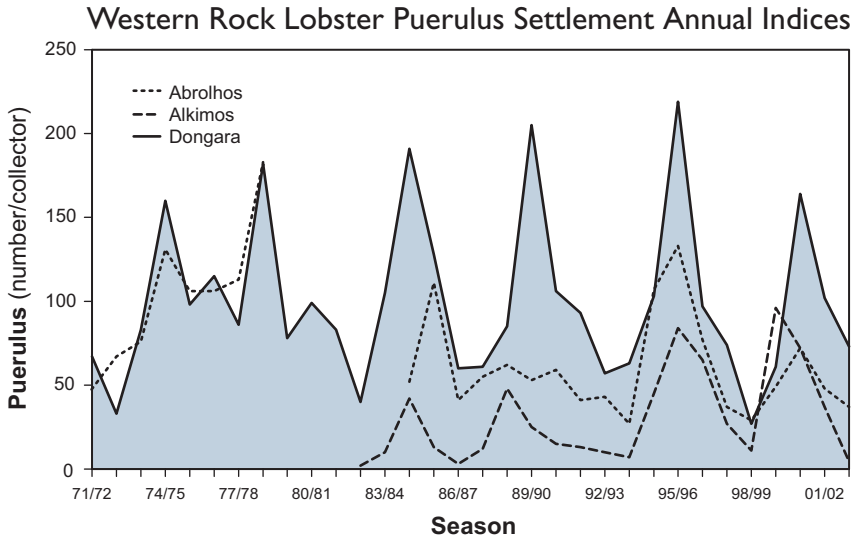
WEST COAST ROCK LOBSTER FIGURE 4

Time series of monitoring spawning stock index (an index of numbers of eggs per pot lift integrated over the whole season) for the north (Jurien and Dongara) and south (Fremantle and Lancelin) coastal regions and the independent breeding stock survey index of egg production adjusted to be equivalent to the 1992/93 average of the monitoring indices. Proportional adjustments to that point have been applied and all indices have been smoothed (moving average of three) to reduce the large variation seen in successive individual points caused by changes in catchability.



WEST COAST ROCK LOBSTER FIGURE 5

Egg production indices (with standard error) as measured by the independent breeding stock survey at the Abrolhos Islands smoothed by a moving average of three years, centred on the middle year (dashed line). Western rock lobster catches (in tonnes) smoothed by a moving average of three years, centred on the middle year (solid line).



WEST COAST ROCK LOBSTER FIGURE 6

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

Abrolhos Islands and Mid West Trawl Managed Fishery Status Report

Prepared by M. Kangas, E. Sporer and G. Parry

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

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.

The fishing gear (net size) in this fishery is unitised, with one headrope unit converting to 4 fathoms (7.32 m). For the 2003 season, the entire entitlement of 46 headrope units was utilised by 16 boats that operated in the fishery.

The Abrolhos scallop fishing season normally runs for three months (April–June), though recent improvements in catch prediction permit the setting of a shorter season when catches are expected to be low. In 2003 the season opened on 1 April and closed on 30 June. During the latter part of the fishing period, high densities of scallops were taken along the eastern boundary within the permitted trawl area near the Port Gregory prawn fishing area. Several surveys were completed on the eastern side of the boundary in the rock lobster B Zone during June and July. A small portion in the southern sector of the survey area was found to contain a significant scallop resource with large meat size of high quality. Consultation between research, managers and the rock lobster industry resulted in an agreement to permit fishing for scallops in this small area, which opened on 5 August and closed on 13 August.

The Port Gregory prawn trawl area of the fishery opens annually on 1 March and closes on 31 October.

Bycatch reduction devices to release large species are fully implemented in the AIMWTF as a licence condition.

The vessel monitoring system (VMS), a satellite tracking system used to monitor the movement of vessels within the waters of a fishery, has been part of the management arrangements since 2000/01.

Research summary

Research monitoring of the scallop stocks in this fishery is undertaken utilising fishers' monthly returns data and an industry-based pre-season survey. Advice on the status of stocks and appropriate season opening and closing dates is provided to industry.

RETAINED SPECIES

Commercial production (season 2003): 5,840 tonnes whole weight

Landings

The total landings for the 2003 season were a record 5,840 t whole weight of scallops compared to a very low catch of 195 t whole weight in 2002 (Abrolhos Islands Scallop Figure 1). The catch prediction for the 2003 season, based on a pre-season survey, was between 2,900 and 4,350 t whole weight. The actual catch exceeded this prediction and included an additional 360 t whole weight caught in the area east of the fishery boundary, which had not been included in the pre-season survey. The total landings were above the upper limit of the acceptable range for this fishery based on historical catches, owing to the exceptional recruitment resulting from good environmental conditions.

In 2003 no fishing took place in the Port Gregory area.

Fishing effort/access level

A total of 10,382 trawl hours (nominal effort) were recorded for the 2003 season, equivalent to 9,124 standardised trawl hours (standardised to 14 fathoms headrope length). This is much higher than the 912 standardised trawl hours recorded in 2002 owing to the much higher abundance of scallops in 2003 and the additional days of fishing in August (Abrolhos Islands Scallop Figure 1). This effort level represents a fishing season of 97 days duration in 2003, compared to 6 days in 2002.

Catch rate

The catch rate in 2003 was 640 kg/hr (whole weight, standardised effort), compared with 218 kg/hr for 2002, reflecting a significant (approximately threefold) increase in abundance.

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, and the high recruitment abundances seen during the pre-season survey in 2002 enabled very high scallop catches to be forecast for 2003. However,

the average catch rate for the 2002 pre-season survey was well beyond the catch rates from previous surveys carried out between 1997 and 2001, requiring extensive extrapolation beyond the data available to date.

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. Derivation of a reliable survey abundance–catch relationship will require several more years of data and an extension of the survey to cover more of the potential settlement area.

Exploitation status: Fully exploited

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.

Projected catch next season (2004):
155–245 tonnes whole weight

Using the November 2003 survey data, the projected catch range for 2004 is likely to be 155–245 t whole weight for the surveyed areas.

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 2003, the total area of the fishery that was fished by scallop boats was 11% compared to 1.4% in 2002. Owing to the focused nature of this fishery and the large mesh size (100 mm), little bycatch is 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 2003. 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. However, the trawling was more extensive during 2003 due to high scallop abundances throughout the fishery. Also, a small portion outside the fishery boundary was fished in 2003. The areas associated with scallops are sandy habitats and these are not impacted significantly by trawling activity. An underwater survey was undertaken by the Department of Fisheries in 1994 to delineate trawlable habitats in the Abrolhos Islands and trawling is largely contained within these areas.

SOCIAL EFFECTS

This scallop fishery utilises large numbers of crew (up to 13 per vessel) to carry out on-board processing during the short period of fishing in the season. The estimated employment for the year 2003 was 200 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003:
$19.6 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 $3.36/kg whole weight or $16.80/kg meat weight. Meat weight is approximately 20% of the whole weight.

FISHERY GOVERNANCE

Acceptable catch range for next season:
95–1,830 tonnes whole weight

The acceptable catch range for this fishery has been amended during 2003/04 using improved methodology. The revised range is derived by applying an autoregressive moving average (2,2) control quality procedure to the annual catch data from 1985 to 2003. The confidence intervals are obtained by estimating the variation of the observations compared with the variation of the predictions for these 19 years.

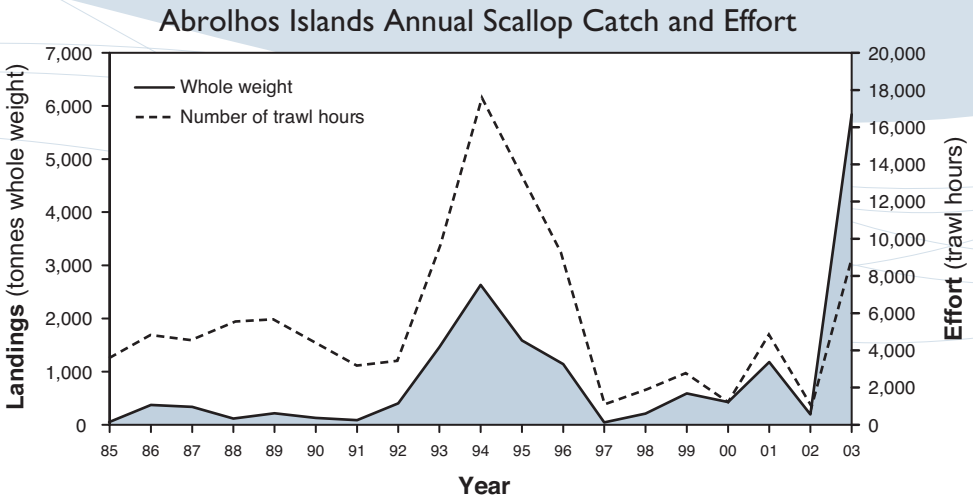
New management initiatives (2003/04)

A final application is being developed for certification of the AIMWTF as environmentally sustainable under the provisions of the Australian Government *Environment Protection and Biodiversity Conservation Act 1999*. It is anticipated that this will be submitted to the Department of Environment and Heritage in the latter part of 2004.

Discussions are currently occurring between the scallop and rock lobster industries to further delineate sensitive or rock lobster habitats to be avoided by scallop trawlers whilst fishing. Also there has been an increased use of spatial closures when small shell was detected during surveys.

EXTERNAL FACTORS

The high level of recruitment seen in late 2002 following a very low catch season, and the subsequent low abundance of newly recruited scallops on the grounds in late 2003, 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, 1985–2003.

South West Trawl Managed Fishery Status Report

Prepared by M. Kangas, with management input by M. Holtz

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 sytem 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. Although access to Zone C is permitted between 1 July and 30 September, following a Fishery Adjustment Scheme all four authorisations to fish in Zone C 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 utilising fishers' monthly returns data.

RETAINED SPECIES

Commercial production (season 2003):

Prawns 20 tonnes
Scallops 12 tonnes whole weight

Landings

The total landings for the season were 20 t of western king prawns and 12 t whole weight of scallops. The catch of king prawns was 23% up on the catch of 2002 and 27% up on average catch levels for the last five years (14.3 t). The scallop catch was 50% up on catches of 2002. The fishery also lands a mixture of by-product species, of which the most abundant species recorded were 7 t of western sand whiting (*Sillago schomburgkii*), 4 t of blue swimmer crabs (*Portunus pelagicus*) and 2 t each of squid and mixed skates and rays.

Fishing effort/access level

A total of 428 days were recorded as being fished by 6 boats in 2003 compared to 258 days by 8 boats 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

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. 1993a) of the environmental effects of this fishery has shown that the fishery has minimal impact on bycatch species.

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 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. (1993a) concluded that the fishery has minimal impact on the benthic sand habitats involved.

SOCIAL EFFECTS

The estimated employment for the year 2003 was 18 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003:
Prawns $260,000
Scallops $40,000

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 $13.20/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 $3.36/kg whole weight or $16.80/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 (2003/04)

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

Prepared by L. Bellchambers and D. Harris, with management input from H. Greif

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 stock is concentrated in the coastal embayments between Geographe Bay in the south and Port Hedland in the north.

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. While commercial crab fishers in WA traditionally used set (gill) nets or drop nets, most have now converted to purpose-designed crab traps. Crabs are also retained as a by-product of the state's prawn and scallop trawl fisheries.

Blue swimmer crabs are also targeted by recreational fishers in Western Australia, 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 (Sumner and Williamson 1999; Sumner et al. 2000). 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*

Consultation process

Department–industry meetings

Boundaries

The bulk of the commercial blue swimmer crab catch in Western Australia comes from 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 Swan River Estuarine Fishery encompasses the waters of the Swan and Canning Rivers, located in the Perth metropolitan area.

The Mandurah Estuarine Fishery covers the waters of the Peel Inlet and Harvey Estuary, together with the Murray, Serpentine, Harvey and Dandelup Rivers. (Note that the Mandurah and Swan River Estuarine Fisheries were amalgamated for management purposes in November 2003, but are considered separately here as the catch season reported predates this change.)

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 Geographe Bay fishery covers the waters south of a line drawn from the north-west tip of Cape Naturaliste to McKenna Point lighthouse in Bunbury.

Gascoyne: Currently, separate licence conditions describe 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, are permitted to use traps in the waters of Shark Bay south of Koks Island. The Carnarvon Experimental Crab Trap Fishery covers the waters from Quobba Point in the north, to Bernier and Dorre Islands in the west, and south to Cape Peron.

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. 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 adequacy of breeding stocks in the commercial crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. Blue swimmer crabs become sexually mature below 100 mm carapace width (CW) while legal minimum sizes range from 127 mm CW to 135 mm CW in different fisheries. Maintaining legal minimum sizes above the size at sexual maturity ensures adequate egg protection for blue swimmer crab stocks regardless of fishing pressure.

Exploitation rates in several commercial crab fisheries (Cockburn Sound, Mandurah Estuarine, Geographe Bay) are directly controlled by effort (trap) quotas to ensure stock is available to the recreational sector.

Research summary

Research monitoring of fishing activity for blue swimmer crabs was initially based on analysis of monthly returns data and interviews with commercial crab fishers. Following a rapid increase in commercial catches during the 1990s, combined with the high level of participation by recreational fishers, additional research became necessary to address key biological parameters and collect additional fishery information required for future stock assessments. Consequently, a number of research projects were instigated during 1997/98, with funding from the FRDC, under the umbrella of the national collaborative blue swimmer crab research initiative. This research, which included the basic biology of crabs along the Western Australian coast, gear–catchability relationships, recreational catch surveys, commercial catch monitoring, discard mortality estimation and stock assessment modelling, was completed in 2000/01. A further three-year FRDC project to develop stock allocation and assessment techniques in Western Australian blue swimmer crab fisheries is due for completion in 2005.

Well over 90% of the annual commercial blue swimmer crab catch in Western Australia comes from four of the state's crab fisheries: Shark Bay, Cockburn Sound, the Pilbara and the Mandurah Estuarine Fishery. The following status report summarises the research findings for these fisheries for the 2002/03 financial year, with catch and effort data pooled for the remaining areas of the state.

RETAINED SPECIES

Commercial production (season 2002/03): 890 tonnes

West Coast Bioregion

Landings

The commercial catch of blue swimmer crabs taken in Western Australian waters during 2002/03 was 890 t. This represents an 18% increase from 2001/02 (754 t), primarily due to the continued expansion of the developing fisheries in the north of the state.

Shark Bay recorded a 5.9% increase in catch (506 t compared to 478 t in 2001/02) as the Carnarvon Experimental Crab Trap Fishery continued to develop. Dedicated crab trap fishermen accounted for 389 t (a 15.7% increase over 2001/02), with the Shark Bay trawl fleet contributing the remaining 117 t (a 17.3% reduction).

The commercial catch for the 2002/03 season from dedicated trap fishers in Cockburn Sound was 231 t, representing a 122% increase from 2001/02 and a return to the accepted 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. Cockburn Sound net fishers took a further 1.6 t.

The commercial catch from the Mandurah Estuarine Fishery for 2002/03 was 52 t, a decrease of some 22.6% from the 68 t taken in 2001/02 (Blue Swimmer Crab Figure 1).

Experimental fishing continued in the Pilbara region during 2002/03, with dedicated crab trap fishers operating intermittently throughout the year. Total blue swimmer crab landings were 30.5 t, a 43% increase over the 21.3 t taken in 2001/02. Conversely, the retained catch from trawlers operating in the area fell considerably. During 2002/03, trawlers retained 3.1 t of blue swimmer crabs, compared to 17.5 t in 2001/02.

A further 66.6 t of blue swimmer crabs were caught in the remaining areas of the state during 2002/03. Of this catch, 40.3 t was caught using crab traps, 10.6 t using gill (set) nets, 8.8 t by otter trawlers and 6.7 t using drop nets, with the remaining 0.2 t taken by haul net or purse seine.

Fishing effort/access level

The commercial crab catch in Western Australia is taken using a variety of fishing methods (Blue Swimmer Crab Figure 2). In the past year, traps accounted for 83% of the commercial catch (up from 74% in 2001/02), with the remainder taken primarily by trawling (14%, down from 22%), gillnetting (1.2%, down from 3.6%) and drop netting (0.9%, up from 0.4%). The overall state fishing effort during 2002/03 increased by 11% for traps, up from 522,668 trap lifts in 2001/02 to 578,817 trap lifts for 2002/03. Conversely, less effort appeared to be targeted at blue swimmer crabs by trawlers, gillnets or drop nets during 2002/03.

Effort in Shark Bay again increased marginally during 2002/03, consistent with the continuing development of the Carnarvon Experimental Crab Trap Fishery. The five dedicated Shark Bay crab trap fishermen made 245,600 trap lifts over 987 days, up from 226,092 trap lifts over 856 fishing days during 2001/02 (Blue Swimmer Crab Figure 3).

During 2002/03, 189,427 trap lifts were reported in Cockburn Sound from 1,560 fishing days, up from 156,497 trap lifts over 1,471 fishing days during 2001/02 (Blue Swimmer Crab Figure 4).

Effort levels from fishers using crab traps in the Mandurah Estuarine Fishery remained effectively constant. A total of 47,982 trap lifts were reported during 2002/03 (Blue Swimmer Crab Figure 5).

Catch rate

Owing to the variety of fishing methods used to take blue swimmer crabs and the diversity of areas fished, a single catch rate statistic has not been produced. Comparative rates are given here for the three areas that contributed the majority of the blue swimmer crab catch for the past year. All three fisheries use dedicated crab traps.

The catch rate in Shark Bay for 2002/03 was 1.58 kg/trap, representing a 6.5% increase from 1.48 kg/trap in 2001/02 (Blue Swimmer Crab Figure 4). After remaining relatively static since 1991/92 (1.0–1.2 kg/trap), the catch rate in Shark Bay has increased measurably over the last three years (1.5–1.8 kg/trap).

The trap catch rate in Cockburn Sound for 2002/03 was 1.22 kg/trap, up from 0.66 kg/trap for the 2001/02 season (Blue Swimmer Crab Figure 4). This represents the second highest CPUE since the introduction of crab traps in 1993/94 and is considered to reflect an increase in abundance due to better recruitment.

Effort remained constant in the Mandurah Estuarine Fishery for 2002/03 so the catch rate decreased in line with the reduction in catch. An overall catch rate of 1.07 kg/trap was recorded for 2002/03, down 22% from 1.38 kg/trap for 2001/02 (Blue Swimmer Crab Figure 5).

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 the bioregion to be about 40% of the total catch. The recreational take was dominated by catch from the Peel/Harvey Estuary. Recent surveys produced recreational catch estimates for Cockburn Sound of 18.2 t and 23 t, for the 2002 and 2003 calendar years respectively. Over 98% of the recreational crab catch taken was male. Surveys quantifying recreational catch are currently being conducted in Cockburn Sound, Geographe Bay and along the south coast of Western Australia.

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 that catch was taken in the Shark Bay area.

A survey of recreational crabbing in Nickol Bay estimated a blue swimmer catch of 20 t for the 2000 calendar year (Williamson et al., in prep.). 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.

STOCK ASSESSMENT

Assessment complete: Preliminary

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

Shark Bay: Trap catches in Shark Bay (Blue Swimmer Crab Figure 3) show an almost five-fold increase since the commencement of the Carnarvon Experimental Crab Trap Fishery in 1998, while effort and catch per unit effort have increased just three and 0.5 times respectively. These recent increases in catch and CPUE reflect the more efficient fishing of blue swimmer stocks in Shark Bay, as the commercial operators' knowledge of the region has increased over time. Further sustainable increases in catch are possible as the fishery continues to refine work practices and explore areas that have previously not been fished for crabs.

Cockburn Sound: Following the change from gillnets to purpose-designed traps in 1994/95, trap catches in Cockburn Sound increased until reaching a peak of 333 t in 1997/98 (Blue Swimmer Crab Figure 4), after which the catches declined. Similarly, effort peaked in 1997/98 but has subsequently declined due to industry buy-backs and latent effort in the fishery not being utilised. However, on an annual basis the catch, effort and CPUE in Cockburn Sound display significant variation.

Mandurah Estuarine Fishery: Blue swimmer catches in the Peel/Harvey Estuary (Blue Swimmer Crab Figure 5) have maintained fairly consistent levels in terms of catch, effort and CPUE since the implementation of traps in 1995/96.

Yield-per-recruit analysis has indicated that yields may be increased by lowering the legal minimum size or carapace width (Melville-Smith et al. 2001). Egg-per-recruit analysis indicated that as blue swimmer crabs mature at a small size (CW_{50} = 86.2 mm females and CW_{50} = 96.8 mm males in Cockburn Sound, Potter et al. 2001), even substantial reductions in the minimum legal size may not be detrimental to egg production per recruit (Melville-Smith et al. 2001). However, optimising the weight of catch in the fishery by reducing size (age) at first capture would not produce the best economic outcome because the market pays premium prices for animals > 130 mm CW. Similarly, catching smaller crabs with lower meat yields is unlikely to be satisfying to recreational fishers.

Length-frequency data gathered from ongoing monitoring programs in Shark Bay, Cockburn Sound and Port Hedland suggest that management controls currently in place are adequate in maintaining a sustainable level of catch and effort in the state's crab fisheries, while allowing exploitation of the available resource. 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 severely limited the catch of sub-adult 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.

Exploitation status: Fully exploited (Cockburn Sound/ Mandurah Estuarine/Geographe Bay)
Under-exploited (Shark Bay)

Breeding stock levels: Adequate

As the legal size at first capture (127–135 mm CW) is well above the size at maturity in all sectors of the fishery, the breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas. The industry voluntarily applies a higher minimum size for marketing purposes, thus further increasing the level of spawning prior to capture.

NON-RETAINED SPECIES

Bycatch species impact: Low

The shift from using gillnets to traps in most areas has resulted in a substantial reduction in bycatch from dedicated crab fishing. 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.

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 2002/03, approximately 54 people were employed as skippers and crew on vessels fishing for blue swimmer crabs at various locations along the west coast, from Geographe Bay in the south to Port Hedland in the north. 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 2002/03: $3.8 million

The state blue swimmer crab catch for the 2002/03 season was valued at approximately $3.8 million, representing a small increase on the $3.4 million generated in 2001/02. Beach prices varied between $4/kg and $6/kg live weight, with the average price for the year being $4.25. While the majority

of the product was sold through local and interstate markets, several Shark Bay fishermen have been exploring the viability of accessing markets in south-east Asia and value-adding of product on the domestic market.

FISHERY GOVERNANCE

Acceptable catch range for next season: 200–350 tonnes (Cockburn Sound only)

For the managed fishery in Cockburn Sound, the commercially acceptable 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 and effort stabilised.

Catches from new and expanding fisheries are expected to take the statewide catch for the species to in excess of 850 t.

New management initiatives (2003/04)

The Australian Government Department of Environment and Heritage is currently considering an application to certify the Shark Bay Experimental Crab Fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. Applications for certification of the other blue swimmer crab fisheries are expected to be submitted in 2005.

A management plan is being finalised to govern the administration of the Shark Bay Crab Fishery. The plan 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.

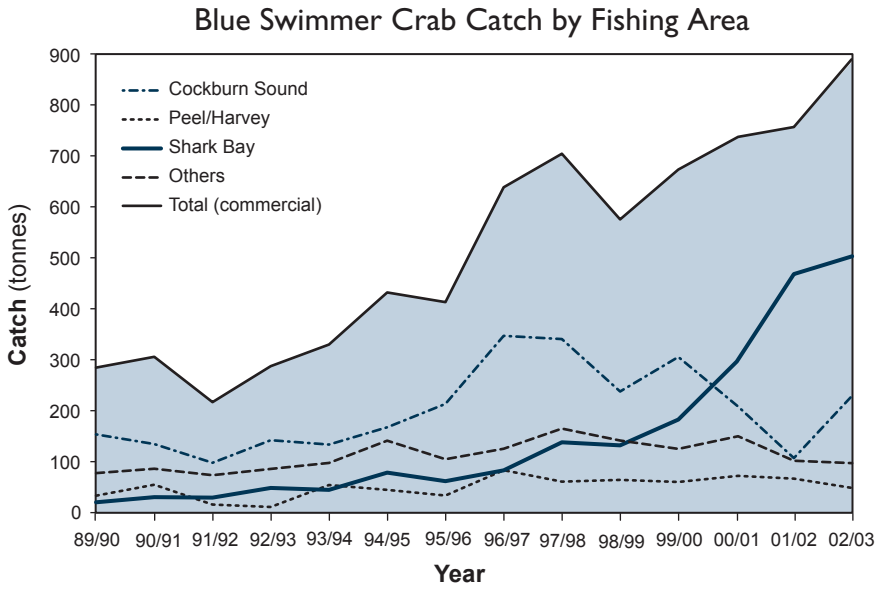
Owing to similarities between the Swan River Estuarine Fishery and the Mandurah Estuarine Fishery, the two fisheries were amalgamated from November 2003 to form the West Coast Estuarine Managed Fishery, managed under the provisions of the West Coast Estuarine (Interim) Management Plan 2003.

EXTERNAL FACTORS

The broodstock in Western Australian blue swimmer crab populations is considered robust, with a minimum legal size limit (127–135 mm CW) set well above size at sexual maturity (< 100 mm CW). Levels of recruitment to many of the crab fisheries, however, still fluctuate considerably. While the specific causes of this variation are yet to be fully understood, it is considered most likely due to environmental influences on larval survival.

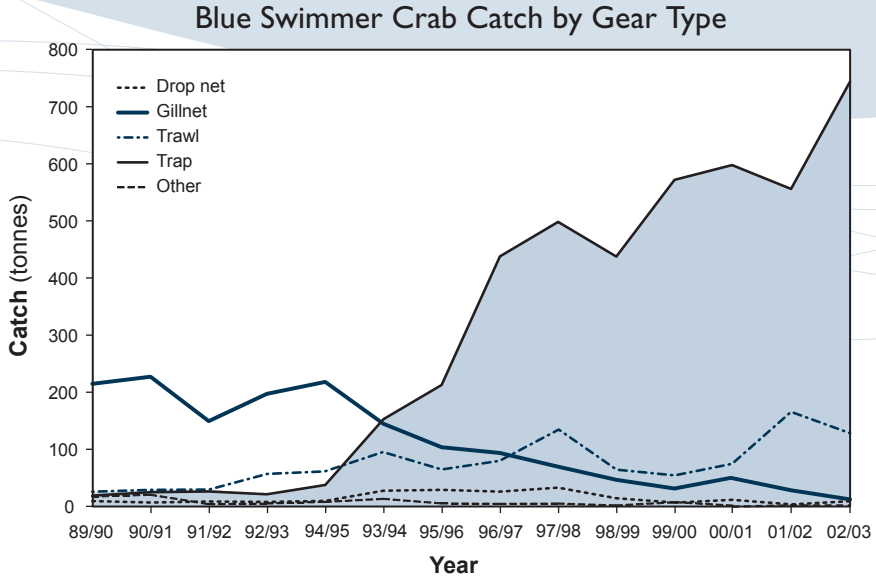
Currents and water movement play a significant role in determining recruitment success, as a specific window of time is available during the megalopal larval stage of the blue swimmer crab to reach and/or select a suitable settlement site (Bryars 1997). Both temperature and salinity influence the spawning behaviour, distribution, activity and movement of blue swimmer crabs (Meagher 1971), while juvenile growth is also markedly influenced by the availability of food (Kangas 2000).

Surveys measuring the strength of recruitment to the Cockburn Sound crab fishery are currently being undertaken as part of a three-year FRDC project. As more years of recruitment survey and catch/effort data become available, the relationship between environmental factors and recruitment will be further evaluated.



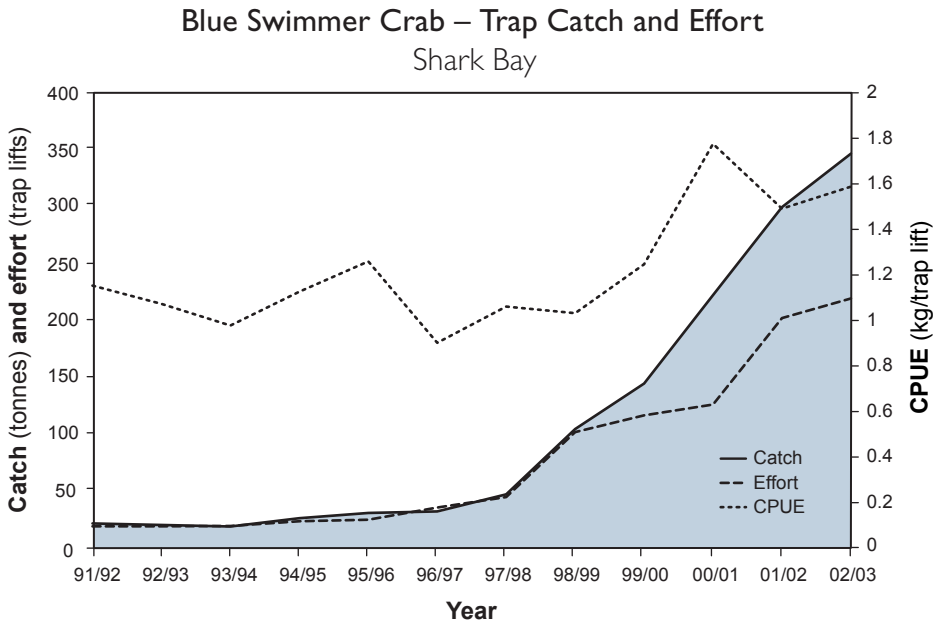
BLUE SWIMMER CRAB FIGURE 1

Commercial catch history for the blue swimmer crab (*Portunus pelagicus*) in Western Australia between 1989/90 and 2002/03, indicating main regions of commercial catches.



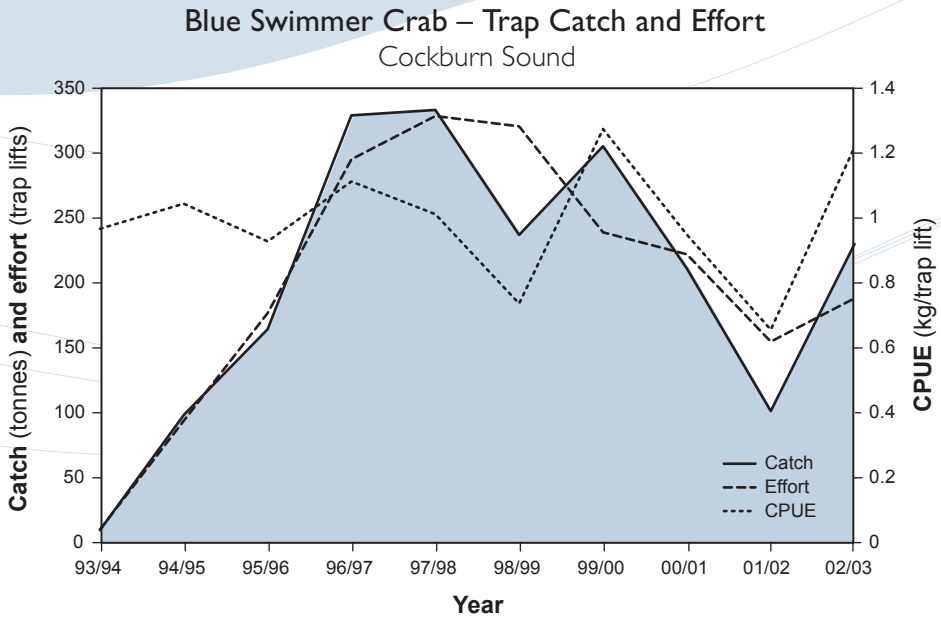
BLUE SWIMMER CRAB FIGURE 2

Blue swimmer crab catch taken by different gear types in Western Australia during the period 1989/90 to 2002/03.



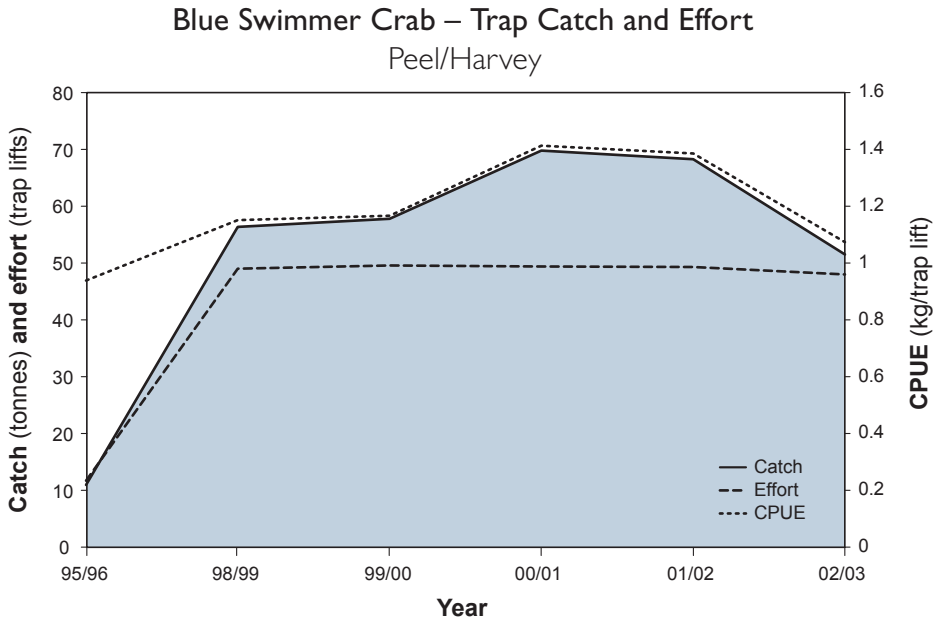
BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (t), effort (trap lifts x 1000) and catch per unit effort (kg/trap lift) in Shark Bay during the period 1991/92 to 2002/03 using traps.



BLUE SWIMMER CRAB FIGURE 4

Blue swimmer crab catch (t), effort (trap lifts x 1000) and catch per unit effort (kg/trap lift) in Cockburn Sound during the period 1993/94 to 2002/03 using traps.



BLUE SWIMMER CRAB FIGURE 5

Blue swimmer crab catch (t), effort (trap lifts x 1000) and catch per unit effort (kg/trap lift) in the Mandurah Estuarine Fishery during the period 1995/96 to 2002/03 using traps.

BLUE SWIMMER CRAB TABLE 1

Management arrangements for the Western Australian blue swimmer crab fisheries during the 2002/03 season.

BIOREGION	FISHERY	NO. OF LICENCES IN FISHERY	NO. OF LICENCES ACTIVE IN 2002/03	GEAR TYPE	TOTAL POT/NET ALLOCATION	NO. OF POTS/NET FISHED IN 2002/03	MINIMUM COMMERCIAL SIZE LIMIT (MM CW)	SPATIAL AND TEMPORAL CLOSURES
WEST COAST	Cockburn Sound	11	6	Hour glass traps	800	800	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 *or* set net	100 traps *or* 1,200m net	85 traps 1,200 m net	130	
	Swan River Estuarine	4	4	Haul/set nets	256 m crab set net 2,000 m set net* 2,000 m haul net* 732 m sunk net*	256 m crab set net 2,000 m set net 2,000 m haul net 732 m sunk net	127	
	Mandurah Estuarine	8	6	Hour glass traps	336	250	127	
	Comet Bay	1	1	Hour glass traps	80	80	127	
	Mandurah–Bunbury	5	2	Hour glass traps	Northern - 160 Southern - 240	Northern - 0 Southern - 180	128	
	Geographe Bay	7	4	Hour glass traps	320	160	128	
GASCOYNE	Carnarvon Experimental Crab Trap	3	3	Hour glass traps	800	800	135	
	Shark Bay	2	2	Hour glass traps	600	600	135	
	Exmouth Gulf	2	0	Hour glass traps	400	0	135	
PILBARA	Northern Crab	2	2	Hour glass traps	400	400	135	

* nets not used to target blue swimmer crabs

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

Prepared by R. Melville-Smith, with management input by D. Griffiths

FISHERY DESCRIPTION

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

Governing legislation/fishing authority

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

Consultation process

Department–industry meetings

Boundaries

The West Coast Deep Sea Crab Fishery, which during the season being reported (2003) 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 2004 and should the fishery continue to demonstrate its sustainability, consideration will be given to providing equal access to all seven permit holders. Consultation with industry regarding the new management plan is already underway, with consideration being given to the reduction and control of effort.

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. Final reports for these research projects are due in the second half of 2005.

RETAINED SPECIES

Commercial production (season 2003): 193 tonnes

Landings

A catch of 193 t of crystal crabs was taken in the fishery in 2003, a decrease of 6% on the catch taken in the 2002 season (205 t), but nevertheless high compared to earlier years in this fishery (Deep Sea Crab Figure 1). As in 2002, catches of champagne and giant crabs on the west coast were negligible.

Fishing effort/access level

Effort increased by 14% from an estimated 111,500 pot lifts in the 2002 season to 127,000 pot lifts in the 2003 season. This effort estimate is based on a combination of compulsory catch and effort returns and voluntary research log book data.

Catch rate

The catch per unit of fishing effort for crystal crabs decreased by 21%, from 1.9 kg/pot lift in 2002 to 1.5 kg/pot lift in 2003. This CPUE estimate is based on research log book data.

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

Although a full stock assessment cannot be undertaken until the current exploratory project is completed in 2005, some preliminary analysis of the survey data has now been undertaken. This indicates that catch rates in the crystal crab fishery have fallen by 53% between 2000 and 2003. These data, together with a number of reasonable assumptions (based on research on similar crabs elsewhere), have been used in a depletion assessment using the CPUE between 2000 and 2003 plotted against cumulative catch (West Coast Deep Sea Crab Figure 2). This has provided a first estimate of the fishable biomass of crabs at the start of the fishery. Using these results, an estimate of the future sustainable yield for the crystal crab fishery, relative to annual recruitment, has been calculated as being between 15 and 60 t per annum. This is substantially lower than the current level of catch (193 t), which is thought to be based on harvesting the accumulation of large crabs expected in a virgin stock.

Exploitation status: Not assessed

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 these minimum

sizes in both species (Kim Smith, Murdoch University, unpub. data). 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 protects 40% of pristine egg production in the Western Australian portion of Australia's giant crab population.

NON-RETAINED SPECIES

Bycatch species impact: Low

The gear used in this fishery generates minimal bycatch and the single-compartment design of the pots is such that they are unlikely to '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.

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 2003: $2.5 million

The beach value of the fishery was about $2.5 million in 2003, based on an average beach price of $13/kg for crystal, $9.5/kg for champagne and $25/kg for giant crabs. The majority of the catch is exported live to south-east Asia.

FISHERY GOVERNANCE

Acceptable catch range for next season: Not assessed

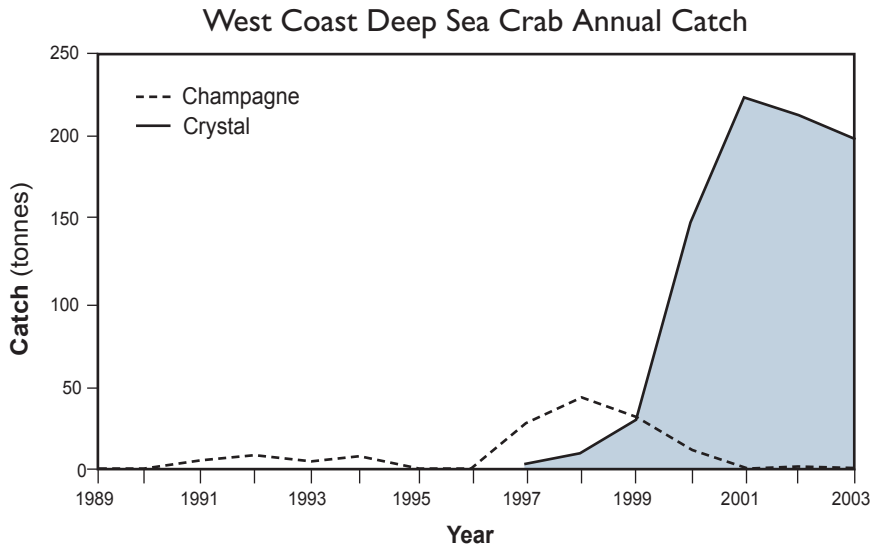
The effort in this interim managed fishery during 2003 was restricted to five full-time and two part-time fishers spread throughout the range of the fishery. At this stage, not all these licences are being utilised and it is not yet possible to determine what the acceptable catch should be.

Future access arrangements under the management plan are designed to limit the level of exploitation, but still obtain a sufficient spread of fishing effort across the five zones of the fishery for stock assessment purposes.

New management initiatives (2003/04)

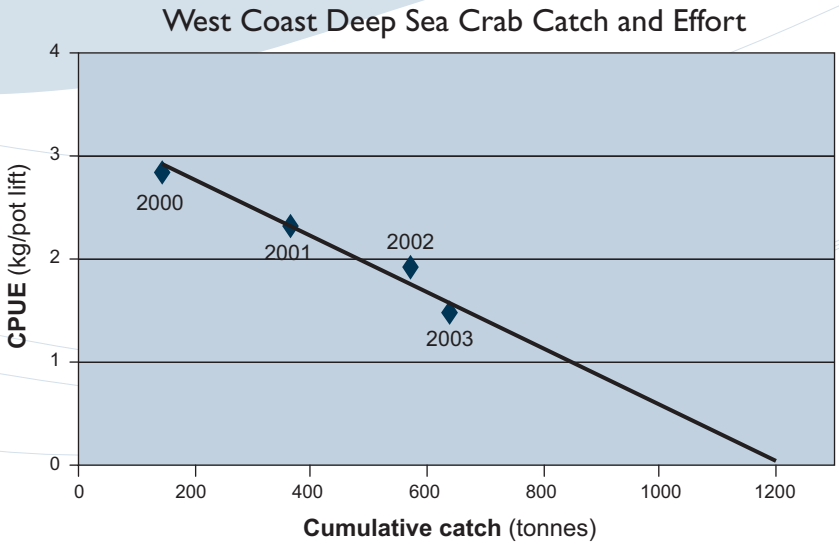
The Australian Government Department of Environment and Heritage is currently considering an application to certify the West Coast Deep Sea Crab (Interim) Managed Fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

The interim management plan is due to expire in December 2004 and it is expected that the fishery will move to a formal management plan at that time. Discussions with stakeholders are currently taking place as to whether future management will be by way of input or output controls. It is realised that the fishery will not be able to sustain current landings and this is being addressed in the new management plan.



WEST COAST DEEP SEA CRAB FIGURE 1

Annual catches of crystal and champagne crabs from 1989 to 2002. Annual giant crab catches have always been small, and they have therefore been excluded.



WEST COAST DEEP SEA CRAB FIGURE 2

CPUE for 2000–2003 for crystal crabs, plotted against the cumulative annual catch.

West Coast Estuarine Fisheries Status Report

Prepared by K. Smith and G. Nowara, with management input by K. Saville

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, while not included in the WCEF management plan implemented during 2003, is also reported here as it shares the characteristics of the west coast estuaries.

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

Governing legislation/fishing authority

Swan/Canning and Peel/Harvey Estuaries

West Coast Estuarine Fishery (Interim) Management Plan 2003

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 27° S and 33°11′ S. However, the plan incorporates a broad range of closures, so that in general terms (but with some exceptions) the only areas open to fishing are:

- The Swan and Canning rivers upstream of a line connecting Point Resolution to the Point Walter jetty, to:
  - (in the Swan) a line from Plain Street running 100 m off the tip of Heirisson Island to the southern bank of the river; and
  - (in the Canning) a line connecting the northern extremity of Second Avenue, Rossmoyne to the southern extremity of Sulman Avenue.

The exceptions relate to closures around Canning Bridge, waters around a number of jetties and some areas of Perth Water.

- The Peel/Harvey Estuary, with a complex series of closures that effectively limit the fishery to the main body of the estuary.

Note: The closures in both the Swan/Canning and Peel/Harvey Estuaries are complex, so the management plan, 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 of 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. The main fishing methods are gillnets and haul nets, but crab pots are also used in the Peel/Harvey estuary.

Research summary

Research monitoring of fisheries and fish stocks in the west coast estuaries is primarily based on monthly CAES returns

provided by industry. These 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. This database from commercial fishermen has provided a valuable and consistent source of information for monitoring recreationally important stocks where they are harvested by both sectors.

Reduced levels of fishing activity have occurred in recent years as a result of voluntary buy-back of commercial access. This will almost certainly render these valuable long-term commercial catch and effort data sets less useful in assessing the status of estuarine species in future years.

This will necessitate far greater reliance on the recreational sector and/or independent surveys to provide data that can be used to determine the status of our important estuarine fish and crustaceans. In addition, even greater co-operation will be required from the remaining commercial fishers to provide information on targeted fishing effort and catches needed to develop a catch curve for these species.

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, these confidential data are however used by the researchers to monitor the status of stocks and provide advice to management.

This report presents some information for three key finfish species from the west coast estuaries, namely black bream (*Acanthopagrus butcheri*), cobbler (*Cnidoglanis macrocephalus*) and King George whiting (*Sillaginodes punctata)*. These stocks are not subject to species-specific management plans, but are fished under each estuary's licence arrangement.

RETAINED SPECIES

Commercial production (season 2003): 211 tonnes

Landings

The total landings from west coast estuaries of 211.2 t during the 2003 season include the following catches of key target species:

Sea mullet	*Mugil cephalus*	68.7 t
Blue swimmer crabs	*Portunus pelagicus*	53.5 t
Yellow-eye mullet	*Aldrichetta forsteri*	33.8 t
Western sand whiting	*Sillago schomburgkii*	18.2 t
Perth herring	*Nematalosa vlaminghi*	11.2 t
Australian herring	*Arripis georgianus*	6.5 t
King George whiting	*Sillaginodes punctata*	6.2 t
Tailor	*Pomatomus saltatrix*	2.6 t
Cobbler	*Cnidoglanis macrocephalus*	1.6 t
Other species		8.9 t

Swan/Canning: The 2003 catch level was similar to that of 2002. The catch level trend has been stable since 2000, following a generally declining trend throughout the 1990s (actual figure not available owing to the small number of operators). The catch from the Swan/Canning Estuary during 2003 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 over the past 25 years are shown in West Coast Estuarine Figure 1. While there was little variation in the catches during the early 1990s when the catch was about 350 t, a dramatic decline to 200 t occurred between 1998 and 2000. Since 1999, the catch has declined at a more gradual rate. The total catch declined from 172 t in 2002 to 158 t in 2003. Approximately 26% of the total 2003 catch consisted of blue swimmer crabs, with sea mullet and yellow-eye mullet making up 78% of the finfish catch.

Hardy Inlet: The 2003 catch increased by approximately 5 t from the 2002 catch 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 catch was composed of western sand whiting and sea mullet with small quantities of black bream and yellow-eye mullet. There were no reported catches of blue swimmer crabs in 2003.

Key species

Black bream: Catches of black bream were reported from the Swan/Canning Estuary and the Hardy Inlet during 2003. The reported catches from the Swan/Canning of 2.7 t showed a minor decrease from the 2002 catches, and there was a minor increase in catches from the Hardy Inlet.

Cobbler: Minor catches of cobbler were reported from all three estuaries during 2003. The reported catches of cobbler in the Swan/Canning Estuary have been declining from the late 1980s. Since 2001, catches have been negligible (< 100 kg). The 2003 catch in the Peel/Harvey Estuary was 1.4 t, which is also at the lower end of historical catches. A small catch of cobbler was reported from the Hardy Inlet in 2003.

King George whiting: King George whiting catches for 2003 were reported from the Peel/Harvey Estuary (4.8 t) and the Hardy Inlet. While catches increased slightly from 2001 to 2002 and again from 2002 to 2003, they were still much lower than the exceptionally high catches reported during the late 1990s.

Fishing effort/access level

Swan/Canning:	level of access – 4 units
Peel/Harvey:	level of access – 8 units
Leschenault:	level of access – no commercial access
Hardy Inlet:	level of access – 1 unit

The levels of access listed above are as at June 2003. Unit holders in the three west coast estuaries open to commercial fishing are endorsed to fish a single estuary system only.

Fishing effort is reported as the average number of boats fishing per month. This measure of effort provides a general indication of effort changes over time. In most of these fisheries, the general licence buy-back scheme applied to commercial fishing licences has resulted in a decline in effort and hence reduced catches.

Swan/Canning: The general trend in effort has been a decrease in the mean monthly number of fishing units from around 25 in the mid-1970s to 3 in 2003.

Peel/Harvey: Fishing effort remained at fairly constant levels during the 1990s after a rapid decline during the 1970s and 1980s (West Coast Estuarine Figure 1). More recently there has been a pronounced decline in the number of boats actively fishing, from approximately 16 fishing units in 1998 to the current level of 7 in 2003.

Hardy Inlet: Fishing effort (mean monthly number of fishing units) in the Hardy Inlet has declined from 3 in the 1970s to the current level of only one unit operational in 2003.

Catch rate

Swan/Canning: Annual values of the catch per unit effort for the finfish fishery in the Swan/Canning Estuary have varied over the past 15 years, with a declining trend from 1990 to 2000 and an increasing trend from 2000 to 2003. While targeted fishing effort cannot be determined for individual stocks from the CAES compulsory monthly fishing returns, the general stability of the overall CPUE during the past several years suggests the total abundance of the suite of species that make up the majority of the catch has remained constant. However, the proportion of estuarine-dependent species (particularly those that depend on the estuary for spawning or nursery habitats) in the catch has decreased in recent years.

Peel/Harvey: During the 1980s, the catch rate followed the downward trend in catches in this fishery. After 1990, the catch and effort continued to decline but the CPUE increased, particularly after 1997. While targeted fishing effort cannot be determined from the CAES compulsory monthly fishing returns, the general stability of the overall CPUE over this period suggests the abundance of the suite of species that make up the majority of the catch has remained constant since 1990, though apparently at a significantly lower level than during the period 1975–1985.

Hardy Inlet: Since the early 1990s the trend in the CPUE has generally followed the fluctuations in the catches. The CPUE increased from 2002 to 2003.

Recreational component: **30–75%**

In 2000/01, the National Recreational and Indigenous Fishing Survey (Henry and Lyle 2003) collected data on all target species. From this survey, the recreational finfish catch was estimated to be similar to the commercial catch in the Swan/Canning Estuary, about 50% of the commercial catch in the Peel/Harvey Estuary and about three times the commercial 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: **Preliminary**

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

Basic assessments have been undertaken previously for select 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. A preliminary yield-per-recruit stock assessment was developed for the black bream stock in the Swan River using biological data for the Swan River population from research by Sarre (1999), previously presented in the *State of the Fisheries Report 1999/2000*. Since the mid-1990s, the catch rates for the Swan River and Hardy Inlet stocks have increased slightly. In April–June 2003, a bloom of the toxic dinoflagellate *Karlodinium micrum* killed numerous black bream and other species in the Swan/Canning Estuary. Precise estimates of mortality were not obtained at the time of the kill. However, no declines in commercial and recreational catch rates were observed after this event, suggesting that stock abundance was not strongly affected. An age-based population model is currently being developed for black bream in the Swan River, in collaboration with Murdoch University. The model will assist in future stock assessments, including the assessment of any future fish kill impacts.

Cobbler: Cobbler populations are genetically unique within each west coast estuary. A preliminary yield-per-recruit stock assessment was developed for the cobbler stock in the Swan River using biological data for Swan River cobbler from research by Nel (1983), previously presented in the *State of the Fisheries Report 1999/2000.* In 2003, 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 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 history (1–3 years) in estuaries before migrating to offshore reef areas at about age 4 where they grow to maturity and breed. They are most vulnerable to capture while residing in the estuaries. The results of a preliminary yield-per-recruit stock assessment, which was conducted for King George whiting along the lower west coast using biological data from research by Hyndes et al. (1998) and Potter et al. (1997), were previously presented in the *State of the Fisheries Report 1999/2000.* The lower catches of King George whiting from 2000 to 2003, compared with the late 1990s, appear to be due to lower recruitment and the maturing and offshore movement of the abundant cohort of fish previously recruited into the estuaries in the late 1990s.

Exploitation status: **Fully exploited**

Breeding stock levels: **Not assessed**

Black bream: A preliminary egg-per-recruit model was developed for the black bream stock in the Swan River using

biological data for the Swan River population from research by Sarre (1999), previously presented in the *State of the Fisheries Report 1999/2000.* Because the size at maturity is less than the legal minimum length, breeding stock levels are believed to be adequate. Black bream possess different growth rates in different estuaries. In all cases, the legal minimum length is set above the length at maturity. An age-based population model is currently being developed for black bream in the Swan River, in collaboration with Murdoch University. The model will provide an estimate of breeding stock levels.

Cobbler: A preliminary egg-per-recruit model was developed for the cobbler stock in the Swan River using biological data for the Swan River population from research by Nel (1983), previously presented in the *State of the Fisheries Report 1999/2000.* Cobbler exhibit different growth rates depending on the estuary in which they reside. In all cases the size at maturity is less than the legal minimum total length, which would normally afford protection to the breeding stock. However, breeding stock levels in the three west coast estuaries are likely to be very low as a result of environmental factors and the low fecundity of the species.

King George whiting: The age of King George whiting at first capture is 2+ to 3+ years at approximately 250 mm length. The length at 50% maturity is 413 mm for females. 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. Although the legal minimum length is considerably less than the size at maturity, a downward adjustment in the number of commercial fishers in estuaries and coastal waters is likely to have reduced the inshore fishing pressure on this stock. However, targeted recreational fishing for these fish will need to be monitored to ensure overall fishing mortality does not reduce breeding stocks below safe limits.

NON-RETAINED SPECIES

Bycatch species impact: Low

These small-scale, multi-species fisheries using mesh nets are unlikely to generate significant impacts such as discarding, as virtually all species taken are 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 the habitat of these estuaries.

SOCIAL EFFECTS

In 2003, there was an average of 18 fishers operating in west coast estuarine fisheries, largely supplying fresh fish to meet demand for locally caught product.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $570,900

FISHERY GOVERNANCE

Acceptable catch range for next season: 75–220 tonnes (Peel/Harvey only)

Under the current management regime, the acceptable range for total catch in the Peel/Harvey fishery is 75–220 t. 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 assessed at this time given the very small number of commercial fishers operating in these estuaries and the limited data available.

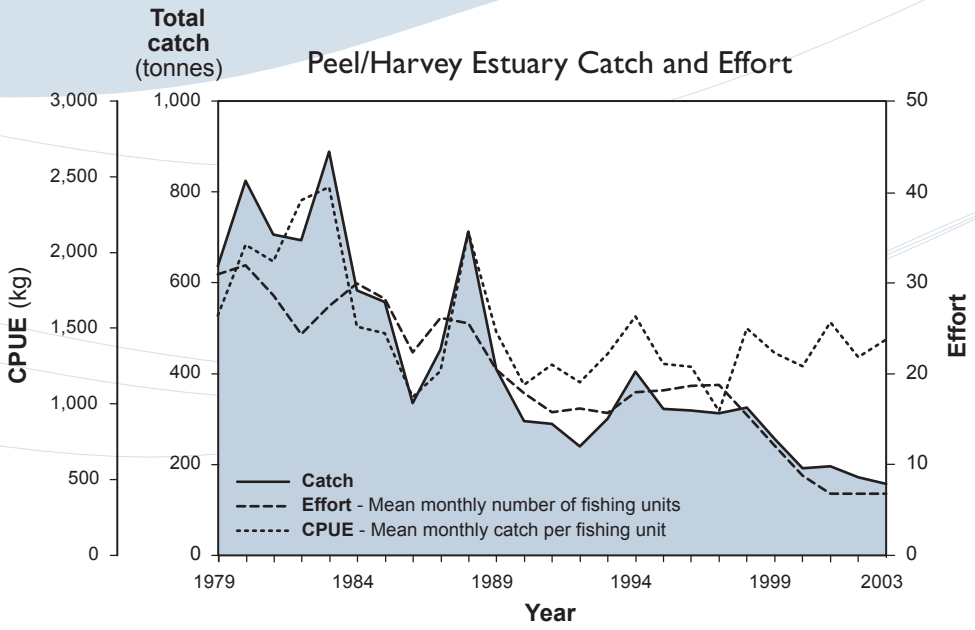
New management initiatives (2003/04)

An interim management plan for the Swan/Canning and Peel/Harvey Estuaries was gazetted on 31 October 2003 and commenced operation on 8 November 2003.

During 2003, there was an extensive review of commercial fishing operations in the Hardy Inlet (Fisheries Management Paper no. 169). However, at the time of preparation of this report, an outcome of the review had not been determined.

EXTERNAL FACTORS

Declines in catches of some species are likely to reflect changing environmental factors. The abundance of many species targeted by this fishery is affected by the quantity and quality of estuarine habitats that are available for spawning, feeding and/or nursery areas. The future sustainable management of such estuarine-dependent species will require a collaborative effort between fishery and habitat managers.



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 1978–2003.

Cockburn Sound Finfish Fisheries Status Report

Prepared by G. Nowara and R. Lenanton, with management input by H. Greif

FISHERY DESCRIPTION

There are four managed fisheries that operate wholly and two managed fisheries that operate partly within Cockburn Sound. The Cockburn Sound (Mussel), (Crab), (Fish Net) and (Line and Pot) 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, mussel and crab fisheries (see pp. 42-44, 45-47, 67-68 and 24-29 respectively).

Cockburn Sound (Fish Net) Managed Fishery: Fish are taken in this fishery by gillnet, beach seine and haul net with the main targeted species being garfish and Australian herring. Other fish species, including shark, whiting and mullet are taken opportunistically.

Cockburn Sound (Line and Pot) Managed Fishery: The fishing methods employed include handline, longline and squid jigging; the pots used are unbaited octopus pots. Recreational fishers also target many of the species targeted by this fishery, e.g. garfish, herring and pink snapper.

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 meetings

Boundaries

The Cockburn Sound 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 fish net fisheries are managed through input controls in the form of limited entry, gear restrictions and closed areas. Over the past 10 years the number of licences in the two fisheries has been reduced

from 42 to 14, mainly as the result of Voluntary Fishery Adjustment Schemes.

Research summary

Data for monitoring the status of the Cockburn Sound finfish stocks are obtained primarily from the analysis of CAES records provided by industry. These data, together with biological knowledge from historical research, provide the basis for the status report.

RETAINED SPECIES

Commercial production (season 2003): 52 tonnes

Landings

The total catch of finfish from Cockburn Sound reported here excludes bait fish (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; however, the figures do include the catch of 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 annual finfish catch has generally declined since the peak catch of 165 t in 1992. In 2003, the catch of 52 t of finfish is a decrease of almost 10 t from the 2002 catch (Cockburn Sound Figure 1). The composition of the 2003 catch included about 15 finfish and elasmobranch species. Around 95% of the total catch consisted of Australian herring (*Arripis georgianus*), sea garfish (*Hyporhamphus melanochir*), pink snapper (*Pagrus auratus*), maray (*Etrumeus teres*) and skates and rays. The contribution of the catch of skates and rays to the total landings has increased in 2002 and 2003 to around 5% of the catch.

Australian herring catches showed a steady increase from 1980, reaching a peak in 1994 (around 50 t). Since the second half of the 1990s, catches have declined to a lower level fluctuating between 15 t and 30 t per year. The catch for 2003 was 17 t, a decrease from the previous year (Cockburn Sound Figure 2). With the exception of the 2000 catch (14 t) this was the lowest catch recorded since 1983.

The catch of sea garfish also increased steadily from 1980 to a high level in 1994, after which time the catch declined, with a larger drop in 1997. The catch peaked again in 1999; however, the current catch is at the level of the late 1980s and early 1990s (actual figures are not able to be reported as there are fewer than five operators catching this species).

Fishing effort/access level

As at April 2003 there was only one licensee in the fish net fishery and 13 licensees in the line and pot fishery.

Fishing effort is measured as the number of fishing boat days for finfish catches (excluding purse seine and pot catches) from the Cockburn Sound (Line and Pot) and the Cockburn Sound (Fish Net) Managed Fisheries. This provides only an indication of the overall usage of the area by the commercial sector, which is composed of a number of different fisheries and various fishing methods.

The fishing effort peaked during the early 1990s at 1,400–1,600 boat days. It subsequently declined to 882 boat days in 1997, but rose to 1,562 boat days in 1999. Since then, it has again declined to its current level of 591 boat days for 2003 (Cockburn Sound Figure 1). This is the lowest level of effort experienced since 1977.

Catch rate

The catch rate for the different fisheries and the various fishing methods has averaged approximately 80 kg/boat day during the past 10 years (Cockburn Sound Figure 1). The peak catch rate during the 1990s was 118.5 kg/boat day in 1992 and the lowest reported catch rate was 49 kg/boat day in 2001, with the 2003 catch rate at 88 kg/boat day. The catch rate of herring peaked at 35 kg/boat day in 1994, dropping to lower levels (15 kg/boat day) in 2000, but increasing over the past three years. The 2003 catch rate for Australian herring was 28.9 kg/boat day (Cockburn Sound Figure 2).

Recreational component: 56–80%

The most recent information on Cockburn Sound recreational shore- and boat-based fishing is from a creel survey conducted between September 2001 and August 2002. Catch and effort data collected as a part of this survey reported 57 finfish species and six invertebrate species from Cockburn Sound and Owen Anchorage, with the key recreational finfish species being Australian herring, whiting and King George whiting (Sillaginidae), tailor (*Pomatomus saltatrix*), pink snapper, garfish, skipjack trevally (*Pseudocaranx dentex*) and silver bream (*Rhabdosargus sarba*) (Cockburn Sound Table 1).

The results of the National Recreational Fishing Survey, conducted slightly earlier between May 2000 and April 2001, are also now available (Henry and Lyle 2003). The catch composition of the key recreational target finfish species was of a similar species mix to that recorded during the later creel survey. Some noticeable differences for demersal species (snapper, dhufish) were likely to be related to differences in the areas surveyed (Cockburn Sound Table 1). The estimated boat-based catches of these species from the national survey are thought to be an over-estimate and may be revised at a future date.

The effort recorded during the two surveys was similar for boat fishing days in the 2001–2002 creel survey and events (≈days) in the national survey, but the number of shore fishing days reported was 1.5 times greater in the national survey (Cockburn Sound Table 1). The difference in shore fishing effort and catch may in part be related to the fact that the creel survey was restricted to daylight hours. Thus the evening fishing activities may have accounted for the higher shore-based days and catch during the national survey (eg. tailor, Cockburn Sound Table 1). As a consequence of these differences in methodology, the reported catches from the national survey are generally more than twice those reported from the 2001–2002 creel survey.

During the calendar year 2002, the commercial catch of these same species was approximately 53 t. Thus the recreational fishery is estimated to have taken approximately 56% of the combined recreational and commercial catch of these key

recreational finfish species in 2002. The recreational component of the combined recreational and commercial catch for the 2000 calendar year was estimated to be 80%, but this may be an over-estimate given the problem cited above.

STOCK ASSESSMENT

Assessment complete: Not assessed

For an assessment of Australian herring stocks, see pp. 180-182.

Exploitation status: Not assessed

Breeding stock levels: Not assessed

For an assessment of Australian herring stocks, see pp. 180-182.

NON-RETAINED SPECIES

Bycatch species impact: Low

This small-scale, multi-species fishery using line and mesh nets to target primarily surface species is unlikely to generate significant impacts such as discarding, as virtually all species taken are marketed in the metropolitan area.

Protected species interaction: Not assessed

ECOSYSTEM EFFECTS

Food chain effects: Not assessed

Habitat effects: Low

The fishing methods used in this fishery do not impact significantly on the habitat.

SOCIAL EFFECTS

During 2003, 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 18. Production supplies restaurant and retail sectors in the metropolitan area.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $116,800

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

FISHERY GOVERNANCE

Acceptable catch range for next season: 30–112 tonnes

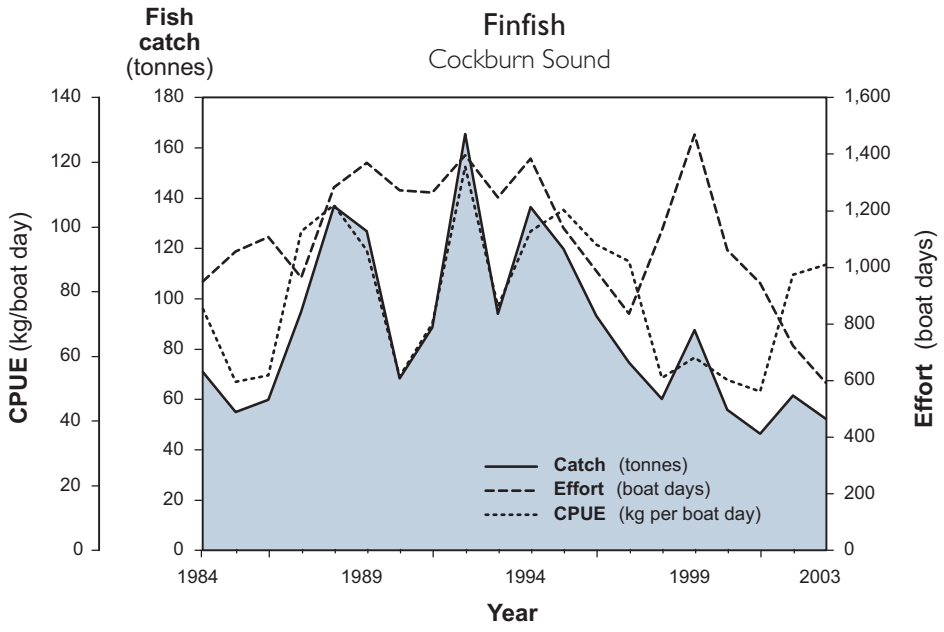
The acceptable catch range for this fishery has been amended during 2003/04 using improved methodology. The revised range is derived by applying an autoregressive moving average (2,2) control quality procedure to the annual catches from 1983 to 2002 subject to the corresponding fishing effort. The confidence intervals are 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 2003 catch of 52 t was within the acceptable catch range.

New management initiatives (2003/04)

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

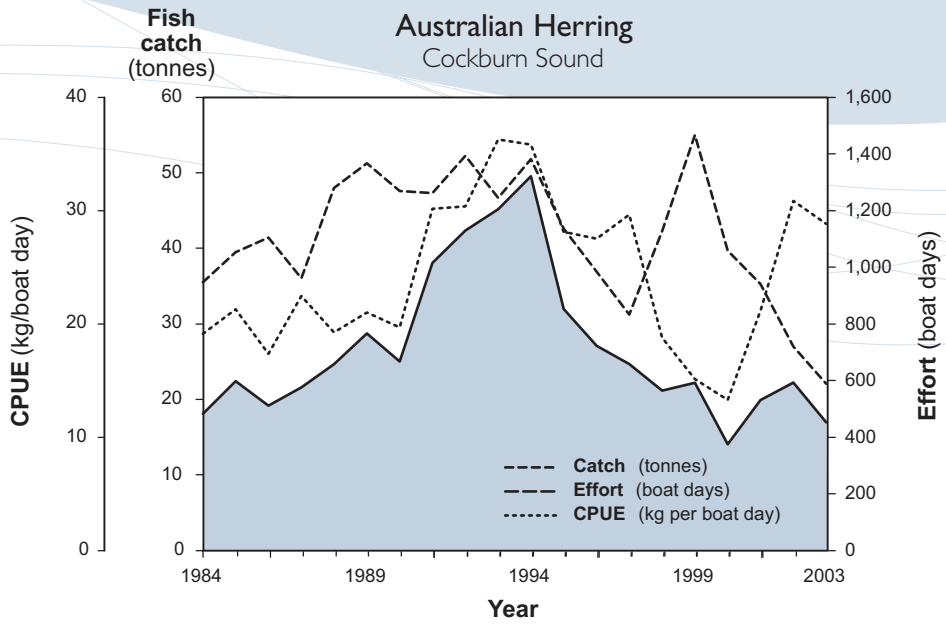
EXTERNAL FACTORS

Catch information from the small commercial sector provides a valuable input to the research database for monitoring the abundance of these stocks, which are also important to recreational fishing. However, the gradual decline in numbers of commercial fishers in recent years may render the catch statistics less useful in future.



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 1984–2003.



COCKBURN SOUND FIGURE 2

The annual catch, effort and catch per unit effort (CPUE) for Australian herring (*Arripis georgianus*) in the Cockburn Sound fisheries over the period 1984–2003.

COCKBURN SOUND TABLE 1

Recreational catch and effort for key finfish recreational target species, and recreational catch as a percentage of total catch of these species, from surveys in Cockburn Sound during 2000–2001 and 2001–2002.

	CREEL SURVEY (2001–2002) CATCH			NATIONAL SURVEY (2000–2001) CATCH		
SPECIES	t	% SHORE	% BOAT	t[1]	% SHORE	% BOAT
A. herring (*Arripis georgianus*)	**31**	48	52	**62**	76	24
Whiting (Sillaginidae)	**19**	21	79	**26**	20	80
Tailor (*Pomatomus saltatrix*)	**5**	10	90	**17**	98	2
Pink snapper (*Pagrus auratus*)	**4**	0	100	**11**	0	100
Sea garfish (*Hyporhamphus melanochir*)	**4**	50	50	**18**	99	1
Skipjack trevally (*Pseudocaranx dentex*)	**3**	33	67	**27**	57	43
Silver bream (*Rhabdosargus sarga*)	**2**	50	50	**nr[2]**		
Dhufish (*Glaucosoma hebraicum*)	**nr[2]**			**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%		

1. Boat-based estimates from the national survey may be over-estimates and subject to future revision.
2. nr - not reported.

West Coast Beach Bait Managed Fishery Status Report

Prepared by D. Gaughan and T. Leary, with management input by H. Greif

FISHERY DESCRIPTION

The West Coast Beach Bait Managed Fishery (WCBBF), together with the as yet unmanaged fishing sector to its south, primarily target whitebait (*Hyperlophus vittatus*). The main fishing method is beach seine netting, although non-powered purse seining and haul netting from small boats are also utilised.

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 WCBBF is managed primarily through input controls such as limited entry, temporal and spatial closures and gear restrictions. A Government-funded Fishery Adjustment Scheme has reduced the fishery in recent years from 15 licences to 3 at the end of 2003.

Ongoing management arrangements for the south-west beach seine 'fishery' are yet to be finalised. A discrete group of fishers is endorsed to operate in this area using similar methods to the managed beach bait fishers in the metropolitan and Mandurah areas.

Research summary

A significant research project on the biology and stock assessment of whitebait was completed in 1996. Ongoing monitoring of catches as a de facto indicator of abundance forms the basis of current research.

RETAINED SPECIES

Commercial production (season 2003):

All species 155 tonnes
Whitebait 103 tonnes

Landings

The main target species in this fishery is whitebait, of which 103 t were caught in the 2003 season. The catch of all other species in this fishery was 52 t, which was dominated by sea mullet, blue sprat, yellow-eye mullet, western sand whiting, buffalo bream and pilchard (West Coast Beach Bait Tables 1 and 2).

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: The catch of whitebait for the metropolitan region during 2003 was only 1.6 t, an order of magnitude lower than catches for the preceding three years: (2002: 16 t, 2001: 11 t and 1999: 11.1 t).

Mandurah: The whitebait catch at Mandurah was 8 t, a fourfold increase from the 2002 season (2t) but still below the catches for 2001 (32.1 t) and 2000 (33.6 t).

Bunbury: The Bunbury catch of 92 t was slightly over half that of recent years, with 165 t caught in 2002,197 t in 2001 and 175 t in 2000.

Fishing effort/access level

There were 10 operators with access to the WCBBF for all or part of 2003, of whom six landed fish during the year. In the southern sector, where the number of licences with access is not yet formally specified, 16 boats landed whitebait in 2003.

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, the data are not useful for measuring the amount of effort applied to the whitebait stock.

Catch rate

See 'Fishing effort/access level' above.

Recreational component — Nil

There is no recreational fishery for whitebait. Only small catches of a limited number of the other retained species are taken recreationally.

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 lands a significant part of the total whitebait catch and as such trends in the 'Bunbury' catch dominate the overall trends. Thus, while reduced effort through fewer operators in the metropolitan region can explain the low catch for that region, the relatively low catch from the unmanaged sector south of Mandurah cannot be attributed to fewer operators. On this basis, abundance in 2003 can be considered to have

been at a relatively low level, which is consistent with the below-average Leeuwin Current in 2002 (see 'Breeding stock levels').

The overall 2003 whitebait catch of 103 t is at the lower bounds of the acceptable range and is lower than expected, underlining the need for further work on the Leeuwin Current/whitebait model. Although there have been licence buy-backs in the northern part of the fishery, the remaining licence holders have expressed the desire to take up purse seining rather than beach seining as the preferred fishing method. Such a major shift in fishing practice would require a substantial change to the management of the fishery and the method of assessment.

Exploitation status: Fully exploited

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 stock is characterised by cycles in abundance apparently related to variations in the Leeuwin Current, where a strong current provides good catches and breeding stocks in the subsequent year. In circumstances of low recruitment, breeding stock levels may become limiting, but are generally protected by the corresponding reduction in effort by this beach-based fishery. The Leeuwin Current has been weaker than average in both 2002 and 2003, so abundance may again be low in 2004.

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 of the difficulty of sorting. 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 protected species can easily be seen and avoided. Furthermore, few individuals of protected species occur in the near-shore fishing areas and are therefore not susceptible to capture.

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 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, whereas the fish stock is more widely distributed, suggesting that natural predators have greater access to the stock than does the fishery. There may be competition in years of low whitebait abundance between fishermen and the little penguins that breed on Penguin Island and feed in the metropolitan and Mandurah regions of the whitebait fishery where catches are relatively low. Although the links between little penguins and whitebait are now clear, the impact of any such competition is still not understood. The ecological impact of the fishery has previously been considered to be low and the reduced number of licences would indicate that this continues to be the case. If, however, there is a move towards purse seining for whitebait in these regions this may change the relationship, so potential food chain and direct impacts would need to be investigated.

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.

SOCIAL EFFECTS

Approximately 22 boats with 50 crew participated in the beach bait fishery in 2003. This represents an apparent decrease of approximately 30% from the previous year in numbers of boats fishing (and thus crew).

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $307,000

Prices paid to fishers for whitebait are dependent on size of the individual fish, with a premium paid for the larger fish. Thus prices paid in 2003 varied from $2.50/kg to $3.50/kg, amounting to a net worth of approximately $307,000.

FISHERY GOVERNANCE

Acceptable catch range for next season: Whitebait 60–275 tonnes

The catch range previously provided for whitebait (106–331 t) reflected catches achieved since 1990 by operators with access to this stock. The range has been adjusted downwards this year to account for the permanent reduction in number of operators (from 15 to 3 licences) in the WCBBF, which constitutes the metropolitan and Mandurah regions of the broader whitebait fishery. It should be noted, however, that the major portion of the whitebait catch is taken from the Bunbury sector, which does not yet have a formal management plan in place.

The expected low abundance of whitebait in 2004 indicates that catches will again be at the lower end of the acceptable range.

New management initiatives (2003/04)

The Department is exploring the option of changing the existing beach-seine-based managed fishery to a purse-seine-based fishery, given the ongoing issues associated with local council by-laws excluding fishers from beaches. The Department is also in the process of streamlining the administrative clauses in the legislation. Furthermore, the Department is looking to progress the southern fishing sector to a formal managed fishery.

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. Further research into the Leeuwin Current/whitebait relationship is needed, and will be undertaken when time becomes available.

Ongoing 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 the four-wheel-drive vehicles needed to transport the beach seining gear and catches.

WEST COAST BEACH BAIT TABLE 1

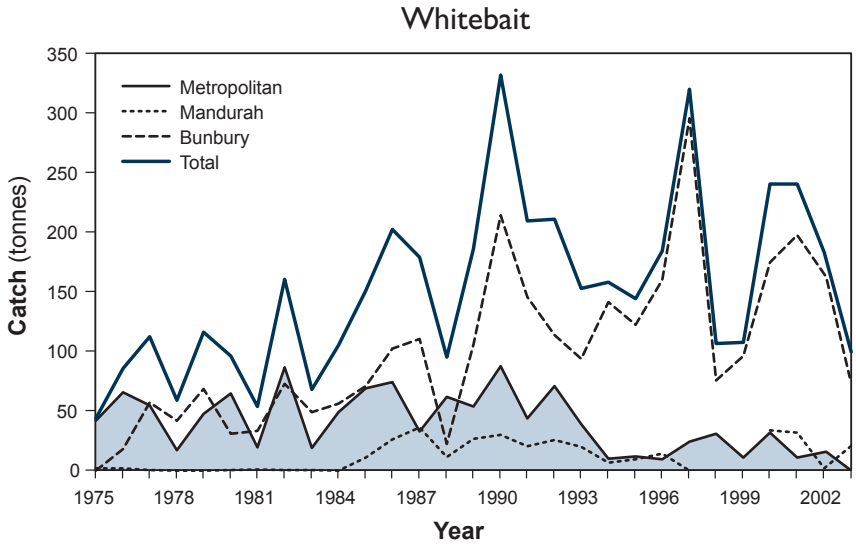
Catches in 2003 of retained species other than whitebait from the West Coast Beach Bait Managed Fishery. Numbers in brackets indicate that part of the catch taken from Cockburn Sound.

SPECIES		CATCH (tonnes)
Mullet, sea	*Mugil cephalus*	3.3 (1.1)
Sprat, blue	*Spratelloides robustus*	3.7 (3.7)
Others		1.1 (0.8)
Total		**8.1 (5.6)**

WEST COAST BEACH BAIT TABLE 2

Catches in 2003 of retained species other than whitebait from the south-west beach seining sector.

SPECIES		CATCH (tonnes)
Mullet, sea	*Mugil cephalus*	16.0
Mullet, yellow-eye	*Aldrichetta forsteri*	9.6
Sprat, blue	*Spratelloides robustus*	9.1
Whiting, western sand	*Sillago schomburgkii*	5.5
Bream, buffalo	*Kyphosus sp.*	1.6
Pilchard	*Sardinops sagax*	1.5
Others		0.9
Total		**42.2**



WEST COAST BEACH BAIT FIGURE 1

Total annual catch of whitebait for each sector from 1975 to 2003.

West Coast Purse Seine Managed Fishery Status Report

Prepared by D. Gaughan and T. Leary, with management input by K. McCarthy

FISHERY DESCRIPTION

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

Governing legislation/fishing authority

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

Consultation process

Purse Seine Management Advisory Committee
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 currently managed through a combination of input and output controls incorporating limited entry, capacity setting and controls on gear and boat size.

Currently a single total allowable catch (TAC), that applies to both the metroplitan fishery and the Southern Development Zone, is set annually 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 (ITQ) units would be. For the 2003/04 licensing period, there was a catch cap of 1,000 t for pilchards, with a combined limit of 1,500 t on the catch of other small pelagic species permitted to be taken by licensees. The Northern Development Zone has a separate TAC.

Vessels are restricted to less than 16 m in length, but an exemption to use a vessel approaching 20 m in length has been in operation during this reporting period. This large vessel had spatial restrictions to keep it away from waters around Rottnest Island and from inshore areas.

Research summary

Directed research is currently only carried out on pilchards. This research continues to focus on fishery-independent spawning biomass surveys, as part of a five-year FRDC-funded project examining the regrowth of the pilchard stocks in Western Australia following the mass mortalities of the late 1990s. The most recent spawning biomass survey was carried out in the west coast purse seine fishery in July 2002, with another planned for July 2004. Monitoring of pilchard catches is undertaken monthly to provide robust age-composition data, from which relative recruitment strengths can be inferred. Biomass surveys, age-composition data and analysis of catches together allow the annual review of pilchard and compilation of the following status report. Owing to the importance of sardinella in the catch in recent years, there may be a need to undertake catch sampling of this species.

RETAINED SPECIES

Commercial production (2003): 1,164 tonnes

Landings

The combined catch of pilchards, sardinella and other minor species for the metropolitan and Southern Developmental Zone fishery areas decreased from 1,347 t in 2002 to 1,164 t in 2003; however, the Southern Developmental Zone contributed only 2 t of pilchards during this year. This level of harvest is still considerably less than the catches in the mid-1990s (West Coast Purse Seine Figure 1). The contribution of pilchards to the combined catch decreased to 300 t compared to 512 t in 2002. The sardinella catch increased from 701 t in 2002 to 773 t in 2003 (a further increase from 596 t in 2001). In addition, 75 t of maray, 12 t of yellowtail scad and 2 t of anchovy were landed. Overall, the catch reflects a steady availability or abundance of pilchards, and a further increase in the trend toward the utilisation of other species available to the fishery.

Fishing effort/access level

A small number of vessels continued to participate in the fishery in 2003. Together they fished a total of 525 days, a minor effort decrease of 3% from 2002 (543 days). It is not possible to estimate effort separately for the different species targeted.

Catch rate

The estimated catch rate for all small pelagic fish was 2,218 kg/day. Note that because factors other than abundance are influencing fishing effort, it is currently difficult to determine how this estimate relates to those from previous years.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

Stock assessment is completed for pilchards, which are

fully exploited on the west coast. The fishery-independent spawning biomass survey conducted in 2002 indicated that the pilchard stock was recovering strongly after the 1998/99 mass mortality event. The average age of individuals in the west coast pilchard catches in 2003 was nearly 5 years, with few fish caught below 4 years of age, which indicates little recruitment to the fishery in 2002/03. This represents a downturn from the good levels of recruitment in recent years. Assuming there has been strong recovery, as has been the case on the south coast, availability of the stock to the fleet has remained very low and sporadic. A further spawning biomass survey is scheduled for July 2004.

Although no stock assessment has been undertaken for sardinella in the metropolitan region, application of results obtained from a detailed study on sardinella in the Geraldton region indicate that the stock on the lower west coast is at the southern limit of its geographic range and is fully exploited when it occurs off Fremantle. The levels of exploitation are not thought to pose a risk to the viability of the spawning biomass.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

NON-RETAINED SPECIES

Bycatch species impact: Low

This fishery specifically targets schools of pilchards and sardinella, so unwanted bycatch is insignificant. Other similar-sized pelagic fish which may sometimes be discarded include yellowtail scad, maray, anchovies and blue mackerel.

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 indirect interactions between these and the purse seine industry in this region.

ECOSYSTEM EFFECTS

Food chain effects: Moderate

Small pelagic fish, typically pilchards or anchovies, occupy a pivotal position of energy transfer in food webs in which they occur and are often the main link between primary (phytoplankton) and secondary (zooplankton) production and larger predators. This trophic position has been termed the 'wasp's waist' since pilchards feed on many species and are eaten by many species.

The completion of FRDC project 98/203 (Gaughan et al. 2003) and research by Murdoch University has now provided clear evidence that some species of seabird are heavily reliant on pilchards and sardinella. These data, derived from local studies, have proven to be invaluable when discussing food chain effects during management deliberations. For example, various seabirds will predate on a variety of species of small pelagic fish and therefore the whole suite of small pelagic fish must be considered during management deliberations, not simply the primary target species. This is particularly the case in pelagic ecosystems (a) characterised by low productivity, as is the case in southern Western Australia, and (b) in which the dominant species can change in abundance inter-annually (e.g. due to environmental factors), as is the case along the lower west coast.

In 'normal' circumstances (i.e. in the absence of disease events or extended periods of very poor recruitment) the quota for pilchards and other small pelagic species is set at a maximum of 10–15% of the spawning biomass, thus leaving 85–90% available to natural predators.

Habitat effects: Negligible

Purse seining appears to have very little effect on the habitat. Although the purse seine gear used in Western Australia can contact the sea floor in some areas, the relatively light construction of the gear suggests that there is no significant impact occurring to, for example, seagrass beds.

SOCIAL EFFECTS

The fishery employs approximately 17 full-time workers and 7 part-time workers.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $661,000

While some fish are utilised as high-value products for human consumption and recreational bait, slightly more than half of the catch in 2003 went to lower-value uses such as pet food and commercial rock lobster and finfish trap bait. This influenced the price paid to the boats this year to result in a net payment only 40% of the previous year ($1.6 million). Owing to the 'booming' South Australian pilchard fishery, the demand for Western Australian product for use as tuna feed decreased throughout 2003.

FISHERY GOVERNANCE

Acceptable effort range for next season: Not available

The acceptable maximum catch is governed by changes in the TACs for pilchards and other small pelagic fish. For the 2004/05 licensing period a single TAC of 3,000 t has been set, to cover both these categories. When a formal quota system (TAC and ITQs) is adopted for this fishery, an acceptable effort range will be developed.

The fleet remains somewhat unstable in terms of long-term participants, with only a small number of vessels operating. In addition, some of these vessels operate only irregularly. As such, the TAC may again not be achieved in 2004.

The inability to consistently find pilchards around the metropolitan region may need further investigation.

New management initiatives (2003/04)

A revised management plan is being developed for this fishery. The new plan will include the Southern and Northern Development Zones. These regions, 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 licences.

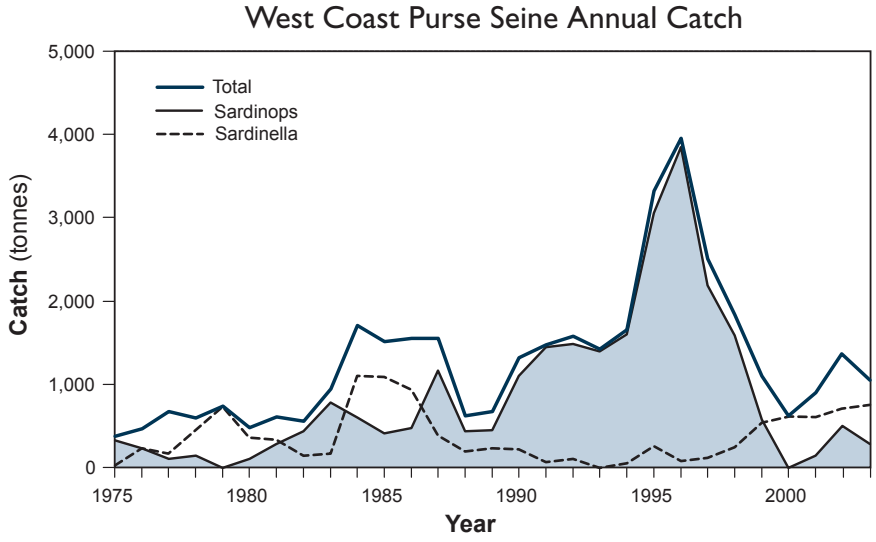
Implementation of the new management plan will see the fishery change to a formal quota system with ITQ units and a TAC. The ITQ unit values will be reviewed annually and changed, as required, depending on stock assessment data.

The concept of managing ecosystems, rather than single species, was presented to the Purse Seine Management Advisory Committee during 2001. Small pelagic fish represent a conceptually easy group for which to begin implementing ecosystem-based fisheries management. This issue represents a complex shift in the management philosophy for purse seine fisheries in Western Australia and continues to undergo further development. During 2003 this concept was put into practice, with the setting of TACs for 2004/05 reliant on consideration of the region having a 'sardine' carrying capacity, for pilchards, sardinella and other small pelagic fish, in the range of 20,000–30,000 t. Although this range represents the longer-term level of small pelagic biomass in the region, note that the 'sardine' biomass could sometimes be higher, but could also be lower.

EXTERNAL FACTORS

The major factor influencing the pilchard stock in recent years has been the impact of the pilchard herpes virus epidemic in 1998/99. The fishery is also heavily influenced by the contribution of the two dominant pelagic species, which dictates the make-up of the catch in any one year. The influences of environmental factors on the two species are not yet well understood, but oceanographic variability appears to affect the distribution and availability of both species.

The continued lack of significant quanitities of pilchards in the Southern Development Zone remains a concern. The results from a plankton survey in 2004 will be closely scrutinised to assess whether or not there are sufficient spawning pilchards in the traditional grounds north of Cape Naturaliste.



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

Prepared by J. St John and J. King

FISHERY DESCRIPTION

The 'west coast demersal scalefish fishery' describes a significant subset of the state's wetline fishery, which has access to species or fishing methods not currently subject to a management plan. The wetline fleet comprises both 'wetline only' vessels and the 'wetline' activities of vessels with other managed fishery licences, and is currently limited only by the overall ceiling on fishing boat licences.

The main fishing methods used in demersal wetline fishing are handlines and droplines. The major areas for wetlining within the west coast bioregion are the Abrolhos Islands, Perth metropolitan area and the south-west coast.

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)* and coral trout (*Plectropomus leopardus*) as well as taking a range of other species including sharks. Some of these species are also caught in other commercial managed fisheries using demersal gillnets and longlines, as well as in the recreational and charter boat sectors.

Governing legislation/fishing authority

Fish Resources Management Regulations 1995
Fishing Boat Licence

West Coast Bioregion

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.

Management arrangements

Line fishing for west coast demersal scalefish is not yet subject to a specific management plan. The process to implement formal management arrangements for the wetline fishery is underway and expected to result in the development of a management plan for wetline fishing by 2006. This fishery will be one of the first to be considered under a formal Integrated Fisheries Management framework that accounts for all users (commercial, recreational, charter boat, indigenous, passive users).

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 Abrolhos Islands).

Research summary

The major focus of research is to determine the regional variations in the biology and exploitation of the major fish species, and clarify catch share among the different fishery sectors.

An FRDC-funded research project commenced in July 2003 to study the stock structure of populations of the two major species, dhufish and pink snapper, along the west coast to determine the appropriate geographical scale for management. This will investigate intermixing of populations, regional variations in age structure and timing of reproduction. Information on the biological parameters for lower west coast pink snapper is being collected by a PhD student from Murdoch University. This research project will provide age-based stock assessments for dhufish and pink snapper in 2006.

The FRDC-funded project on post-release mortality of demersal fish species has been extended to December 2006. The collaborative tagging program with the Australian National Sportsfishing Association (WA) will determine the effect of three release methods (simple, vented and shotline) on the longer-term mortality of released under-size dhufish, snapper, baldchin groper and breaksea cod.

Further examination of the size at sexual maturity of dhufish by the Department of Fisheries is underway and preliminary results suggest that younger mature fish spawn less frequently and for a shorter period than older individuals. A new FRDC-funded project on spawning aggregations of several west coast species, focusing on samson fish but including dhufish and pink snapper, will begin in July 2004. A recreational creel survey of boat fishing in the west coast bioregion is scheduled to commence in 2005 and will provide important information for use in Integrated Fisheries Management.

Preliminary assessments of other major demersal species in the west coast bioregion 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.

RETAINED SPECIES

Commercial production (season 2002/03): 1,154 tonnes

Landings

In 2002/03 the catch of the entire fishery was 1,154 t, which is an increase of 60 t from the previous year. The main species landed during 2002/03 (West Coast Demersal Scalefish Table 1) included 10 demersal finfish species, two non-demersal finfish species and four groupings of sharks that together comprised 89% of the total catch of all species. The remainder of the catch included 80 other scalefish species and 15 species of sharks and rays as well as squid and cuttlefish.

The six major targeted demersal species comprised 61% of the total catch of all species caught by handline and dropline in the fishery. The landings of pink snapper were highest at 272 t, followed by dhufish at 232 t. In the northern area of the bioregion off Geraldton, other major species in the catch included 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 collectively ranked third with 151 t caught by 100 boats. Baldchin groper, with catches of 41 t, was another important demersal finfish species. Also, 58 boats caught 12 t of coral trout.

Four other species of finfish – samson fish (*Seriola hippos*), bight redfish (*Centroberyx gerrardi,* a deep-water species), sweetlip (Haemulidae) and goldband snapper (*Pristipomoides multidens*) – ranked in the top 10 with catches over 20 t. Three species of sharks – wobbegong (Orectolobidae) and copper and dusky whalers (*Carcharhinus brachyurus* and *C. obscurus*) – ranked in the top 12 species.

Some species reported in this wetline fishery are also reported elsewhere (e.g. sharks, see pp. 186-191). Catches of demersal scalefish taken under other managed fishery licences also need to be considered when assessing this fishery. In this context, the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) landed a further 89 t of scalefish in 2002/03. The Cockburn Sound finfish fishery also lands small quantities of large mature pink snapper, which are likely to form part of an oceanic stock. The charter boat sector that lands many species of fish in the west coast bioregion is reported in detail on pp. 65-66.

The catch of the three demersal species used as the main indicator species for the fishery is examined in more detail below.

Dhufish: The reported total catches of dhufish along the west coast over the last 10 years reflect general trends in fishing effort (West Coast Demersal Scalefish Figure 1). The catch of 232 t of dhufish by this fishery during 2002/03 is the highest reported over the last decade and this current trend of escalating catch is approaching the historical peak of 295 t in the mid-1980s. The catch of dhufish in the WCDGDLF for 2002/03 was 13 t, which was 3 t lower than the previous year. The catch by the charter sector was reported as 23 t in 2003.

The reported dhufish catch for 2002/03 is 50% above the average over the past 10 years of 155 t. Moreover, for the third consecutive year, it is above the upper limit of the acceptable range of 125–179 t. Monthly catches surpassed 20 t for five months in 2002/03 compared to two months in 2001/02.

Pink snapper: The trend in increasing catch of pink snapper continued in 2002/03 with landings of 272 t, an increase of 22 t over the previous year. Although the catch this year was above the 10-year average of 204 t, it remains well below the last peak in catch of 309 t in 1995/96 (West Coast Demersal Scalefish Figure 2).

Baldchin groper: The catch of baldchin groper in 2002/03 was 41 t, up 7 t from last year and above the 10-year average of 31.8 t. The catch of baldchin groper in 2002/03 was the highest reported since 1993/94 and shows a general upward trend (West Coast Demersal Scalefish Figure 3).

A number of other species have also recorded significant catch increases over the last five years (West Coast Demersal Scalefish Figure 4).

Fishing effort/access level

An estimate of the fishing effort applied annually by the demersal wetline sector is extracted from the monthly CAES returns. As a result of the method of recording, effort days for each species can overlap, and represent the maximum number of days each month on which each species may have been captured (when vessels utilised their wetline entitlements). While effort days do not measure fully the targeted effort applied to the various species, they do provide an indicator which allows a year-to-year comparison of wetline activity and demonstrate the very high level of latent effort existing in the wetline sector.

During 2002/03, 262 licensed fishing boats in the west coast bioregion line-fished for demersal finfish, an additional 19 boats compared to last year. These vessels reported wetlining activities on a total of 12,254 days during 2002/03. Both fishing effort and the number of active boats in the entire wetline fleet increased slightly (by 1% and 8% respectively) throughout the bioregion compared to the previous year. Over half the catch (50.4% or 582 t), however, was caught by just 20 vessels during 1,087 days (or 8.9% of the total effort). Overall 252 boats reported catching dhufish, 243 boats caught pink snapper and 164 boats caught baldchin groper. Using the above approach of identifying vessels which reported the key indicator species on their monthly returns, the effort days relating to each species are as follows.

Dhufish: At a total of 10,234 fishing days, this fishing effort indicator for dhufish has almost reached the previous peak effort for the decade in 1997/98.

Pink snapper: Fishing effort for this species has risen steeply in the last two years throughout the entire bioregion, surpassing 10,000 days for the first time to reach 10,429 days in 2002/03.

Baldchin groper: Fishing effort for baldchin groper has almost doubled over the last 10 years to reach its highest levels yet at 5,835 days.

Catch rate

Effort reporting in CAES poses some challenges for multi-species fisheries such as this. While catch can be separated by species in CAES, effort is not broken down into time spent targeting or fishing for different species. As effort is reported as a monthly total, catch rates can be calculated for individual species using the total annual effort for some or all of the boats that caught that species in the year. Therefore, catch rates of individual species in this multi-species fishery may reflect the temporal or spatial variations in targeting among boats in the fleet.

To examine the catch rates of indicator species caught throughout the bioregion, catch and fishing effort from a subset of the fleet that targeted these species were examined in two areas (Geraldton and Fremantle) that have different levels of fishing pressure. Annual catch rates have been calculated using the top 10 boats with reliable data for each year in each region. This method allows for the frequent changes in boat ownership or skippers that are common in the wetline sector. Average catch rates, and standard errors depicting variability of catch rates among the 10 boats, were calculated for dhufish and snapper in both regions and for baldchin groper in the Geraldton region only (West Coast Demersal Scalefish Figures 1, 2 and 3). The nominal effort of each boat used to calculate dhufish CPUE was further adjusted upwards by 5% in 1992/93, 10% in 1993/94 and by 15% from 1994/95 onwards to the present, to account for increases in fishing efficiency due to technological improvements in the early to mid-1990s such as colour sounder and GPS.

Recreational component: **> 30% (to be revised)**

Results of the national telephone survey of recreational fishing conducted from May 2000 to April 2001 provide an update of the recreational catch for Western Australia and all Australia (Henry and Lyle 2003). The only analyses of these data currently available report on the statewide estimates of catch for the main target species. Of the species important in the west coast demersal scalefish fishery, the statewide catch figures for only two species, pink snapper and dhufish, were reported.

The analyses to provide estimates of the catch of the main species on a bioregional basis are currently underway. Preliminary analyses indicate that the recreational catch of dhufish and snapper may have increased significantly from that previously estimated for this region in 1996/97 using boat ramp surveys (Sumner and Williamson 1999). These data indicated that the recreational catch shares in 1996/97 were dhufish 46%, snapper 10.5% and baldchin groper 44% (see *State of the Fisheries Report 2000/01* for more details). The preliminary national survey estimates indicate that the recent annual recreational catch of dhufish is in the order of 250–500 t, which is at least equal to the commercial catch and possibly much higher; however, this estimated range is undergoing further examination to determine its reliability.

STOCK ASSESSMENT

Assessment complete: **Preliminary**

In the absence of representative age structures for fish populations, stock assessments are generally restricted to the

use of catch rates to provide a relative measure of abundance. Such assessments assume that the relationship between catch rate and abundance remains constant. This relationship is affected by the increase in fishing efficiency of this fleet due to the technological improvements over the last 10 years (see above). To assess trends in the major demersal stocks targeted by this fishery, standardised catch rates and overall catch and effort data are monitored. Unless stated otherwise, all catch rates are adjusted for fishing efficiency.

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 cannot sustain current levels of catch. Further research to generate the regional age structures of dhufish and pink snapper populations within the west coast bioregion has commenced to enable more sophisticated age-based stock assessment techniques to be used in the future.

Catch rates of dhufish (as an indicator of abundance) in the Geraldton area are considered to differ from catch rates in Fremantle owing to the regional differences in targeting. In Geraldton fishers target a suite of high-value species including coral trout, baldchin groper and lethrinid species, whereas in Fremantle fishers specifically target dhufish, the most valuable species available, making these catch rates a better indicator of dhufish abundance.

Catch rates of dhufish in Geraldton rose from 1996/97 to the highest catch rate of the decade at 52 kg/day in 2001/02. At 44.1 kg/day, the catch rate for 2002/03 fell for the first time in six years, although the present catch rates continue to be significantly higher than the average of 32 kg/day over the past 10 years. The catch rates of dhufish around Fremantle are similar to last year (West Coast Demersal Scalefish Figure 2). At 42 kg/day, the 2002/03 rate is higher than the 10-year average of 37 kg/day but not as high as the previous peak of 58 kg/day in 1997/98. This previous peak appeared to be largely due to a relatively high abundance of dhufish that year, with high catch rates in both the demersal gillnet fishery and the line fishery off Fremantle. Since 1999/2000 the increases in total catch have not been parallelled by increases in the catch rates of the top 10 boats, which provide an index of abundance. Thus, the recent escalation in catch must have been due to an increase in effective effort being applied to the stock.

The WCDGDLF (reported elsewhere in this volume) uses gillnets, which are a passive form of fishing that does not target dhufish directly. Therefore, gillnet catch rates (kg fish/km gillnet/hour of standardised effort) provide an alternative and arguably more reliable index of abundance. In the past four years, the catches of dhufish caught by the WCDGDLF have gradually declined from 17.7 t in 1999/2000 to 13.5 t in 2002/03. The corresponding values of the CPUE (kg/km gillnet/hr) of dhufish caught by the WCDGDLF have decreased by 21% over the last three years (i.e. from 0.37 in 2000/01 to 0.29 in 2002/03), at a time when effort has been relatively stable.

The continuing increase in the commercial catch of dhufish at a time when the recreational catch is of a similar or greater order of magnitude, and appears to be increasing further, is of concern and supports the need for improved stock assessments which will be undertaken as part of the current project.

Pink snapper: Most of the pink snapper caught in this fishery come from the north of the bioregion, with the Geraldton-based boats dominating the annual trends in the total catch of snapper for the bioregion (West Coast Demersal Scalefish Figure 3). The two regions have very different patterns of average catch rates of pink snapper over the decade. Within each region, variability in catch rates was higher among boats in Geraldton than in Fremantle. In Fremantle average catch rates are relatively low and stable (ranging from 15 kg/day to 32 kg/day), whereas average catch rates in Geraldton have varied annually from 67 kg/day to 174 kg/day (West Coast Demersal Scalefish Figure 3). The large differences in both the magnitude and the annual trends of average catch rates between the two areas suggest that the population of pink snapper in Fremantle is probably not influenced by recruitment events occurring in the Geraldton region.

Although this year's higher catch appears to fit a general cyclical pattern of snapper catches in this region, continuing higher catches of pink snapper may not necessarily reflect a greater abundance in stocks. The 2002/03 increase in the total catch of pink snapper to 272 t appears to be related more to increased fishing effort than total abundance. In the last two years (since 2000/01), fishing effort has increased 45% but catch has increased only 23%. The Geraldton catch rates generally track the pattern of total catch because most of the catch is from the north of the bioregion; however, catch rates of schooling species do not always provide a reliable measure of abundance. For example, off Shark Bay where pink snapper are fished in large aggregations, a major decline in abundance was associated with a small decline in catch rates (see pages 93-97). The alternative indicator of abundance, the CPUE of pink snapper in the WCDGDLF, has remained similar between 2001/02 and 2002/03 at 0.28 and 0.27 kg/km gillnet/hr respectively.

In conclusion, although the indicators for the abundance of the pink snapper stock do not suggest any significant trends at present, the reliability of the data is relatively low. Of particular concern for this fishery is the continuing high level of latent fishing effort available to target this species, especially the northern stocks.

Baldchin groper: Generally, the catch and catch rates of baldchin groper are the least variable of the major species in the west coast demersal scalefish fishery. Up until 1999/2000, catch rates of baldchin groper followed total catch. Since then there has been a trend of decreasing catch rates, which have now fallen below the average for the past 10 years of 15 kg/day (West Coast Demersal Scalefish Figure 3). Meanwhile fishing effort has increased by 25%, reaching a record level (5,835 fishing days), and thus the total catch of 41 t for baldchin groper reflects this increased fishing effort. The increased catch coupled with a downward trend in catch rates indicates that more detailed assessments are required to ensure that over-exploitation does not occur.

Exploitation status: Fully exploited

Breeding stock levels: Not assessed

Currently, only efficiency-adjusted catch rates for the three main target species are available to provide an indication of spawning biomass. Fish species that aggregate to spawn, however, are more vulnerable to over-exploitation because these aggregations may be predictable in time and/or space and allow fishers to maintain high catch rates of spawning fish even when the stock is declining. Of the main target species, pink snapper are known to form large spawning aggregations and dhufish are suspected of schooling to spawn; however, very little is known about their spawning behaviour. Although catch rates in 2002/03 suggest that the breeding stock levels of dhufish and pink snapper are not showing any particular trend, the more reliable indication provided by the WCDGDLF shows a decreasing trend for dhufish, suggesting that the effort estimates for the line fishery are still not sufficiently precise, despite the adjustments for increases in efficiency. Furthermore, the declining trend for dhufish in the non-target demersal gillnet fishery (WCDGDLF) also provides support for the view that current levels of catch are too high (Hesp et al. 2002). It is not known to what extent catch rates relate to the breeding stock level of 40% of virgin biomass which is considered the minimum safe level for these long-lived species. The decline in catch rate of baldchin groper in recent years indicates that the fishery for this species needs to be closely monitored and reassessed in relation to the new management closures.

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 75% (197) of the boats in the wetline fleet are associated with other licensed fisheries. Only 67 boats in the wetline fleet hold no other licences and thus are 'wetline only'. On average, the 'wetline only' fleet fished 55.4 days each, employing on average 2.03 crew to take demersal finfish during 2002/03. Thus the 'wetline only' fleet employed 7,535 'person days' during 2002/03.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002/03: $5.6 million

The estimated value of the fishery in 2002/03 includes all species caught by handlines and droplines on the west coast of Western Australia. Nearly 100 species or groups of seafood were recorded as catch and sold for an estimated $5.6 million. The highest-valued catch was dhufish at 37% of the total value, followed by pink snapper (23%), the lethrinids (11%) and baldchin groper (4%), while redfish (3%), coral trout (2%) and goldband snapper (2%) all had catches with estimated values of over $100,000. Prices used to calculate the value of the fishery in 2002/03 have not been updated since 2000/01 when dhufish, pink snapper and baldchin groper sold on average for $9.41/kg, $5.24/kg and $6.72/kg respectively. At $10.54/kg, coral trout commanded the highest average price of all species in the fishery.

FISHERY GOVERNANCE

Acceptable catch range for next season: 558–798 tonnes

The proposed acceptable 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 acceptable catch range has been set at 558–798 t. Acceptable 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 third consecutive year, the catch of the entire fishery at 1,154 t is well above the proposed acceptable range, reflecting the increasing mobilisation of the latent effort in the wetline fishery in the west coast bioregion. The acceptable range was exceeded by 12% in 2000/01, 37% in 2001/02 and 46% in 2002/03. For the first time all three species (dhufish at 232 t, pink snapper at 272 t and baldchin groper at 41 t) exceeded their acceptable catch ranges.

New management initiatives (2003/04)

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 and catch rates remain profitable.

When management of the wetline sector is introduced, the current acceptable catch range will need to be reviewed and adjusted to ensure the ongoing maintenance of adequate breeding stocks for the key targeted species. 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 period, the previous research that indicates current catch is too high provides a case for immediate action to stabilize or reduce catch.

Recommendation 13(a) from Fisheries Management Paper no. 139 (Fisheries WA 2000) has led to the introduction of a

baldchin groper closure around the Abrolhos Islands during the reproductive season (December to March), beginning December 2003. This precautionary closure was implemented because this species is a hermaphrodite (changes sex) and the general rules around setting legal minimum length (LML) for gonochoristic fishes do not apply. Generally, LML is set above the size at which 50% of females are mature (L_{50}) to allow a proportion of females to spawn prior to capture. An LML set at this size will not be effective for protogynous hermaphrodites (where females change into males) because it does not adequately protect males from capture by the fishery.

EXTERNAL FACTORS

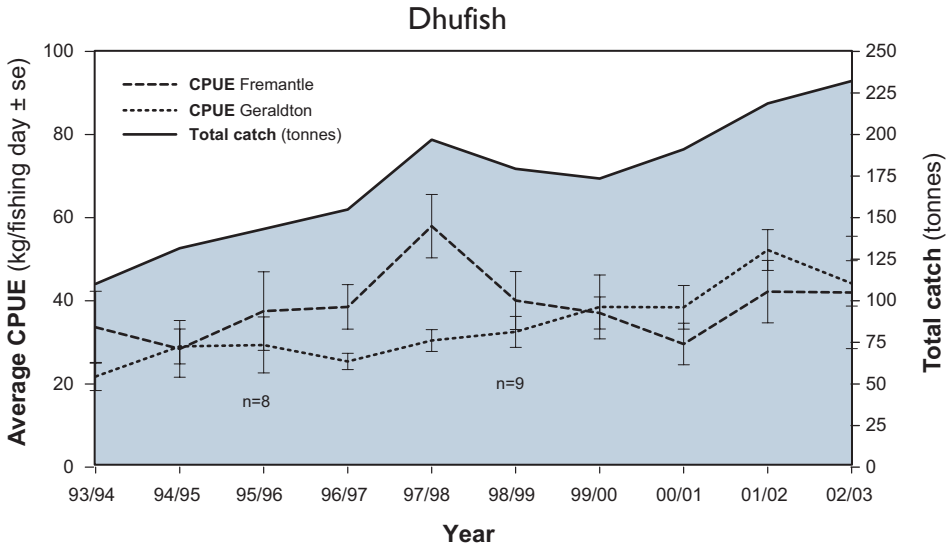
The productivity of the west coast demersal scalefish fishery relies on the maintenance of both the snapper and dhufish populations, which is most likely dependent on large recruitment events. The relationship of such recruitment events to environmental factors is presently unknown.

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 2002/03. Major target species are in **bold type**.

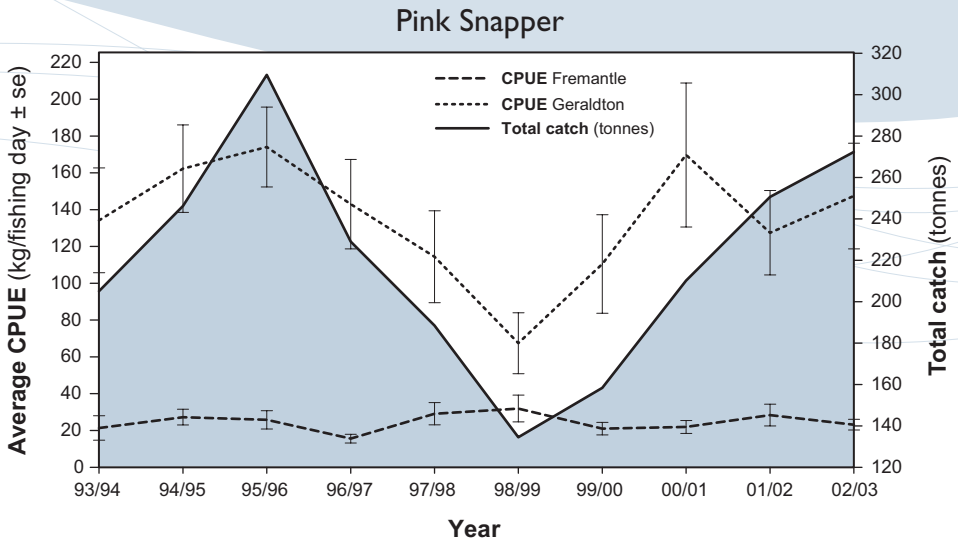
RANK	DEMERSAL FINFISH	NON-DEMERSAL FINFISH	SHARKS	SCIENTIFIC NAMES	LANDINGS (tonnes)
1	**Pink snapper**			*Pagrus auratus*	272
2	**Dhufish**			*Glaucosoma hebraicum*	232
3	**Lethrinid species (2)**			*Lethrinus nebulosus, L. miniatus*	151
4		Samson fish		*Seriola hippos*	75
5			Wobbegong	Orectolobidae	54
6	Bight redfish			*Centroberyx gerrardi*	52
7	**Baldchin groper**			*Choerodon rubescens*	41
8			Copper whaler	*Carcharhinus brachyurus*	30
9	Sweetlip			Haemulidae	26
10	Goldband snapper			*Pristipomoides multidens*	20
11		Skipjack trevally		*Pseudocaranx dentex*	17
12			Dusky whaler*	*Carcharhinus obscurus*	16
13	Mulloway			*Argyrosomus hololepidotus*	16
14			Other shark		13
15	**Coral trout**			*Plectropomus leopardus*	12
	Total				**1,027**

* Note: dusky whalers are often misreported as bronze whalers in the catch statistics.



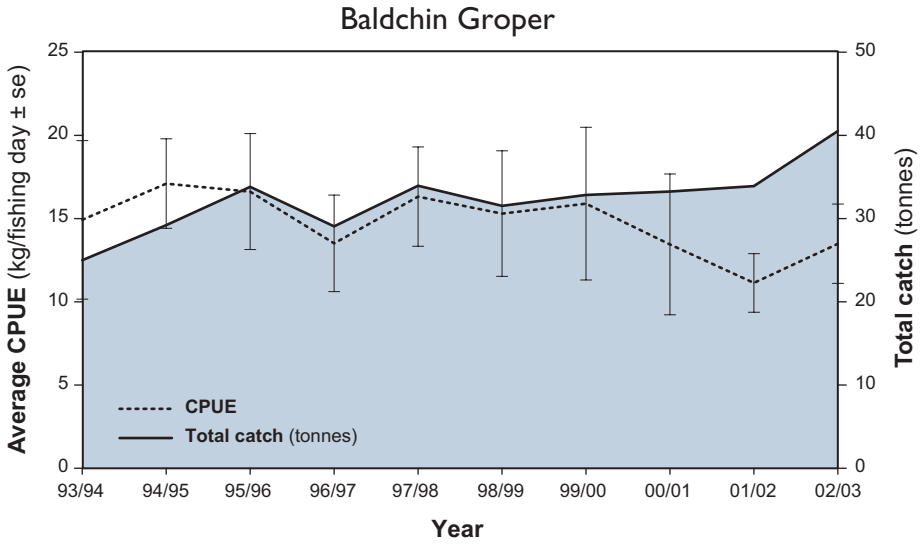
WEST COAST DEMERSAL SCALEFISH FIGURE 1

Annual catch of dhufish in the west coast demersal scalefish fishery over the decade from 1993/94 to 2002/03. Catch per unit effort (CPUE, kg/adjusted fishing day) is shown for dhufish caught by the top 10 boats (unless indicated otherwise) each year in two regions, Fremantle and Geraldton.



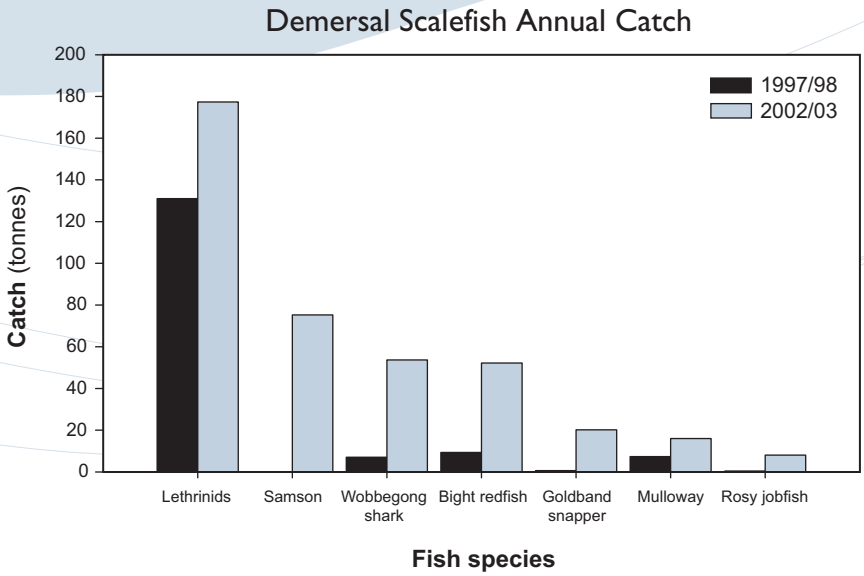
WEST COAST DEMERSAL SCALEFISH FIGURE 2

Annual catch of pink snapper in the west coast demersal scalefish fishery over the decade from 1993/94 to 2002/03. Catch per unit effort (CPUE, kg/adjusted fishing day) is shown for pink snapper caught by the top 10 boats each year in two regions, Fremantle and Geraldton.



WEST COAST DEMERSAL SCALEFISH FIGURE 3

Annual catch of baldchin groper in the west coast demersal scalefish fishery over the decade from 1993/94 to 2002/03. Catch per unit effort (CPUE, kg/adjusted fishing day) is shown for baldchin groper caught by the top 10 boats each year off Geraldton.



WEST COAST DEMERSAL SCALEFISH FIGURE 4

Increases in annual catches of selected species in the west coast demersal scalefish fishery during the five-year period from 1997/98 to 2002/03. Species with a current catch less than 8 t were not considered in this analysis.

Wetline Fishing

The catch and effort statistics (CAES) database indicates that over half (57%) of the wetline catch in 2002/03 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 12 species comprised pink snapper (*Pagrus auratus*) 272 t, West Australian dhufish (*Glaucosoma hebraicum*) 232 t, whitebait (*Hyperlophus vittatus*) 158 t, Australian herring (*Arripis geogianus*) 88 t, sweetlip emperor (*Lethrinus miniatus*) 76 t, samson fish (*Seriola hippos*) 75 t, wobbegong (*Orectolobus* spp.) 54 t, nor-west snapper (Lethrinidae) 53 t, redfish (*Centroberyx* spp.*) 52 t, sea mullet (*Mugil cephalus*) 47 t, baldchin groper (*Choerodon rubescens*) 41 t and Spanish mackerel (*Scomberomorus commerson*) 36 t. It is interesting to note the increasing prominence of wobbegong shark and deeper-water species such as redfish in the wetline catch.

These catches of dhufish, pink snapper and emperor are the main product of the demersal scalefish operations reported on pp. 47-54, 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. 42-44).

*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, with 68% of the recorded effort or an estimated 5.6 million fishing days during 2003/04 (Baharthah 2004).

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 is 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 is 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 Western 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. These findings highlighted the importance of proper management for recreational fisheries.

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). 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.

An FRDC-funded survey to examine changing recreational shares of crab catches in Cockburn Sound and Geographe Bay following management changes is currently in progress.

Licensed Recreational Rock Lobster Fishery Status Report

Prepared by R. Melville-Smith and A. Thomson, with management input by 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 carrying eggs 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 lobster. 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 the daily bag limit is 4 and the boat limit 8 lobsters.

There is 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. More recently, as a result of international concern over 'mad cow disease' and the sensitivity of the export lobster market, it was decided to prohibit the use of any bovine matter or any animal skin or hide as lobster bait for both commercial and recreational lobster fishers.

Research summary

General research for managing the rock lobster stock is covered in the commercial fishery report (pp. 14-20).

For the recreational component of this fishery, an annual mail-based survey of participants is used to estimate the

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

RETAINED SPECIES

Recreational catch estimate (season 2002/03): **890 tonnes**

Landings

The recreational catch of western rock lobster for 2002/03 was estimated at 890 t, with 625 t by potting and 265 t by diving. Comparative catch estimates for 2001/02 were 383 t by potting and 162 t by diving. The increase in catch was predicted but the catch achieved was above the 700–800 t range predicted in the *State of the Fisheries Report 2002/03,* due to a higher than expected number of licences sold and a higher usage rate of the licences.

Fishing effort/access level

A total of 44,455 licences that permitted fishing for lobsters in the course of the 2002/03 season (rock lobster licences plus umbrella licences) were purchased, with an estimated 33,700 (75%) utilised for lobster fishing. This is substantially higher than in 2001/02 when only 39,623 licences were sold and there was also a lower proportion of users (69%). The average rates of usage by pot and diving fishers (excluding all those who held a licence but failed to use it) were 32 and 12 days respectively during the 2002/03 fishing season. These rates are similar to those found for the 2001/02 fishing season.

Catch rate

The average pot and diving catch rates were 1.7 and 2.9 lobsters per person per fishing day in the 2002/03 fishing season. These compare closely to the 2001/02 fishing season where potters and divers caught 1.3 and 2.7 lobsters per person per fishing day respectively.

Commercial share: **93% (approx.)**

The commercial fishery accounted for around 93% 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 7%), the full assessment information is provided in the commercial fishery status report.

Exploitation status: **Fully exploited**

See the commercial fishery status report.

Breeding stock levels: **Adequate**

See the commercial fishery status report.

Projected catch next season (2003/04): **900–1,200 tonnes**

The recreational rock lobster catch has been estimated by an annual mail survey since the 1986/87 season. Regional estimates suggest that licence usage 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 100 t per year. By contrast, 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 highly significant impact on catch over time with the average annual rate of increase estimated to be 6%.

In addition to licence usage, the 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 higher overall recreational rock lobster catch due to a combination of increased lobster abundance and higher fishing effort.

Based on the strong settlement in the 1999/2000 season, along with the predicted increase in licence usage, it is forecast that the recreational rock lobster catch will increase to around 970 t in 2003/04 (Recreational Rock Lobster Figure 1), which would be a record recreational catch. Similar, or slightly lower catches are expected in 2004/05 (970 t) and 2005/06 (870 t).

Licence sales and usage are also expected to increase over the next few years; the prediction is that sales will increase to approximately 45,000 and usage to 34,000 in 2003/04. The price rise implemented in 2002, which took the cost of buying a lobster licence from $25 to $30 per year, did not appear to have any impact on licence sales or usage patterns in the 2002/03 season.

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 approximately 30,000 people taking approximately 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 2002/03 season was about $18 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

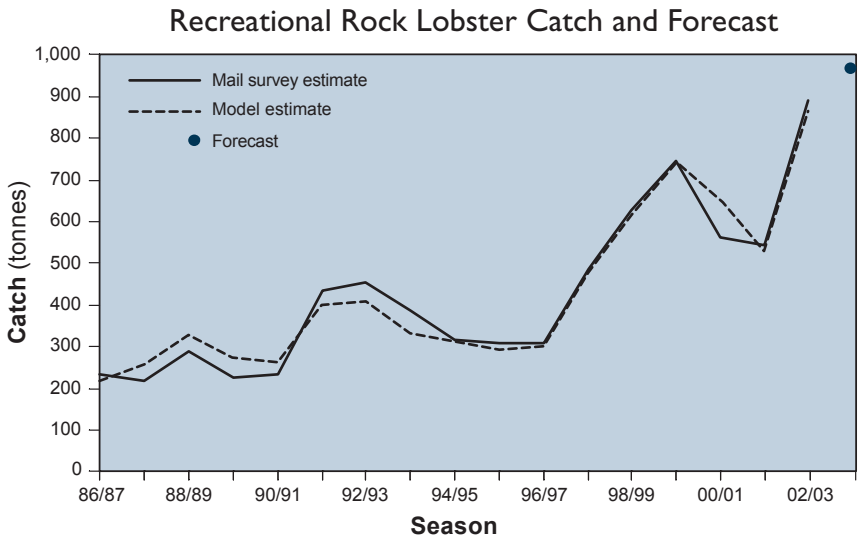
While the annual take by the recreational sector in this fishery is subject to size, bag and pot usage limits and seasonal constraints, there is no direct control on the number of recreational licences issued.

New management initiatives (2003/04)

A telephone diary survey will be undertaken in 2004/05 to compare against the mail survey catch estimate method that has been reported on here. It is recognised that mail survey methods are prone to various catch estimate biases, and results from a different survey method will provide greater confidence in the recreational rock lobster catch estimate.

EXTERNAL FACTORS

As noted previously under the projected catch for the 2003/04 season, 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 mail survey results, and model estimates of catches in 2003/04 based on puerulus settlement three to four years earlier and expected licence usage.

Licensed Recreational Abalone Fishery Status Report

Prepared by A. Hart, T. Baharthah and B. Hancock

FISHERY DESCRIPTION

The recreational abalone fishery exploits three species (greenlip abalone, *Haliotis laevigata*; brownlip abalone, *Haliotis conicopora*; and Roe's abalone, *Haliotis roei*). Recreational fishing for Roe's abalone is carried out while wading or snorkelling on reef platforms and sub-tidal reefs mainly between Geraldton and Augusta, with a concentration of fishing activity around the Perth metropolitan area and Geraldton. 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 fishery is divided into 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, some of

which were amended in 2003 following a review of the fishery.

The fishing season in the Northern and Southern Zones, which were formerly open year-round, now runs from 1 October to 15 May. The West Coast Zone is still open for six Sundays only, 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 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 (Roe's, greenlip and brownlip) 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.

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

Research summary

Recreational catch and effort estimates are derived from two independent surveys: an annual telephone survey covering the entire State, and a field survey for the west coast Roe's abalone fishery. The telephone survey estimates the catch of all three species based on interviews stratified by licence type (abalone or umbrella) and respondent location (country or Perth metropolitan area) from the licensing database. Because of the wide confidence limits in the telephone survey of south coast greenlip and brownlip catches, future surveys will use the more accurate telephone-diary survey method. The field survey estimates the catch and effort from each distinct Roe's abalone stock within the Perth fishery. Field survey estimates are based on average catch (weight and numbers), catch rates (derived from 1,563 interviews in 2003), and fisher counts conducted by VFLOs (Volunteer Fisheries Liaison Officers) and research personnel from vantage points and aerial surveys.

A fishery-independent survey of Perth metropolitan stocks is carried out annually. Size and density of Roe's abalone across the near-shore habitat has been measured at six indicator sites between Burns Beach and Penguin Island, the area that yields the majority of the recreational catch. In 2003, an extra indicator site (Marmion Angling and Aquatic Club) was included in the surveys.

An FRDC-funded project is also underway which is designed to test the possibility of underwater video for monitoring density and size structure of abalone stocks. The project had success within greenlip stocks in 2003, and effort will be focused on Roe's abalone stocks in 2004.

RETAINED SPECIES

Recreational catch (season 2003:)

Roe's Perth fishery 45 tonnes
Roe's rest of State 25 tonnes
Greenlip 16 tonnes
Brownlip 6 tonnes

Landings

Catch estimates for the Perth fishery during 2003, derived from telephone and field surveys, were 47.2 and 42.6 t respectively, an increase of about 16% from 2002 (Recreational Abalone Figure 1). This was caused by increases in effort, catch rate, and meat weight (Recreational Abalone Table 1). Catch of Roe's abalone from the rest of the state, based on an annual phone survey, declined by 7% from 27 to 25 t, with major decreases on the west coast (not including Perth) offset by increases on the south coast (Recreational Abalone Table 2).

Catch estimates for greenlip abalone declined by 47% from 30 t in 2002 to 16 t in 2003 (Recreational Abalone Table 2). Similarly, estimates of brownlip catch declined by 45% from 9 t in 2002 to 5 t in 2003. Because of the wide confidence limits around these estimates, the variation between years should be treated with caution.

Fishing effort/access level

Effort estimates for the Perth fishery during 2003 were 28,700 days (telephone survey) and 23,700 days (field survey), an increase of about 9% (telephone) and 6% (field) over the 2002 estimates (Recreational Abalone Table 1). The field surveys established that the overall effort increase was due mainly to an increase in effort in Section 38 (Burns Beach – Beaumaris area), and not by an increase in the number of licence holders, which has remained relatively steady since 2001 (Recreational Abalone Figure 2). Effort on Roe's abalone from the rest of the state declined by 5% from 24,400 days (2002) to 23,100 days (2003), with major decreases on the west coast (not including Perth) offset by increases on the south coast (Recreational Abalone Table 2).

Catch rate

The catch rate during the 2003 Perth season was estimated at 17.1 (telephone) and 18.62 (field) abalone per fisher day, an increase of 2% (telephone) and 4% (field) over the 2002 figures (Recreational Abalone Table 2). The Roe's abalone catch rates on the west (not including Perth) and south coasts were estimated at 12.5 and 11.3 abalone/day respectively, which represented a decrease of 12% (west coast) and an increase of 43% (south coast) over 2002.

The catch rates for greenlip were 0.5 and 2.6 abalone/day on the west and south coasts respectively, decreases of 69% and 26% from 2002 (Recreational Abalone Table 2). Brownlip catch rates were 0.3 and 0.5 abalone/day on the west and south coasts respectively, decreases of 25% and 55% since 2002.

Commercial share: Roe's 53–61% approx.
Greenlip/brownlip 87–93% approx

Commercial catches in 2003 totalled 95 t of Roe's abalone and 212 t of greenlip/brownlip abalone. More precise estimates of greenlip/brownlip recreational catch will be obtained during a diary survey commencing in October 2004 and continuing throughout the 2004/05 recreational season. This will ensure that catch share arrangements negotiated under Integrated Fisheries Management are based on sound scientific data.

STOCK ASSESSMENT

Assessment complete: Yes

Size distributions and densities were measured from seven indicator reefs in the Perth metropolitan fishery, six of which have a seven-year data history (Burns Beach, Beaumaris, Waterman's Reserve, Mettams Pool, Bailey Street and Penguin Island). One new site (Marmion Angling and Aquatic Club) was surveyed in 2003. Surveys were conducted in January and February 2004, and measured the state of abalone stocks following the recreational fishery in November and December of 2003 (Recreational Abalone Table 3).

Densities of sub-legal animals (< 60 mm) on the reef platform habitat increased at four sites in 2004, and decreased at the other two (Recreational Abalone Table 3). The decrease at the Waterman's Reserve, where no abalone fishing is allowed, may be due to density-dependence survival. This site has shown a continual increase in legal-sized abalone since 1999. On the sub-tidal reef habitat, densities of sub-legal animals declined substantially at Penguin Island, but at other sites remained stable or increased slightly.

Densities of legal-sized animals (60+ mm) on the reef platform habitat decreased at Burns Beach and Beaumaris but increased or remained stable at other reef platform sites. In the sub-tidal reef habitat, densities declined at all sites, with the exception of Bailey Street where they increased (Recreational Abalone Table 3).

The decline in legal-sized abalone at Burns Beach and Beaumaris may be reflecting the increase in effort put into this area during the 2003 season. Both sites are at their lowest legal-sized densities since 1996. At this stage the declines do not represent a sustainability issue, particularly at Burns Beach as the sub-legal abundance is very good. However, at Beaumaris there is also a decline in sub-legal abundance and if the declines continue into the next year or two, there may be sustainability implications. Similarly, the decline in legal-sized abalone in the sub-tidal habitat is noted, but is not a sustainability concern at this stage, as values are still within the historical range (see Fishery Governance section).

West and south coast stock assessments are based on catch and effort data from the commercial fishery (see commercial fishery status report, pp. 166-171).

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Size at sexual maturity (50% of animals mature) for all species is below the minimum legal size, and considered to provide adequate protection for the breeding stock. 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, higher than the normal legal minimum size for Roe's abalone of 60 mm.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

See the commercial fishery status report.

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 report.

Habitat effects: Negligible

See the commercial fishery status report.

SOCIAL EFFECTS

Over 21,000 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 sectors of the community which appreciate the abalone as a food.

ECONOMIC EFFECTS

Not available.

FISHERY GOVERNANCE

For Roe's abalone densities in Perth stocks to remain at a historically sustainable level, the densities following the recreational season effort should fall within the seven-year (1997–2003) historical range that reflects the acceptable variation in the stocks. This range is 28–38 abalone/m^2 for animals < 60mm, and 28–34 abalone/m^2 for animals 60+ mm.

Post-season surveys conducted in early 2004 showed overall densities of < 60mm animals to be 27 abalone/m^2, while densities of 60+ mm animals were 29 abalone/m^2. Sub-legal densities fell below the historical range, while legal-sized densities are within the historical range.

New management initiatives (2003/04)

This was the first season in which the new bag limits for greenlip/brownlip abalone and the seasonal restrictions in the Northern and Southern Zones were in operation.

EXTERNAL FACTORS

Effort in the Roe's abalone recreational season is primarily controlled by weather, hence the large fluctuations in the annual catch from year to year (Recreational Abalone Figure 1).

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 telephone and field surveys.

YEAR	TELEPHONE SURVEY				FIELD SURVEY				
	EFFORT (days)	CATCH RATE	CATCH (number)	CATCH (tonnes)	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	23,300	17.6	410,000	48.8	22,070	17.4	383,600	45.8	0.1195
2000	21,800	17.0	369,000	33.7	19,800	16.7	330,300	30.2	0.0913
2001	29,600	17.6	521,500	47.8	25,590	18.8	481,300	44.1	0.0917
2002	26,300	16.7	438,500	39.3	22,450	17.9	401,500	36.0	0.0897
2003	**28,700**	**17.1**	**489,800**	**47.2**	**23,700**	**18.62**	**442,405**	**42,6**	**0.0960**

RECREATIONAL ABALONE TABLE 2

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

Note: Field validation of aspects of these telephone-based surveys has yet to be undertaken, and may alter the individual species catch estimates when completed. A more accurate diary survey is being conducted in the 2004 season.

YEAR	EFFORT[1]	ROE'S ABALONE			GREENLIP ABALONE			BROWNLIP ABALONE		
	(days)	CATCH RATE	CATCH (number)	CATCH[2] (tonnes)	CATCH RATE	CATCH (number)	CATCH[3] (tonnes)	CATCH RATE	CATCH (number)	CATCH[4] (tonnes)
WEST COAST[5]										
1999	10,300	12.4	128,700	11.8	1.9	20,400	13.5	1.2	11,900	8.1
2000	9,800	12.7	123,500	11.2	2.3	23,400	15.5	0.6	6,900	4.6
2001	18,400	13.1	240,700	21.6	1.9	35,600	23.6	0.9	16,200	11.0
2002	17,500	14.3	250,300	22.5	1.6	27,900	18.4	0.4	6,900	4.6
2003	**13,600**	**12.5**	**169,000**	**15.2**	**0.5**	**6,600**	**4.4**	**0.3**	**3,500**	**2.4**
SOUTH COAST										
1999	16,300	11.0	186,800	17.0	3.0	48,400	22.6	0.7	10,900	7.1
2000	13,000	7.3	90,900	8.3	5.0	67,500	31.5	0.8	11,400	7.4
2001	9,600	7.1	68,100	6.1	5.1	48,700	22.7	1.1	10,200	6.6
2002	6,900	7.9	54,600	4.9	3.5	24,400	11.4	1.1	7,300	4.7
2003	**9,500**	**11.3**	**107,300**	**9.6**	**2.6**	**25,000**	**11.7**	**0.5**	**4,800**	**3.2**

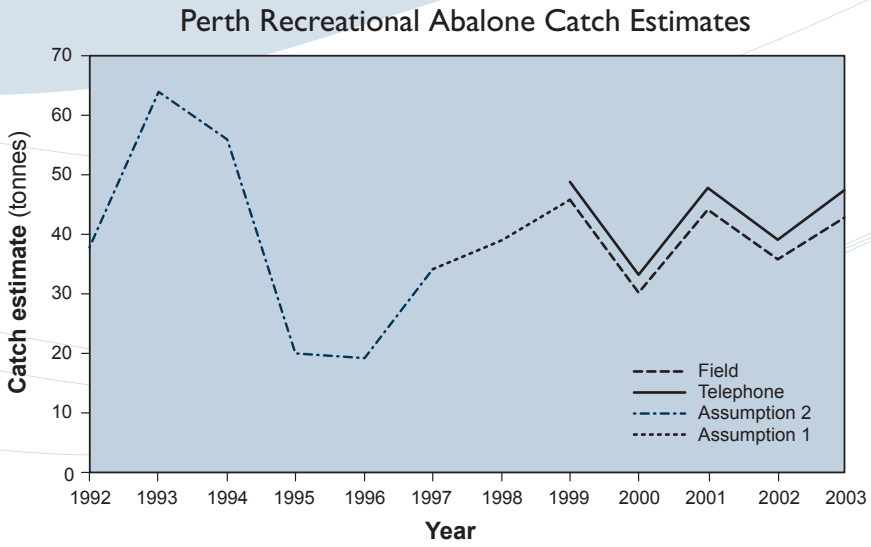
Table 2 Notes:

1 Effort is estimated for all species combined.
2 Mean whole weight for Roe's abalone is assumed to be 0.09 kg (mean weight measured from the Perth fishery for 2000).
3 Mean whole weight for greenlip is assumed to be 0.661 kg for the west coast and 0.467 kg for the south coast.
4 Mean whole weight for brownlip is assumed to be 0.675 kg for the west coast and 0.650 kg for the south.
5 The west coast area for the telephone survey includes the coastline from Cape Leeuwin to Cape Naturaliste, which is in the southern licence zone (Area 3) for the commercial fishery.

RECREATIONAL ABALONE TABLE 3

Preliminary mean densities of sub-legal abalone (5–59 mm) and mean densities of legal-sized abalone (60 mm and over) from the seven reef platform monitoring sites in the Perth fishery, measured as abalone/m^2.

YEAR	BURNS BEACH		BEAUMARIS		WATERMAN'S RESERVE		METTAMS POOL		BAILEY STREET		PENGUIN ISLAND		MAAC	
	<60	60+	<60	60+	<60	60+	<60	60+	<60	60+	<60	60+	<60	60+
REEF PLATFORM														
1996	90	34	44	46			61	23	73	37				
1997	58	43	57	62	59	31	41	39	56	51	42	34		
1998	77	42	57	65	63	46	50	31	71	38	54	50		
1999	82	45	47	45	70	36	55	35	63	25	96	53		
2000	91	46	39	47	39	45	61	27	65	21	76	55		
2001	99	56	38	50	50	45	49	25	61	26	84	54		
2002	107	61	24	45	54	49	30	26	52	33	77	53		
2003	89	59	22	48	45	51	20	29	42	34	69	39		
2004	**100**	**40**	**26**	**34**	**43**	**63**	**24**	**26**	**72**	**42**	**46**	**44**	**39**	**30**
SUB-TIDAL REEF														
1997	3	14	4	12	12	24	15	17	4	33	21	30		
1998	3	16	6	14	19	38	1	8	8	25	22	30		
1999	5	14	10	12	18	35	0	0	4	16	10	21		
2000	6	22	1	11	14	39	0	1	3	9	6	40		
2001	6	19	3	14	13	35	0	1	4	10	11	36		
2002	6	29	5	15	12	40	0	1	4	12	7	28		
2003	6	27	2	17	8	32	0	1	10	14	23	35		
2004	**6**	**19**	**2**	**10**	**9**	**28**	**0**	**0**	**13**	**19**	**4**	**25**	**30**	**44**



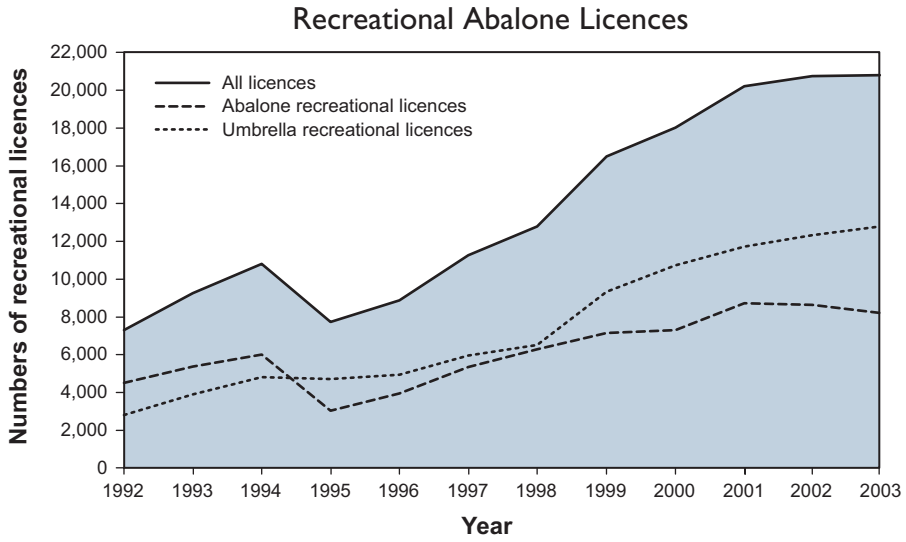
RECREATIONAL ABALONE FIGURE 1

Catch estimates for the Perth recreational abalone fishery for the period 1992 to 2003, 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. 105.4 g, averaged from 119.5 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 1997–2003. 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 2003.

Recreational Tailor Fishery Status Report

Prepared by R. Lenanton and G. Nowara, with management input by I. Curnow

FISHERY DESCRIPTION

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

The majority of the recreational catch is taken from the metropolitan area in the west coast region, whilst the majority 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. The recreational proportion of the total tailor catch on the west coast in 2000/01 was 94%.

Management arrangements

The recreational component of the fishery for tailor is managed under a suite of broad input and output controls for inshore species common to the west coast.

Following the west coast regional review, which examined a range of issues including those associated with the sustainability of tailor stocks, new recreational fishing management controls were implemented for the west coast and Gascoyne bioregions from 1 October 2003. Under the new arrangements, tailor is assigned to the 'medium risk' category. The daily bag limit remains at 8, with the additional proviso that only two of these may be fish over 600 mm, while the legal minimum length has been increased from 250 to 300 mm.

Research summary

Research to support the management of tailor stocks was undertaken during the early 1990s. This research identified genetically homogeneous populations along the west coast of Western Australia, between Shark Bay and Cape Naturaliste. However otolith carbonate analysis suggests that the inner Shark Bay populations may 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.

Concerns about increasing recreational fishing pressure on tailor in the greater Perth metropolitan area in the early 1990s initiated the change in the daily bag limit from 20 to 8 fish per angler, and prompted two research studies, a tagging and a short-term hooking mortality study. Further research has been undertaken which investigated the basic biology of tailor to provide information on the age structure, growth and reproduction of this important recreational species. Once finalised, these data will be included in future modelling of the dynamics of tailor populations to support management needs.

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. A volunteer angling program for this purpose began in 1995 and is ongoing at Point Walter between February and April of each year. These data, coupled with similar information from the near-shore marine environment of the lower west coast, provide an indication of the strength of annual recruitment to the lower west coast population.

Further work on factors influencing the distribution and abundance of larval tailor off the lower west coast is currently being undertaken by an Honours student at Murdoch University. Once completed, this will contribute to an assessment of the significance of environmental influences on recruitment to the fishery.

The scientific information from these research projects has been used to compile this status report.

RETAINED SPECIES

Recreational catch estimate (season 2003): Not assessed

Landings

Comprehensive recreational tailor catch estimates are not available for the current year (2003). The most complete recent estimates (all areas, all methods) for tailor catches are available from the National Recreational Fishing Survey funded by the FRDC. This survey was completed between May 2000 and April 2001 and estimated that a total of 587,000 tailor were caught in Western Australia during this 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). The catch of tailor occurred in three bioregions, with the majority of the catch (182 t or 97%), including boat and shore fishing, occurring in the west coast region (Recreational Tailor Fishery Table 1). An estimated 87% of the catch was from shore-based fishing. The estimated boat-based catch from this survey is possibly an over-estimate and may be revised at a future date.

More recent recreational tailor catch estimates are available for the current year (2003) from the Shark Bay region. An estimated take of 0.7 t was reported from a survey of boat-based fishing for the calendar year 2003, compared with

an estimated take of 1.4 t in 2002. This survey covers fish caught in the inner gulfs of Shark Bay and landed at the boat ramps at Nanga, Denham and Monkey Mia. These data can be compared with previous surveys in this bioregion.

For example, recreational catch information from a boat- and shore-based angler survey in the Gascoyne region (Steep Point to Exmouth Gulf) between 1 April 1998 and 30 March 1999 produced a total recreational catch of 6,600 tailor kept (5 t) (± 1,300 fish) with 1,600 tailor released. The greatest proportion of the Gascoyne tailor catch (87%) was taken from the Shark Bay Marine Park (Sumner et al. 2002). A similar 2001 boat-based-only creel survey from Nanga, Denham and Monkey Mia, within Shark Bay Marine Park, reported a boat-based tailor catch of 1,800 fish (1.1 t) with 130 released, while 1,100 fish (0.8 t) were caught and 70 released during the equivalent 2000 survey (Sumner and Malseed 2002).

Fishing effort/access level

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

Catch rate

Not assessed.

Commercial share: 24% (approx.)

Of the combined recreational catch of tailor for 2000/01 (from the National Recreational Fishing Survey) and commercial catch from the whole state in calendar year 2000, the commercial catch comprises 24%, the majority of which was taken in the Gascoyne region.

In 2003, commercial catches of tailor were recorded from the coastal fishing areas and three major estuaries along the lower west coast (Swan/Canning, Peel/Harvey and Hardy Inlet). Wetline fishers in the coastal fishing areas between Kalbarri and Cape Naturaliste reported a catch of 0.7 t, representing approximately 21% of the total 2003 annual west coast commercial catch. The three estuaries reported a combined catch of 2.6 t, which is approximately 79% of the total 2003 annual west coast commercial catch.

Approximately 95% (28.7 t) of the 2003 total annual Gascoyne commercial catch was recorded from the Shark Bay Beach Seine and Mesh Net Managed Fishery. The remaining 5% (1.6 t) was recorded from wetline fishers in the Gascoyne region.

STOCK ASSESSMENT

Assessment complete: Preliminary

A full assessment of the status of the stock is not yet possible, although previous tagging studies have provided a basis for preliminary assessments. These studies provided data on growth and migration, and indicated that the stock experiences a mortality rate of approximately 10% of sub-legal-size fish on release (Ayvazian et al. 2001). They also showed that about 21% of the total stock in the metropolitan region is located offshore, and consists primarily of mature fish. Utilising these data, together with an age at first capture (based on survey data) of one year and preliminary estimates of fishing mortality rates undertaken in 1996, assessment modelling indicates a level of egg production at that time of around 36% of the unexploited stock's egg production.

The recent trends observed in the Swan River and the lower west coast recruitment indices strongly suggest that the lower west coast population has experienced consistently low recruitment since 1997/98.

Anecdotal evidence from recreational fishers suggests poor catches of mature fish in the metropolitan region over recent years. This, combined with an absence of the run of juvenile fish from beaches in spring/summer over recent years, is of serious concern and is consistent with the trends in low recruitment reported above.

Exploitation status: Not assessed

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. For this relatively heavily fished sector of the stock, the above assessment indicates that the breeding stock in 1996 was above the 30% 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. Given the consistently low recruitment on this section of the coast over recent years, there is now 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

Excessive removal of tailor from the food chain could potentially allow for some increase in the numbers of its prey species.

Habitat effects: Negligible

The line fishing methods used to fish for tailor have a negligible impact on the substrate of the river or ocean. The greatest potential for impact is from trampling of the riverbanks or beds and from pollution through the discarding of rubbish associated with fishing activity.

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

At this time, control of the 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 the recreational sector. Commercial catch is limited to south-west estuaries and Shark Bay where strict licence and gear limits apply.

New management initiatives (2003/04)

Management has requested a further creel survey of boat-based recreational fishing, and this survey, scheduled for 2005, will provide up-to-date estimates of this component of the tailor catch. This is important, as historically offshore tailor stocks have not generally been targeted by recreational fishers; however, anecdotally this practice has been increasing in recent years.

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	1.0	1			4
West	15	143.0	1	5	17.0	181
South		0.5		1	0.5	2
Total	**17**	**144.5**	**2**	**6**	**17.5**	**187**

Fishing and Aquatic Tour Industry

Prepared by C. Telfer

The west coast bioregion has the highest number of licensed tour operators in the state, with 130 fishing tour operators, plus an additional 16 restricted fishing tour or eco-tour operators, licensed at the end of 2003.

During 2002, operators reported 4,401 tours, which increased by 22.5% to 5,395 tours in 2003. Activities conducted on these tours included fishing, diving, snorkelling, wildlife observation and sightseeing.

Fishing effort

The number of tours on the west coast involving only fishing decreased from 2,828 in 2002 to 2,751 in 2003. These tours are directly related to the catch information presented in West Coast Fishing Tours Table 1. The total fishing effort reported by tour operators in 2002 was 29,499 fisher days compared to 28,715 fisher days in 2003, a decrease of 2.7%.

Catch

Since issuing tour operators' licences, 13,785 daily catch and effort returns have been received for the west coast bioregion. These returns enable an estimate of the total catch by tour operators to be calculated.

Catches of the major finfish species for 2002 and 2003 within the west coast bioregion are shown in West Coast Fishing Tours Table 1. The estimated total finfish catch for 2003 was 115 t, which was only a slight increase from 113 t in 2002. These catches from tour operators' vessels are recreational in nature, and are in addition to reported commercial catches. In future years, where practicable, they will be included in the 'recreational catch share' for relevant species and fisheries.

WEST COAST FISHING TOURS TABLE 1

Estimated catch of major finfish species reported by tour operators for 2002 and 2003.

SPECIES		ESTIMATED CATCH (tonnes) 2002	ESTIMATED CATCH (tonnes) 2003
Pink snapper	*Pagrus auratus*	14	20
Skipjack trevally	*Pseudocaranx dentex*	6	5
Dhufish	*Glaucosoma hebraicum*	25	23
Breaksea cod	*Epinephelides armatus*	5	4
Baldchin groper	*Choerodon rubescens*	7	8
Queen snapper	*Nemadactylus valenciennesi*	11	10
Samson fish	*Seriola hippos*	18	15
Sweetlip emperor	*Lethrinus miniatus*	2	5
Other finfish		25	25
Total		**113**	**115**

AQUACULTURE

Regional Research and Development Overview

Aquaculture production statistics are compiled at the WA Marine Research Laboratories in Perth by S. How and C. Lawrence. These show encouraging trends, with the value of aquaculture (revised) increasing by 11.3% and aquaculture tonnage increasing by 22.9% in 2002/03 compared to equivalent data for 2001/02 (excluding marine algae and all pearl oysters). While such precise data are not available for the aquaculture feeds industry, it is clear that the industry worldwide is using much more lupin kernel meal and Western Australia, as the major lupin producer in a world context, is developing a very significant industry as an ingredients supplier for domestic and export use.

Key matters for the Department in 2003/04 included addressing policy and environmental scoping issues in relation to a yellowfin tuna (*Thunnus albacares*) farm proposed for this bioregion. In addition, given encouraging experimental results from rock lobster (*Panulirus cygnus*) farming trials (see below), it was important to contribute policy perspectives that led to Ministerial Policy Guideline no. 20, 'Assessment of applications for authorisations with regards to rock lobster aquaculture'.

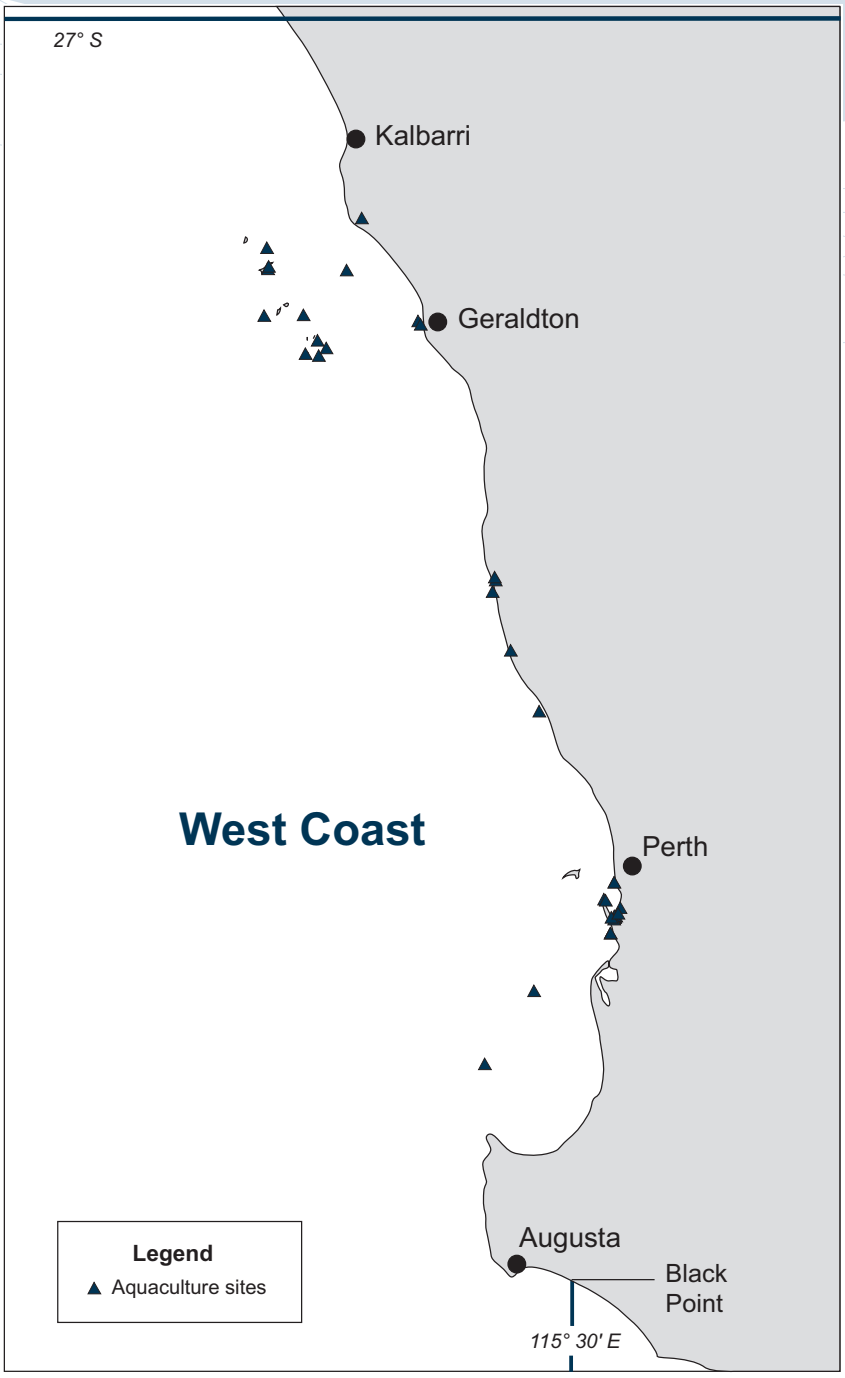
Another major activity involved developments in the ongoing management of environmental and safety issues associated with mussel (*Mytilus edulis*) leases. Examples include appropriate navigational lighting and the Western Australian Shellfish Quality Assurance Program, which ensures that mussels are only harvested when water quality is appropriate for safe consumption of the product.

Joint research on marine finfish aquaculture, led by S. Kolkovski, continued with the Challenger TAFE WA Maritime Training Centre. One encouraging result has been the production of broodstock from hatchery-reared fish in an intensive system for yellowtail kingfish (*Seriola lalandi*) culture as part of a project on aquaculture of this very fast-growing species funded by the Aquaculture Development Fund.

Other research led by S. Kolkovski, and based at a marine algae farm in Port Gregory, has shown good progress with growing brine shrimp (*Artemia*) for cyst production. Reliance on unpredictable supplies of imported cysts poses a major risk for marine finfish and prawn farming initiatives. Within this FRDC project, different experimental and commercial products have been evaluated for improving the nutritional content of brine shrimp larvae (enhancement) while minimising transfer of bacterial load to finfish larval tanks. This has already led one international feed company to redesign its main enhancement product. One of the microdiets developed with Challenger TAFE researchers has outperformed a key international product when used to reduce reliance on brine shrimp larvae for larval finfish.

Using the algal facility at Challenger TAFE, joint abalone research with S. Daume and Murdoch University has shown that the common sea lettuce is a promising seaweed for growing juvenile greenlip abalone on to a robust size for stocking into growout systems.

Initial results within an FRDC project involving R. Melville-Smith, D. Johnston and S. Saxby, aimed at growing wild western rock lobsters in land-based tanks, suggest that relatively low water exchange rates are needed and that periodic additions of fresh mussels, to complement a formulated feed, have helped produce encouraging growth and survival rates.



WEST COAST AQUACULTURE FIGURE 1

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

Mussel Farming Status Report

Prepared by C. Lawrence

INDUSTRY DESCRIPTION

Production method

Mussels (*Mytilus edulis*) are farmed by collecting wild spat that is then attached to vertical ropes for grow-out to market size on longlines.

Production areas

Mussel farms are found mainly in Cockburn Sound and Warnbro Sound, as well as in the Albany harbours and Wilson Inlet on the south coast. Growth of this industry is constrained by resource-sharing issues that limit access to additional sites in protected and productive areas. Production has commenced in the Southern Flats area of Cockburn Sound where mussel farmers now have more secure access to growing 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 (2002/03): 653 tonnes

Number of producers for year 2002/03: 16

Production projection next year (2003/04): 700–800 tonnes

Mussel production declined again in 2002/03 (Mussel Farming Figure 1), this year reflecting an over-reliance on the new lease areas in Southern Flats.

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. 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

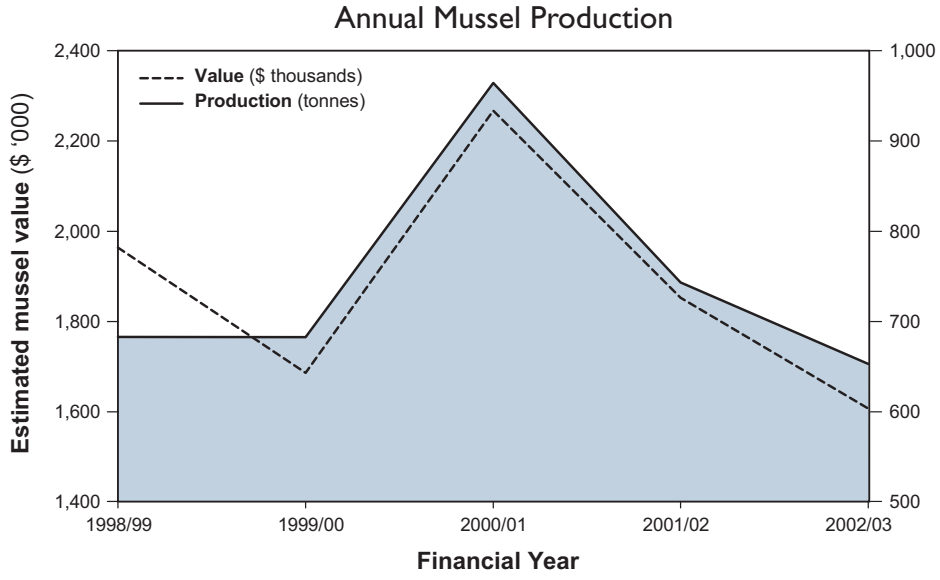
The industry provides direct employment to 40–50 personnel and adds valuable diversity to the Western Australian seafood industry.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2002/03: $1.61 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.



MUSSEL FARMING FIGURE 1

Estimated mussel production and value from 1998/99 to 2002/03.

COMPLIANCE

Regional Compliance and Community Education Overview

The Regional Services Branch of the Department provides a range of at-sea and land-based compliance services within the west coast bioregion. Fisheries Officers provide these services from offices in Denham, Geraldton, Dongara, Jurien, Lancelin, Fremantle, Mandurah, Bunbury and Busselton and the Serious Offences Unit, as well as aboard the large ocean-going patrol vessels *Baudin*, *McLaughlin* 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 to 12 m. They also provide support to seagoing personnel and provide a wide variety of education and extension services through formal and informal media to commercial fishers, fishing organisations, other resource management agencies and departments and general community members.

The ocean-going patrol vessels are used to ensure that fishers adhere to zone and closed water requirements, particularly in the West Coast Rock Lobster Managed Fishery, gear specification and limits, and seasonal closures.

Activities during 2002/03

During 2002/03, Fisheries Officers delivered 61,102 hours of compliance work in commercial fisheries (West Coast Compliance Table 1), of which around half was focused on the West Coast Rock Lobster Managed Fishery. While compliance in the fishery was generally good, 348 infringement warnings and 79 infringement notices were issued and 28 prosecutions were initiated or completed. This was a small increase over the previous year in the number of infringement warnings (up from 328), a large increase in the number of infringements (up from 47) and a decrease in prosecutions (down from 35). The increased number of warnings and infringements related to a campaign on licensing.

Throughout the fishing season, patrol vessel operations continued to target areas of non-compliance, these being mainly zone boundary offences, gear interference and over-potting. The three patrol vessels delivered a total of 328 sea days, with two prosecution briefs being submitted for excess gear and nine for closed waters offences.

The run of rock lobsters in the Capes area (Cape Leeuwin to Cape Naturaliste) continued, as did the annual migration of vessels from northern ports to capitalise on the good catches. This again led to a number of joint operations and increased focus on the interaction between recreational and commercial rock lobster fishers and other users of the marine environment in the near-shore coastal areas between the Capes.

The strong compliance partnership with industry continued, with the third rock lobster compliance risk assessment workshop being held prior to the season opening. Industry members and Departmental management, research and operational staff attended the workshop. Major risks identified included illegal sale into the restaurant trade, interference with commercial fishing gear, over-potting and failing to release rock lobsters within the specified times.

The Rock Lobster Compliance Coordinator continued the industry liaison and education program through attendance at association meetings, educating fishers in regard to rule changes and providing information and feedback on local compliance issues which could then be incorporated into the compliance planning process. Fourteen rock lobster fishermen's association meetings were organised, and four targeted rock lobster compliance operations involving multi-regional staff resources were coordinated.

In the West Coast Rock Lobster Managed Fishery the entire fleet was checked at least once, with an average of six inspections per vessel being achieved. An average of nearly 19 baskets per vessel over the year was also achieved, representing an inspection rate of 2.4–2.5 % of the entire landed catch (West Coast Compliance Table 2). The compliance program also focused on illegal movements of rock lobsters from commercial vessels, with positive results. The Rock Lobster Mobile Patrol detected an increase in the consignment of totally protected rock lobsters and initiated a number of prosecution actions.

In addition to the West Coast Rock Lobster Managed Fishery, Fisheries Officers focused considerable activity on maintaining high levels of compliance in the other commercial fisheries. These include the commercial fisheries for abalone, crabs, scallops, sharks, pilchards, demersal scalefish, inshore and estuarine species, and the wetline fishery. There were no major compliance issues encountered throughout the year.

The protection of totally protected fish is a critical component of fisheries management arrangements and the emphasis on ensuring they are not caught and consigned for sale continued in 2002/03. Additional effort was targeted at commercial wetline fishing operations in the Abrolhos Islands owing to the designation of baldchin groper as a totally protected species in this area.

In respect to recreational fisheries, Fisheries Officers made over 29,000 field contacts with fishers. The major fisheries focused on were abalone, rock lobster, net fishing, marine finfish, crabs and marron. The possession of under-size rock lobster and crabs was an issue across the region.

Approximately 2,500 fishers were contacted during the short six-day metropolitan abalone season. There was an increase in the number of serious offences detected, however overall the number of offences was similar to previous years. The taking of excess bag limit was again the major offence detected.

The successful Volunteer Fisheries Liaison Officer beachfront education programs continued, focusing on correct fishing techniques, ethics and bag and size limits. VFLOs attended major boat shows and other festivals, conducted school and community group fishing workshops, and distributed educational material to tackle shops. VFLOs also assisted in a number of research activities.

West Coast Bioregion

The 'Fishers with Disabilities' program was a finalist in the 8th Annual Community Services Industry Awards in the category of 'Developing and Supporting the Community Services Industry'. A highly successful tour of the program was conducted in the south-west with workshops being held in Mandurah, Port Bouvard, Bunbury, Busselton, Augusta and Albany.

An additional education program entitled 'Get Hooked on Fishing' was established. This program involves fishing workshops for families to promote correct fishing techniques, ethics and bag and size limits. Fifteen 'Learning Circles' were facilitated locally and at Newdegate, Wickepin and Yealering.

Initiatives in 2003/04

Regional Services staff continue to refine compliance techniques aimed at targeted and intelligence-driven outcomes.

A significant initiative commenced in 2003/04 has been the integration of the 'At Sea Marine Safety Compliance' program into the recreational and commercial fisheries compliance programs.

In the southern area of the bioregion, compliance activity has increased, with the aim of assisting industry and other user groups to continue to share the marine environment in a positive manner in line with the agreed industry operating Code of Conduct for the area between Cape Naturaliste and Cape Leeuwin.

The Get Hooked on Fishing program has expanded in the metropolitan area and the Learning Circles program is being expanded into the north-eastern and eastern Wheatbelt region. The Fishers with Disabilities program has been established as an incorporated association.

WEST COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types within the west coast bioregion during the 2002/03 financial year.

CONTACT WITH THE COMMERCIAL ROCK LOBSTER FISHERY	NUMBER
Hours delivered in bioregion to rock lobster fishery	30,182
Fisher field contacts by Fisheries Officers – rock lobster	6,651
District Office contacts by Fisheries Officers – rock lobster	2,233
CONTACT WITH OTHER COMMERCIAL FISHERIES	
Hours delivered in bioregion to other commercial fisheries	30,920
Fisher field contacts by Fisheries Officers – other fisheries	3,765
District Office contacts by Fisheries Officers – other fisheries	5,919
Fishwatch reports *	437
COMMERCIAL OFFENCES DETECTED	
Infringement warnings	348
Infringement notices	79
Prosecutions	28
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	*NUMBER*
Hours delivered in bioregion	20,206
Fisher field contacts by Fisheries Officers	29,027
District Office contacts by Fisheries Officers	18,112
RECREATIONAL OFFENCES DETECTED	
Infringement warnings	480
Infringement notices	244
Prosecutions	88

* This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

WEST COAST ROCK COMPLIANCE TABLE 2

Summary statistics of factory inspections of commercially captured western rock lobster in the 2002/03 fishing season.

STATISTIC	VALUE
Number of unique vessels checked	Entire fleet at least once
Average number of inspections per vessel	6
Average number of baskets checked per vessel *	19
Proportion of total commercial catch inspected	2.4–2.5%
Non-compliance rate (per-animal basis)**	0.0015–0.0022
Total consigned commercial catch ('000 kg)	11,387
Estimated total illegal catch consigned ('000 kg)	17.1–25.1

* 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. 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 WA 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). Mackerel are also taken by a number of wetliners who specifically target this high-value fish.

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 WA community. The Gascoyne is the second most significant recreational fishing region in the State, with fishing being 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. Because recruitment of both large species of pearl oysters in the wild is naturally irregular in this region and cannot be relied upon to provide shell for pearl production, hatchery production of oysters is of critical importance. 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.

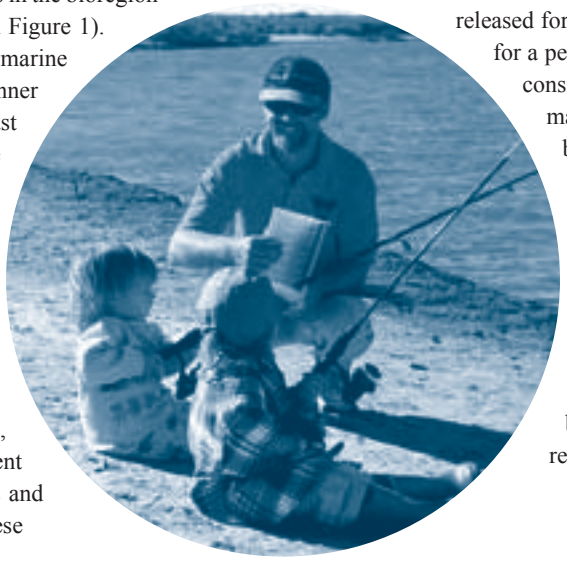
These measures encompassed in the region's long-standing commercial management plans, coupled with recent recreational fishing controls, have enabled this region to retain its high biodiversity status through more than 30 years of commercial fishing and 15 years of significant recreational fishing pressure.

During 2003/04 the Department of Fisheries has provided extensive scientific and management advice and made submissions to Government in relation to the planning for, and in some cases legislative changes arising in relation to:

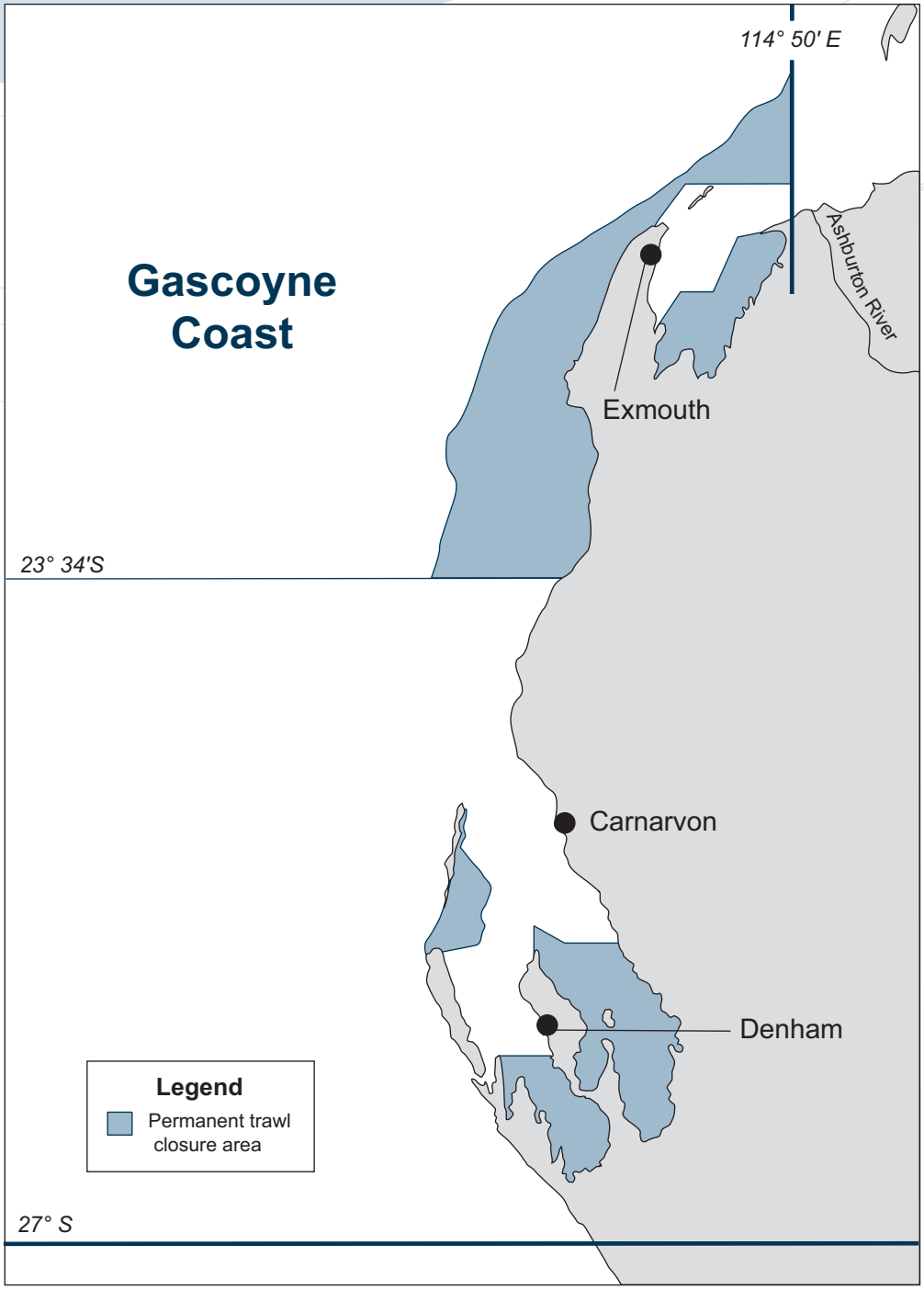
- the proposed southern extension of the Ningaloo Marine Park, and introduction of new sanctuary zones with the park; and
- the proposed Muiron Islands Marine Management Area, and the creation of sanctuary zones within this area.

The Department has also been working on the preparation of orders under the *Fish Resources Management Act 1994* in order to modify fisheries regulations to give effect to new sanctuary zone boundaries within the Shark Bay Marine Park.

The Fish Habitat Protection Area (FHPA) at Miaboolya Beach, Carnarvon, was established in April 2003, at which time the final management plan was released. A draft management plan for the proposed Quobba Point FHPA was developed in consultation with a range of stakeholder groups and released for public review in August 2003 for a period of two months. Following consideration of submissions, a final management plan has been prepared by the Department for release in July 2004.

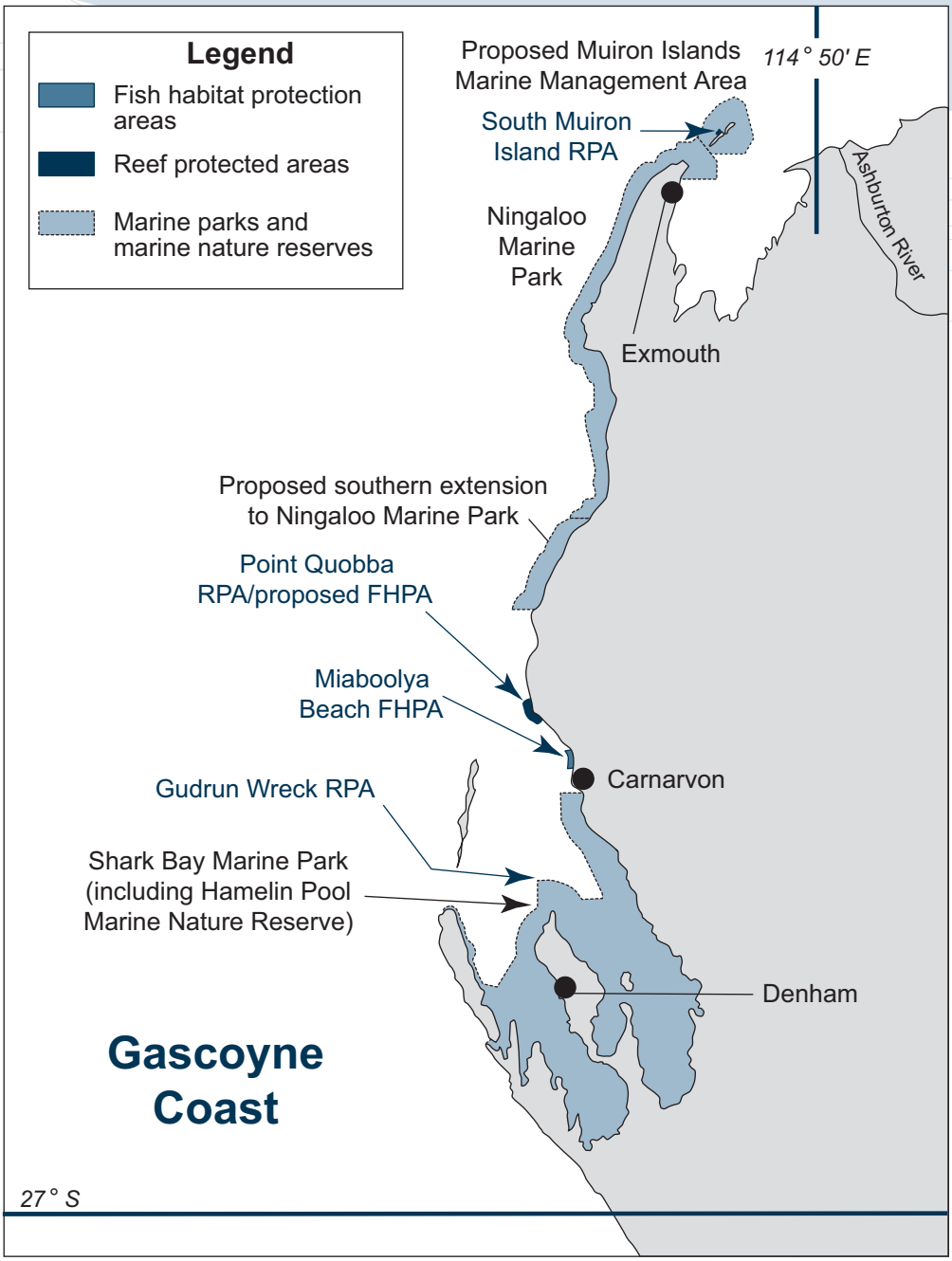


In 2004 the Minister for Fisheries declared a total and permanent prohibition on the recreational collection of coral and live rock in Western Australian waters, which has been an issue of particular relevance to the Ningaloo Reef.



GASCOYNE COAST HABITAT PROTECTION FIGURE 1

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



GASCOYNE COAST HABITAT PROTECTION FIGURE 2

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

COMMERCIAL FISHERIES

Shark Bay Prawn Managed Fishery Status Report

Prepared by E. Sporer and M. Kangas, with management input by M. Holtz

FISHERY DESCRIPTION

The Shark Bay Prawn Managed Fishery targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*) and 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 being trialled in addition to the standard flat wooden otterboards.

Governing legislation/fishing authority

Shark Bay Prawn Management Plan 1993
Shark Bay Prawn Managed Fishery Licence

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, season and area openings and closures and gear controls. These management arrangements are designed to keep effort at levels that will maintain sufficient spawning stocks.

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 closure serves to protect tiger prawn breeding stocks at a threshold catch level. Within the main fishing period, there are various subsidiary openings and closures designed to maximise the size of the king and tiger prawns caught with the aim of increased size, quality and market value while protecting the stocks from recruitment over-fishing. Moon closures operate for three to ten days around the full moon, to increase economic efficiency by shifting fishing effort away from these times of reduced catch rate.

In 2003, the Shark Bay prawn fishing season formally commenced on 6 March and closed on 1 November.

Since 1996, Denham Sound south of the Torbay line has been closed to fishing from the commencement of the fishery until 1 August. However, for the 2003 season the available fishing area was further restricted to the section of Denham Sound north of latitude 25°41′ S. This area opened on 1 April and closed on 1 May. All of Denham Sound, south to the research/industry closure line, re-opened on 1 August and remained open until fishing ceased on 7 October due to low catch rates of king prawns.

Recruitment surveys in March and April within the extended nursery area (ENA) and the closed area south and east of the Carnarvon/Peron Line were used to determine the extent of this area to be opened. The Carnarvon/Peron area was opened on 24 April. Because of small prawn size the ENA remained closed to fishing until 21 May. The tiger prawn spawning area was closed on 21 May. The ENA was closed to fishing on 1 August to protect juvenile king prawns.

The vessel monitoring system continues to be a part of the fishery's management strategy and provides the mechanism to give effect to the various spatial closures in the fishery.

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, with vessels operating for the past few seasons under an exemption from the provisions of the management plan.

Bycatch reduction devices or BRDs (specifically grids) are implemented in this fishery, with all vessels required by way of a condition on the managed fishery licence to fish with a grid in each net. Secondary bycatch reduction devices or fish escapement devices (FEDs) (for example, square mesh panels) were trialled during the 2003 season. These will be compulsory in nets on one side in 2004 and compulsory in all nets in 2005.

During 2002/03, the Australian Government Department of Environment and Heritage certified the fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a number of conditions, certification allows product from the fishery to be exported from Australia for a period of five years before reassessment.

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, which together with pre-season and spawning stock surveys, provide the information sources for monitoring the fishery.

A collaborative three-year project with industry to review the impact of trawling on non-target species, funded by the FRDC, is due for completion in late 2004. The joint evaluation and implementation of gear modifications to reduce bycatch and improve product quality is ongoing. A further FRDC project is examining the biodiversity of bycatch in trawled and untrawled areas of Shark Bay.

RETAINED SPECIES

Commercial production (season 2003): 1,632 tonnes

Landings

The total landings of major penaeids during the 2003 season were 1,632 t, comprising 1,145 t of king prawns, 485 t of tiger prawns and 3 t of endeavour prawns. In addition there were also 84 t of minor penaeids (coral prawns) landed.

The 2003 landings represent a 21% decrease compared to 2002, though the catches of both king and tiger prawns remained within the acceptable catch ranges. King prawn landings for 2003 were 26% lower than the five-year average (1,538 t) (Shark Bay Prawn Figure 2) while the tiger prawn landings were 10% lower than the five-year average (537 t).

Scallop landings by the prawn fleet in 2003 totalled 350 t whole weight. For a more detailed description refer to the Shark Bay Scallop Managed Fishery section (pp. 85-87).

By-product landings included 110 t of blue swimmer crab (*Portunus pelagicus*), 77 t of squid, 12 t of cuttlefish, 21 t of tuna (wetlining), 5 t of mulloway (*Argyrosomus hololepidotus*) and a small quantity of other miscellaneous finfish species.

Fishing effort/access level

Twenty-seven boats are licensed for prawn trawling in this fishery, with all licences active in the 2003 season.

Effort recorded in the 2003 daily log books for the fleet showed nominal effort as 44,616 hours, which was a reduction of 7,917 hours when compared with the last five years' average effort (52,533 hours). Fishing effort is being monitored with the aim of reducing ineffective trawl hours (e.g. around the full moon phase) while maintaining high catch rate levels, thus reducing overall effort to improve economic efficiency within the prawn trawl fleet. Following consultation with the Research Division and industry, the scheduled July, August and September moon closure periods were extended from seven to eight, nine and ten days respectively, and this, together with the voluntary early closure, meant that only a total of 169 nights were actually fished. This compares to 182 nights in 2002. Although the number of fishing nights (and thus trawl hours) was reduced during the 2003 season, effective effort remains high and requires vigilant monitoring.

Catch rate

A catch rate of 25.7kg/hr for king prawns was observed, which is relatively high given that the total landings of king prawns was at the lower end of the acceptable catch range. The 2003 tiger prawn catch rate of 10.9 kg/hr was similar to the 2002 season (10.3kg/hr) and comparable to that of the years 1991–2002 (mean 10.2 kg/hr).

The overall 2003 season catch rates were enhanced by the extended full moon closures, which are designed to reduce periods of ineffective effort whilst maintaining sustainability of the species in this fishery.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

The king and tiger prawn stocks are fully exploited. King and tiger prawn stocks are monitored using catch rate information from log books (throughout the year), and recruit surveys (March and April), along with spawning stock surveys (June and July) for tiger prawns. For tiger prawns, this assessment is supported by the position of recent indices of recruitment and spawning stock with respect to the accepted spawning stock–recruitment relationship (SRR). Voluntary log books provide information on the daily catch (kg/hr) and amount of effort (hours trawled) expended in each fishing area by each boat based on the trawl duration and catch of every shot. From these data the CPUE (kg/hr) is determined for each fishing area.

Mature female tiger prawns are mainly caught in the 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 should be above a 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 2003 the level was 3.7 kg/hr.

This performance measure applies only to the fishery-dependent indicator as described above. This method of estimating spawning stock abundance has been in place many years. In recent years however, trawl closures (at a tiger prawn catch rate threshold level) introduced during the spawning season (July and August) have resulted in the fleet not fishing Areas B and D at these times. Therefore, in the last two years this indicator has been estimated by using the relationship of catch rates in adjacent months and areas to the traditional spawning area catch rates. This method of calculation will continue until fishery-independent threshold limits are developed within the next three years.

Fishery-independent surveys are undertaken to measure recruitment and ensure that fishing is undertaken on appropriate sizes for market value each season. Environmental factors, in particular the variation in the strength of the Leeuwin Current (see below), are being examined to improve the understanding of variations in the SRR for the king prawn stock. New catch trends are also examined in order to enhance evaluations and longer-term predictions. Indications are that at current effort levels, catches of king and tiger prawns are likely to remain in the vicinity of 1,350 t and 550 t (± 20%) respectively.

Gascoyne Coast Bioregion

Exploitation status: Fully exploited

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 maximum 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, most fluctuations in the annual king prawn harvest are 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 employed to increase the level of these spawning stocks. The spatial extent of the tiger prawn spawning area (TPSA) was re-examined and divided into two areas, southern and northern, during the 2001 season (Shark Bay Prawn Figure 1). The southern area is regarded as the prime area for spawning tiger prawns. Furthermore it was agreed, in consultation with industry, to close the spawning areas using a catch rate threshold level of 10 kg/hr (instead of an arbitrary date, which had been the practice prior to 2001); however this catch rate level needs to be confirmed as it may be set too low.

For the 2003 season the southern area only was closed to fishing. No closures or surveys were conducted in the northern area, which was deliberately left open to fishing for the season so that the catch of tiger prawns and the pattern of fishing effort in that area could be monitored.

Two standardised research surveys (to confirm commercial catch rates derived from log book information) were carried out in the southern TPSA in early and late July to obtain the catch rate of tiger prawns. The average catch rate of tiger prawns from the surveys was 26.8 kg/hr in 2003 (compared to 15.5 kg/hr in 2002), but the TPSA remained closed in order to assess the success of subsequent recruitment as a result of this higher spawning stock level.

Changes in the efficiency of the fishing fleet must still be monitored carefully to ensure that tiger prawn spawning stocks are not reduced below optimal levels. This is particularly the case during high river outflow events, when the vulnerability of stocks appears to be increased by the stock moving on to the fishing grounds from inshore areas early, thereby allowing the fishery to deplete the spawning stock well before the prime spawning period starts in August.

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.

NON-RETAINED SPECIES

Bycatch species impact: Moderate

Bycatch composition is dominated by dead wire weed, which naturally 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 loads are moderate relative to other subtropical trawl fisheries at about 4–8 times the prawn catch. Field sampling for a study on the bycatch of trawled and untrawled areas of Shark Bay was completed in 2003 with data analysis currently underway. Trialling and implementation of secondary bycatch reduction devices (square mesh panels in cod-ends) is ongoing and should further reduce the quantity of small fish retained in trawls.

Research completed in 2003 identified an impact from prawn trawling on juvenile pink snapper recruitment in Denham Sound (Moran and Kangas 2003). Modifications to the fishery boundary have been implemented to reduce this interaction.

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) into the fishery during 2002 has 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. This area generally has low occurrence of turtles, minimising captures during this time, and the short trawl duration (approximately 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. For the 2003 season, 13 turtles (8 loggerhead, 5 unidentified) were recorded as caught in nets (either during the grid-exempt period or caught on the grid). All 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.

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 of the central bay, north of Cape Peron and in the northern area of Denham Sound. In 2003, the total area trawled within Shark Bay was approximately 1,119 square nautical miles which represents 23% of inner Shark Bay. This, combined with the fact that the majority of these trawl grounds are on hard sand habitats which characteristically have very low levels of benthic fauna (sponges, corals etc.) means that the typical impact of the trawls on the seabed is minimal.

SOCIAL EFFECTS

The estimated employment for the year 2003 was 135 skippers and crew. There are also prawn processing and support staff employed at Carnarvon and Fremantle. This industry, in conjunction 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 2003: $22.3 million

Wholesale 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 lower than in 2002 and average ex-boat prices were as follows:

King prawns	$13.00/kg
Tiger prawns	$14.90/kg
Endeavour prawns	$7.60/kg
Coral prawns	$2.00/kg

FISHERY GOVERNANCE

Acceptable catch range for next season: 1,501–2,330 tonnes

Under current effort levels and normal environmental conditions, and based on the 10-year range of catches following the restructuring of the fishery to 27 licences (1990), the acceptable catch range for major penaeids is 1,501–2,330 t. Acceptable catch ranges for individual species are king prawns 1,100–1,600 t, tiger prawns 400–700 t and endeavour prawns 1–30 t. The total prawn catch and the catch of the three individual species during 2003 were within the acceptable ranges set. Monitoring of the tiger prawn stock will continue to be a high priority in this fishery and the collaborative initiative with industry to refine the TPSA closure system will continue.

New management initiatives (2003/04)

Following discussions between the Department, the trawl industry and the Shark Bay community, modifications to the southern boundary of trawl fishing in Denham Sound have been implemented for 2004 to reduce its impact on juvenile pink snapper recruitment and the recreational snapper fishery. The effectiveness of the modifications will be monitored.

For the 2004 season, secondary bycatch devices or FEDs must be installed in one of the nets towed by each vessel.

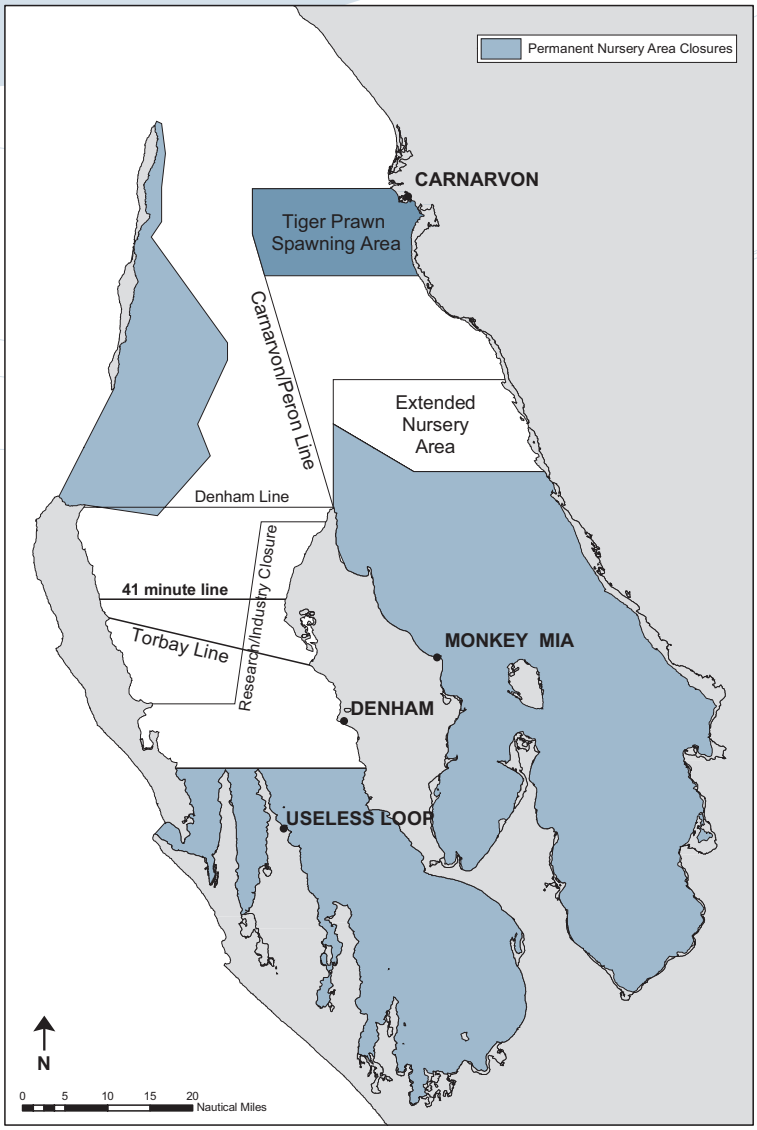
Legislative changes to permit greater flexibility in the distribution of gear units among the fleet are currently in the drafting stage.

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.

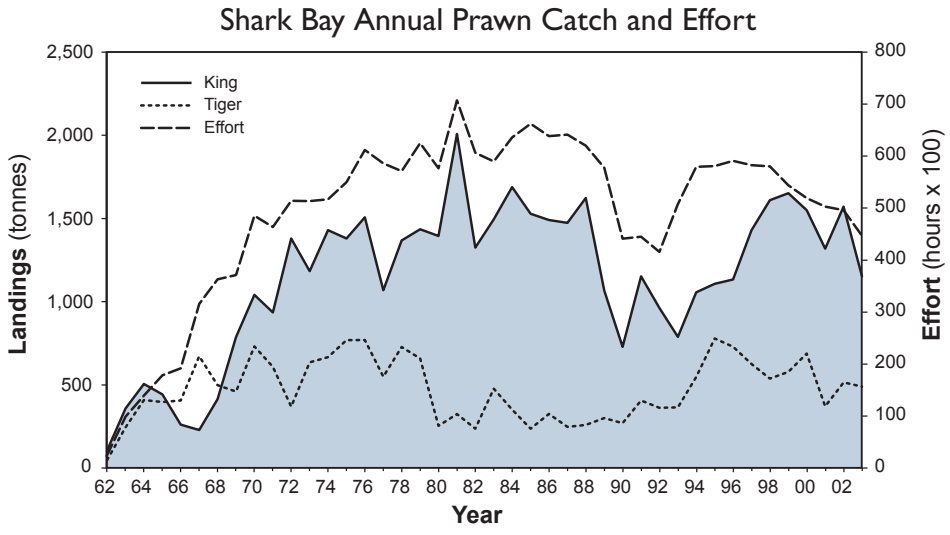
The Leeuwin Current also appears to affect scallop recruitment, which can cause a redirection in effort away from prawn areas and artificially lower prawn catches when scallops are very abundant.

Cyclone effects including high inland rainfall events may also influence prawn catches as strong river flows (Gascoyne and Wooramel Rivers) can flush prawns (particularly brown tiger prawns) from inshore seagrass areas out on to trawl grounds. At these times more wire weed is also encountered on the trawl grounds, which influences fishing patterns.



SHARK BAY PRAWN FIGURE 1

Boundaries of the Shark Bay Prawn Managed Fishery.



SHARK BAY PRAWN FIGURE 2

Shark Bay Prawn Managed Fishery annual prawn catch and effort, 1964–2003.

Exmouth Gulf Prawn Managed Fishery Status Report

Prepared by E. Sporer and M. Kangas, with management input by M. Holtz

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

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 Prawn Figure 1).

Management arrangements

This is principally an input-controlled fishery based on limited entry, closed seasons and areas, gear restrictions and controls on vessel size and power. The main purpose of the management controls is to maintain exploitation rates at a level which ensures the spawning biomass of prawns (particularly tiger prawns) remains above the level that causes recruitment variation.

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. 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 2003 season, official opening and closing dates were set at 1 April and 15 November 2003 respectively; however, this is a flexible arrangement and the season actually commenced on 6 April. There are also spatio-temporal closures during the early part of the season (April–July).

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. 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 19kg/hr (quad gear 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 be a part of the fishery's management strategy and provides the mechanism to give effect to the various spatial closures in the fishery.

The fishery as a whole is subject to a maximum headrope allocation. However, the gear configurations 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.

Bycatch reduction devices (specifically grids) are implemented in this fishery, with all vessels required by way of a condition on the managed fishery licence to fish with a grid in each net. Secondary bycatch reduction devices or fish escapement devices (for example, square mesh panels) were trialled during the 2003 season. These will be compulsory in nets on one side in 2004 and compulsory in all nets in 2005.

Industry, in association with the Department, has successfully applied to the Australian Government Department of Agriculture, Forestry and Fisheries Australia to gain 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 has also installed additional 'hopper' in-water sorting systems on boats with seven boats currently using hoppers. This provides an improved quality of prawns and reduces bycatch mortality for some species.

During 2002/03, the Australian Government Department of Environment and Heritage certified the fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a number of conditions, certification allows product from the fishery to be exported from Australia for a period of five years before reassessment.

Gascoyne Coast Bioregion

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. All boats complete detailed research log books, which together with survey data and factory records, provide the information sources for managing the fishery. A pre-season survey of the king prawn stocks commenced in 2003 in collaboration with industry to assist with developing harvesting strategies.

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).

A collaborative three-year project with industry to review the impact of trawling on non-target species, funded by the FRDC, is due for completion in late 2004. The joint evaluation and implementation of gear modifications to reduce bycatch and improve product quality is ongoing. A further FRDC project is examining the biodiversity of bycatch in trawled and untrawled areas of Exmouth Gulf.

RETAINED SPECIES

Commercial production (season 2003): 1,089 tonnes

Landings

The total catch of 1,089 t for all prawn species was within the acceptable range. Tiger prawn landings in 2003 were the highest since 1994. While the tiger prawn catch of 633 t was outside the normal acceptable catch range of 250–550 t, the recruitment survey indices had provided a catch forecast of 540–810 t and so the landings fell within the predicted catch range for the 2003 season.

King prawn landings were only 231 t in 2003, the lowest in over 20 years, and below the acceptable catch range of 350–500 t. Historically, catches of king prawns have been relatively stable compared to tiger prawn catches irrespective of the high fishing levels. However, since Cyclone Vance in 1999, the king prawn annual landings have been below 300 t.

The endeavour prawn landings of 225 t were within the acceptable catch range for this species.

Recorded landings of by-product included 27 t of coral prawns, 21t of blue swimmer crab (*Portunus pelagicus*), 6 t of squid, 2 t of cuttlefish and 1 t each of bugs (*Thenus orientalis*) and shark.

Fishing effort/access level

There are 16 licences in the fishery, but as a result of changes in gear configuration 13 boats operated during the 2003 season, each towing 4.5 fathom quad gear (four nets).

Total nominal effort for the 2003 season was 27,161 hours. The equivalent effort in twin-gear terms, after adjusting for changes in configuration from twin to quad gear, was 33,428 hours, which was slightly higher than in 2002 (32,440 hours). Of the 200 nights allocated to fishing the entire fleet fished 187 nights during the season, compared to 183 nights in 2002.

Because the catch rates of tiger prawns were higher than the threshold level of 14 kg/hr, the original closing date of the fishery (15 November) was extended until 30 November in 2003. However, fishing ceased voluntarily on 20 November when the catch rate of tiger prawns declined, though it was still above the threshold level.

The effective effort on tiger prawns increased from 31,100 hours in 2002 to 32,411 hours in 2003, coinciding with increased stock levels and implying increased efficiency in the current fleet to target the higher abundance of tiger prawns. Such efficiency increases are made possible by within-season surveys enabling greater targeting of the larger, more valuable prawns, in conjunction with flexible spatial openings and fleet manipulation.

Catch rate

The catch rate in twin-gear terms for king prawns fell from 7.5 kg/hr in 2002 to 6.9 kg/hr in 2003, which is the lowest catch rate recorded for this species since the early 1980s. The catch rates of 18.9 kg/hr for tiger prawns and 6.7 kg/hr for endeavour prawns were higher than those in 2002, which were 12.2 kg/hr and 5.3 kg/hr respectively.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

The tiger and king prawn stocks have been fully exploited each year, as regular surveys permit variations to the management arrangements to optimise the catch and size grades.

For tiger prawns, this process involves analysis of survey-based indices of recruitment and spawning stock compared to the accepted spawning stock–recruitment relationship. Endeavour prawns, a secondary target species whose distribution overlaps that of tiger prawns, are exploited to varying levels depending on the abundance of (and hence the fishing effort applied to) the more valuable tiger prawns.

The king prawn catch in 2003 was below the acceptable catch range (350–500 t) for the fourth year running, having fallen back to the levels seen in the 1970s and 1980s. The reasons for this are being investigated. A regular pre-season survey has been developed, with a high level of collaboration from industry, to monitor the king prawn stocks and assess whether the reduced catches are due to a change in fishing strategy (i.e. early targeting of tiger prawns) or possible recruit over-fishing, or whether the effects of Cyclone Vance have had a longer-term adverse impact on the king prawn stocks. Although there has been limited monitoring of king prawn stocks to date, it is intended to increase the research focus on these stocks during 2004 and in the future.

The total landings of endeavour prawns are within the acceptable catch range. However, fleet manipulation and the opening of Area C for a relatively long period allowed additional access to endeavour prawn stocks, providing increased catches of this species compared to 2002.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Tiger prawn breeding stock levels are maintained at adequate levels by within-season management action each year. This strategy maintains the spawning biomass of tiger prawns above the historically determined biological reference point of 8–10 kg/hr. A cut-off threshold catch rate of 19 kg/hr quad gear (16 kg/hr standard twin gear) is used to ensure that this occurs. During 2003, 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 26.1 kg/hr in the main spawning grounds, well above the threshold level. The August and September surveys showed a CPUE of 22.9 kg/hr and 30 kg/hr respectively, and therefore the tiger prawn spawning area (Area B) was re-opened for fishing on 3 October for the remainder of the season. However, after consultation with industry there were only three limited periods of fishing activity within Area B during October and November, which were monitored to ensure that the catch rate of tiger prawns did not fall below 19 kg/hr. During October, fishing in Area B was carried out for two four-night periods (4–7 and 24–27 October).

From 1 November, the tiger prawn catch threshold level was lowered from 19 kg/hr to 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 the 19kg/hr after the main spawning period had finished. This strategy was first implemented in the 2002 season and the recruitment of tiger prawns for the 2003 was not affected. The long-term effects of this strategy upon sustainability will be assessed. During the fishing period in November 2003 the daily catch was monitored and showed that the catch rate of tiger prawns in the spawning grounds was approximately 15 kg/hr when the fishery ceased on 20 November.

King prawn breeding stock levels in the fishery are maintained at adequate levels during normal environmental conditions through the controls on effort and the extended breeding period and low overall 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 low catchability, which is similar to king prawns.

Projected catch next season (2004): 460–690 tonnes tiger prawns

The catch prediction for tiger prawns is based on the historic relationship between recruitment survey indices (early and late March and early April) and the season's landings (April–November of the same year). For 2004, the projected tiger prawn catch is 460–690 t, which should be close to the high catch of tiger prawns recorded in 2003.

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. Trialling of secondary bycatch reduction devices will continue to improve the quality of the prawn catch by reducing the volume of overall bycatch species retained in the trawls. In addition, five boats used hoppers (in-water sorting systems) during 2003, which improves bycatch survival and product quality.

Protected species interaction: Low

While protected species including dugongs, turtles and sea snakes can be found in this general area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both species are typically returned to the sea alive. Grids were compulsory in 2003, which eliminated the capture of any turtle or other large animal.

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 naturally occurring cyclone events.

Habitat effects: Low

Historically the fishery impacted on 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. During 2003, 37% of the licensed fishery area was fished. An extensive permanent trawl closure in the shallow eastern and southern sectors accounts for 28% of the licensed fishery area, and there is also a series of temporary closures to regulate the size and quantity of prawns taken.

Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little 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.

SOCIAL EFFECTS

The estimated employment for the year 2003 was 41 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 2003: $11.9 million

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

King prawns	$11.30/kg
Tiger prawns	$11.95/kg
Endeavour prawns	$7.60/kg
Coral prawns	$2.00/kg

FISHERY GOVERNANCE

Acceptable catch range for next season: 771–1,276 tonnes

Under current fishing effort levels, the acceptable catch range for major penaeids is that obtained during the 1990s (771–1,276 t). The long-term acceptable 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 figures are for normal environmental conditions and are generally based on a five- to 10-year average.

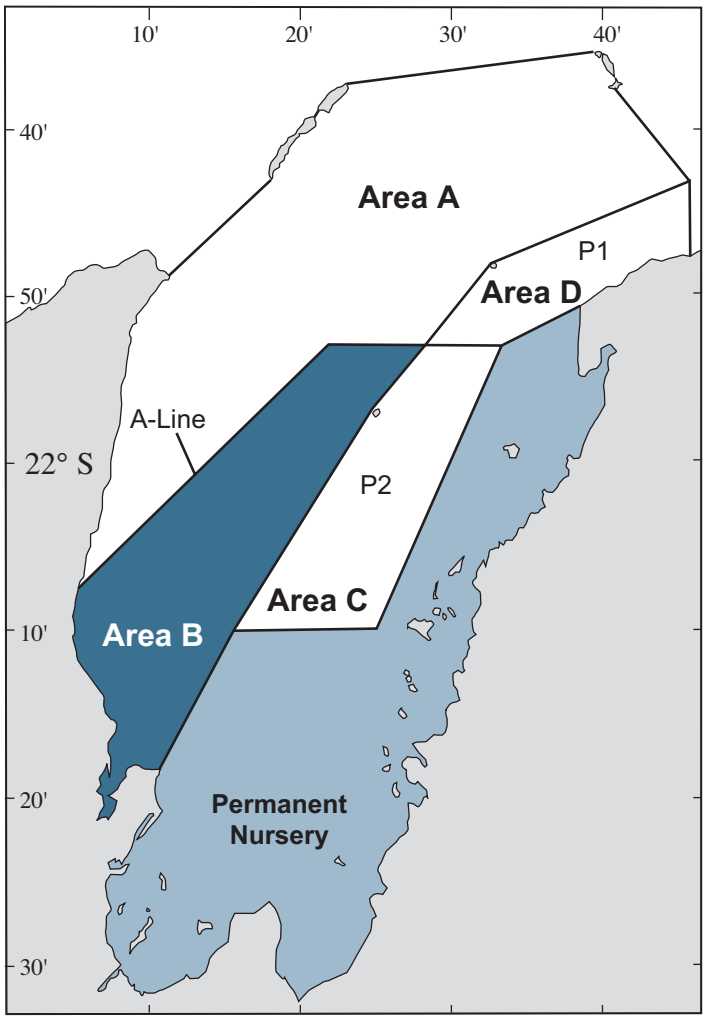
New management initiatives (2003/04)

For the 2004 season, secondary bycatch devices or FEDs must be installed in two of the four nets towed by each vessel.

Legislative changes to permit greater flexibility in gear configurations through unitisation, without increasing the total net headrope length in the fishery, are currently in the drafting stage.

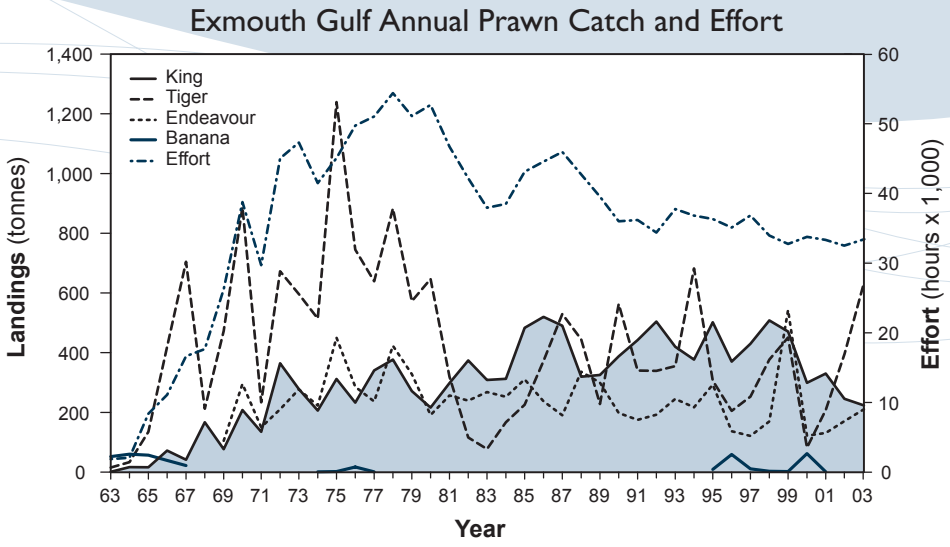
EXTERNAL FACTORS

The impacts of cyclones appear to have a significant effect on the productivity of Exmouth Gulf. The recovery of inshore nursery areas of structured seagrass and algal habitats in three years after Cyclone Vance has been shown to be fast compared to other regions of Australia where cyclones occur. Research will continue to monitor seagrass and algal communities in 2004.



EXMOUTH GULF PRAWN FIGURE 1

Boundaries of the Exmouth Gulf Prawn Managed Fishery.



EXMOUTH GULF PRAWN FIGURE 2

Exmouth Gulf Prawn Managed Fishery annual landings and effort, 1963–2003.

Shark Bay Scallop Managed Fishery Status Report

Prepared by E. Sporer and M. Kangas, with management input by M. Holtz

FISHERY DESCRIPTION

The Shark Bay Scallop Managed Fishery is based on the take of 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

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 (see Shark Bay Prawn Figure 1).

Management arrangements

Management of the fishery is based on input controls which include limited entry, season and area closures, gear controls 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 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 breeding stock levels (measured by a pre-season survey of stock abundance) and the seasonal decline in meat condition associated with spawning.

The 2003 scallop season commenced on 20 May in Denham Sound, which remained open for six days with 12 Class A scallop boats fishing the area. The opening of the extended nursery area for prawns on 21 May meant that 11 Class B scallop boats fished the Denham Sound area for one day only and then left to fish in the ENA. Fishing for scallops on the main Shark Bay scallop grounds commenced on 26 May; however, the Class A boats had ceased fishing after approximately 24 hours. Eleven of the 12 dedicated scallop boats then left Shark Bay to fish for scallops in the Abrolhos Islands and Mid West Trawl Managed Fishery, where the catch rates of scallops were significantly higher during this season. The one remaining Class A scallop boat ceased fishing for scallops by 10 June because of low catch rates and poor

quality of scallop meat. Denham Sound was re-opened on 1 August but no Class A scallop boat fished, and the Shark Bay scallop season officially closed on 1 November in conjunction with the closure of the prawn season.

The vessel monitoring system is an integral part of the fishery's management strategy for the control of spatial and temporal closures.

Bycatch reduction devices (specifically grids) were fully implemented at the start of the 2003 season by way of a condition on the managed fishery licence. Trials and implementation of secondary BRDs are not considered necessary in the fishery at this stage, given the large mesh size used (i.e. 100 mm mesh compared with 50 mm mesh used in the prawn fishery).

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 each year, which, together with existing detailed biological knowledge, enables an annual catch forecast to be provided.

A collaborative three-year project with industry to review the impact of trawling on non-target species, funded by the FRDC, is due for completion in late 2004. A further FRDC-funded project is examining the biodiversity of bycatch in trawled and untrawled areas of Shark Bay. A 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.

RETAINED SPECIES

Commercial production (season 2003): 775 tonnes whole weight

Landings

The total scallop landings for this fishery, for both A and B Class scallop boats, were 775 t whole weight, of which 505 t were taken from the Red Cliff and North West Peron grounds and the remaining 270 t from Denham Sound during the six days of fishing in May. This catch was below both the projected catch of 1,200–1,900 t and the acceptable catch range (1,250–3,000 t), partly due to the low level of fishing effort (see below). The Class A fleet (12 boats fished in 2003) caught 428 t or 55% of the total catch, with the Class B fleet taking 348 t (Shark Bay Scallop Figure 1). Very low quantities of by-product, less than 1 tonne of bugs (*Thenus orientalis*), were recorded for the Class A fleet during 2003.

Fishing effort/access level

The total effort recorded by the Class A boats in 2003 was 1,598 hours, an 80% decline on 2002 and the lowest level of effort recorded in this fishery. This was due to boats preferring to fish the Abrolhos Islands, which recorded their best scallop catch ever in 2003.

Catch rate

A mean catch per unit effort of 267.5 kg/hr (whole weight) was recorded for the Class A fleet in 2003 compared to an average of 113 kg/hr for the previous ten years. This good catch rate was obtained as a result of the decision to cease fishing after a very limited fishing period, with most boats leaving to fish in the Abrolhos Islands and Mid West Trawl. The high catch rate indicates that a higher catch could have been achieved if more effort was applied.

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. This survey enables the start date of the fishery to be determined and allows management of the spawning stock. Recruitment of juveniles to the stock, as measured using the data from the November 2002 scallop survey, was similar to that observed in 2001 for the main fishing grounds and slightly higher in Denham Sound. The survey design and analysis of the data provides separate catch forecasts for the 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.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

The management arrangements for the fishery are designed to ensure significant spawning has occurred each year before the bulk of the stock has been taken. Although the breeding stock level was relatively low in 2003, it is considered adequate to provide recruitment in the normal range for 2004.

Projected catch next season (2004): 1,870–2,800 tonnes whole weight

The catch projection for the 2004 season is based on the 2003 survey results. On the main fishing ground (North West Peron and Red Cliff) in Shark Bay, observed recruitment was higher than the previous year and there was a higher abundance of residuals due to the low fishing effort in 2003. This results in a catch range forecast for this area of approximately 1,430–2,140 t whole weight. This assumes that effort will return to the levels prior to 2003. Higher recruitment and residuals were observed in the Denham Sound area, giving a predicted catch range of 440– 660 t whole weight. The catch projection for the fishery as a whole is therefore in the range 1,870–2,800 t whole weight.

NON-RETAINED SPECIES

Bycatch species impact: Low

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

Protected species interaction: Low

Protected species, occasionally captured, are released alive due to the relatively short duration of trawls. During 2003, grids were installed into 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. No turtles were recorded as captured in the scallop fishery in 2003 by Class A boats.

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 death 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 2003, 4% 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 2003 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 2003: $2.6 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 $3.36/kg whole weight or $16.80/kg meat weight. Meat weight is 20% of whole weight.

FISHERY GOVERNANCE

Acceptable catch range for next season: 1,250–3,000 tonnes whole weight

The acceptable 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.

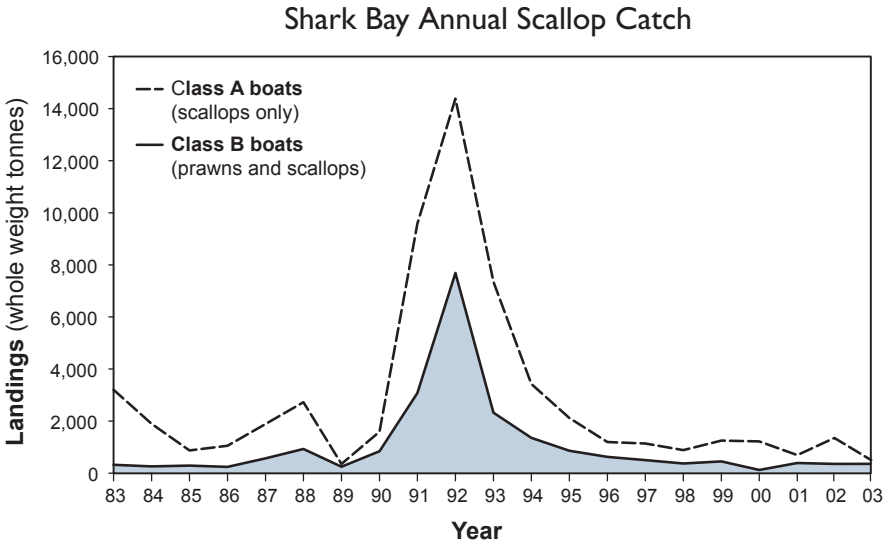
New management initiatives (2003/04)

A review of the season opening process was made for 2004, with selected areas to be opened to fishing earlier than the time indicated from recruit/residual scallop abundance indices. This new initiative will maximise the size and therefore value of scallop meat. As a counter-measure to fishing earlier, all fishing for scallops is to cease at a conservative catch rate level in these areas for the spawning period, thereby providing adequate spawning stock protection.

Following discussions between the Department, the trawl industry and the Shark Bay community, modifications to the southern boundary of trawl fishing in Denham Sound have been implemented for 2004 to reduce its impact on juvenile pink snapper recruitment and the recreational snapper fishery.

EXTERNAL FACTORS

A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay, particularly in the Red Cliff area. Generally, high sea levels (corresponding to strong Leeuwin Current) correlate with poor recruitment. The 2004 recruitment was better due to a weak Leeuwin Current. 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

Annual scallop landings by fleet for the Shark Bay Scallop Managed Fishery, 1983–2003.

Shark Bay Beach Seine and Mesh Net Managed Fishery Status Report

Prepared by K. Smith, with management input by M. Besley

FISHERY DESCRIPTION

The Shark Bay Beach Seine and Mesh Net Managed Fishery is based at Denham and operates in the waters of Shark Bay. It takes a mixed catch of whiting (*Sillago schomburgkii* and *S. analis*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and yellowfin bream (*Acanthopagrus latus*) using a combination of beach seines and haul nets.

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 this fishery 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

This fishery is managed through input controls in the form of limited entry, restricted, family-only transfers and gear limitations. A unit in the fishery comprises one primary vessel, a maximum of three netting dinghies and a maximum team size of three fishers, one of whom must be the owner of the 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 frequently above the legal minimum size for the species concerned.

The fishery is subject to net length and mesh size controls. The management plan requires 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

Research monitoring of the status of the stocks taken in this fishery is undertaken annually using industry-based data coupled with the extensive scientific knowledge gained from previous research. Overall the fishery has remained relatively stable over the past several decades with the main target species being fished at sustainable levels. A comprehensive ESD report has been completed which suggested performance indicators based on catch and catch rates for each of the four main species in the fishery (whiting, sea mullet, tailor and yellowfin bream). The following status report summarises the research findings for this fishery.

RETAINED SPECIES

Commercial production (season 2003): 324 tonnes

Landings

The 2003 total catch for the Shark Bay Beach Seine and Mesh Net Managed Fishery of 324 t represents an increase of 24 t compared to the 2002 reported catch (Shark Bay Beach Seine Figure 1). Since 1990, the total annual landings from this fishery have been stable, with catches averaging 277 t per year. The total landings during 2003 included 106.7 t of whiting, 149.2 t of sea mullet, 27.8 t of tailor and 23.6 t of yellowfin bream (Shark Bay Beach Seine Figures 2–5). The remaining reported landings of 16.3 t comprised over 18 different species of finfish.

Whiting is the main target species in the fishery, and comprised about one-third of the total catch quantity and about 40% of the total catch value in 2003. Whiting landings are reported here as the combined landings of *Sillago schomburgkii* and *S. analis*. However, *S. schomburgkii* comprise about 95% of total whiting landings.

Fishing effort/access level

In 2003, 11 fishing-unit licence holders were registered in the fishery.

Since 1990, total fishing effort in the fishery has declined to a low of 979 days in 1995, then increased slightly to a peak of 1,253 days in 2002. In 2003, there was an average of seven boats fishing per month, expending a total of 1,241 days of fishing effort for the year (Shark Bay Beach Seine Figure 1).

Catch rate

The CPUE (based on nominal effort) for the total fishery increased steadily between 1990 and 1997. Following the 1997 peak, CPUE values have stabilised. The 2003 total catch rate was 260.7 kg/boat day (all species), the second highest on record (Shark Bay Beach Seine Figure 1).

The CPUE for whiting showed a rising trend during the 1990s from 60 kg/day to peak at 110 kg/day, but has declined after 2000. In 2003, the whiting CPUE was 86 kg/boat day (Shark Bay Beach Seine Figure 2).

The CPUE for mullet has been highly variable amongst years, but with an overall rising trend, which peaked at 120.2 kg/boat day in 2003 (Shark Bay Beach Seine Figure 3). The CPUE for

tailor increased after 1990. It peaked at 35.6 kg/boat day in 1995 and was relatively stable until 2000, then declined and was 22.4 kg/boat day in 2003 (Shark Bay Beach Seine Figure 4). The CPUE for bream has fluctuated considerably since 1990 (5–12 kg/day), with no overall trend until 2001. In 2002, the bream CPUE began to increase, and this continued in 2003, when a rate of 19 kg/boat day was attained (Shark Bay Beach Seine Figure 5). This relatively high catch rate appears to be associated with very strong recent recruitment by bream.

Recreational component: **Boat-based catch < 1%**

A 12-month survey of boat-based recreational fishing in Shark Bay between May 2000 and April 2001 (Sumner and Malseed 2001) estimated a total recreational catch of finfish of 50 t, taken in 35,000 fisher days. The estimated catch consisted of pink snapper (25.3 t), black snapper (11.6 t), baldchin groper (3.2 t), mulloway (3.2 t), Queensland school mackerel (1.4 t), tailor (0.8 t), whiting (0.4 t), mullets (0.4 t) and 3.7 t of other species. The boat-based recreational catch of whiting, tailor, sea mullet, and yellowfin bream was equal to approximately 0.6% of the combined commercial and recreational landings of those species in 2000.

A further survey carried out during the following 12 months, between May 2001 and April 2002 (Sumner and Malseed 2002), estimated a total boat-based recreational catch of 50 t, taken in 34,000 fisher days. Of those species taken by the recreational fishers which are targeted by the commercial sector, an estimated catch of 1.1 t of tailor, 0.8 t of whiting and 0.3 t of sea mullet were taken recreationally. The recreational component of the combined commercial and recreational catch for these species was 0.9%.

The assessed proportion of catch taken by the recreational sector is therefore estimated to be less than 1%. However, this does not include shore-based catches and is consequently a minimum estimate.

STOCK ASSESSMENT

Assessment complete: **Yes**

Assessment of the fishery is based on analyses of catch and effort data for the four target species – whiting, sea mullet, tailor and yellowfin bream. An acceptable range of catch levels and a trigger level for catch rate have been determined for each species (Shark Bay Beach Seine Table 1). In the event that a catch is outside the acceptable range or a catch rate is below the trigger level, a review is instigated to determine the cause. The review will determine whether further management action is required.

In 2003, the catch levels of whiting, mullet and tailor by the fishery were within the acceptable range for each species. The catch rates of whiting (86 kg/day) and mullet (120.2 kg/day) were well above their respective trigger levels (75 kg/day and 62 kg/day). The stable catch levels and catch rates of both whiting and mullet exhibited by the fishery over of period of many years (since the 1960s) indicates that their level of exploitation by the fishery is sustainable. The catch rate (22.4 kg/day) of tailor by the fishery in 2003 was above the catch rate trigger level (20 kg/day). While the catch and catch rate were relatively low compared with the past few years, they were still high compared with historical levels.

The 2003 catch level of bream (23.6 t) was well above the acceptable range of 7–15 t and was the highest bream catch level observed in the fishery since the 1960s. The 2003 catch rate of bream (190 kg/boat day) was well above the trigger level of 5 kg/boat day. There appears to have been very strong recent recruitment by bream in Shark Bay. Therefore, high catch and catch rate levels in 2002 and 2003 are likely to reflect a high abundance of bream, rather than an increased level of exploitation, and are considered to be sustainable.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

As the legal minimum length for commercially caught Shark Bay whiting is equivalent to the 50% selection point of the 48 mm mesh used in this fishery, virtually all of the catch is made up of mature fish. Consistent levels of catch of all four target species over recent years provide a good indication that the breeding stocks are being maintained.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The fishery operates throughout its entire licence area but with a very low level of effort as it specifically targets schools of fish. Bycatch is likely to be minimal because seine netting is a highly selective method of fishing. 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 clear waters of Shark Bay. Therefore, schools of non-target species and under-sized fish can usually be avoided.

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 of scalefish by the fishery have been relatively stable over several decades, which suggests that total scalefish recruitment to Shark Bay has not been affected by removals. Also, predatory species (e.g. dolphins, larger scalefish) are abundant in Shark Bay, which suggests that the fishery has not reduced prey levels for these species. Therefore, the total biomass of key species in the region is probably being maintained at a level 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 and resident infauna are adapted to cope with 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 33 fishers can be employed in the fishery, based on 11 managed fishery licences each with a maximum of 3 crew. An average of 18 fishers were employed in the fishery in 2002. 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 2003: $889,000

The overall value of the Shark Bay Beach Seine and Mesh Net Managed Fishery in 2003 includes individual estimated catch values of $357,900 for whiting, $311,800 for sea mullet, $75,900 for tailor and $80,500 for yellowfin bream.

FISHERY GOVERNANCE

Acceptable catch range for next season: 235–335 tonnes

Under the current management regime, 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. These ranges differ slightly from previously reported ranges because the method of deriving acceptable catch ranges was revised in 2003. 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 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.

New management initiatives (2003/04)

The Department will be reviewing the fishery's management arrangements in 2004/05. The review will include assessing and amending the management plan in line with the Department's Estuarine and Marine Embayment Review and Integrated Fisheries Management Strategy. Preliminary discussions with fishers were held in 2003/04.

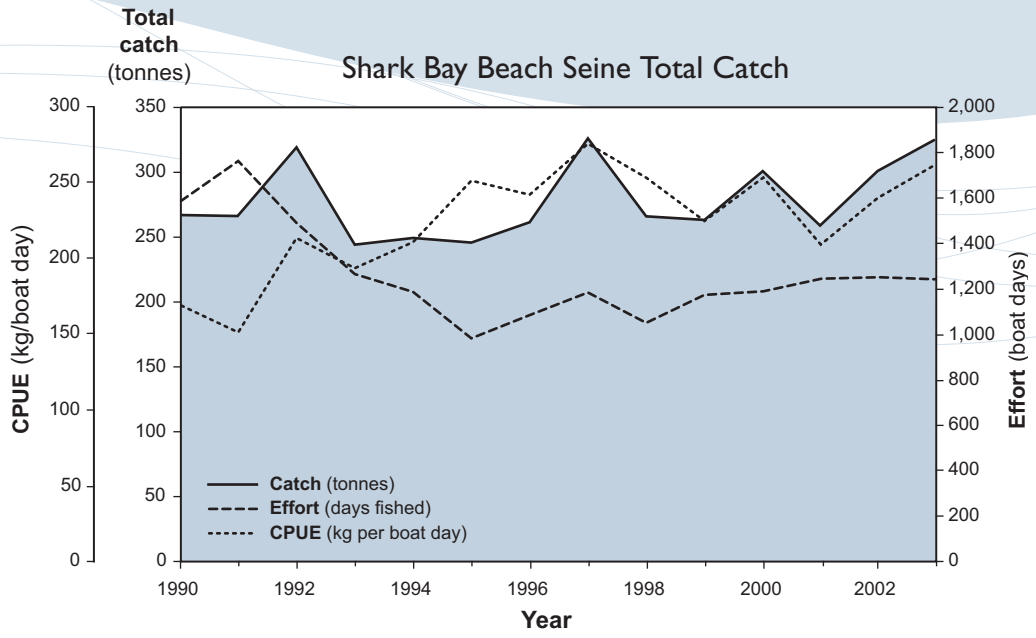
EXTERNAL FACTORS

The inner Shark Bay environment, which supports the finfish stocks exploited by this fishery, is particularly stable as a result of its low-rainfall desert location. The production from the fishery is therefore mostly a reflection of fishing effort (predominantly commercial) rather than any large environmentally driven variations in recruitment.

SHARK BAY BEACH SEINE TABLE 1

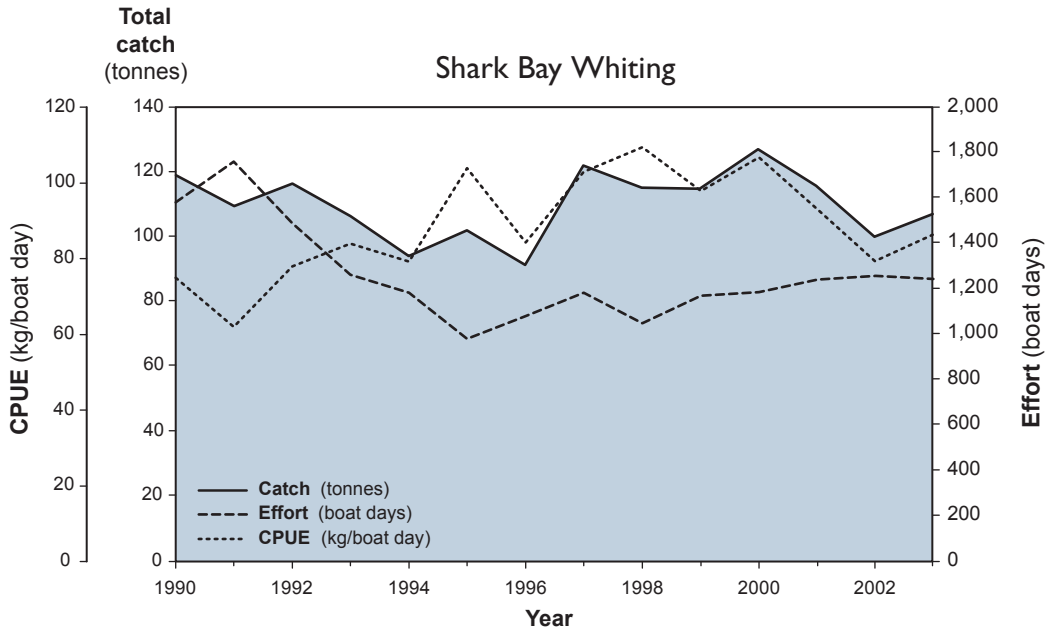
Catch per unit effort (kg/boat day) trigger levels for key species from Shark Bay and annual CPUE over the period 1998–2003. (Note the method of determining CPUE trigger level was revised in 2003 and levels differ slightly from those shown previously.)

SPECIES	*TRIGGER LEVEL (kg/day)*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*
Whiting	75	109	97	106	92	79	86
Sea mullet	62	109	98	107	93	80	120
Tailor	20	33	32	32	21	21	22
Yellowfin bream	5	7.6	5.9	7.3	6.2	13	19



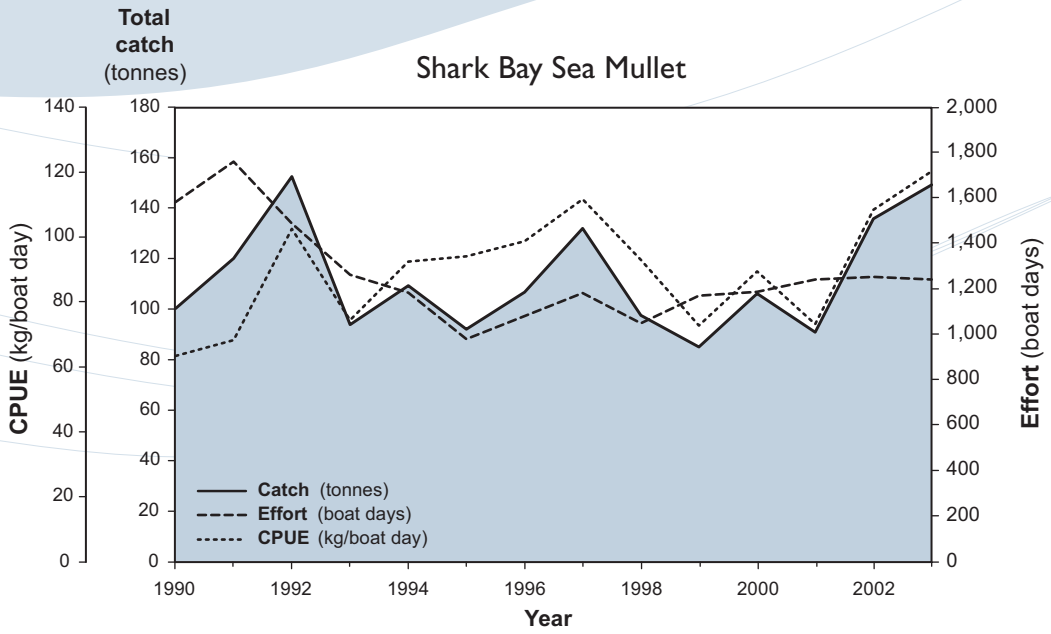
SHARK BAY BEACH SEINE FIGURE 1

The total finfish annual catch (t), effort (boat days) and catch per unit effort (CPUE, kg/boat day) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2003.



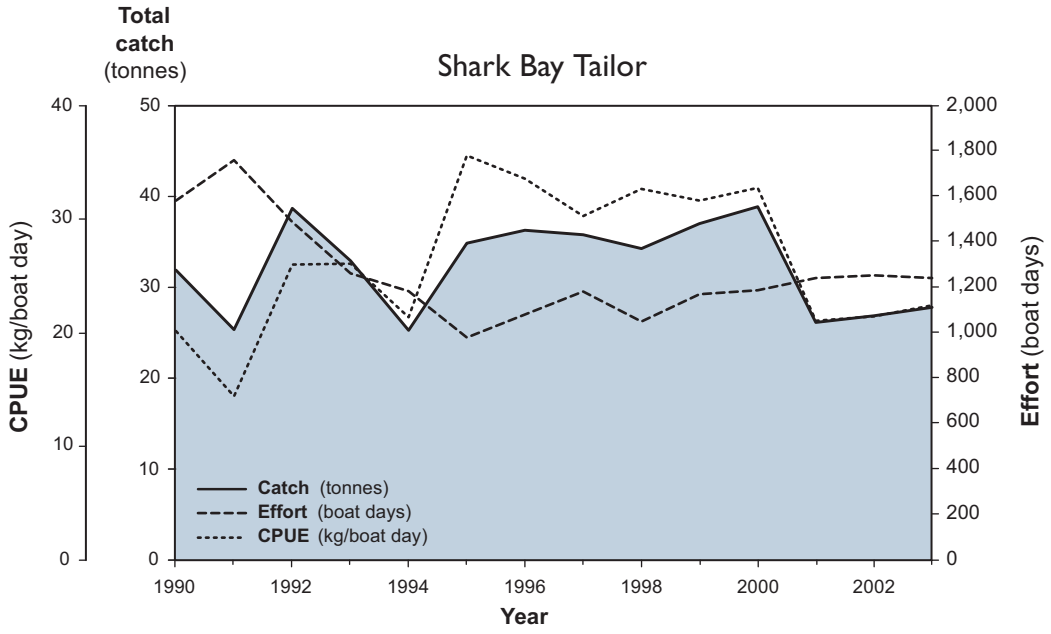
SHARK BAY BEACH SEINE FIGURE 2

The whiting annual catch (t), effort (boat days) and catch per unit effort (CPUE, kg/boat day) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2003.



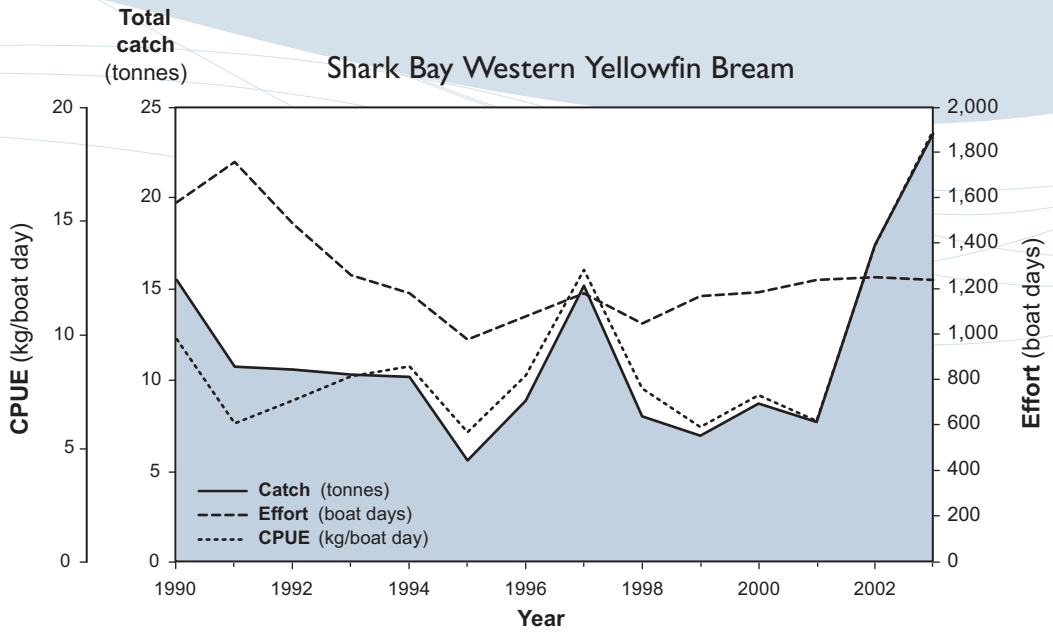
SHARK BAY BEACH SEINE FIGURE 3

The sea mullet annual catch (t), effort (boat days) and catch per unit effort (CPUE, kg/boat day) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2003.



SHARK BAY BEACH SEINE FIGURE 4

The tailor annual catch (t), effort (boat days) and catch per unit effort (CPUE, kg/boat day) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2003.



SHARK BAY BEACH SEINE FIGURE 5

The bream annual catch (t), effort (boat days) and catch per unit effort (CPUE, kg/boat day) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2003.

Shark Bay Snapper Managed Fishery Status Report

Prepared by M. Moran and G. Jackson

FISHERY DESCRIPTION

Commercial fishing for pink snapper (*Pagrus auratus*) in waters off Shark Bay dates back to about the early 1900s. Stock identification studies carried out since the 1980s (including genetics, tagging, otolith microchemistry, variation in head shape) have shown that the oceanic snapper stock is quite distinct from other snapper 'stocks' found in the inner gulfs of southern Shark Bay (see Inner Shark Bay Recreational Fishery, pp. 98-104). The present-day managed commercial fishery uses mechanised handlines and targets the oceanic snapper stock. In recent years, the fishery has increasingly targeted a number of other species, e.g. jobfish (*Pristipomoides* spp.), emperors (Lethrinidae) and cods (Serranidae).

Governing legislation/fishing authority

Shark Bay Snapper Management Plan 1994
Shark Bay Snapper Managed Fishery Licence

Consultation process

Shark Bay Snapper Managed Fishery Working Group
Department–industry meetings

Boundaries

The Shark Bay Snapper Managed Fishery (SBSF) operates in the waters of the Indian Ocean between latitudes 23°34′ S and 26°30′ S and in the waters of Shark Bay north of Cape Inscription.

Management arrangements

The SBSF has been operational since May 1987 and was managed up to 2000 using a combination of input and output controls. Catches of snapper in the peak fishing season (May–August) were formerly subject to individual quotas, while gear controls applied in the off-peak season. In 2001, new management arrangements were introduced under the provisions of the Shark Bay Snapper Fishery Management Plan Amendment 2000. Since then, the snapper 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. For the quota period September 2002 – August 2003, the annual total allowable catch of snapper was set at 563,750 kg (i.e. the same as the previous season), and the value of each unit was 110 kg.

Research summary

Detailed research on the oceanic snapper fishery was undertaken during the 1980s and provides the scientific knowledge base for management. An FRDC-funded project, completed in June 2004, utilised biological and fishery data collected since the 1980s to assess the potential for increased yields from the oceanic stock. Catch and effort monitoring data and the results from the FRDC project were used to provide this status report.

A comprehensive risk assessment for this fishery was conducted as the basis for the recently granted environmental sustainability certification. This process determined a performance indicator for the fishery based on a catch rate trigger level of 500 kg per standard (June–July) boat day.

RETAINED SPECIES

Commercial production (season 2003):

Snapper 429 tonnes
Other species 245 tonnes

Landings

The commercial catch of oceanic snapper in 2003 was 429 t. This was lower than the 487 t taken in 2002 and represents the smallest catch taken since 1988. (The average catch since the SBSF began in 1987 is 505 t.) Continuing the trend of recent years, the fishery took 245 t of other species, a significant increase on the 158 t taken in 2002 and the 105 t in 2001. The catch of outer-shelf species such as goldband snapper (the dominant species in the 'jobfish' category, *Pristipomoides* spp.) has continued to increase rapidly since 2000 to the point that the jobfish catch taken by SBSF vessels was 50% of the total non-snapper catch by weight in 2003 (Shark Bay Snapper Table 1).

Fishing effort/access level

A total of 51 managed fishery licences were involved in the fishery in 2003, including some Shark Bay prawn and scallop trawlers with a SBSF licence. Some vessels operate with several SBSF licences aggregated on one fishing boat licence.

The effectiveness of fishing effort varies markedly on a seasonal basis, peaking in June–July. 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 906 standard boat days in 2003, compared with 887 days in 2002.

Catch rate

Catch per line boat day of the SBSF licensed boats for the peak months (June–July) was 473 kg/boat day in 2003, approximately 15% lower than in 2002 (555 kg/boat day) and approximately 32% lower than average for the 1990s (700 kg/boat day) (Shark Bay Snapper Figure 1). The 2003 catch rate is below the trigger level for this fishery which has been set at 500 kg/standard boat day.

Recreational component: 8% (approx.)

The Gascoyne Recreational Fishing Survey (conducted between April 1998 and March 1999) estimated the recreational oceanic snapper catch at 14 t (or 2.5% of the combined commercial and recreational catch at that time) for the Gascoyne bioregion. In 2003, the recreational catch of oceanic snapper landed at Denham was estimated at 7 t, and while no comparable estimate is available for Carnarvon, it is assumed that the recreational catch of oceanic snapper would have been, at the minimum, the same as that landed in Denham. In addition, the recreational catch of oceanic snapper taken from charter boats in 2003 was reported as 27 t (compared with 24 t in 2002). Consequently, the recreational catch of oceanic snapper is estimated at approximately 8% of the combined commercial and recreational catch in 2003.

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, pp. 98-104).

STOCK ASSESSMENT

Assessment complete: Yes

The oceanic snapper stock is now considered over-exploited due to higher than optimum levels of exploitation since about the late 1990s combined with lower than average levels of recruitment in the mid- and late 1990s. A stock production model assessment in the mid-1980s estimated maximum sustainable annual yield at around 600 t, whereas the average annual commercial catch for the 1990s was 503 t. An objective of the FRDC-funded project was to use more sophisticated age-structured modelling to assess the potential for increased yields from the oceanic stock. The results from this project have shown that the estimated sustainable yield of 600 t was too high given that the stock has continued to decline slowly, even with average catches of around 500 t. Age-structured modelling indicated that the mature biomass of the stock has been at less than 30% of the virgin biomass since 1999 (Shark Bay Snapper Figure 2). The management response to this has been to reduce the TAC for the 2004 season by 40%.

One important outcome from this project is confirmation that, like other snapper stocks in Australia and New Zealand, the Shark Bay oceanic stock is subject to highly variable annual recruitment. Although there was a peak in recruitment in the early 1990s this was followed by lower recruitment in the mid- to late 1990s (Shark Bay Snapper Figure 3). The low recruitments occurred when breeding stocks were at adequate levels and are therefore most likely to be attributed to environmental effects on the survival of eggs, larvae and early juveniles. Fishery data for the period 2001–2003 is being used to update the stock assessment and provide advice for ongoing management prior to the peak season of the 2004 fishing year.

Exploitation status: Over-exploited

Breeding stock levels: Inadequate

The breeding stock level for the oceanic snapper stock has been estimated to be below 30% of the unfished level. The target for species such as snapper is to maintain breeding stock levels above 40% of the unfished level. Management action to restore the stock to this level has been approved by the Minister and will be implemented for the 2004 fishing season.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

Virtually all the catch consists of demersal fish with a medium to high market value, therefore there is no significant catch of non-retained species.

Protected species interaction: Negligible

The line fishing methods used do not catch any protected species.

ECOSYSTEM EFFECTS

Food chain effects: Low

Food chain effects are considered to be low because the quota system restricts catches to a small percentage of the total biomass of snapper. While the oceanic stock is currently going through a low period, corrective management action has been taken in 2004 in an effort to rebuild the adult stock to above 40% of its unfished 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 2003 was slightly different to previous years. Although 24 vessels fished during the peak season, with an average crew of 3, the number of vessels fishing in both the peak and off-peak seasons increased to 17 (from 9 in 2002). This was probably due to the continuing development of the outer-shelf fishery targeting the higher-valued goldband snapper and other species. Snapper are taken incidentally when fishing for goldband and fishers make up their catches with snapper if they have been unable to catch a full load of goldband.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $3.4 million

The value of the snapper taken in the fishery was $2.19 million, while other finfish species added a further $1.21 million.

FISHERY GOVERNANCE

Acceptable effort range for next season: 425–558 days

While the total allowable commercial catch in 2003 under the quota system was 563.7 t, 906 boat days of fishing effort (towards the upper limit of the acceptable effort range of 709–930 boat days set for that season) only produced a total catch of 429 t.

In addition, the average CPUE of 473 kg/June–July boat day for 2003 was well below the average range for the 1990s of 606–796 (mean ± 1.28 SD) and below the trigger rate of 500 kg/standard boat day.

These factors are indicative of low snapper abundance and led to the review of management of the fishery currently in progress.

In view of the 40% reduction in TAC to 338.3 t for 2004, and based on catch per unit effort levels during the period 1990–2000, the acceptable effort range to take the 2004 TAC would be 425–558 standard boat days.

New management initiatives (2003/04)

For the 2004 season, the overall quota has been reduced by 40% in an effort to assist the recovery of the oceanic snapper stock. Additionally, the Department and industry are currently reviewing commercial line fishing in open-access fisheries within the Gascoyne bioregion, to manage other sources of snapper mortality. It is likely that a managed line fishery for the Gascoyne will be implemented as an outcome of this review, covering all demersal finfish species including snapper, and replacing the current SBSF.

In June 2004, the Australian Government Department of Environment and Heritage certified the SBSF as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a number of conditions, certification allows product from the fishery to be exported from Australia for a period of five years before reassessment.

EXTERNAL FACTORS

Wetline vessels operating within the region without a SBSF licence, which are therefore not permitted to land snapper, have been taking increasing catches of other finfish species in recent years. During these operations a considerable, but currently unknown, quantity of snapper are caught and have to be returned to the water. Because a large proportion of these fish are unlikely to survive (due to barotrauma), the wetline fishery is also contributing to the fishing mortality already generated by the SBSF and thereby threatening sustainability.

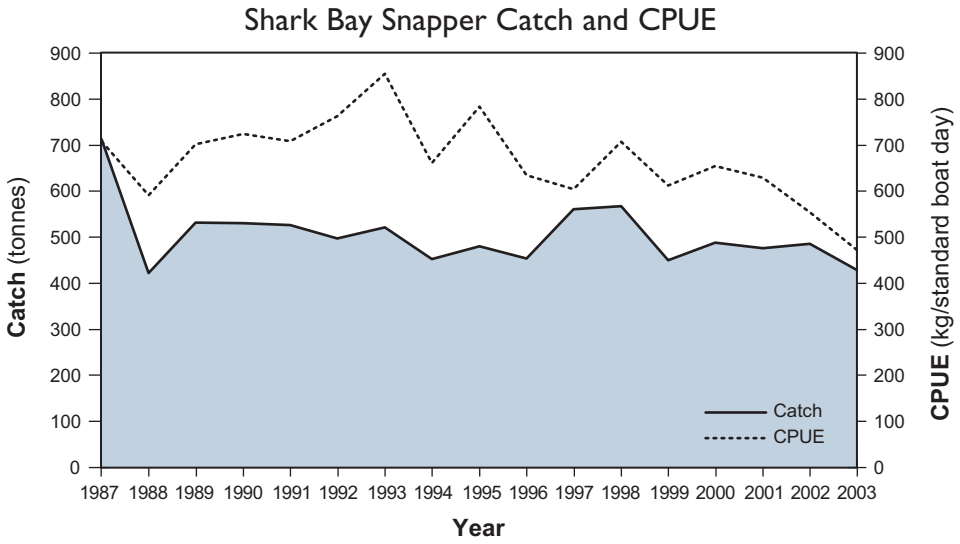
The sustainability of the outer-shelf component of the wetline fishery is also in doubt, given the rapid increases in catches to very high levels for some species. For example, the overall catch of goldband has increased dramatically from less than 10 t in 2000 to more than 300 t in 2003 (Shark Bay Snapper Figure 4). On the basis of extensive knowledge gained from the management of goldband fishing in other, more northerly regions of the state, it is extremely unlikely that this level of exploitation is sustainable. Interim management arrangements introduced in June 2004 to support the oceanic pink snapper stock, in the form of a requirement that all wetlining activity within the waters of the snapper fishery can only take place as part of a licensed snapper operation, will afford some protection. However, in the longer term it is planned to address these matters as part of the development of wetline management arrangements for the region.

Under the Offshore Constitutional Settlement, trawlers licensed by the Australian Government may operate in the region outside the 200 m isobath as part of the Western Deepwater Trawl Fishery. A single Australian Government licence was active in the region in 2003, although less than 50 kg of snapper was reported; the quantity of snapper returned to the water is unknown.

SHARK BAY SNAPPER TABLE 1

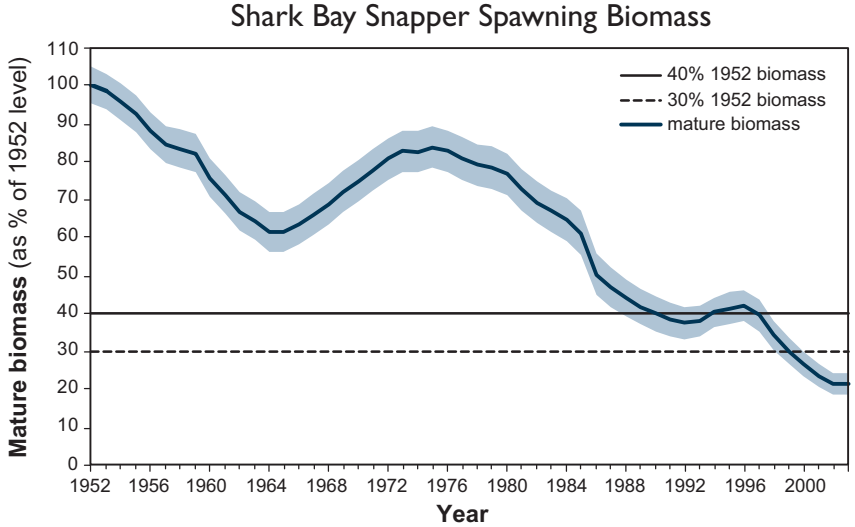
Catches of species other than snapper taken in the years 2001–2003 by SBSF licensed boats in the area between 23° S and 26° S. (Note this list excludes mackerels, reported on pp. 141-146, and tunas which are reported to the Australian Government.)

SPECIES		*2001 (tonnes)*	*2002 (tonnes)*	*2003 (tonnes)*
Jobfish	*Pristipomoides* spp.	5.1	42.1	122.9
Emperors	Lethrinidae	31.1	27.0	34.0
Cods	Serranidae	11.3	19.8	24.9
Mulloway	Sciaenidae	15.9	21.4	12.0
Red emperor	*Lutjanus sebae*	9.1	9.5	11.5
Trevallies	Carangidae	8.1	9.3	9.3
Other		24.4	28.7	30.1
Total		**105**	**157.9**	**244.7**



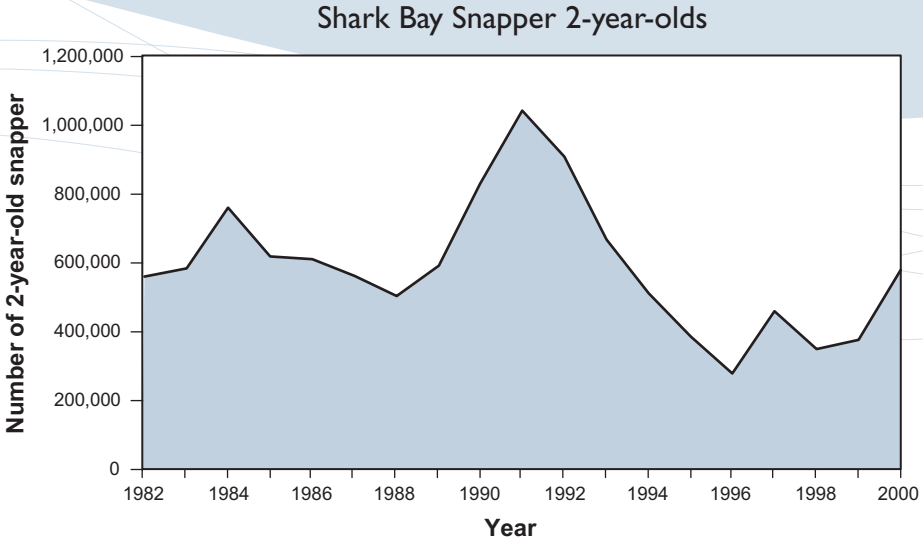
SHARK BAY SNAPPER FIGURE 1

Catch and catch per unit effort by year from 1987 to 2003 for the Shark Bay Snapper Managed Fishery. Units are kg whole weight of pink snapper per standard boat day. As catchability varies markedly throughout the year, peaking in June and July when the fishing effort is focused on snapper, the CPUE for line fishing from June–July is used as the index of abundance.



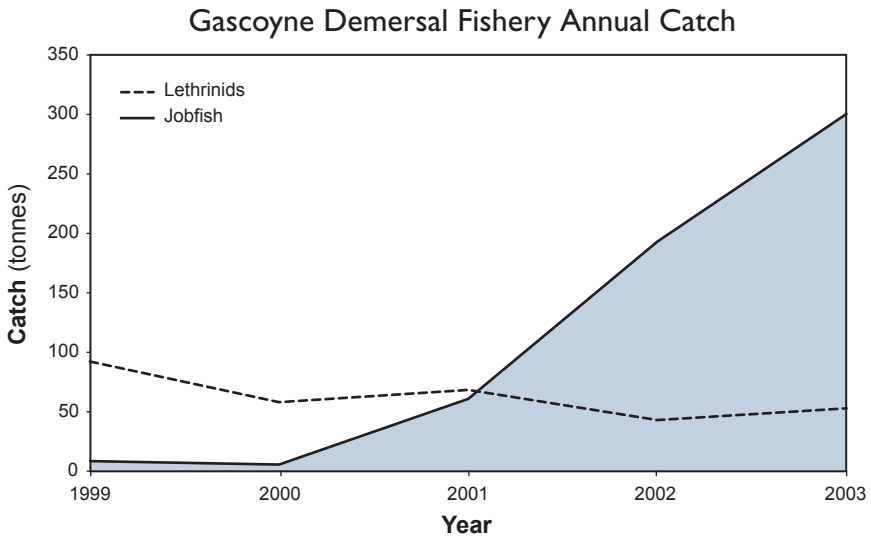
SHARK BAY SNAPPER FIGURE 2

Spawning biomass of the Shark Bay oceanic snapper stock as estimated by the age-structured model (FRDC project), showing 90% confidence intervals and biological reference points (40% of 1952 level; 30% of 1952 level).



SHARK BAY SNAPPER FIGURE 3

Estimates of numbers of juvenile snapper (i.e. 2-year-olds) in the Shark Bay oceanic stock, from cohort analysis of commercially caught fish approximately 5 years and older. (Note cohorts for years 2001 onwards have not yet reached the fishery.)



SHARK BAY SNAPPER FIGURE 4

The increasing catches of deep-water snappers ('jobfish', mainly goldband snapper) and continuing low catches of emperors (lethrinids) taken between 23° S and 26° S by both the SBSF and the wetline fishery in the Gascoyne region, illustrating the shift of focus from the inner to the outer shelf.

Wetline Fishing

The CAES database indicates that around 14% of the state's wetline catch was reported from the Gascoyne coast bioregion during 2002/03. The top 12 species comprised goldband snapper (*Pristipomoides multidens*) 144 t, pink snapper (*Pagrus auratus*) caught outside of the Shark Bay Snapper Managed Fishery 44 t, rosy jobfish (*Pristipomoides filamentosus)* 36 t, Spanish mackerel (*Scomberomorus commerson*) 33 t, unspecified tuna (Scombridae) 22 t, sea mullet (*Mugil cephalus*) 12 t, grey-banded cod (*Epinephelus septemfasciatus*) 9 t, ruby snapper (*Etelis carbunculus*) 9 t, grey mackerel (*Scomberomerus semifasciatus*) 8 t, cobia (*Rachycentron canadus*) 7 t, red emperor (*Lutjanus sebae*) 6 t and pearl perch (*Glaucosoma scapulare*) 6 t.

An interim management plan for the troll fishery for mackerel, details of which are reported under the north coast bioregion (pp. 141-146), will commence later in 2004. Most of the other demersal species are taken by vessels targeting pink snapper in the region's oceanic managed fishery for that species (see pp. 93-97), with the deep-water species assuming far greater prominence in the 2002/03 catch. The majority of the mullet catches were reported from the area between the northern boundary of the beach seine fishery and Carnarvon.

RECREATIONAL FISHERIES

Regional Research Overview

Recreational fishing is a major activity in the Gascoyne, representing 4% of the state's fishing effort and an estimated 348,000 fishing days in 2003/04 (Baharthah 2004). 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 knowledge of the biology of several other secondary 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*) (13,00 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

Prepared by G. Jackson and N. Sumner

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 conducted from small boats using rod and line or handline, with a relatively minor shore-based component using rod and line. A limited number of licensed charter vessels operate out of Monkey Mia and Denham. A range of species are regularly caught by boat-based recreational fishers with the three principal target species being pink snapper (*Pagrus auratus*), black snapper (blue-lined or grass emperor, *Lethrinus laticaudis*), and whiting (*Sillago* spp.) (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. Gascoyne Recreational Fishing Review, Shark Bay Snapper Ministerial Working Group)

Boundaries

The areas covered by this report are shown in Inner Shark Bay Recreational Fishery Figure 1. No fishing is permitted in the Hamelin Pool Marine Reserve.

Management arrangements

This recreational fishery is principally managed using traditional controls including daily bag, possession, size and gear limits. However, more detailed and innovative management arrangements are in place for pink snapper, the main target species taken by the fishery.

Evidence from stock identification studies conducted since the 1980s (genetics, tagging, otolith microchemistry, comparison

of life-history characteristics, hydrodynamic modelling of egg and larval dispersal) indicates that pink snapper inhabiting the inner gulfs comprise several reproductively isolated populations. Because there is little or no apparent mixing between these, or with the oceanic stock found in waters outside Shark Bay, management now explicitly recognises three separate fishable 'stocks' in the inner gulfs, i.e. an eastern, a Denham Sound and a Freycinet Estuary 'stock' (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 a combination of size and bag limits and fishery closures. This included a total prohibition on the take of pink snapper in the eastern gulf between June 1998 and December 2002, introduced to allow the spawning stock in that area to rebuild following over-exploitation in the early to mid-1990s. In 2003, for the first time in fisheries management in Western Australia, a total allowable catch was set for each pink snapper 'stock'/fishery area, that included explicit allocations for the recreational and commercial sectors. These TACs were:

- 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 2003, the following fishing regulations were introduced:

- 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)
- To limit the recreational catch in the Freycinet Estuary, a limited number (900) of non-reuseable 'management tags' were allocated, each 'tag' entitling the fisher to retain one pink snapper per tag

These measures were designed to manage the total catch of pink snapper in each management area to maintain the individual 'stocks' at, or allow them to recover to, the accepted biological reference level, i.e. 40% of the spawning biomass in 1983.

The recreational catch of black snapper comprises a significant part of the total catch in the inner gulfs of Shark Bay and other areas within the Gascoyne bioregion, and community concerns were expressed about the transfer of effort to the species following tighter management of pink snapper since 1998. To provide additional protection for black snapper and other 'Category One' species at higher risk of over-exploitation in the Gascoyne, reduced daily bag limits and possession limits were introduced in October 2003 as part of the Gascoyne Recreational Fishing Strategy.

Research summary

Detailed research has been carried out in inner Shark Bay on the two main recreational target species, pink snapper and black snapper.

Ongoing research to support the management of pink snapper has been underway since 1996/97. Concerns about increasing recreational fishing pressure on inner gulf 'stocks' during the early 1990s, and the outcome of research trawl surveys for juvenile snapper (0+, 1+ age groups) in November 1996 and February 1997, resulted in a comprehensive research project commencing in June 1997. This research includes annual surveys to estimate the size of pink snapper spawning stocks (using the daily egg production method), trawl and trap surveys to measure variation in juvenile recruitment, catch-at-age monitoring and creel surveys to estimate recreational catches. This work has provided scientific assessments of the status of inner gulf 'stocks' each year since 1998. In late 2002, a review of the research to date, and results of model-based stock assessments, were presented to the Ministerial Working Group, and form the basis for the management of this key recreational species for the period 2003–2006. Currently, an FRDC-funded project due for completion in June 2005 is comprehensively evaluating the management of pink snapper under the different arrangements now being used in the inner gulfs.

An FRDC-funded project conducted between 1999 and 2002 resulted in important biological information on black snapper in Shark Bay and provides the scientific basis for the increase in minimum legal size and reduced daily bag limit for emperor species in the Gascoyne. While research on black snapper population structure has not been as comprehensive as with pink snapper, evidence (otolith stable isotope analysis, a limited tagging study) indicates that black snapper display a degree of site fidelity and that fish do not mix significantly between areas separated by as little as 20 km. Although black snapper in Shark Bay are currently managed as a single fishable 'stock', data are presented in this report separately for each management area to allow comparison with pink snapper.

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 during the 1998 season, as part of a broader survey of the entire Gascoyne region (Sumner et al. 2002), that included both boat-based and shore-based fishing. Results from this survey showed that 99% of both the pink and black snapper catch was taken by boat fishers. More recently, recreational fishing surveys have focused on boat fishing only, with interviews conducted at the main boat ramps (Monkey Mia, Denham, Nanga) during the 2000 (Sumner and Malseed 2001), 2001 (Sumner and Malseed 2002), 2002 and 2003 seasons.

Data from charter fishing operations are now also being collected through compulsory catch returns.

RETAINED SPECIES

Recreational catch estimates (season 2003):

Pink snapper:	Eastern gulf 3 tonnes
	Freycinet Estuary 1.5 tonnes
	Denham Sound 6 tonnes
Black snapper:	Eastern gulf 5 tonnes
	Freycinet Estuary 1 tonne
	Denham Sound 3 tonnes

Landings

All catches reported here have been rounded to the nearest 0.5 t.

Pink snapper: The recreational catches of pink snapper in all three areas of the inner gulfs have decreased since 1998 as a direct result of management intervention (Inner Shark Bay Recreational Fishery Figure 2). This year (2003) was the first year, since the fishery was closed in June 1998, that pink snapper could be taken in the eastern gulf, with an estimated 3 t caught by recreational fishers. Recreational catches in both Denham Sound and Freycinet, estimated at 6 t and 1.5 t respectively, have declined dramatically compared with 2002 (14.5 t and 19 t respectively). The proportion of pink snapper captured by recreational fishers that were subsequently released was 95% in the eastern gulf, 96% in Denham Sound, and 93% in Freycinet.

The above catches include 0.5 t of pink snapper taken in the eastern gulf and 0.5 t taken in Denham Sound by licensed charter vessels. Reported catches from charter vessels were available for the first time in 2003 and showed very low numbers of most species caught, with a total of 426 pink snapper retained (465 released).

Black snapper: There has been a decline in the estimated recreational catch of black snapper taken by boat fishers in the inner gulfs between 1998 and 2003 (Inner Shark Bay Recreational Fishery Table 3). The Gascoyne Recreational Fishing Survey in 1998/99 estimated that a total of 33,400 black snapper (approx. 34 t) were caught and kept by shore and boat-based fishers throughout the Gascoyne region. The majority of this catch (17,073 fish, approx. 16 t) was taken by boats fishing within the Shark Bay Marine Park. In this survey, black snapper was the second most common species landed (in order of number kept) after whiting, just ahead of pink snapper. Subsequently, the total catch of black snapper taken in inner Shark Bay has varied between 7 t and 12 t, with 9 t taken in 2003. This includes an estimated 0.5 t taken by licensed charter vessels (498 fish retained and 76 released).

Fishing effort/access level

In 2003, approximately 42,000 fisher days were expended in the inner gulfs by boat fishers launching from the main ramps, with 63% of the effort in the western gulf and 37% in the eastern gulf (Inner Shark Bay Recreational Fishery Table 3). This shows a shift in fishing effort from the western gulf (76% in 2002) to the eastern gulf (24% in 2002). Compared with 2002, effort in 2003 had increased by approximately 20% in Denham Sound and 47% in the eastern gulf but had decreased by 72% in Freycinet. Overall, effort in both Denham Sound and the eastern gulf were higher in 2003 than in any previous year since surveys commenced and are therefore likely to represent an all-time high in these two areas. This trend reflects the continuing increase in recreational fishing activity at the key tourist destinations across Western Australia

Catch rate

Pink snapper: It is not useful to use catch rates as a measure of abundance for pink snapper in this fishery, owing to the many management changes in recent years and highly aggregating behaviour of the species during the winter (spawning) period.

Black snapper: The overall catch rates of black snapper estimated for boat-based fishers in inner Shark Bay (all areas) in 1998, 2000, 2001, 2002 and 2003 were 0.35, 0.29, 0.21, 0.26 and 0.24 fish kept per fisher day, respectively. This represents a decline in catch rate between 1998 and 2003.

Commercial share:

Pink snapper:	Eastern gulf 9%
	Freycinet Estuary 0%
	Denham Sound 21%

Pink snapper: A small amount of commercial fishing (handline, beach seine, haul net) for pink snapper still takes place in the inner gulfs but is limited to the 11 licensed fishing units of the Shark Bay Beach Seine and Mesh Net Managed Fishery. The reported commercial catch of pink snapper in 2003 was 0.3 t in the eastern gulf and 1.6 t in Denham Sound, equating to around 9% and 21% respectively of the total catch in these areas. No pink snapper were taken by commercial fishers in Freycinet in 2003.

Black snapper: Black snapper are not targeted by the commercial fishery.

STOCK ASSESSMENT

Assessment complete:

Pink snapper:	Yes
Black snapper:	Preliminary

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 each year since 1997. Research trawl (since 1996) and trap surveys (1998–2000) have provided information on the abundance of 0+ age snapper in both gulfs to measure annual recruitment strength. Results indicate that recruitment is highly variable in the inner gulfs, 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'. From 2002 onwards, all available biological and fishery information has been incorporated into quantitative age-structured models to assess the status of the three inner gulf pink snapper 'stocks'.

Exploitation status:

Pink snapper:	Eastern gulf fully exploited
	Freycinet Estuary over-exploited
	Denham Sound fully exploited
Black snapper:	Not assessed

Breeding stock levels:

Pink snapper: Eastern gulf adequate
Freycinet Estuary inadequate (locally depleted)
Denham Sound adequate

Black snapper: Adequate

Pink snapper: The breeding stock level of each pink snapper 'stock' is currently estimated using age-structured models, and assessed in relation to a target reference level of 40% of the 1983 mature (spawning) biomass.

The estimated mature biomass of the eastern 'stock', which fell below the reference level in the early 1990s, has recovered steadily since the fishery was closed in 1998 and is now estimated to be above the reference level (mature biomass in 1983 estimated at approximately 250 t). In Denham Sound, the estimated mature biomass, which briefly dipped below the reference level in the late 1990s, has subsequently recovered and is currently above the reference level (mature biomass in 1983 estimated at approximately 300 t). In Freycinet, the estimated mature biomass fell below the reference level in about 1997 and continued to decline until 2002. It remains critically low relative to the reference level (mature biomass in 1983 estimated at approximately 300 t).

Black snapper: A preliminary yield-per-recruit model was developed using biological data obtained from the black snapper research conducted between 1999 and 2002. Results indicated that fishing mortality between 1999 and 2002 was higher than optimum, and suggested that improved yields (weight) would be achieved with a larger size at first capture. The minimum legal size was increased from 280 mm to 320 mm in October 2003 as part of the Gascoyne Recreational Fishing Strategy. This larger size also provides for significantly higher breeding stock levels because the length at 50% maturity is 228 mm for females, well below the minimum legal size. Breeding stock levels are therefore believed to be adequate.

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

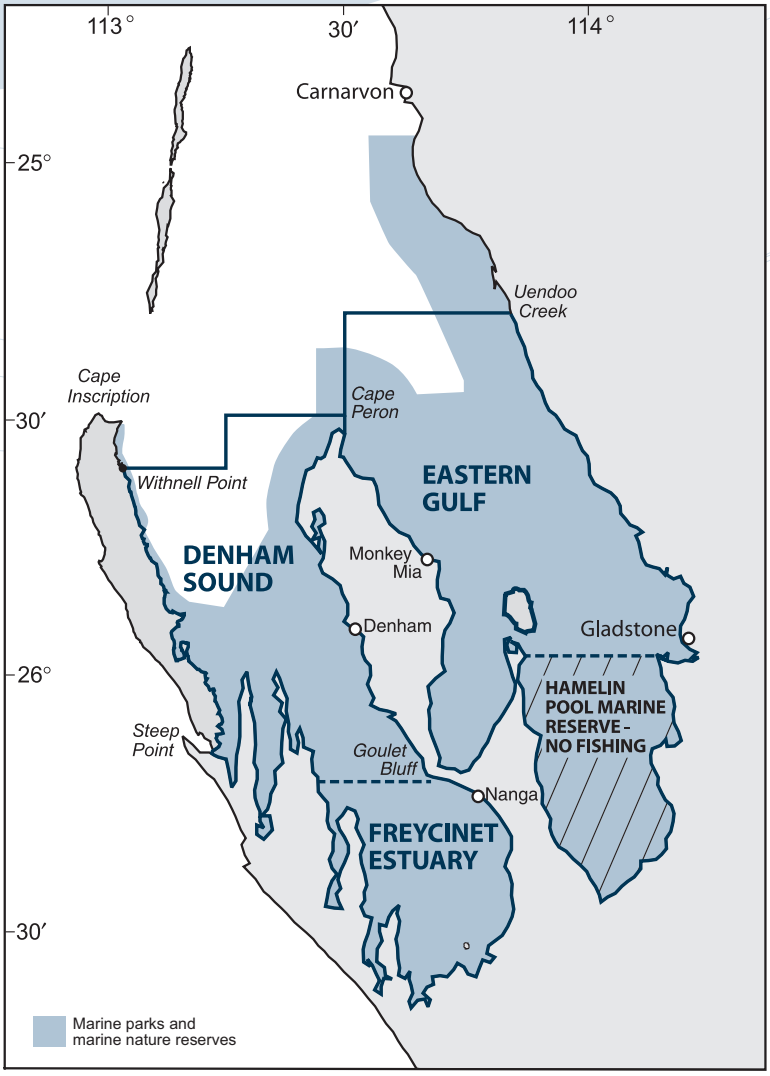
Management controls introduced in 2003 appear to have been successful in constraining catches of pink snapper in all three areas to within the respective TACs (Inner Shark Bay Recreational Fishery Table 4). These same arrangements, different for each 'stock'/fishing area, will remain the same in 2004. The management of pink snapper is scheduled to be further reviewed in late 2005, following the completion of the current FRDC research project, at which time TACs and regulations will be determined for the next three period (2006–2008).

EXTERNAL FACTORS

A comprehensive investigation into the potential impact of prawn trawling in Denham Sound on juvenile pink snapper recruitment and the consequences for the recreational pink snapper fishery in this area was completed in late 2003 (Moran and Kangas 2003). Discussions between the local community, the prawn trawl industry and the Department of Fisheries took place into 2004. Following these, changes to trawl fishery management, specifically modifications to the southern boundary line of the trawl fishery in Denham Sound, were agreed to and implemented for the 2004 fishing season.

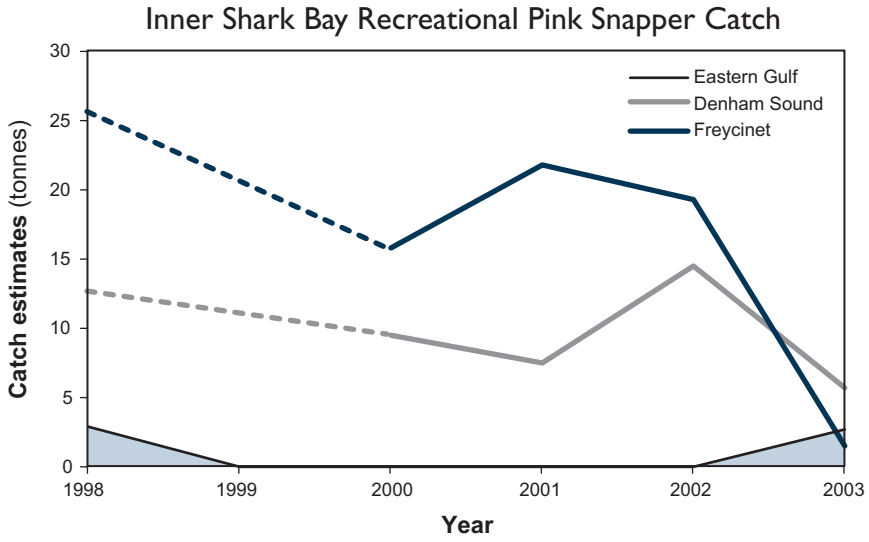
Recruitment variability has now been shown to be an important feature of the dynamics of both oceanic and inner gulf pink snapper populations. There is a need to better understand this recruitment variability, and correlation with possible environmental drivers (as in New Zealand), potentially allowing stock assessment models used for the oceanic (commercial) and inner gulf (recreational) fisheries to become more predictive.

More generally, the key finfish species other than pink snapper targeted by the recreational fishery in the inner gulfs of Shark Bay are expected to come under increased pressure into the future as fishing effort in both gulfs continues to increase. Increasing tourism to the region and further infrastructure development, e.g. proposed marina/canal development in Denham, will continue to present challenges in relation to ongoing fisheries sustainability. The key issue for fisheries management is how to manage recreational fishing effort and cost-effectively monitor catches and stock abundance for the key target species into the future.



INNER SHARK BAY RECREATIONAL FISHERY FIGURE 1

The recreational fishing areas of inner Shark Bay. Waters to the west of the Peron Penisula, i.e. Denham Sound and Freycinet Estuary, are collectively known as the western gulf.



INNER SHARK BAY RECREATIONAL FISHERY FIGURE 2

Recreational catches of pink snapper in the three fishing areas of inner Shark Bay, 1998 to 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. Numbers 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)**

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, 1998–2003. Note 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**	**1.5[3]**	**42,070**	**10**

1 for period April - June only (fishery closed June 1998)
2 estimates for Nanga only, does not include Tamala
3 estimates for all Freycinet Estuary, including Tamala
4 fishery open Jan - Mar and Aug - Dec (closed Apr-July)

INNER SHARK BAY RECREATIONAL FISHERY TABLE 3

Estimated catch of black snapper taken by recreational boats in inner gulfs of Shark Bay.

YEAR	AREA	FISHING EFFORT (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**	**20,548**	**9**

INNER SHARK BAY RECREATIONAL FISHERY TABLE 4

Catches (tonnes) of inner Shark Bay pink snapper taken by each sector in 2003 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	2.7	5.7	1.5
Charter vessels	0.5	0.5	0
Commercial	0.3	1.6	0
Total catch	**3.5**	**7.8**	**1.5**
TAC	15	10	5
Commercial share (%)	9	21	0
Recreational share (%)	91	79	100
Total catch: TAC (%)	**23**	**78**	**30**

Fishing and Aquatic Tour Industry

Prepared by C. Telfer

At the end of 2003 the Gascoyne bioregion had 72 licensed fishing tour operators, plus an additional 12 licensed restricted fishing tour or eco-tour operators.

During 2002, operators reported 4,072 tours, with an increase in 2003 to 4,494 tours. Activities conducted on these tours included fishing, diving, snorkelling, wildlife observation and sightseeing.

Fishing effort

The number of tours in the Gascoyne involving only fishing decreased from 1,441 in 2002 to 1,287 in 2003. These tours are directly related to the catch information presented in Gascoyne Fishing Tours Table 1. The total fishing effort reported by tour operators for the Gascoyne bioregion in 2002 was 12,038 fisher days, with a decrease in effort of 13% to 10,448 fisher days in 2003.

Catch

Since issuing tour operators' licences, 10,852 daily catch and effort returns have been received for the Gascoyne bioregion. These returns enable an estimate of the total catch by tour operators to be calculated.

Catches of the major finfish species for the Gascoyne bioregion in 2002 and 2003 are shown in Gascoyne Fishing Tours Table 1. The estimated total finfish catch for 2003 was 81 t, which is a decrease of 11% compared to the 91 t caught in 2002. These catches from tour operators' vessels are recreational in nature, and are in addition to reported commercial catches. In future years, where practicable, they will be included in the 'recreational catch share' for relevant species and fisheries.

GASCOYNE FISHING TOURS TABLE 1

Estimated catch of major finfish species reported by tour operators for 2002 and 2003.

SPECIES		ESTIMATED CATCH (tonnes) 2002	ESTIMATED CATCH (tonnes) 2003
Pink snapper	*Pagrus auratus*	24	29
Spangled emperor	*Lethrinus nebulosus*	17	15
Sweetlip emperor	*Lethrinus miniatus*	7	6
Red emperor	*Lutjanus sebae*	10	7
Black snapper (blue-lined emperor)	*Lethrinus laticaudis*	2	2
Rankin cod	*Epinephelus multinotatus*	5	3
Emperors, general	*Lethrinus* sp.	5	1
Chinaman cod	*Epinephelus rivulatus*	0.5	1
Other finfish		20.5	17
Total		**91**	**81**

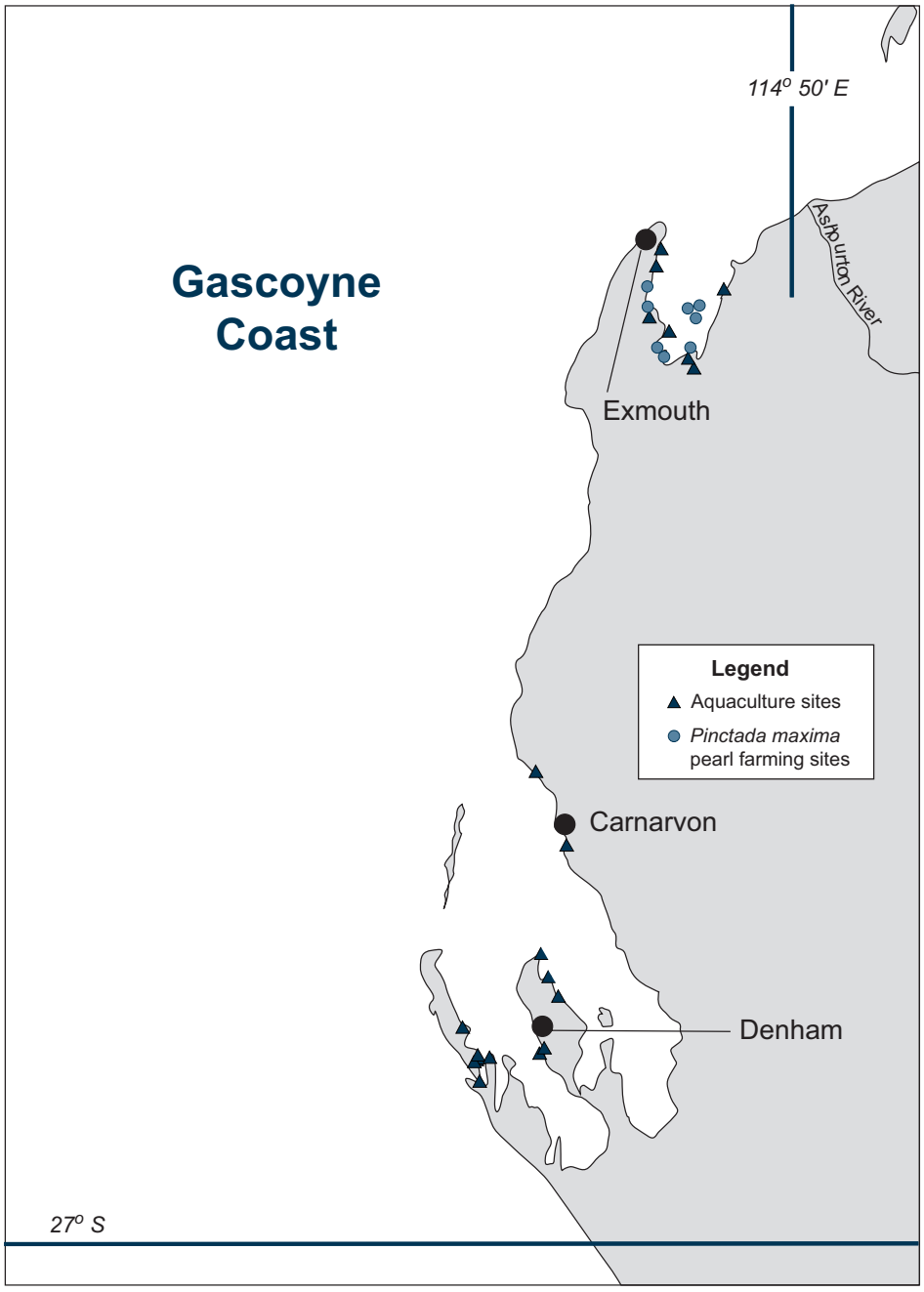
AQUACULTURE

Regional Research and Development Overview

The Department's main focus in the Gascoyne continues to be on encouraging the growth of pearling industries using species that complement the major state industry based on silverlip pearls (*Pinctada maxima*).

There have been no major research activities during 2003/04 except health monitoring by the Fish Health Unit (see Appendix 5). However, specialised technical advice has been provided to assist hatchery operations and to help progress aquaculture and related licence applications.

Key development tasks have involved supporting the emergence of a local aquarium fish production sector, the establishment of a mahi-mahi (*Coryphaena* sp.) farm at Exmouth and the diversification of a nearby prawn hatchery into other marine species.



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

Regional Compliance and Community Education Overview

Compliance activities and education in relation to commercial and recreational fishery regulations in the Gascoyne coast bioregion are undertaken by Fisheries Officers working out of three District Offices located at Denham, Carnarvon and Exmouth. A total of 8 Fisheries Officers operate throughout the bioregion. These officers were supplemented by the seasonal deployment of a two-officer Mobile Recreational Fisheries Patrol. Collectively, the officers deal with a wide range of fisheries within the region, encompassing activities such as boat and shore fishing, diving and netting, as well as creek fishing and aquaculture.

Officers at Denham make extensive use of a 10 m patrol vessel (PV *John Brockman*) to conduct at-sea inspections throughout Shark Bay, while those at Exmouth use an 8 m vessel (PV *Gnulli*) to conduct at-sea operations and inspections within Exmouth Gulf and along the western side of the North West Cape, particularly within the Ningaloo Marine Park. Officers at Exmouth also make use of fixed-wing aircraft for surveillance and monitoring activities. Additionally, several smaller boats are used to monitor protected waters and creek fishing activities. Carnarvon staff utilise small dinghies for inshore coastal and creek patrols, and a quad-bike is used to access mangrove creeks and beaches to detect possible illegal netting. The larger (20+ m) ocean-going patrol vessels *Walcott* and *McLaughlan* are utilised to make at-sea inspections of commercial vessels during the Shark Bay prawn and scallop fishing seasons, especially in the Shark Bay World Heritage Area.

Both commercial and recreational fishery compliance activities involve inspections of catches for compliance with bag, size, quota and possession limits; of gear and fishing methods used; and both the areas and times fishers undertake their fishing. Additionally, extensive liaison is conducted with all fishers to promote better awareness and understanding of the fisheries rules and regulations.

While high-profile patrol activities aimed at maximising personal contacts with fishers are a regular feature of this work, covert observation also plays an important role in ensuring high levels of compliance. The vast majority of commercial and recreational fishers are aware of and comply with the rules. However, some non-compliant fishers are very careful to hide their illegal activities. Officers often covertly observe fishing activity, particularly in response to information provided to them through the toll-free Fishwatch service, and sometimes this is the only way to determine what the level of compliance with the fishing rules actually is.

Activities during 2002/03

In terms of commercial fisheries, Fisheries Officers delivered 9,716 hours of compliance activities, mostly through catch inspection and monitoring, and at-sea inspections of vessels operating in the trawl fisheries. Of particular concern was the emerging intelligence regarding the possible taking of shark fin for private sale by crews. This matter is subject to ongoing investigation. Overall, the inspection activities provided a positive picture of the commercial industry in terms of complying with the rules relating to their fisheries.

During this period, compliance risk assessments were carried out in respect of the commercial Exmouth Gulf Prawn Managed Fishery and the Commercial Marine Safety program (all commercial fisheries).

Fisheries Officers delivered 8,620 hours of compliance work to recreational fisheries, concentrating mainly on the activities of shore-based and boat-based anglers. A total of 11,181 compliance 'field' contacts were made and as a result of these activities, 90 infringement warnings and 70 infringement notices were issued, while 11 prosecutions were initiated for more serious offences. Overall, this represented a very low field contact to prosecution rate of 1.5% and, assuming this to be a representative sample, suggests a good level of compliance with the recreational fishing rules.

Outputs from the Volunteer Fisheries Liaison Officer (VFLO) program were down considerably this year due to a significant movement in the volunteer base to other parts of the state, however a rebuilding program is being developed for the 2003/04 year.

During this period, compliance risk assessments were carried out in respect of the Fishing and Aquatic Tour industry (charter boats) and the Recreational Marine Safety program.

Initiatives in 2003/04

Ongoing concerns remain with the status of the Shark Bay snapper stocks. As such, Fisheries Officers at Denham continue to conduct a mix of high-profile at-sea and on-land patrols to remind locals, commercial fishers and visitors of the need to protect local pink snapper stocks in both the western and eastern gulfs of Shark Bay.

Staff from Exmouth continue to promote the unique Ningaloo Marine Park experience, while reminding people of the specific requirements for fishing in the area in relation to possession limits, landing limits, sanctuary zones and bag limits. The management arrangements for this marine park are currently under review (by the Department of Conservation and Land Management).

The program of formal compliance risk assessments has continued, covering the commercial Shark Bay prawn, scallop and snapper fisheries and the Gascoyne bioregion recreational fishery during 2003/04.

Marine Safety became a new role for Fisheries Officers during the year, further enhancing their ability to protect both fish stocks and fishers by limiting the level of unsafe commercial and recreational fishing vessel activity in Western Australian waters.

GASCOYNE COMPLIANCE TABLE 1

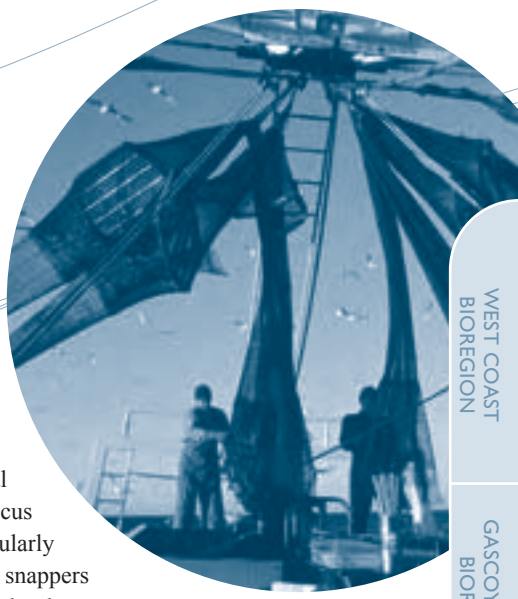
Summary of compliance and educative contacts and infringement types within the Gascoyne coast bioregion during the 2002/03 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	9,716
Fisher field contacts by Fisheries Officers	1,759
District Office contacts by Fisheries Officers	4,553
Fishwatch reports *	5
COMMERCIAL OFFENCES DETECTED	
Infringement warnings	52
Infringement notices	32
Prosecutions	9
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	8,620
Fisher field contacts by Fisheries Officers	11,181
District Office contacts by Fisheries Officers	4,852
RECREATIONAL OFFENCES DETECTED	
Infringement warnings	90
Infringement notices	70
Prosecutions	11

* This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

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. 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 metres along the Kimberley section of the coast down to around 2 metres at Onslow in the west Pilbara.

As a result of these factors, the generally tropical low-nutrient offshore waters are significantly influenced by rainfall 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 back 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. Nearshore 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 tonnes 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 tonnes 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. 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, sea perches such as 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 many members of the demersal sea perch family such as scarlet sea perch 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.

Other developing marine aquaculture initiatives include growing trochus and black tiger prawns. A focus of aquaculture development in the region is provided by the Department's Broome Tropical Aquaculture Park, which houses a commercial pearl oyster hatchery, an Aboriginal-owned multi-species hatchery and the Kimberley TAFE aquaculture training facility.

ENVIRONMENTAL MANAGEMENT

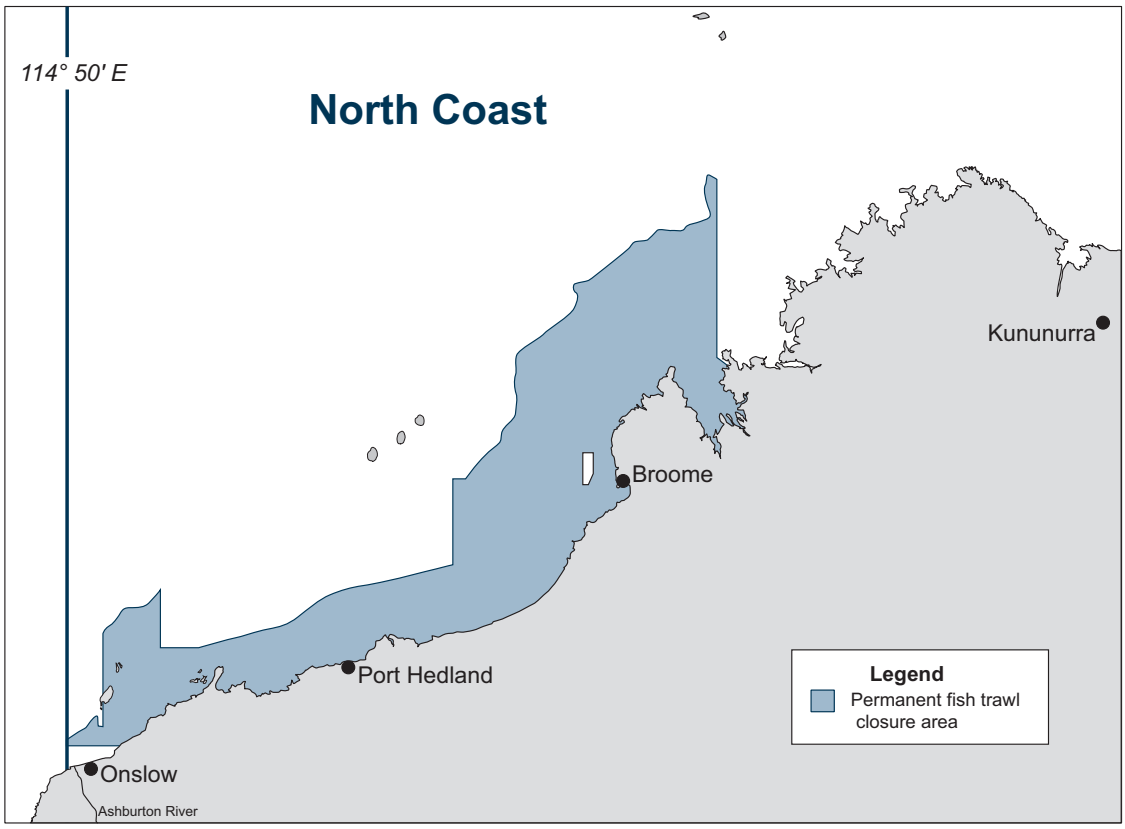
Regional Overview

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 Australian 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 reef protected areas under Fisheries legislation and marine parks and reserves around offshore islands and reefs (North Coast Habitat Protection Figure 2).

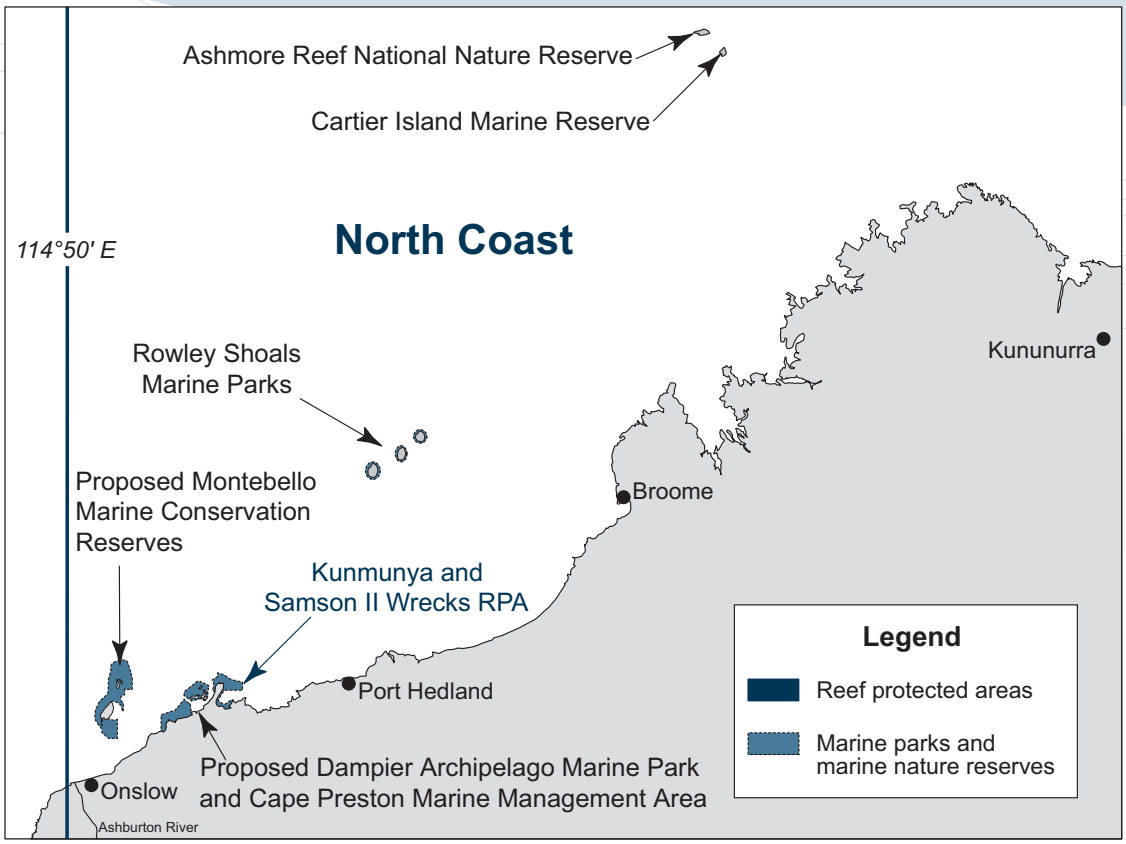
During 2003/04 the Department of Fisheries has provided scientific and management advice and made submissions to Government in relation to the planning for, and in some cases legislative changes arising in relation to:

- the proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area;
- changes to the boundary and zoning scheme of the Rowley Shoals Marine Park; and
- the proposed Montebello marine conservation reserves (consisting of the Montebello Marine Park, the Barrow Island Marine Park, and the Montebello Marine Management Area).



NORTH COAST HABITAT PROTECTION FIGURE 1

Map showing areas permanently closed to trawling for finfish 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

Prepared by M. Kangas, E. Sporer and J. Brown, with management input by G. Baudains

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

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/Nickol Bay Prawn Figure 1).

The fishery is divided into three fishing zones with associated nursery areas as follows: Area 1, incorporating Ashburton Nursery; Area 2, incorporating Coolgra Point Nursery; and Area 3, incorporating Fortescue Nursery.

Management arrangements

Management controls for the Onslow Prawn Managed Fishery are based on limited entry, seasonal and area closures, gear controls and restrictions on boat size.

The opening and closing dates for the fishery vary from year to year and are based on advice from the Research Division. Furthermore, different areas within the fishery have different season dates, which protects smaller prawns and allows access to the various target species, primarily tiger and banana prawns, at appropriate times.

The 2003 fishing season commenced on 1 March and ended on 15 November. Within these dates, the various areas were open during the following periods:

North Coast Bioregion

Area 1	1 April – 15 November
Area 2	1 March – 15 November
Area 3	1 March – 15 November
Fortescue Nursery	1 May – 15 November
Ashburton and Coolgra Point Nurseries	1 June – 31 July

An area inside the boundary of the Coolgra Point Nursery was closed in 2003 for the whole year. This closure is to be in place until 2005, when its effectiveness will be reviewed.

The management system involves a total allowable effort arrangement where all vessels have an equal allocation of headrope length. The fleet is composed of trawlers up to 23 m operating twin-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m).

Bycatch reduction devices (grids) were fully implemented in the fishery in the 2003 season, with vessels required to have grids fitted to both nets. In addition, the vessel monitoring system has been in operation in the fishery since 2002.

Research summary

Research needed to manage this small fishery involves stock monitoring and assessment utilising the CAES monthly return data provided by industry, along with information from voluntary log books and some interviews with boat skippers. Annual meetings are held with boat operators to consider the status of the stocks and recommend changes to fishing operations.

A current FRDC project to examine the biodiversity of trawled and untrawled areas in Exmouth Gulf is also gathering data from Onslow Area 1.

RETAINED SPECIES

Commercial production (season 2003): 193 tonnes

Landings

The total landings of major penaeids for the 2003 season were 193 t, including 12 t of king prawns, 172 t of tiger prawns, 9 t of endeavour prawns and 1 t of banana prawns (Onslow Prawn Figure 2). The Onslow fishery is a small fishery in which tiger and king prawns have been the dominant species caught over the long term, with the acceptable catch range based on total landings ranging from approximately 60 t to 130 t. This season's catch of 193 t is the highest catch recorded and is above the acceptable catch range for this fishery. The high catch was dominated by tiger prawns, mirroring the relatively high catch of tiger prawns observed in the adjacent Exmouth Gulf fishery. The high tiger prawn abundance may reflect very favourable environmental conditions. Recorded landings of by-product species included 4 t of bugs (*Thenus orientalis*), 2 t of squid, 2 t of blue swimmer crabs (*Portunus pelagicus*), 1 t of coral prawns and less than 1 t each of black tiger prawns (*Penaeus monodon*), 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 2003 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 2003, 785 fishing days were recorded by boats licensed to fish in the Onslow prawn fishery. This was approximately 20% less than the number of fishing days recorded in 2002.

Catch rate

Not assessed.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

The catches during 2003 were well above average for tiger prawns, and slightly below average for king and endeavour prawns but within their individual acceptable ranges. Tiger prawn landings were well above the acceptable catch range and may reflect highly favourable environmental conditions for this species (i.e. an absence of destructive cyclonic activity). Banana prawn catches were low, again reflecting the low summer rainfall (13 mm) in the area. The rainfall during summer 2003/04 was a total of 241 mm and therefore it is expected that banana prawn catches in 2004 should be up on the very low catches seen in 2003. Work continues on assessing the relationship between summer rainfall and banana prawn catches from Area 1, which includes the Ashburton River estuary, a nursery area for this species.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

NON-RETAINED SPECIES

Bycatch species impact: Low

Bycatch from the fishery is typical of tropical trawl fisheries (i.e. up to about 6:1 relative to the target species), but the effort levels and spatial coverage are too low to impact bycatch species populations. Information gathered during a current research project on biodiversity of trawled and untrawled areas within Onslow Area 1 will provide additional information on bycatch composition and abundance. The introduction of fish escapement devices within the nets by 2004/05 should reduce this risk even further.

Protected species interaction: Low

The Onslow prawn fishery has on rare occasions previously caught turtles and sea snakes, 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

Because of 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 nursery areas are fished (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 2003 was 12–15 skippers and crew, with up to 10 people involved in local processing.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $2.4 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 along the Pilbara coast in 2003 were as follows:

King prawns	$13.20/kg
Tiger prawns	$12.70/kg
Endeavour prawns	$7.00/kg
Banana prawns	$11.00/kg
Coral prawns	$2.50/kg

FISHERY GOVERNANCE

Acceptable catch range for next season: 60–130 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:

King prawns	10–55 t
Tiger prawns	5–40 t
Endeavour prawns	5–20 t
Banana prawns	2–90 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, as occurred in 1997 and 2000.

New management initiatives (2003/04)

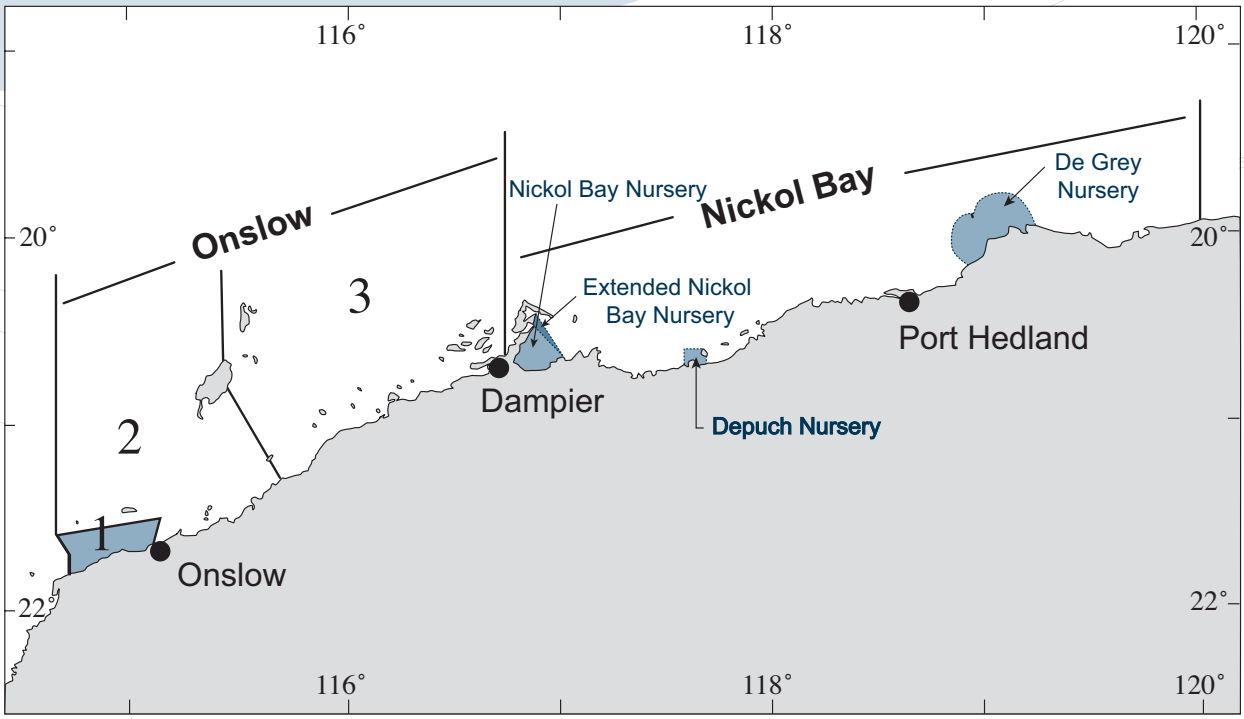
The Australian Government Department of Environment and Heritage is currently considering an application to certify the Onslow Prawn Managed Fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

Amendments to the Onslow Prawn Management Plan 1991 have recently been approved by the Minister and should be implemented later in 2004. These changes will help to modernise the plan and bring it into line with the management controls used in the state's other prawn trawl fisheries. Some of these amendments include the removal of the hull size control and the re-description of port areas and the Onslow townsite closure that will simplify the nominations process. Similarly, existing nursery areas have been redrawn and further inshore areas have been nominated for temporal and permanent closures. These temporal closure areas will be known as size management areas and permanently closed areas as nursery areas.

EXTERNAL FACTORS

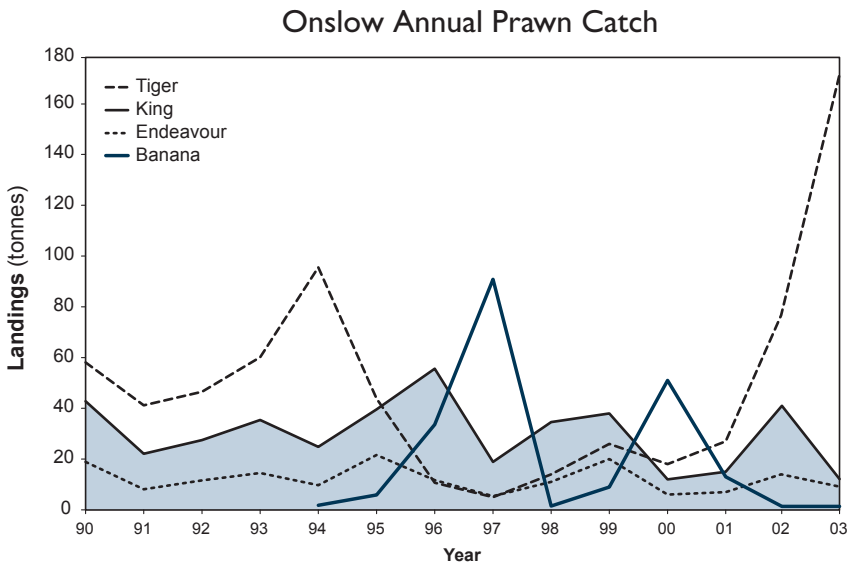
The catches taken are from a number of separate nursery areas and are highly variable from year to year. This is particularly the case for the rainfall-dependent banana prawn.

Catches of tiger prawns from this fishery are also quite variable, with very high catches seen in 2003. It is likely that severe cyclonic activity impacts negatively on tiger prawns in some years, and moreover, the effect varies depending on whether juvenile prawns are still in vulnerable, shallow nursery areas at the time. Severe cyclones can also impact directly on endeavour prawns. The king prawn catch has remained stable, indicating that environmental effects such as cyclonic activity (producing heavy rainfall) have little effect on the abundance of the king prawn stock. However, fishers report that there can be an indirect, short-term impact on the distribution of king prawns when heavy rainfall inland and subsequent river flooding appear to disperse the stock, affecting overall catches. At times, debris from flooding is reported to restrict fishing activities and hence landings for the year.



ONSLOW/NICKOL BAY PRAWN FIGURE 1

Boundaries of the Onslow and Nickol Bay Prawn Managed Fisheries.



ONSLOW PRAWN FIGURE 2

Annual landings for the Onslow Prawn Managed Fishery, 1990–2003.

Nickol Bay Prawn Managed Fishery Status Report

Prepared by M. Kangas, E. Sporer and J. Brown, with management input by G. Baudains

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

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'* (Onslow/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 and restrictions on boat size. Different areas within the fishery have different season dates allowing access to target species at appropriate times.

During the 2003 season the major fishing areas were open during the following periods:

Nickol Bay Nursery	1 May – 31 August
Extended Nickol Bay Nursery	1 Ma y– 15 November
Depuch Nursery	1 May – 31 August
De Grey Nursery	1 May – 15 November

The management system involves a total allowable effort arrangement where all boats have an equal allocation of headrope length. The fleet is composed of trawlers up to 23 m which operate twin or quad-rigged (four nets) otter trawls to a maximum headrope length of 16 fathoms (29.27m).

Bycatch reduction devices (grids) were fully implemented in the fishery in the 2003 season, with vessels required to have BRDs fitted to both nets. In addition, the vessel monitoring system has been in operation in the fishery since 2002.

Research summary

Research for the management of this small fishery involves stock monitoring and assessment utilising monthly return data provided by industry, information from boat skippers, and rainfall records. 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 operations.

RETAINED SPECIES

Commercial production (season 2003): 248 tonnes

Landings

The total landings of major penaeids for the 2003 season were 248 t, comprising 165 t of banana prawns, 59 t of king prawns, 21 t of tiger prawns and 2 t of endeavour prawns (Nickol Bay Prawn Figure 2). The total catch was within the acceptable catch range for this fishery.

The catch of banana prawns in 2003 was much higher than the projected catch range of 40–80 t (but within the acceptable catch range) and indicates that at lower rainfall levels, other factors as well may influence banana prawn catches. King, tiger and endeavour prawn catches were all within the acceptable ranges for these species.

Recorded by-product species for 2003 were 21 t of coral prawns, 5 t of bugs (*Thenus orientalis*), 2 t of shark, 1 t each of squid and mixed fish species and less than 1 t each of black tiger prawns (*Penaeus monodon*) and blue swimmer crabs (*Portunus pelagicus*).

Fishing effort/access level

There were 14 boats licensed to trawl for prawns in Nickol Bay during 2003, with all 14 boats fishing during the season.

During 2003, 725 days of fishing was recorded by boats licensed to fish in the Nickol Bay prawn fishery, compared to 647 days in 2002 and 289 in 2001.

Catch rate

Not assessed.

Recreational component: Nil

Stock 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).

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Projected catch next season (2004):
Banana prawns 250–370 tonnes

The catch projection for banana prawns, based on the 425 mm of rain during the 2003/04 summer period, is between 250 t and 370 t (Nickol Bay Prawn Figure 3).

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 2003, only 5% of the total Nickol Bay prawn fishery area was fished. The introduction of fish escapement devices within the nets by 2004/05 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, minimising 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, making 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

Estimated employment for year 2003 was 20–30 skippers and crew, with up to 20 people involved in onshore processing in the region.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $2.9 million

Ex-vessel prices for prawns vary depending on the grade of the product and the market forces operating at any one time. Generally, average prices received by vessels fishing along the Pilbara coast in 2003 were as follows:

Banana prawns	$11.00/kg
King prawns	$13.20/kg
Tiger prawns	$12.70/kg
Endeavour prawns	$7.00/kg
Coral prawns	$2.50/kg

FISHERY GOVERNANCE

Acceptable catch range for next season: 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

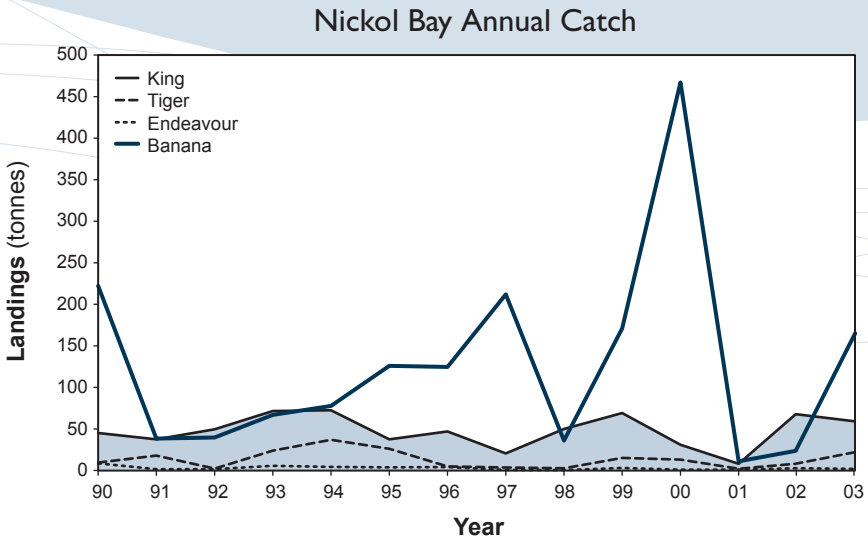
Note the overall acceptable range for all species combined is different from the aggregate of the individual species ranges shown because the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species in the same year. It should also be noted that the banana prawn catch has exceeded 400 t following extreme cyclonic rainfall on three occasions over the past 35 years and the predicted catch for 2004 may exceed the acceptable catch range based on historical catches due to high rainfall events in early 2004.

New management initiatives (2003/04)

The Australian Government Department of Environment and Heritage is currently considering an application to certify the Nickol Bay Prawn Managed Fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

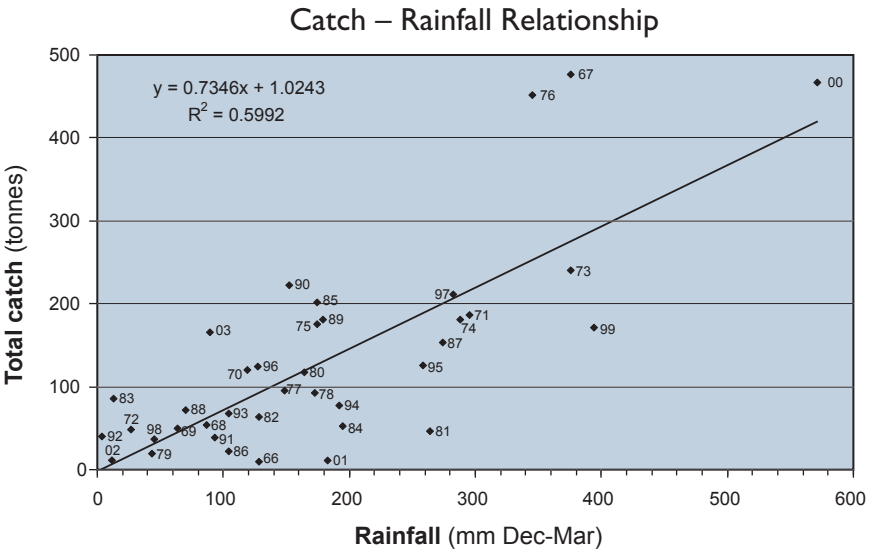
EXTERNAL FACTORS

The majority of boats in the prawn fleet of Nickol Bay are also licensed to trawl for finfish stocks offshore in the Pilbara Fish Trawl (Interim) Managed Fishery (PFTF). Some 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, and the catch rates available in these other fisheries. Fishing for finfish has encouraged the construction of larger boats with greater fishing power than would otherwise have been supported by fishing prawns alone. However, in recent years, concern about over-exploitation in the PFTF has led to time quotas and other restrictions. The impact of these restrictions has forced some of these larger fishing vessels to return to the NBPF and other fisheries for which they have licences, leading to variable effort in the fishery.



NICKOL BAY PRAWN FIGURE 2

Annual landings for the Nickol Bay Prawn Managed Fishery, 1990–2003.



NICKOL BAY PRAWN FIGURE 3

Relationship between banana prawn landings and rainfall between December and March for the years 1966–2003.

Broome Prawn Managed Fishery Status Report

Prepared by M. Kangas and E. Sporer, with management input by D. Harvey

FISHERY DESCRIPTION

The Broome Prawn Managed Fishery operates in a designated trawl zone off Broome and targets western king prawns (*Penaeus esculentus*) 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 Managed Fishery Licence

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°20' 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° east longitude; thence north to the intersection of 17°30' south latitude and 122° east longitude; thence north-west to the intersection of 17°20' south latitude and 122°55' east longitude; thence west to the commencement point'*.

Management arrangements

Management controls for the Broome Prawn Managed Fishery are based on limited entry, seasonal closures and gear controls.

The fishery dates generally coincide with the seasonal closures for the Australian Government's Northern Prawn Fishery (NPF) and the Kimberley Prawn Managed Fishery. In 2003, as in 2002, the longer NPF mid-season closure allowed a longer fishing period in the Broome fishery, where the season commenced on 24 May and closed on 12 August. There were three fishing periods around the new moon phase, thus optimising the best catching periods for king prawns for the time available in this fishery.

Bycatch reduction devices (grids) were fully implemented in the 2003 season, with all vessels operating in the fishery required to install grids in all gear (except try nets).

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 also completed which assists in the assessment of the king prawn stocks within this region.

RETAINED SPECIES

Commercial production (season 2003): 201 tonnes

Landings

The total landings for the 2003 season were 201 t, including 73 t of king prawns and 128 t of coral prawns (Broome Prawn Figure 1). King prawn landings for 2003 were approximately 18% below the five-year average (89 t) but within the acceptable range. The catch of coral prawns was the highest recorded in this fishery and greater than the acceptable range. It is assumed that this was due to improved recruitment.

Fishing effort/access level

Five WA-based NPF (Gulf of Carpentaria) boats are licensed to operate in this fishery.

A total of 77 days were fished in 2003. Nominal effort recorded in the daily research log books for the fleet was 4,158 hours, 3% higher than recorded in 2002 and the highest on record. The increased effort reflects the additional days allocated for fishing in 2003 over the appropriate moon phases, and the fact that catch rates (of the two species combined) were maintained over the extended fishing period.

Catch rate

A lower catch rate (17.4 kg/hr) than last year was observed for king prawns throughout the fishing period. This was 42% down on the five-year average but remained constant between May and August. Lower king prawn catch rates were observed in all northern prawn fisheries in 2003 and may have been due to poor environmental conditions over fairly large spatial scales. The catch rate of coral prawns was 30.9 kg/hr, 22% higher than the five-year average. The catch rate of coral prawns increased from May to August.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

A Delury depletion analysis incorporating lunar effects was carried out on the 2003 log book data to quantify the standing stock of king prawns in the Broome fishery. From this analysis, a standing stock of approximately 220 t was estimated. This indicates that for the 2003 season approximately 33% of the stock was taken by fishing, utilising the 4,158 hours of fishing recorded in this fishery. This compares with a stock estimate of 320 t in 2002 and an exploitation rate of 40%. The approach of using a depletion analysis has potential to examine variation in recruitment strength from year to year because the standing stock estimate for each year will reflect this. The depletion method applied has provided a good insight into stock levels. It has the advantage of being a very direct assessment method, with the potential to carefully control exploitation rates. It is intended to continue its use as the primary assessment method for this fishery.

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.

Exploitation status: Under-exploited

The exploitation rates obtained from the depletion analysis (30–40%) indicate that this fishery is still under-exploited (most prawn fisheries take 70–80%) despite the fishing effort being the highest on record over the last two seasons.

Breeding stock levels: Adequate

Depletion analysis indicated that approximately 67% of the king prawn stock was left when fishing ceased in the 2003 season. This stock would contribute to the spawning stock for 2004 and some females would have spawned prior to capture. These data indicate that the king prawn stock is being maintained well above the level of 20% of virgin biomass generally considered to be sufficient to sustain this type of prawn stock.

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 2003, 50% of the gazetted fishing area was fished, which represents less than 1% of the total Broome Prawn Managed Fishery area. The introduction of fish escapement devices within the nets by 2004/05 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 small number of boats involved, means that interaction with protected species is minimal. The full implementation of bycatch reduction devices (grids) in the fishery in 2003 has further minimised 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 this 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. The fishery is 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 Fisheries Research Division and industry 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 2003 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 2003: $1.3 million

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices received by boats fishing off Broome for 2003 were as follows:

King prawns	$13.20/kg
Coral prawns	$2.50/kg

FISHERY GOVERNANCE

Acceptable catch range for next season: 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 73 t of king prawns taken in 2003 is in the lower end of the acceptable range for this species. The catch of 128 t of coral prawns is above the range. The acceptable catch range may need to be reviewed since more accurate reporting of coral prawn landings is now occurring.

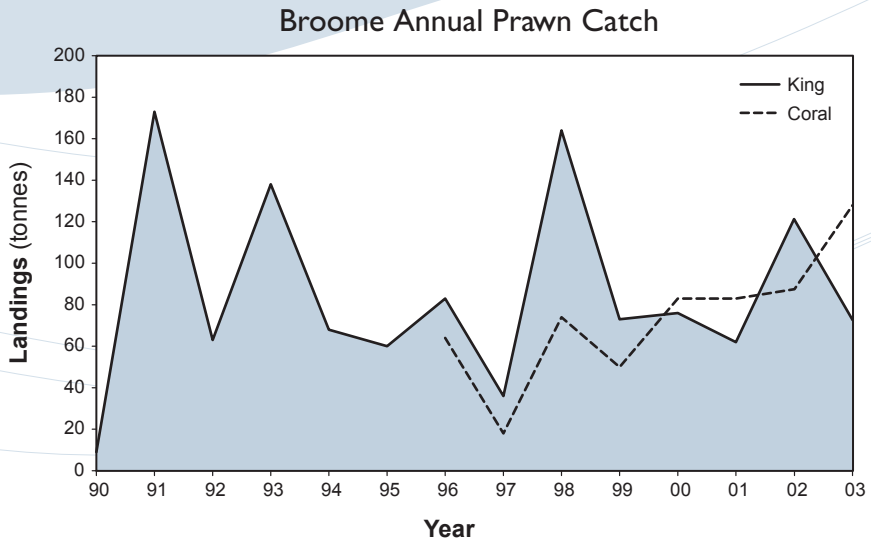
New management initiatives (2003/04)

The Australian Government Department of Environment and Heritage is currently considering an application to certify the Broome Prawn Managed Fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

EXTERNAL FACTORS

Catches of king prawns in the Broome Prawn Managed Fishery have fluctuated between 36 t and 173 t since 1991. Before that time this fishing area was used on a casual basis by boats transiting to the Northern Prawn Fishery in the Gulf of Carpentaria. 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

Annual landings for the Broome Prawn Managed Fishery, 1990–2003.

Kimberley Prawn Managed Fishery Status Report

Prepared by M. Kangas, E. Sporer and G. Parry, with management input by G. Baudains

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 Fishery Managed Fishery Licence

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 Australian Government's Northern Prawn Fishery (NPF).

Management arrangements

The management controls for the Kimberley Prawn Managed Fishery are based on limited entry, seasonal closures, gear controls and restrictions on boat replacements.

Seasonal dates for the Kimberley Prawn Managed Fishery are aligned with those of the adjacent Northern Prawn Fishery. 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 Kimberley fishery. Consequently, the 2003 Kimberley season opened on 1 April and closed for the mid-season closure on 27 May. The fishery re-opened on 1 September with a promulgated final season closure on 9 November.

In 2003 a total effort cap system was introduced that restricts the number of fishing days available within the fishing season, based on historical effort levels in the fishery. This was split as 600 days for the first half of the season and 900 days for the second half.

The vessel monitoring system has been in operation in the fishery since 2001. From the second half of the 2003 season, bycatch reduction devices (specifically grids) were also required in all gear (except try nets).

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 2003): 390 tonnes

Landings

The total landings for the 2003 season were 390 t, comprising 309 t of banana prawns, 47 t of tiger prawns, 26 t of endeavour prawns and 7 t of king prawns (Kimberley Prawn Figure 1).

The banana prawn catch was within the projected catch range (240–370 t) calculated using the relationship between

summer rainfall and catches. Banana, tiger and endeavour prawn catches were all within their acceptable catch ranges. Recorded by-products were 75 t of squid, 5 t of bugs and 1 t of coral prawns.

Fishing effort/access level

Although a total of 135 boats had access to the Kimberley Prawn Managed Fishery under various licensing arrangements, 32 boats operated in the fishery during some period of the year. Nineteen boats fished in the first half of the season and 25 boats operated in the fishery during the second half of the 2003 season.

During the 2003 season, the 32 vessels operated in the fishery for a total of 1,478 fishing days, compared to 30 vessels fishing 1,135 days in 2002. The effort cap in the first half of the season was 600 days and 468 days were fished during this period. The effort cap in the second half of the season was set at 900 days, and as it appeared likely that this total would be exceeded the fishery was closed on 27 October, two weeks before the promulgated closure date. A total of 1,010 days of fishing took place in the second half of the season.

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.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Projected catch next season (2004):
Banana prawns 230–350 tonnes

Rainfall during the period January–February 2004 was 511 mm at Derby and 615 mm at Kalumburu so the rainfall–catch relationship indicates that banana prawn catches for 2004 should be in the range of 230–350 t, which is a similar range to 2003.

NON-RETAINED SPECIES

Bycatch species impact: Low

The majority of the catch in this fishery comprises banana prawns, which usually form schools that are specifically targeted, meaning that bycatch is minimal. However, banana prawns may occasionally be dispersed due to the local tidal conditions in the Kimberley, with the result some untargeted trawling may also occur. Overall, the fishery is likely to have a low impact on bycatch species. The introduction of fish escapement devices within the nets by 2004/05 should reduce this risk even further.

Protected species interaction: Negligible

Grids were fully implemented in the fishery during 2003. These measures should minimise the catch of large animals including turtles.

ECOSYSTEM EFFECTS

Food chain effects: Low

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 Kimberley prawn trawl fishery operates over a very limited sector, estimated to be 7% of the licensed area during 2003. Owing to the unusual nature of the environment, characterised by extreme (10 m) tidal ranges, heavy mud substrates and high turbidity, the fishing is judged to have minimal impact on the habitat.

SOCIAL EFFECTS

Estimated employment for the year 2003 was 120 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003:
$4.3 million

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices received by boats fishing along the Kimberley coast in 2003 were as follows:

Banana prawns	$11.00/kg
Tiger prawns	$12.70/kg
King prawns	$13.20/kg
Endeavour prawns	$7.00/kg

FISHERY GOVERNANCE

Acceptable catch range for next season:
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 (2003/04)

The Australian Government Department of Environment and Heritage is currently considering an application to certify

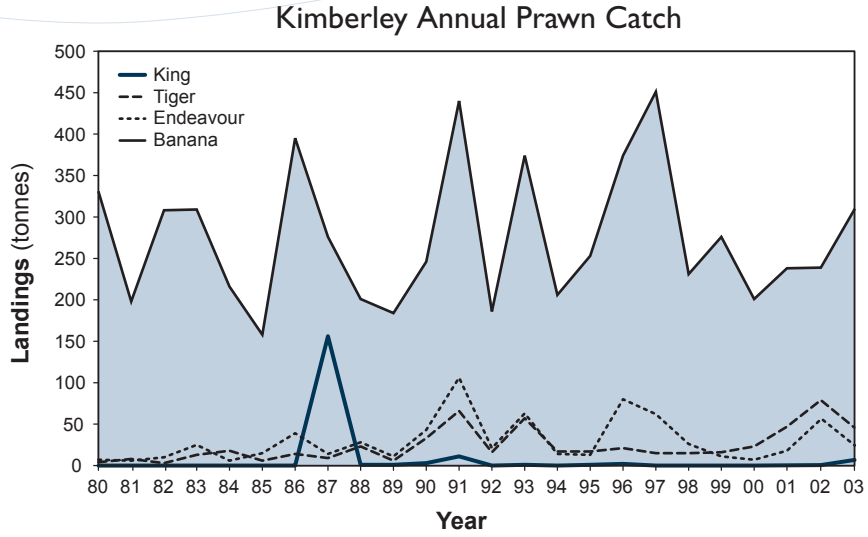
the Kimberley Prawn Managed Fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

The effort cap instigated in 2003 will be continued at the same level in 2004 and then reviewed.

EXTERNAL FACTORS

The relationship between summer rainfall and the catch of banana prawns is being investigated further. As banana prawns usually comprise the majority of the prawn catch from this fishery, this correlation will assist fishers and managers to make the best use of the fishery.

Few Kimberley-only boats operate for the complete fishing season. In general, boats from Nickol Bay and elsewhere in Western Australia operate within this fishery at certain times of the year to complement catches in their 'local' fisheries. Boats fishing in the Northern Prawn Fishery in the Gulf of Carpentaria also operate in this fishery for periods each year, with the Kimberley fishing season set to mirror dates used in the NPF. This was done to prevent the small Kimberley fishery from attracting too much fishing effort from its much larger neighbour. However, the effort cap that was introduced in 2003 addresses the issue of latent effort in this fishery.



KIMBERLEY PRAWN FIGURE 1

Annual landings for the Kimberley Prawn Managed Fishery, 1980–2003.

Kimberley Gillnet and Barramundi Managed Fishery Status Report

Prepared by S. Newman, with management input by D. Harvey

FISHERY DESCRIPTION

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) extends from the WA/NT border to the top of Eighty Mile Beach, south of Broome. It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi by any means.

The species taken are predominantly barramundi (*Lates calcarifer*), giant threadfin salmon (*Polydactylus macrochir*) and blue threadfin salmon (*Eleutheronema tetradactylum*). The main areas of the fishery are the river systems and tidal creek systems of the 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

Department–industry meetings

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' south latitude'.*

The distribution of barramundi and threadfin salmon catches in Western Australia extends south of the KGBF along the Pilbara coast. These latter catches are outside of the boundaries of the managed fishery, but have been shown 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 area closures and gear restrictions.

Access to the KGBF is currently limited to seven licences, with all seven vessels fishing during 2003. Currently there are also two exemption holders authorised to operate along the Eighty Mile Beach in the Pilbara Coast fishing area.

There is a closed season in which fishing is prohibited in the KGBF, from 1 December 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, and the Fitzroy River north of 17°27′ S.

There are also limits on the length of net to be used and mesh sizes in the fishery.

Research summary

A collaborative three-year FRDC-funded research project between Murdoch University and Department of Fisheries to study the biology of both the threadfin salmon species along with estuary cod, Malabar grouper and mangrove jack is due for completion in 2005. A detailed stock assessment of the threadfin salmons in the KGBF will be undertaken when the research study is finalised.

The data used in this report to assess the status of the series of barramundi stocks taken 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 2003):

All species 148 tonnes
Barramundi 45 tonnes
Threadfin salmon 94 tonnes

Landings

The principal species in the landed catch are two species of threadfin salmon – the giant threadfin salmon *Polydactylus macrochir* (also called whites) and the blue threadfin salmon *Eleutheronema tetradactylum* (also called blues) – and barramundi (*Lates calcarifer*). Lesser quantities of elasmobranchs (sharks and rays, e.g. blacktips, pigeyes, sawfish), black jewfish (*Protonibea diacanthus*) and tripletail (*Lobotes surinamensis)* are also landed.

There are five principal fishing areas within the north coast (Pilbara/Kimberley) bioregion: Cambridge Gulf (including Ord River), Kimberley Coast (six 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, 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 2003 was 148 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 45 t for 2003 (Kimberley Gillnet Figure 3), the highest catch of barramundi for 10 years and reflecting an increasing catch trend.

The 2003 landings of threadfin salmon in the KGBF were 94.1 t, more than double those of barramundi (Kimberley Gillnet Figure 4). Catches of threadfin salmon from the KGBF have increased sharply since 2001, with the 2003 catch near record highs. In addition, the reported catch of threadfin salmon in the Pilbara Coast fishing sector in 2003 was 65.1 t.

These two main species groups (barramundi and threadfin salmon) comprise 94% 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 2003 are summarised in Kimberley Gillnet Table 3.

Fishing effort/access level

The annual fishing effort in this gillnet fishery is calculated as the total number of fishing days by all boats multiplied by the average daily total of 100 m lengths of gillnet used per boat. During 2003, the total effort across the four prescribed fishing areas was 2,233 units. This total level of effort is the highest in the fishery since 1993 (Kimberley Gillnet Figure 2) and represents an increase of more than 40% from the level of effort units reported in 2002.

Catch rate

Both the catch and effort for barramundi were highest in the late 1980s and since then the total catch of barramundi has been steady while effort units used in the fishery have decreased. This resulted in an increase in the barramundi CPUE up until 2000. Subsequently, the barramundi CPUE has declined to low levels associated with increased levels of effort within the fishery (Kimberley Gillnet Figure 3).

The trends for catch and CPUE for threadfin salmon are very similar to barramundi: both peaked during 1999 and declined from 2000 to 2003 (Kimberley Gillnet Figure 4). It was reported previously that the reduced catch and CPUE from 1999 to 2001 may have resulted from a switch in targeting practices from threadfin to barramundi. However, in 2002 and 2003 there have been increasing catches of threadfin salmon due to increases in the level of effort in the fishery, with CPUE declining sharply.

The declining CPUE trends for both barramundi and threadfin salmon suggest that the increasing effort levels within the fishery may be a cause for concern.

Recreational component: Key species 8–11% (approx.)

A 12-month creel survey of recreational boat-based and shore-based fishing in the Pilbara and West Kimberley region was conducted from December 1999 to November 2000 (Williamson et al., in prep.). 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 about 300 t. Recreational fishers in the survey area reported an estimated total catch of about 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, and assuming similar recreational catch levels in 2003, the recreational catch can be estimated at around 11% of the combined (commercial and recreational) threadfin salmon catch and around 8% of the combined barramundi catch in these areas.

STOCK ASSESSMENT

Assessment complete: Yes

The last detailed stock assessment 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. The trends in catch and effort were relatively stable in the Broome Coast sector from 1998 to 2001, but both increased substantially in 2002 and 2003. This increase in catch and effort will be monitored closely in future years. The catch levels in Cambridge Gulf in 2003 were much higher than those recorded in 2002. There is on average an increasing trend in CPUE in the Cambridge Gulf sector. In King Sound the level of catch has reflected the level of effort expended in that sector of the fishery, noting that the CPUE has remained relatively stable. In both sectors, effort has tended to fluctuate at low levels. The level of catch in the Kimberley Coast sector has almost doubled in 2003.

The reported catch of threadfin salmon, the other key target species, declined from 1999 to 2001 before increasing in 2002 and 2003. The increased level of catch of both threadfin salmon and barramundi needs to be investigated further.

Exploitation status: Fully exploited

Barramundi are considered on average to be fully exploited.

Breeding stock levels: Adequate

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. The declining levels of threadfin CPUE in 2002 and 2003, however, require further investigation.

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 estuarine crocodiles (*Crocodylus porosus*). Because of the low effort levels, these impacts are unlikely to be significant.

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 2003, 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 local fresh fish for the tourist industry throughout the Kimberley region.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $843,000

The KGBF landed a total of 148 t of fish in 2003, for a catch value of approximately $843,000 (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 2000/01 average price per kilogram of whole weight of each species as supplied by fish processors.

The Pilbara Coast sector landed a total of 92 t of fish in 2003 for a catch value of around $373,000 (including an estimate of the value of shark fins landed by this fishery). The value of this sector is lower than the KGBF value as the catch of the highly prized barramundi is negligible in this sector. However, the catch of the KGBF and the Pilbara Coast sector together yields an annual value to fishers from this near-shore coastal fishing zone of over $1.2 million.

FISHERY GOVERNANCE

Acceptable catch range for next season: Barramundi 25–40 tonnes

The acceptable 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 past four years (1999–2002), the level of barramundi catch has been at the top end of the acceptable catch range. The catch in 2003 exceeded the catch range and thus there is a need to review the likely impacts of this increased level of exploitation.

New management initiatives (2003/04)

The Barramundi Accord 2000 is due to expire at the beginning of 2005. Therefore it is anticipated that 2004 will see the commencement of negotiations towards the next instalment of the Accord. The Department of Fisheries will facilitate meetings between commercial, recreational and indigenous stakeholders towards developing a new agreement.

EXTERNAL FACTORS

The barramundi stocks utilising the large, productive 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.

The reintroduction of recreational netting in the Pilbara and Kimberley is a major issue as the extent and magnitude of this component of the catch is not known.

Resource sharing between commercial and recreational fishers on the Ord River has been an ongoing issue of debate. However, recent and anticipated levels of commercial fishing by existing operators in this area are not considered to pose a threat to the viability of the resource.

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 2003.

CATCH CATEGORY	PRINCIPAL FISHING AREA				
	CAMBRIDGE GULF	KIMBERLEY COAST	KING SOUND	BROOME COAST	PILBARA COAST
Barramundi	4.9	23.1	6.4	10.6	<1.0
Threadfin Salmon	1.0	7.2	2.8	83.0	65.1
Total	**6.8**	**32.0**	**12.8**	**96.4**	**92.0**

KIMBERLEY GILLNET TABLE 2

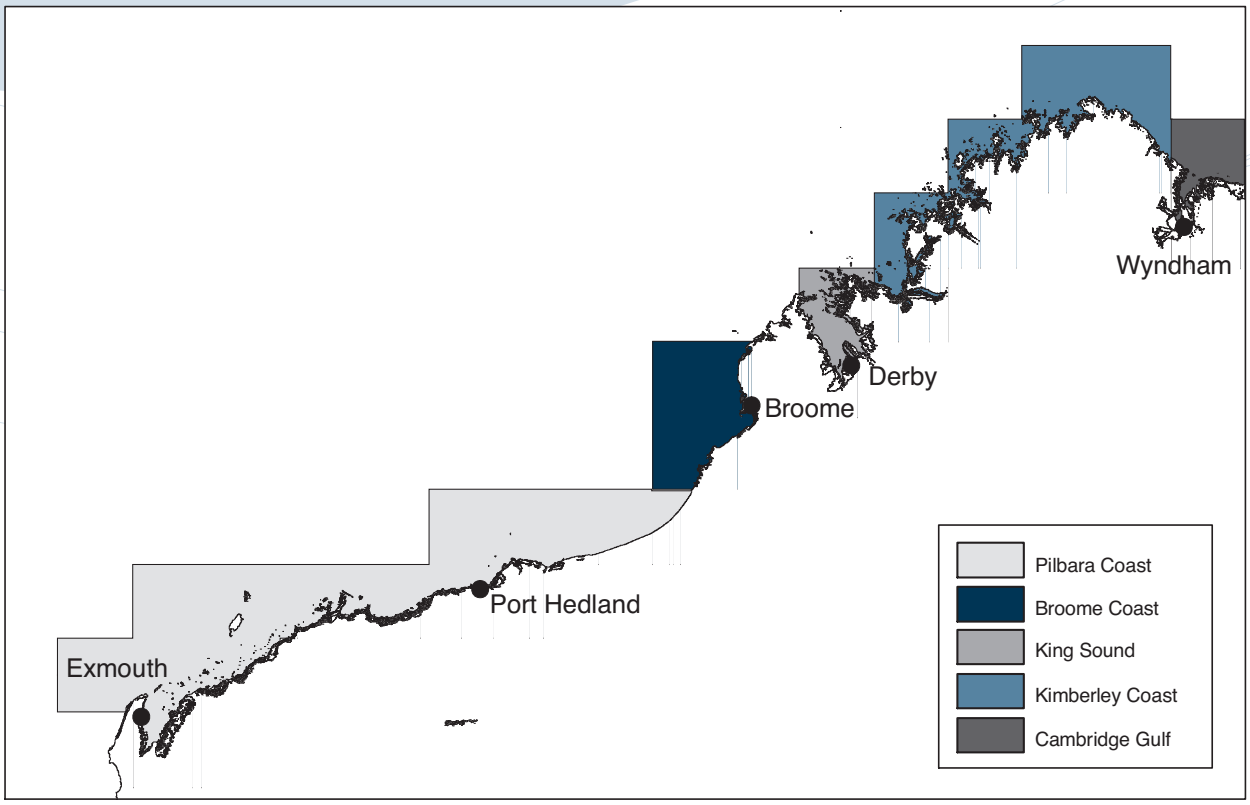
Recent annual catches of the major target species by the KGBF.

SPECIES	KIMBERLEY GILLNET ANNUAL CATCH (tonnes)								
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Barramundi	37.8	39.4	34.3	33.5	41.2	42.9	38.8	39.5	45.0
Threadfin salmon	32.5	51.0	80.2	81.3	109.8	66.7	50.9	76.4	94.1
Total	**81.2**	**101.0**	**124.6**	**123.2**	**160.4**	**120.7**	**100.5**	**124.4**	**148.0**

KIMBERLEY GILLNET TABLE 3

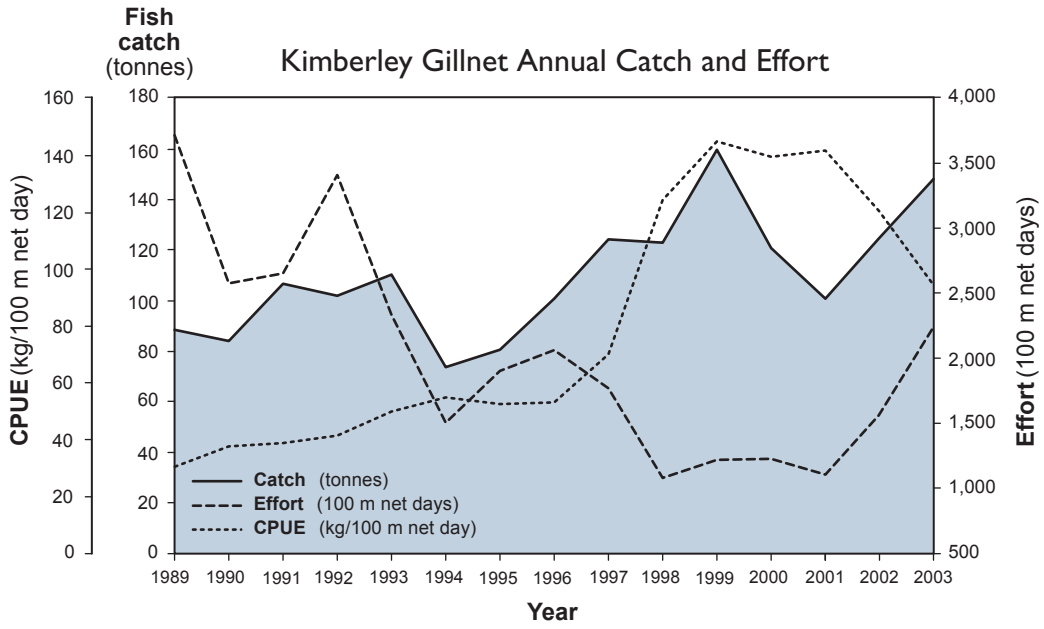
Summary of the reported catch (t) and percentage composition of each of the major species taken in the KGBF in 2003.

SPECIES	CATCH (tonnes)	COMPOSITION %
Threadfin salmon	94.10	63.55
Barramundi	45.00	30.41
Sharks and rays	4.60	3.08
Black jewfish	1.20	0.79
Tripletail	0.93	0.63
Other fish	2.30	1.54
Total	**148.13**	**100.00**



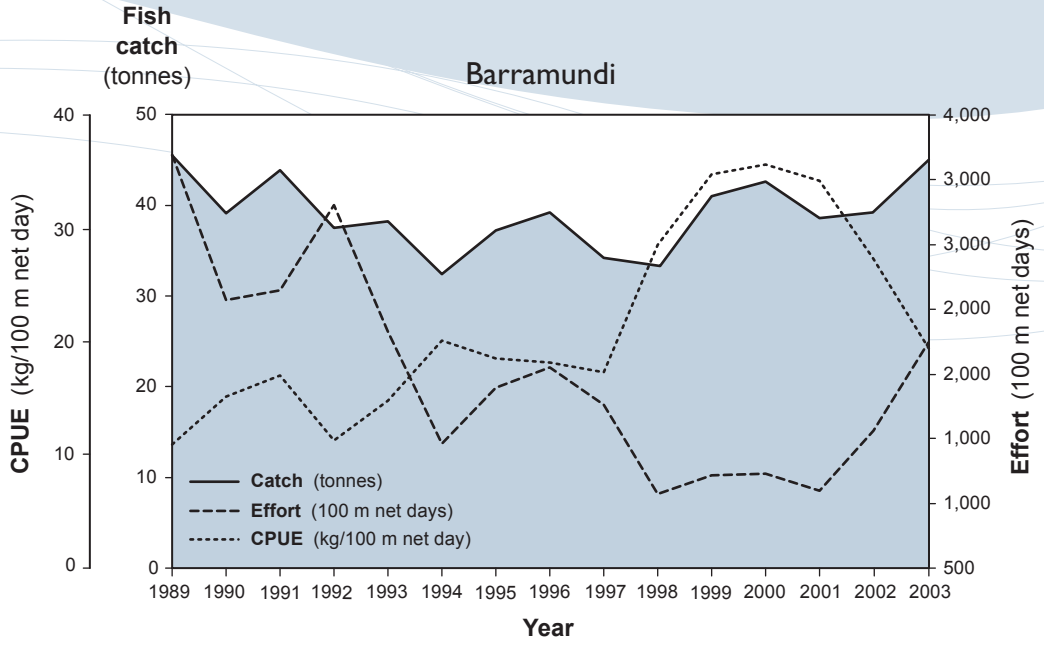
KIMBERLEY GILLNET FIGURE 1

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 below latitude 19° S.



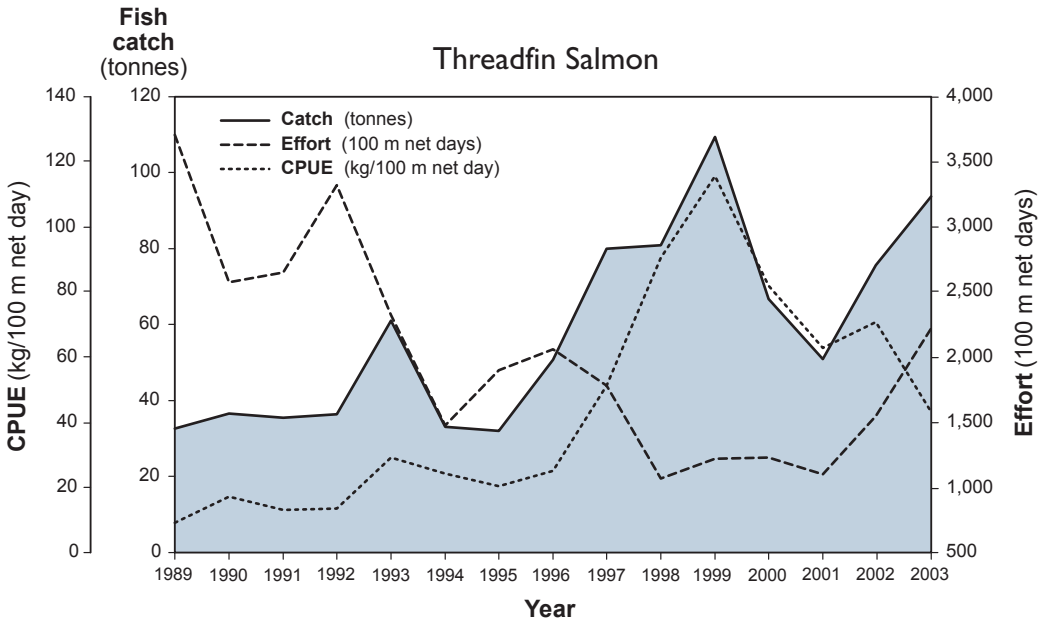
KIMBERLEY GILLNET FIGURE 2

The annual total catch, effort and catch per unit effort (CPUE, kg/100 m net day) from the KGBF over the period 1989 to 2003.



KIMBERLEY GILLNET FIGURE 3

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for barramundi from the KGBF over the period 1989 to 2003.



KIMBERLEY GILLNET FIGURE 4

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for threadfin salmon from the KGBF over the period 1989 to 2003.

Northern Demersal Scalefish Managed Fishery Status Report

Prepared by S. Newman, with management input by D. Harvey

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. Commercial catches are dominated by tropical snappers, emperors (or nor-west snappers) and groupers (or cods).

Governing legislation/fishing authority

Northern Demersal Scalefish Managed Fishery Management Plan 2000

Northern Demersal Scalefish Managed Fishery Managed Fishery Licence

Consultation process

Department–industry meetings

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'. Access to the research zone can be facilitated by the licence holders through the submission of an agreed research framework.

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 (TAC). The annual effort quota is determined by dividing the notional target TAC by the average catch rates per vessel per day within the fishery 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 2003, the notional TAC was 800 t of demersal scalefish and the total effort allocation was 1,760 days.

The NDSF introduced performance indicators for catches of the key target species, red emperor and goldband snapper, during 2002. Catch levels above these indicator values will result in a review of the stock assessment advice for the fishery.

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 2003, 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.

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. Little information is currently available on their species composition and relative abundance. 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 2003): 552 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). Following 1996 catch levels decreased and are now relatively stable at current levels. In the six years since the implementation of management controls, the reported catch in the NDSF has ranged between 430 t and 580 t, reflecting an annual average over this period of approximately 511 t. The catch of demersal scalefish in the NDSF in 2003 was higher than that reported in the previous year due to an increase in the trap catch, with no line catch reported (Northern Demersal Scalefish Table 1, Northern Demersal Scalefish Figure 2).

The NDSF principally targets red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidens* and related *Pristipomoides* species), with many species of snappers (Lutjanidae), emperors (Lethrinidae) and cods (Serranidae) comprising a large component of the landed by-product. The catch of the major target and by-product 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 2002. There was an increase in the landed catch of red emperor, up from 101 t to 118 t, concomitant with a large increase in the catch of goldband snapper from 152 t to 226 t. One of the performance measures for red emperor and goldband snapper is that the total annual catch of each should not increase by more than 20% above the annual average from the previous four years. Thus in 2003, the acceptable level of catch (average + 20%) for red emperor was less than 116 t and for goldband snapper was less than 253 t The 2003 level of catch for red emperor is marginally above the acceptable range and the level of catch in 2004 will be closely monitored. The goldband catch in 2003 is within the acceptable catch range.

Fishing effort/access level

The five fish trap vessels that fished in the NDSF in 2003 reported using between 20 and 48 fish traps per day. No line fishing was undertaken in the NDSF in 2003.

The effort allocated in 2003 was 160 fishing boat days per licence, or a total of 1,760 standard fishing days. The number of standard fishing days (SFDs) recorded using VMS data was 1,060, indicating that 700 SFDs remained unutilised in the fishery at the end of the season.

This level of fish trap effort in 2003 was the highest recorded since the introduction of management controls in 1998 (Northern Demersal Scalefish Table 2). Over this period, fish trap effort has varied between 890 and 1,060 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.

Catch rate

The average trap CPUE during 2003 was 585.2 kg per standard trap fishing day (20 traps x 29.26 kg/trap/day). The annual average trap CPUE in the fishery has ranged from 400 kg/day to 585 kg/day in the period from 1990 to 2003.

The introduction of management controls in 1998 resulted in an increase in catch per unit effort for trap vessels in the NDSF. This increase in CPUE 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 trap CPUE in 2003 has increased above that recorded in 2002; however, no overall trend in the trap CPUE is evident.

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 was undertaken in the fishery in either 2002 or 2003. Prior to 1998 the handline and dropline CPUE was low and variable.

Recreational component: Not assessed

At present there is little recreational or charter boat fishing effort directed towards those deeper-water fish species in Area 2 of the NDSF that are the key species targeted by commercial fishers. 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 the recreational fishing catch is small relative to the total commercial catch.

STOCK ASSESSMENT

Assessment complete: Yes

The introduction of formal management procedures has restricted the number of vessels permitted to fish in the waters of the NDSF. A notional target TAC of 800 t was initially adopted in order to constrain harvest rates to historical levels while formal management arrangements were put in place. The control mechanism implemented to maintain this catch level was a restriction on the number of trap or line days that could be fished by each vessel exploiting the NDSF resource.

Trap and line effort units (fishing days) are allocated annually on the basis of historical catch rate trends and set to enable the target TAC to be achieved within each year. The outcome from this effort determination process for the 2004 fishing season is outlined in the 'Acceptable catch range' section below. However, it should be noted that the level of catch in the NDSF over the past six years since effort controls were implemented appears to have stabilised in the range of 500–600 t due to the decision by vessel operators not to fully utilise the allocated effort each year.

Detailed biological information is now available on the two key demersal finfish species in the NDSF, red emperor and goldband snapper. This biological information has provided the foundation for detailed age-structured stock assessment models to be developed for the two key species.

The current stock assessment analyses indicate that the maximum sustainable yield of the two target species can be obtained at current effort levels. As such, the fishery is fully exploited.

It should also be noted that higher levels of catch from the fishery may be possible if the fishers modify their targeting practices to increase their exploitation of a number of

secondary (lower-value) species which are faster-growing and more productive.

Exploitation status: Fully exploited

The two key species are fully exploited.

Breeding stock levels: Adequate

The spawning biomass of the key target species in the NDSF has been estimated by the stock assessment model and assessed in relation to accepted international reference points for these types of species.

The assessment of breeding stock levels for the two key species is based on outputs from age-structured stock assessment models incorporating catch history and catch rate data from the area of the fishery. Current levels of breeding stock from the most recent stock assessment work indicate that goldband snapper is at approximately 41% of the estimated virgin level, while red emperor is at approximately 54% of the estimated virgin level. These levels are both above the recommended limit of 40% of the virgin spawning biomass and therefore the current breeding stock and catch levels are considered adequate.

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 2003 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 2003: $3.2 million

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery landed a total of 552 t of demersal scalefish in 2003, for a catch value of around $3.2 million. This estimate is based on the landed weight of each species recorded in the CAES system and the average price per kilogram of whole weight of each species as supplied by fish processors (note value is calculated from prices based on a price survey undertaken in 2000/01).

FISHERY GOVERNANCE

Acceptable catch range for next season: 600–1,000 tonnes

For the calendar year 2004, the total allowable effort was again set at 1,760 fishing days distributed equally among the licences operating 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.

In the six years since the introduction of management controls (1998–2003), the fleet has been unable to achieve the 800 t TAC. In each of these years a large amount of unutilised effort has remained at the end of the fishing year. Results from the age-structured stock assessment models for each of the key species in the NDSF indicate that the current levels of catch for both species are acceptable, as the spawning biomass of each species is above the limit biological reference point. However, if the catch level of either of the key target species increases by more than 20%, this increased level of exploitation and its possible impact on the stocks will need to be reassessed and discussed with industry.

New management initiatives (2003/04)

The Australian Government Department of Environment and Heritage is currently considering an application to certify the NDSF as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

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 the deep-slope fish resources within the fishery.

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.

NORTHERN DEMERSAL SCALEFISH TABLE 1

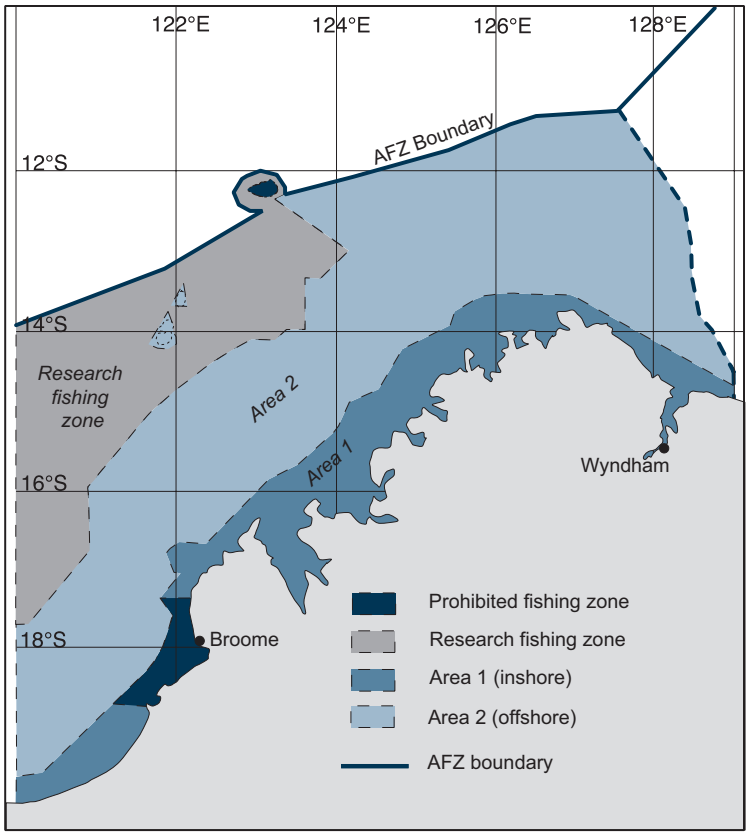
Recent annual catches of major target and by-product species or species groups by the NDSF.

SPECIES	NDSF ANNUAL CATCH (TONNES)				
	1999	2000	2001	2002	2003
Goldband snapper *(Pristipomoides* spp.*)*	292	189	209	152	226
Red emperor (*Lutjanus sebae*)	101	90	95	101	118
Scarlet perch *(Lutjanus malabaricus)*	18	23	39	61	48
Spangled emperor (*Lethrinus nebulosus*)	27	32	36	35	39
Cod/grouper (Serranidae)	76	75	84	49	74
Other species	63	67	45	36	47
Total demersal scalefish catch	**577**	**476**	**509**	**434**	**552**

NORTHERN DEMERSAL SCALEFISH TABLE 2

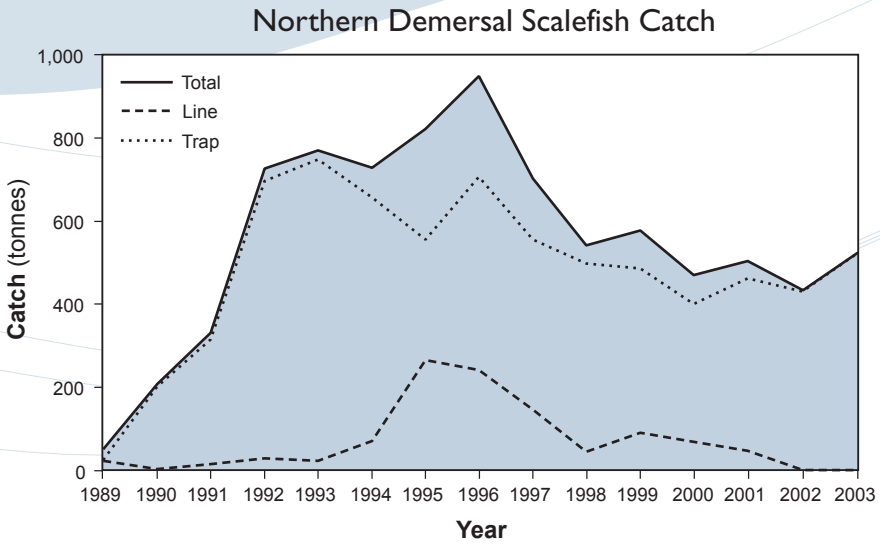
Catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF since the introduction of full management arrangements in 1998.

YEAR	TOTAL ALLOWABLE EFFORT (days)	LINE CATCH (tonnes)	LINE EFFORT (days)	TRAP CATCH (tonnes)	TRAP EFFORT (days)	TOTAL CATCH (tonnes)
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**	**526**	**1,060**	**552**



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, 1989–2003.

Pilbara Demersal Finfish Fisheries Status Report

Prepared by P. Stephenson and J. King, with management input by 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, some demersal scalefish are taken by 'wetline only' vessels that do not have access to specific managed fisheries.

The trawl fishery targets 10 main species, namely blue-spot emperor (*Lethrinus hutchinsi*), threadfin bream (Nemipteridae), flagfish (*Lutjanus vitta*), red snapper (*Lutjanus erythropterus*), red emperor (*Lutjanus sebae*), scarlet perch (*Lutjanus malabaricus*), goldband snapper (*Pristipomoides multidens*), spangled emperor (*Lethrinus nebulosus*), frypan snapper (*Argyrops spinifer*) and Rankin cod (*Epinephelus multinotatus*).

The main catch in the trap fishery comprises six of these same species (blue-spot emperor, spangled emperor, red emperor, Rankin cod, red 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)

Consultation process

Department–industry meetings

Boundaries

The boundaries of the Pilbara Fish Trawl (Interim) Managed Fishery are the waters lying north of latitude 21°35′ S and between longitudes 114°9′36″ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 50 m isobath (Pilbara Figure 1). The trawl fishery consists of two zones. Zone 1, in the west of the fishery, is currently not being trawled. In Zone 2, the interim management plan introduced in 1998 set down boundaries for six management sub-areas. The exact latitudes and longitudes delineating the areas are listed in the Pilbara Fish Trawl Fishery (Interim) Management Plan 1997.

The Pilbara Trap Managed Fishery (Pilbara Figure 1) lies north of latitude 21°44′ S and between longitudes 114°9′36″ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath. The exact latitudes and longitudes delineating the fishery are listed in the Pilbara Trap Management Plan 1992.

Management arrangements

The 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 main target species and age-structured modelling of red emperor, Rankin cod and blue-spot emperor. 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 two vessels in 2003.

In 2003, following a research stock assessment, the value of allocated units was altered to effect a 7% overall effort reduction in the trawl and trap fishery. The trawl unit value was reduced by 10% in Areas 1 and 5 to achieve this.

A comprehensive risk assessment was conducted for the trawl and trap fisheries while developing an application for environmental sustainability certification. This process has determined a number of performance indicators for the fisheries, which state that a review and possible management action will be triggered if:

- spawning biomass across all management areas of the Pilbara falls below 40% (target) and 30% (limit) of the 1972 level for red emperor, the 1990 level for Rankin cod, or the 1993 level for blue-spot emperor (these three species are used as indicators of the other species in the fishery);
- the catch rate of any of the main target species has decreased in three consecutive years; or
- the catch of any of the main target species has increased by more than 20% of the previous four-year average.

Plans for future management of line fishing in the Pilbara are being considered during the current statewide wetline fishing review.

Research summary

Baseline research for managing these important fish stocks was conducted in two FRDC-funded projects from 1993 to 1999, providing a basis for long-term research monitoring of the stocks.

The monitoring of the Pilbara fishery now focuses on the collection of spatial data on effort and catch of 10 major target species in the trawl and trap fisheries. Otoliths (for age-composition analysis) are collected from the trawl catches of the three indicator species red emperor, Rankin cod and blue-spot emperor, and from 2004 will also be collected from goldband snapper. The status of the fishery is determined annually using catch and catch rates of the 10 major species, and every two to three years the data on the indicator species will be incorporated in the age-structured stock assessment model.

In 2004, an observer program will commence in the trawl fishery to improve estimates of the quantity of bycatch, especially protected species. In addition, an FRDC-funded bycatch mitigation project will commence. This will investigate ways of reducing the catch of dolphins and turtles.

RETAINED SPECIES

Commercial production (season 2003):

Trawl 2,860 tonnes
Trap 363 tonnes
Line 81 tonnes

Landings

Catches of the major species for 2003 are shown in Pilbara Table 1. The catches by different fishing methods for the years 1985 to 2003 are shown in Pilbara Table 2 and illustrated in Pilbara Figure 2. Demersal scalefish catch by trawl, trap and line was 2,860 t, 363 t and 81 t respectively.

The trawl catch was outside the acceptable range due to retention of a greater variety of species and increased catch rates of many species. The composition of the trawl fishery demersal scalefish catch changed in 2003 with increased catches of some small species (blue-spot emperor, flagfish and threadfin bream) and a decrease in catches of some larger species (spangled emperor, red snapper and goldband snapper). Thus the major target species landed in 2003 (2002 catch in brackets) were blue-spot emperor 601 t (353 t), threadfin bream 456 t (363 t), flagfish 244 t (211 t), red snapper 220 t (278 t), red emperor 106 t (79 t), scarlet perch 91 t (82 t), goldband snapper 79 t (99 t), spangled emperor 39 t (19 t) and Rankin cod 24 t (17 t). Retained by-product was154 t, including shark 67 t (68 t), bugs 7 t (5 t) and cuttlefish 78 t (104 t). The catch performance indicator was triggered in 2003 with blue-spot emperor, threadfin bream, red snapper, red emperor, goldband snapper and spangled emperor catches exceeding the four-year average by more than 20%. The catch levels of these species will require review in 2004.

The trap fishery catch increased to 363 t in 2003 (306 t in 2002). Major species taken by the trap fishery in 2003 (2002 figures in brackets) were blue-spot emperor 68 t (57 t), red emperor 43 t (36 t), Rankin cod 39 t (20 t), red snapper 38 t (41 t) and goldband snapper 34 t (38 t). The trap catch was outside the acceptable catch range due to fishers retaining a greater variety of species and the catch rate increasing for several species. There is no by-product in this fishery.

Demersal scalefish catches by line fishing were lower in 2003 at 81 t (90 t in 2002). The catches in 2003 (2002 figures in brackets) were mainly goldband snapper 16 t (27 t), red emperor 6 t (6 t), spangled emperor 5 t (11 t) and Rankin cod 3 t (3 t). In addition, line vessels recorded catches of 133 t (193 t) of sharks and rays (which includes part of the North Coast Shark Fishery catch) and 132 t (119 t) of mackerel in the Pilbara.

The Pilbara shark catch is reported in more detail in the Northern Shark Fisheries Status Report (pp. 146-150), and the mackerel catch in the Mackerel Fishery Status Report (pp. 141-146).

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 2003 is also recorded as the net bottom time (hours) taken from skippers' voluntary log book 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 (verified by a satellite monitoring system), the number of hours used (VMS effort), and the percentage of the allocation used over the period 1998–2003 are shown in Pilbara Table 4.

The management plan allows for some over-run in effort between areas. In 2003 the effort over-run was 1% in Area 2 and 4% in Area 4 (compared with 1% and 3% in 2002). There was no trawling in Area 3 or Area 6 in 2003.

Two trap boats were allocated 5,867 trap units in 2003 (days multiplied by number of traps) and the number of units used, calculated from VMS, was 5,733. This number of units equates to 389 days fished with an average of 13.7 traps per day, a decrease from the average of 15.2 traps used per day in 2002. The number of days allocated, the number of days used and the percentage of the allocation used for the period 2000–2003 are shown in Pilbara Table 5.

In 2003, line fishers reported operating for 715 days, compared with 660 days in 2002. This effort does not include trolling, which is reported in the Mackerel Fishery Status Report (pp. 141-146), nor the dropline and longline effort in the Northern Shark Fisheries (pp. 146-150).

Catch rate

Concerns over the decline in catch rates of Rankin cod and spangled emperor in 2002 resulted in a review and consequent effort reduction in 2003. In 2003, catch rates increased for the target species, including Rankin cod, and this indicator was not triggered.

The trawl catch rates (based on nominal VMS effort) for red emperor increased in every area of the fishery, between 30% and 50%. The catch rates in kg/hour for 2003 (2002 in brackets) in Areas 1, 2, 4, and 5 were 3.5 (2.2), 9.6 (6.3), 7.1 (5.2) and 4.3 (3.4). Rankin cod trawl catch rates have also increased in 2003. Based on nominal effort the 2003 catch rates in kg/hour (2002 in brackets) were 0.8 (0.4), 1.6 (1.2), 2.2 (1.4) and 1.5 (1.1). The trawl catch rates of the major species, pooled for all areas, between 1989 and 2003 are shown in Pilbara Figure 3 and Pilbara Figure 4. The total demersal scalefish catch rate from the trawl fishery increased by 27%, from 112 kg/hour in 2002 to 142 kg/hour in 2003, due to increased stock size, retention of a greater variety of species, and increased efficiency.

Catch rates of the major species in the trap fishery (based on reported number of days fished) from 1985 to 2003 are shown in Pilbara Figure 5. The total scalefish catch rate increased from 801 kg/day in 2001 to 933 kg/day in 2003 (a 25% increase) due to increased stock size, retention of more short-lived species, and some efficiency increase.

The line catch rate in 2003 was considerably lower than in 2002.

Recreational component: **< 2%**

There is a major recreational fishery in the Pilbara and the charter sector in this area is an increasing user of the resource, however the inshore closures to the commercial sector provide a degree of separation between the two groups. The reported charter catches of the two key commercial species, red emperor and Rankin cod, were 3 t and 1 t respectively in the Pilbara in 2002/03.

In addition, there are data available 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., in prep.). 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 about 300 t. Recreational fishers in the survey area reported an estimated total catch of 12 t of spangled emperor, 6 t of red emperor, and less than 1 t of scarlet perch. Boat- and shore-based recreational fishers do not catch significant quantities of the other species that are targeted by the commercial Pilbara trawl, trap and line fisheries, which generally operate further offshore.

STOCK ASSESSMENT

Assessment complete: **Yes**

Red emperor and Rankin cod are used as indicators of long-lived species and blue-spot emperor is used as an indicator of short-lived species.

In 2002, the stock assessment model used catches from the four sectors of the fishery (trawl, trap, line and recreational) together with catch rate and age-composition data from the trawl fishery. The assessment indicated that the stock of the three species appears adequate. The model using 2002 data indicated an upward trend in spawning biomass of red emperor, depleted Rankin cod stocks in Area 5, and the blue-spot emperor stock in Area 1 depleted but increasing.

The 2003 catch rates increased in all areas for these three indicator species, generally confirming the model predictions.

There have been quite variable efficiency increases between vessels in the Pilbara trawl fishery in 2002 and 2003, with consolidation of the fleet and vessel changes resulting in an estimated efficiency increase of 15% in the two-year period. It also appears that some of the additional increase in catch rate (20% over two years) is due to increased stock size of target species and a reduction in the quantity of discarded fish. It is likely that the 7% effort reduction introduced in 2003 will need to be followed by a further effort reduction in the trawl and trap sector to compensate for efficiency increases.

The line fishers in the Pilbara have unrestricted access and this continues to be of concern. There are ongoing indications that line fishers are operating in deeper water targeting goldband snapper and other deeper-water species which generally have a biology which makes them vulnerable to over-exploitation. The goldband snapper stocks in the Pilbara are managed separately from the adjacent Gascoyne and Kimberley regions as there is little mixing of recruited goldband snapper over this spatial scale. The very high goldband catch by line fishers in

the Pilbara in 2001 highlighted the risk to the stock posed by a small number of dedicated line operators.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

The spawning biomass of the indicator species was above the target performance level and this is supported by increasing catch rates.

The effort reduction in 2003 should ensure breeding stock levels of the indicator species are maintained at satisfactory levels in the short term. Effort adjustment to compensate for any further increased efficiency will be necessary in the future.

NON-RETAINED SPECIES

Bycatch species impact: Low

The bycatch survey in the trawl fishery (Stephenson and Chidlow 2003) indicated an annual discard of 1,000 t of unmarketable scalefish and 150 tonnes of sharks. The scalefish and small species of sharks returned to the water are expected to have poor survivorship.

The trap and line fisheries have minimal bycatch.

Protected species interaction: Moderate

The trawl bycatch survey (Stephenson and Chidlow 2003) documented the 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. Given the area of distribution and expected population size of these protected species, the impact of the trawl on protected species is probably minimal. There is a small catch of green sawfish, a species which is expected to be protected in the near future.

A new trawl log book, revised to enable the recording of protected species, was introduced at the end of 2003. Mechanisms to reduce the interaction of fishing gear with dolphins are being investigated.

There is no indication of interaction between the line fishery and protected species. The trap fishery has a negligible impact on protected species.

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 restricted to a relatively small proportion 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 area open to trawling, 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. Recent analysis of archived photographs of benthos by CSIRO indicates the diversity was greatest in Area 1 of the trawl fishery. It is not known whether the detachment rate exceeds the rate of regrowth.

SOCIAL EFFECTS

It is estimated that 22 fishers on 4 vessels were directly employed during 2003 in the Pilbara trawl fishery, and 7 fishers on 2 vessels in the trap fishery. The level of employment in line fishing is not available.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $11.2 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 blue-spot emperor and threadfin bream, and its value in 2003 was $9.1 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 $1.7 million (trap) and $400,000 (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. 146-150) and the Mackerel Fishery Status Report (pp. 141-146) respectively. The trawl fishery also has a retained by-product valued at $500,000.

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 (2004):

Trawl 2,000–2,800 tonnes
Trap 160–360 tonnes
Line 50–115 tonnes

In the trap and line fisheries, the acceptable catch range was previously based on the catch variation of the target

species over the period 1993 to 2001. In the trawl fishery, the acceptable catch range was determined from the past catch rates and the allocated effort.

The trawl and trap fishery catches in 2003 were above the acceptable ranges as previously set (trawl 1,900–2,200 t, trap 150–300 t) due to retention of more species, increased stock size, and to a lesser extent efficiency increases.

Between 2001 and 2003 there was an effort reduction of 7% and an estimated increase in the exploitable biomass of 20%. On this basis, the acceptable catch range for the trawl fishery has been revised to 2,000–2,800 t, and for the trawl fishery to 160–360 t.

Consideration should be given to setting an effort level in the trawl and trap fishery which could be left unadjusted for several years. There would need to be appropriate adjustment to the allocated effort in the trawl and trap sectors. The increased line catch of deep-water species like goldband snapper and the increasing charter catch are also cause for concern, as these sectors do not have effort or catch limits at present.

New management initiatives (2003/04)

On 1 July 2003, the management period for the trawl fishery changed from calendar year to financial year. This will facilitate effort management by fishers in the peak pre-Christmas marketing period when cyclones are more likely to occur.

The Australian Government Department of Environment and Heritage is currently considering an application to certify the Pilbara trap and trawl fisheries as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

Planning for future management of line fishing in the Pilbara is continuing.

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 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 2003.

		FISH TRAWL CATCH		TRAP CATCH		LINE CATCH		TOTAL CATCH
		tonnes	%	tonnes	%	tonnes	%	tonnes
Blue spot emperor	*Lethrinus hutchinsi*	601	90%	68	10%	-	-	669
Threadfin bream	*Nemipteridae*	456	100%	-	-	-	-	456
Red snapper	*Lutjanus erythropterus*	220	84%	38	15%	3	1%	261
Flagfish	*Lutjanus vitta*	244	97%	7	3%	-	-	251
Goldband snapper	*Pristipomoides multidens*	79	61%	34	27%	16	12%	129
Red emperor	*Lutjanus sebae*	106	68%	43	27%	6	5%	155
Scarlet perch	*Lutjanus malabaricus*	91	87%	10	10%	4	3%	105
Spangled emperor	*Lethrinus nebulosus*	39	38%	59	57%	5	5%	103
Frypan snapper	*Argyrops spinifer*	47	98%	1	2%	-	-	48
Rankin cod	*Epinephelus multinotatus*	24	36%	39	60%	3	4%	66
Other demersal scalefish		953	90%	64	6%	44	4%	1,061
All demersal scalefish		**2,860**	**87%**	**363**	**11%**	**81**	**2%**	**3,304**
Shark and ray		67	33%	0	-	133*	67%	200
Other by-product		87	100%	0	-	0	-	87

* Includes part of the North Coast Shark Fishery catch.

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.

	DEMERSAL SCALEFISH				BY-PRODUCT*
YEAR	Line	Trap	Trawl	Total	Trawl
1985	180	168	-	348	-
1986	65	113	-	178	-
1987	67	192	3	262	-
1988	136	243	3	382	-
1989	104	457	124	685	-
1990	157	407	421	985	4
1991	107	119	754	980	14
1992	63	148	1,413	1,624	21
1993	67	178	1,724	1,969	42
1994	79	207	2,506	2,792	102
1995	95	222	2,821	3,138	77
1996	136	302	3,201	3,639	102
1997	109	234	2,630	2,973	133
1998	78	250	2,512	2,840	119
1999	50	371	2,136	2,419	69
2000	59	257	1,995	2,314	80
2001	99	266	2,221	2,592	150
2002	90	306	2,310	2,706	180
2003	**81**	**363**	**2,860**	**3,304**	**154**

* 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	17,329
2003	**715**	**412**	**-**	**14,663**

PILBARA TABLE 4

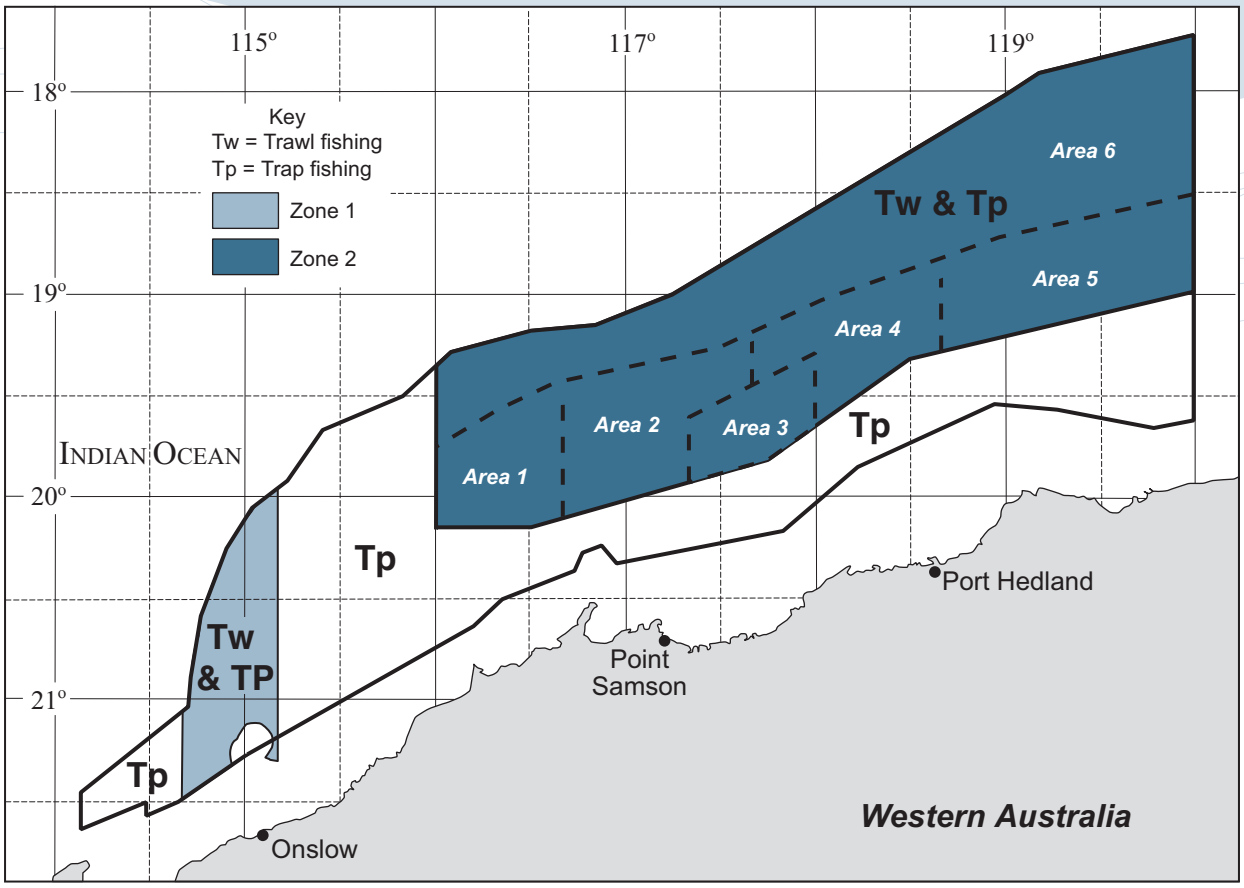
The number of hours allocated, the number of hours used and the percentage of the allocation used in each area of the Pilbara trawl fishery.

		AREA 1	AREA 2	AREA 3	AREA 4	AREA 5	TOTAL
1998	time allocation	17,136	3,360	0	3,360	5,712	29,568
TRAWL	time used	15,076	3,842	0	3,736	4,955	27,609
	% of time used	88%	114%	-	111%	87%	93%
1999	time allocation	11,481	3,360	0	3,057	5,198	23,096
TRAWL	time used	10,237	3,767	0	3,213	4,973	22,190
	% of time used	89%	112%	-	105%	96%	96%
2000	time allocation	11,481	3,360	0	3,057	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%**

PILBARA TABLE 5

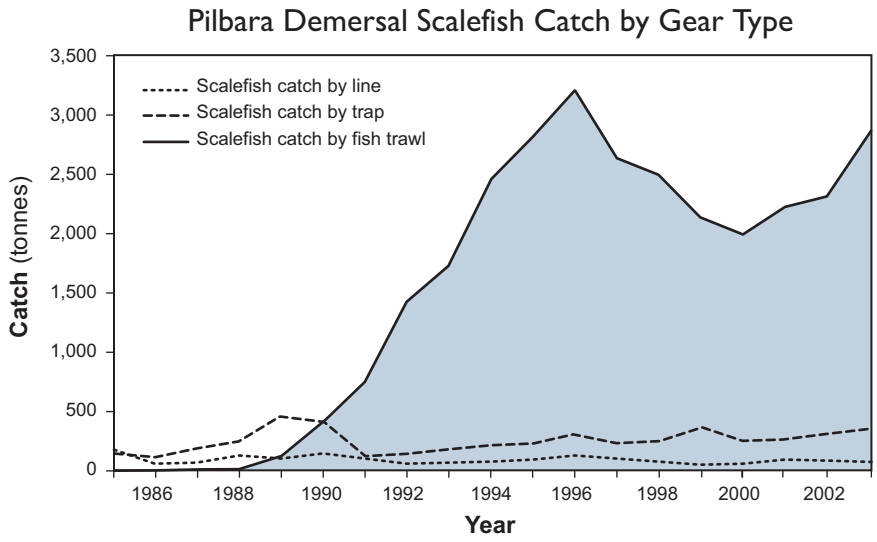
The number of days allocated, the number of days used and the percentage of the allocation used in the Pilbara trap fishery.

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%**



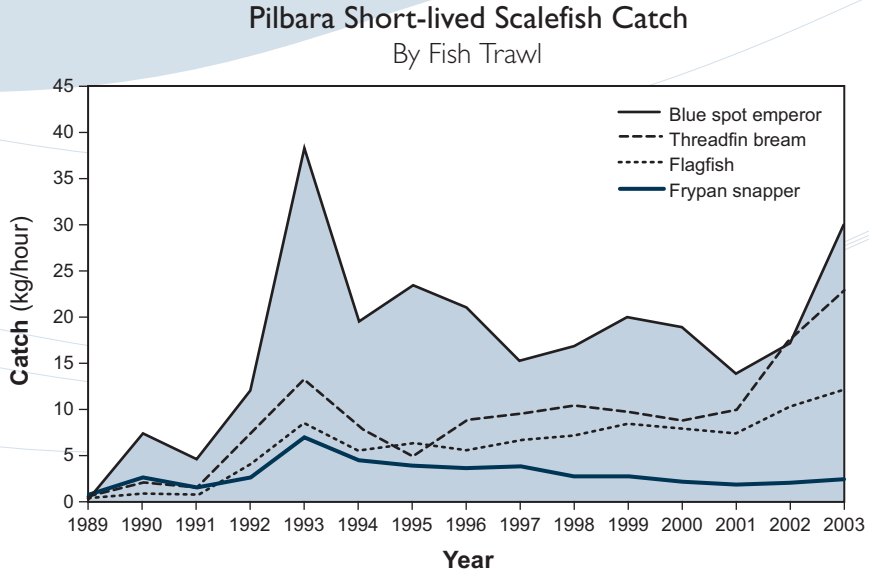
PILBARA FIGURE 1

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.



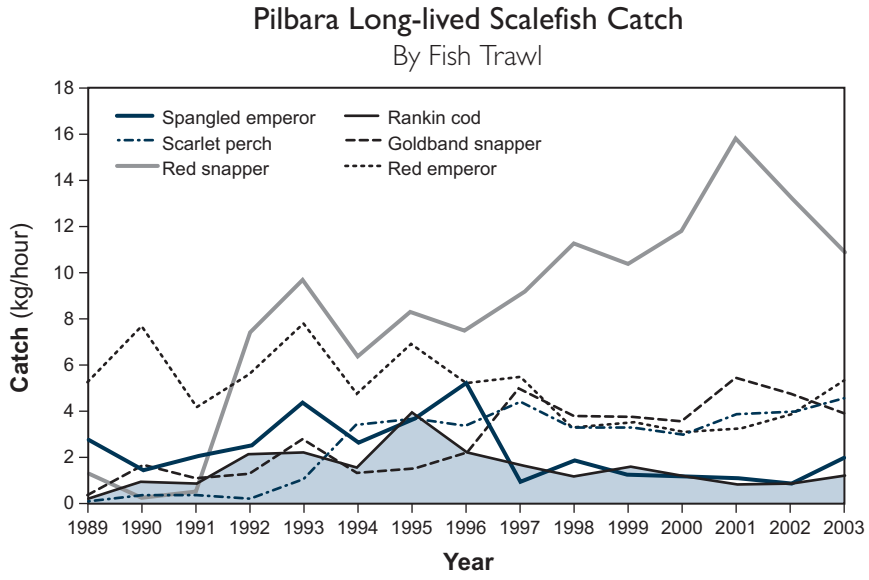
PILBARA FIGURE 2

Demersal scalefish catches by trawl, trap, and line from 1985 to 2003.



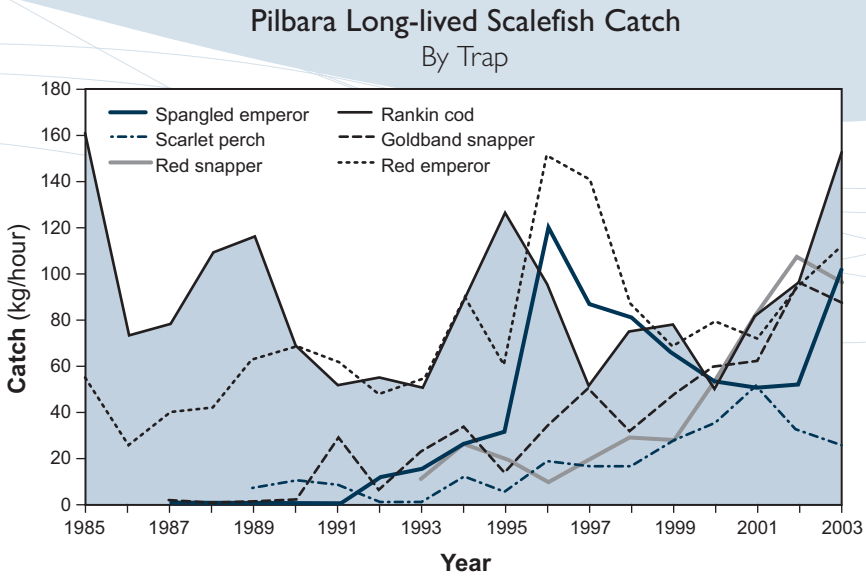
PILBARA FIGURE 3

Catch rates (kg/hour) of short-lived scalefish caught by trawl from 1989 to 2003.



PILBARA FIGURE 4

Catch rates (kg/hour) of long-lived scalefish caught by trawl from 1989 to 2003.



PILBARA FIGURE 5

Catch rates (kg/day) of long-lived scalefish caught by trap from 1985 to 2003.

Mackerel Fishery Status Report

Prepared by M. Mackie, with management input by J. Kennedy

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 mackerel (*Scomberomorus semifasciatus*). The commercial fishery mainly operates between Geraldton and the WA/NT border, with the largest catches being recorded off the Kimberley and Pilbara coasts. Fishing methods vary somewhat to suit the conditions in different regions.

Kimberley: Some operators in the Kimberley use dories, small boats of approximately 4–6.4 m in length which work in conjunction with the main fishing boat (usually 15–20 m in length). Each dory usually trolls two to three lines. Fishing gear used in this area is relatively heavy (8–10 mm rope with a 200+ kg mono line and wire trace), crew numbers vary between three and five, and fishing trips generally last between one and three weeks. Mackerel captured in this area are usually filleted, boxed and frozen for distribution throughout Australia.

Pilbara: Vessels used in this area are between 9 and 15 m in length, with one to two crew using 180 kg mono line and wire trace. In recent years the main catches from this area have come from the vicinity of Port Hedland. Fishing trips usually last less than a week, and the product is trunked, brined, and sold locally or sent fresh to Perth markets.

Gascoyne/west coast: Boats used in these areas are usually 7–15 m in length and are crewed by one to two persons for trips of one to five days' duration. Fishing gear used is rod and reel with 20–30 kg line and wire trace. Fish caught by Carnarvon- and Quobba-based fishers are usually kept whole in brine for export, while fish landed at other ports are usually trunked and sold locally or sent fresh to Perth markets.

Governing legislation/fishing authority

Fish Resources Management Regulations 1995
Fishing Boat Licence

Consultation process

Department–industry meetings

Boundaries

While the mackerel fishery at this stage has no formal boundaries, catches are reported in 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).

Management arrangements

The mackerel fishery is currently open to all WA fishing boat licence holders and subject only to minimum legal sizes of 90 cm total length (TL) for Spanish mackerel, 75 cm TL for grey mackerel and 50 cm TL for 'other' mackerel.

However, formal management of the fishery will commence in the latter half of 2004 under an interim management plan (IMP), which has been developed in consultation with a Mackerel Independent Advisory Panel and stakeholders.

The new management arrangements will initially limit access to each of the three areas of the fishery (Kimberley, Pilbara and Gascoyne/west coast) to those who meet specific access

criteria and will impose closed seasons. Catch quotas for each area will be introduced in 2006.

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, which is the main target species in the Western Australian mackerel fishery. Together, these projects provided description of the biology, spatial structure and status of mackerel stocks in Western Australian waters, and serve as a basis for management arrangements to control future catches from the fishery.

A long-term recruitment monitoring project involving recreational fishers at Dampier is currently being developed. This project will look for patterns between the number of newly recruited mackerel captured by fishers in the Dampier Archipelago and numbers of fish entering the fishery in subsequent years.

RETAINED SPECIES

Commercial production (season 2003):
Spanish mackerel 457 tonnes
Other mackerel 42 tonnes

Landings

Spanish mackerel is the main target species and may comprise more than 90% of the catch. Grey or broad-barred mackerel is the dominant by-product, particularly in the Gascoyne and west coast areas where it is sometimes captured in large numbers. However, because fishing methods need to be modified in order to catch this species in quantity, it is essentially a separate component. Other by-products of Spanish mackerel fishing include spotted mackerel (*S. munroi*) and shark mackerel (*Grammatorcynus bicarinatus*), wahoo (*Acanthocybium solandri*), cobia (*Rachycentron canadum*), tunas, smaller sharks and the occasional reef fish such as spangled emperor and coral trout. Quantities of mullet, whiting and garfish are also netted by some fishers for use as bait in their mackerel fishing operations.

The reported catch of 457.2 t of Spanish mackerel in 2003 comprised 234.5 t from the Kimberley area, 149.9 t from the Pilbara area, 36 t from the Gascoyne area and 36.7 t from the west coast area (Mackerel Figure 1 and Table 1).

Historic trends in catches were described in the *State of the Fisheries Report 2000/01*. In brief, yearly variations and the overall trends in total catch of Spanish mackerel are mainly influenced by catches in the Kimberley area, which is the largest of all the areas. Aside from a substantial drop in catches in 2000, which was probably due to environmental factors, catches in this area exhibit a rising trend since 1990. Reported catches in the Pilbara area also continue to rise, with the 2003 catch being the highest on record. In contrast, reported catches in the Gascoyne area have dropped steadily since 2001 and in 2003 were lower than catches taken in the more marginal fishery within the west coast area. The relatively high catches of 32–33 t recorded in the west coast area since 2001 are probably due to an unusually high recruitment year in 1999/2000. Overall, the total catch of Spanish mackerel in 2003 was slightly lower than the record year experienced in 2002, but continues the upward trend in catches through time.

Annual catches of the other species of mackerel caught by this fishery, including grey, spotted, shark and school mackerel, show large fluctuations, including peaks in total catch in 1992 and 1997 (Mackerel Table 1). These mainly reflect periods of high abundance of grey mackerel in each area. This species, which typically makes up 80–90% of the 'other mackerel' catch, is preferred over Spanish mackerel on the export market and makes up a high proportion of the total catch in the Gascoyne area. However, 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.

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. Apart from the fluctuations in catches, it is evident that catches of 'other mackerel' in recent years have decreased. In 2003 a total of 41.6 t 'other mackerel' were reported, with catches in each area ranging from 5.5 t (west coast) to 16.2 t (Kimberley).

Fishing effort/access level

The commercial fishing effort for Spanish mackerel recorded in the CAES database for the 2003 season was:

Kimberley area	8 boats	646 days
Pilbara area	19 boats	703 days
Gascoyne area	29 boats	736 days
West coast area	39 boats	971 days

The annual number of boats recording catches of Spanish mackerel has varied substantially since 1980, 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. Note some of these boats may fish in more than one area. A total of 75 boats caught Spanish mackerel in 2003 (19% of all boats that reported catches of finfish).

The unit of effort recorded here is CAES fishing days, i.e. the total number of days fished for any month during which Spanish mackerel were landed. These data do not, therefore, provide a true indication of the effectiveness of fishing effort, as they contain considerable latent effort (i.e. effort not specifically directed at mackerel – see catch data below). Initiation of a fishery-specific log book under the IMP will provide more reliable data on real mackerel fishing effort.

Fishing catch and effort for Spanish mackerel is seasonal. Approximately 85% of the total annual catch occurs from May to October each year with the peak in monthly catch varying between areas. This peak occurs earliest in southern waters: during May in the west coast area, in July in the Gascoyne area and in August in the Kimberley and Pilbara areas. The Pilbara area tends to have a slightly longer mackerel fishing season than other sectors.

Catch rate

Analysis of catch rates (kg whole fish per day) is complicated because many fishers who catch Spanish mackerel do not normally target them. The effort these fishers expend in catching mackerel is thus likely to be confounded with effort spent catching other species. In order to properly evaluate trends in catch rates, the analyses are therefore based on data for vessels known to target mackerel.

Because of restricted boat numbers, the data for the Gascoyne and west coast sectors have also been pooled.

There are few data for reliably assessing catch rates in the Kimberley sector before 1985. Since this time, catch rates have varied between 124 kg/day and 210 kg/day (average 157 kg/day), with an increasing trend since 1996. In 2003 190 kg/day were taken in this sector (Mackerel Figure 2). Catch rates in the Pilbara sector have fluctuated significantly through time, reaching a low in 1988 of 43 kg/day but increasing steadily since 1990. Catch rates in this sector have been the highest in the state since 1999 and reflect the increased efficiency of the main mackerel fishers in this sector. In 2003, 238 kg/day were captured by this sector. Catch rates in the combined west coast/Gascoyne sector are lower than in the two northern sectors and have tended to dip every 4–7 years before returning to levels of around 80 kg/day. During the past 20 years, peaks of 95 kg/day were captured by this sector during 1994 and 2000, with the lowest catch rate recorded in 1992 (20 kg/day). In 2002, the catch rate in the Gascoyne/west coast sector decreased to 50 kg/day before rising to 86 kg/day in 2003.

Recreational component: West coast 40% (approx.) Gascoyne 40% (approx.) Pilbara 20% (approx.)

Recreational survey data are available for the west coast in 1996/97 (Sumner and Williamson 1999), the Gascoyne in 1998/99 (Sumner et al. 2002) and the Pilbara in 1999/2000 (Williamson et al., in prep.). Data obtained during the Pilbara survey also included an estimate of recreational catches in the Broome region of the Kimberley sector. Mackerel catch estimates from these surveys were reported in the *State of the Fisheries Report 2001/02*.

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 are currently being analysed and will be available in 2004. Preliminary analyses indicate increased catches by this sector since previous surveys, particularly in the west coast sector.

Reported catches of Spanish mackerel by recreational charter boats are relatively minor. In 2003 approximately 14 t of Spanish mackerel were reported by these boats. Catches were mainly taken in the Kimberley and Pilbara sectors (57%) or Gascoyne sector (29%).

STOCK ASSESSMENT

Assessment complete: Yes

An initial assessment of Spanish mackerel stocks was completed in 2002, using biomass dynamics and yield-per-recruit modelling, and 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 were not updated in the current year, although additional catch and effort data for Spanish mackerel were collected in 2003 and will be incorporated into future models.

A new time-series model to forecast Spanish mackerel catches using lagged fishery-dependent monthly catch rates and environmental interactions has also been assessed and is currently undergoing further development.

Insufficient data are available for assessment of stocks of other mackerel species.

Exploitation status: Fully exploited

The above analyses indicate that at current catch levels the Spanish mackerel fishery is fully exploited and further increases in effort would not be appropriate. Anecdotal evidence from mackerel fishers suggests that grey mackerel stocks are currently under-exploited in the Gascoyne sector, although they are increasingly being targeted for the export market. The abundance of this species in the Pilbara and Kimberley sectors is unknown but it is probably under-exploited in these areas also. The status of other mackerel species has not been assessed.

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. Based on the results of the 2002 stock assessment project, the current rates of exploitation around the Western Australian coastline appear to be allowing sufficient survival of the breeding stock to maintain recruitment levels.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

Fishing for Spanish mackerel uses specialised troll lines to target the schooling fish and involves limited discarding. Species occasionally caught and generally discarded include sailfish, billfish, pike, barracuda, shark, mackerel tuna, queenfish and trevally. A high proportion of the above species are expected to survive capture and release by the fishery. Consequently, it is considered likely that the fishery has a negligible impact on stocks of discarded species.

Protected species interaction: Negligible

The line fishing methods used in this fishery do not catch any protected species.

ECOSYSTEM EFFECTS

Food chain effects: Low

The effect of the fishery on the food chain is likely to be

minimal because a relatively low proportion of the total mackerel biomass is caught, and because discards of non-retained bycatch and fish waste products are low in this fishery

Habitat effects: Negligible

The line fishing methods used in this fishery have minimal impact on the habitat.

SOCIAL EFFECTS

Approximately 78 people were employed catching Spanish mackerel during the 2003 mackerel fishing season. This estimate is based on those boats recording significant catches of Spanish mackerel (> 500 kg in the Gascoyne, > 1000 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. This estimate does not consider employment of fishers in the west coast sector or of fishers catching minor amounts of mackerel in other sectors, as they are considered employees of other fisheries. 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 2003:
Spanish mackerel $2.7 million
Other mackerel $182,000

Overall ex-vessel prices for Spanish mackerel ($5–6/kg) and other mackerel ($3–6.50/kg) were obtained from fish processors and represent an average price per kilogram of whole weight. Actual prices paid to fishers for their product may reach over $10/kg for fillets and trunks, particularly during summer when few mackerel are captured.

FISHERY GOVERNANCE

Acceptable catch range for next season: 246–410 tonnes

Acceptable catch ranges for each sector were previously based on historic catches as well as minimum and maximum catches occurring within the criteria period for the IMP. These ranges were: Kimberley 150–198 t, Pilbara 69–134 t, Gascoyne 50–70 t and west coast 6–15 t. In 2003, reported catches were above the acceptable catch range for the Kimberley, Pilbara and west coast sectors. These relatively high catches are thought to reflect a strong recruitment into the fishery in 1999–2000, with fishers in the Pilbara sector in particular reporting good catches much earlier and for a longer period of the year than usual.

In contrast, catches in the Gascoyne sector were below the acceptable catch range, with fishers indicating an unusual summer run of fish followed by a poor catch during the normally more productive winter period. Given the increase in catches of Spanish mackerel in other sectors this is of concern but may be explained by movement of fish into these other sectors.

Future catches of mackerel in all sectors will be constrained by total allowable commercial catches (TACCs) and other management measures implemented under the IMP. Therefore, upper bounds of the acceptable catch ranges will in future be set at the allocated TACCs whereas lower bounds will be determined from long-term averages (Kimberley and Pilbara sectors) and estimates of regional biomass (combined Gascoyne/west coast sector). In keeping with the IMP, acceptable catch ranges will be inclusive of catches for all mackerel species except grey mackerel, which have been allocated a separate TACC to allow further development of the fishery for this species. From 2004, the acceptable catch ranges for mackerel (excluding grey mackerel) are, therefore, 246–410 t (Kimberley 110–205 t, Pilbara 80–126 t, Gascoyne/west coast (combined) 56–79 t).

New management initiatives (2003/04)

Upon implementation of the interim management plan in mid-2004, fishing for all mackerel of the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium* between the WA/NT border and Cape Leeuwin will be restricted to operators who hold a Mackerel Fishery Interim Managed Fishery Permit. The fishery will be divided into three management areas (Kimberley, Pilbara and Gascoyne/west coast) and access to each area will be dependent on satisfaction of specific entry criteria. A fishing season will also be introduced for each area (Kimberley 1 June to 30 November, Pilbara 1 April to 30 September and Gascoyne/west coast 1 March to 30 September).

Catch quotas will be formally introduced for each area of the fishery in 2006.

Enforcement of fishing area and season restrictions, as well as adherence to individual quota holdings, will be assisted by the use of the vessel monitoring system.

The Australian Government Department of Environment and Heritage is currently considering an application to certify the mackerel fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

EXTERNAL FACTORS

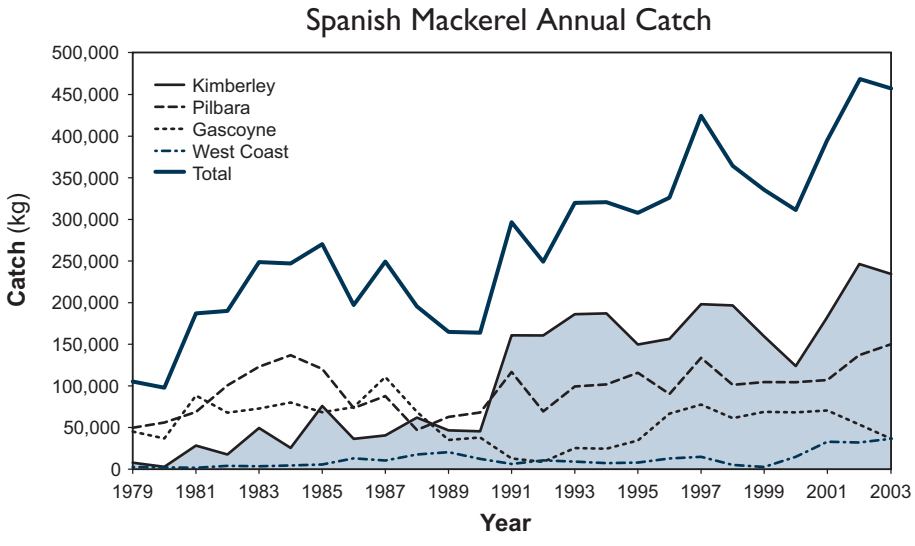
Spanish mackerel and the other mackerel species caught by this fishery are relatively short-lived, fast-growing species that exhibit annual variations in recruitment strength due to environmental fluctuations. This is exemplified by the appearance of a large number of juvenile Spanish mackerel in 1999/2000 which led to increased captures in subsequent years.

MACKEREL TABLE 1

Catches of Spanish and other mackerel within each sector. The main species included under 'other mackerel' are grey mackerel (*Scomberomorus semifasciatus*), school mackerel (*S. queenslandicus*), spotted mackerel (*S. munroi*) and shark mackerel (*Grammatorcynus bicarinatus*). WC = west coast sector.

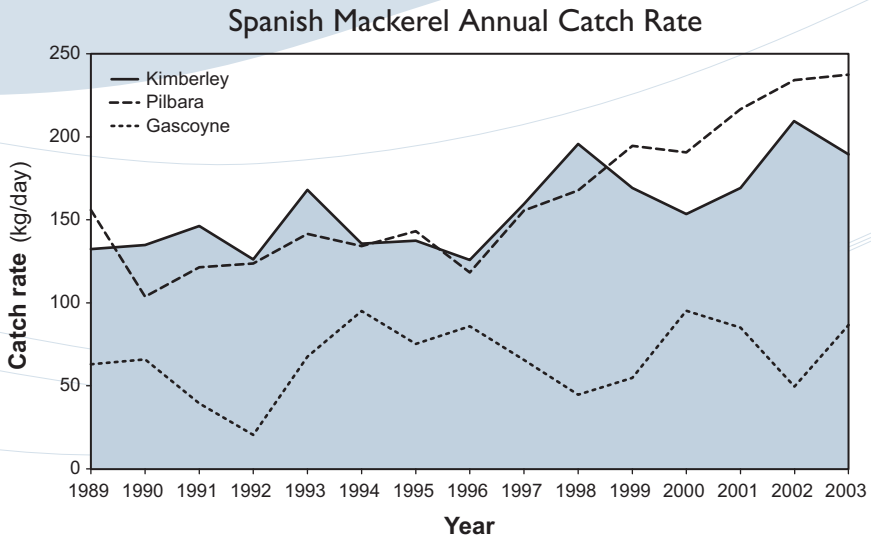
YEAR	SPANISH MACKEREL (tonnes)					OTHER MACKEREL (tonnes)				
	KIMBERLEY*	PILBARA	GASCOYNE	WC	TOTAL	KIMBERLEY	PILBARA	GASCOYNE	WC	TOTAL
1980	2.8	56.0	36.9	2.2	97.9	0.0	8.6	2.1	0.0	10.8
1981	28.3	68.7	88.5	1.7	187.2	1.9	0.4	0.1	0.1	2.5
1982	17.6	100.7	67.8	4.0	190.1	3.3	3.6	11.8	1.2	19.9
1983	49.5	123.0	72.8	3.5	248.7	0.0	2.2	0.9	0.6	3.6
1984	25.5	136.9	80.1	4.5	247.0	0.4	1.2	0.2	0.0	1.8
1985	75.9	120.4	68.3	5.7	270.3	11.7	5.7	2.0	0.1	19.4
1986	36.4	73.5	72.3	12.9	195.1	16.7	11.4	8.9	2.2	39.2
1987	40.6	87.8	110.6	10.3	249.3	12.2	2.3	8.6	0.7	23.9
1988	62.0	47.1	68.8	17.6	195.5	56.6	16.2	3.3	13.3	89.3
1989	46.6	62.7	35.1	20.4	164.8	13.4	35.8	18.2	37.1	104.5
1990	45.4	68.0	38.1	12.3	163.8	24.8	97.3	23.6	20.9	166.4
1991	160.7	116.8	12.8	6.3	296.7	50.5	44.3	12.1	8.9	115.8
1992	160.6	69.3	8.7	10.6	249.2	37.0	30.5	5.2	6.8	79.5
1993	186.1	99.3	25.4	9.1	319.9	28.0	36.4	8.1	2.4	75.0
1994	187.1	101.8	24.6	7.2	320.7	67.9	9.7	6.5	3.8	87.9
1995	149.7	115.8	34.5	7.9	307.9	27.6	15.6	9.7	2.8	55.8
1996	156.4	90.3	66.7	12.8	326.2	34.1	31.0	25.9	2.9	93.8
1997	198.2	133.2	77.6	14.9	423.9	64.7	31.8	20.6	3.5	120.6
1998	196.7	101.2	61.2	5.2	364.3	25.8	16.2	21.2	2.6	65.7
1999	159.5	104.7	68.8	2.6	335.6	26.9	7.9	32.7	5.2	72.7
2000	123.8	104.5	68.1	14.9	311.3	14.3	27.1	29.2	4.0	74.6
2001	179.3	107.0	70.5	33.0	389.9	13.7	13.0	17.7	11.5	56.0
2002	245.8	136.8	53.5	31.9	467.9	16.8	8.7	16.0	14.7	56.2
2003	**234.5**	**149.9**	**36.0**	**36.7**	**457.2**	**16.2**	**6.8**	**13.1**	**5.5**	**41.6**

* 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.



MACKEREL FIGURE 1

Annual catch of Spanish mackerel in Western Australia.



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

Prepared by D. Gaughan and J. Chidlow, with management input by D. Griffiths

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. These fisheries primarily operate shark longlining vessels with power-hauled gear to target a variety of species including 'blacktip', sandbar and lemon sharks. As the principal methods and some target species are common to the JANSF and WANCSF, these data have been combined and the two regions are considered as a single fishery for assessment purposes.

A significant bycatch of shark is also taken by vessels not specifically licensed for shark fishing.

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 and a variety of gear and spatial restrictions.

The Western Australian-controlled sector of the northern shark fishery is managed by an order 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 and droplines with metal traces.

The commercial take of shark in Western Australian waters east of 123°45′ E longitude is controlled by a joint authority arrangement between the Australian Government and the State of Western Australia gazetted in February 1995. In this arrangement, the state is given control of the JANSF on behalf of the WA Fisheries Joint Authority (WAFJA), whose members include the state and Australian Ministers for Fisheries. Permitted fishing methods are demersal and pelagic gillnets and demersal longlines.

There are 14 licences in the northern shark fisheries, 8 allowing access to the WANCSF and 6 to the JANSF. Of these, 11 (2 more than in 2001/02) were active during 2002/03, however not all fished full-time and there is therefore considerable scope for mobilisation of latent effort within this sector. New management arrangements for the WANCSF and JANSF are currently being discussed, as it has become apparent that existing regulations in the JANSF are inadequate to prevent increased shark fishing effort on the north coast. Until formal stock assessment of key northern shark species has been completed, any further increases in fishing effort in this fishery are considered to be highly undesirable.

Despite regulations passed in October 2000 which prohibit fishing vessels landing only the fins from sharks, there is concern over reports that some operators have been illegally finning part of their catch and dumping the low-value carcasses at sea.

Research summary

Research to monitor the status of northern shark stocks has been undertaken as an extension of the south and west coast shark research project. A three-year research project funded by the FRDC, due for completion by late 2004, is focusing on the sandbar (thickskin) shark component of the fishery and will provide an improved understanding of these fisheries and of northern shark stocks generally. Age-specific exploitation rates and biological data from this sandbar shark research have been incorporated into a preliminary demographic analysis, to determine the likely response of the stock to current levels of exploitation. A further research project which began in 1999, funded by the Department of Environment and Heritage and FRDC to examine the sustainability of Australia's tropical sharks and rays, will also help to improve our understanding of the impacts of various fishing sectors which exploit elasmobranchs across the northern half of Australia. This project involves shark researchers from the Department of Fisheries, CSIRO, and the Northern Territory and Queensland fisheries agencies. Phase 2 is scheduled for completion in June 2005.

This status report is prepared based on CAES data supplied by industry and a knowledge of tropical shark stocks obtained from preliminary research data and the scientific literature. CAES data from the northern shark fisheries are available from 1994/95, although the accuracy of early records is uncertain. Since July 2000, catch identification and reporting in the northern fisheries has been validated by at-sea observation of catches and the accuracy of returns is now considered to be good.

In addition to ongoing monitoring of catch and effort data from the longline fishery, collection of the following data should be considered as a high priority in the short to medium term:

- Improved shark catch data, with emphasis on correct species identification and accurate reporting of shark catch from other commercial, recreational and charter fishing sectors.
- Size/age composition of the longline fisheries' catch.
- Fishery-independent monitoring (employing commercial fishing techniques), which has the potential to mitigate many of the problems associated with the use of fishery-dependent CPUE data.

Other issues with lower priority include the stock assessment of 'blacktip' species in the northern shark fisheries and research into the biology and ecology of high conservation-value species, especially sawfish and grey nurse sharks.

RETAINED SPECIES

Commercial production (season 2002/03):
Northern shark fisheries 490 tonnes
Other fisheries 194 tonnes

Landings

The catch of shark in the state's two northern shark fisheries has risen dramatically in recent years (Northern Shark Figure 1) and is now higher than the catch from the West Coast Demersal Gillnet and Demersal Longline Fishery. This increase appears to have slowed significantly over the last year. In 2002/03, the total shark catch increased to 490.1 t, its highest level since records began but only 7.4% higher than in 2001/02 (456 t).

'Blacktip' species remained the primary component of the fisheries' catch at 178 t (Northern Shark Table 1). The generic 'blacktip' category refers to a suite of carcharhinid species that have black markings on one or more of their fins. In northern WA, the 'blacktip' catch is known to consist mainly of the Australian blacktip whaler (*Carcharhinus tilstoni*), the common blacktip whaler (*C. limbatus*) and the spot-tail shark (*C. sorrah*).

The catch of sandbar shark (*Carcharhinus plumbeus)* increased by 21.4% to 87.7 t, with most of the rest of the catch comprising 56.9 t of lemon sharks (*Negaprion acutidens*), 44.7 t of hammerhead species (family Sphyrnidae), 42.6 t of tiger sharks (*Galeocerdo cuvier*) and 32.4 t of pigeye sharks (*Carcharhinus amboinensis*).

The northern shark fisheries' scalefish catch increased by 136.1% in 2002/03 but still remained small at 8.2 t, accounting for less than 2% of total fishery landings. This comprised 7 t of grey mackerel (*Scomberomorus semifasciatus*) and 1.2 t of 'other' scalefish.

In addition to the catch by the two dedicated fisheries, sharks are also caught by other commercial operators. During 2002/03, 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 78 t. A further wetline/longline catch of 116 t of sharks and rays was taken by vessels without access to managed fisheries. The combined 'external' catch of 194 t is 14% higher than last year and is greater than one-third of the landings from the dedicated shark fisheries, making the total catch of sharks in this region 684 t.

Fishing effort/access level

Because longlining is the primary fishing method in the northern shark fisheries, effort is standardised in terms of hook days. The standardised effort measure is the number of longline or dropline hooks multiplied by the number of fishing days. Comparative longline and gillnet catch and effort data were used to convert gillnet effort into the equivalent longline effort.

In 2002/03, the total fishing effort was 422,670 hook days expended by 11 vessels, which represents a decrease of 4% from the previous year (Northern Shark Figure 2). Given the continued high value of shark fins and the increasingly full-time operation of vessels, effort in this fishery is likely to rise further in coming years.

Catch rate

In 2002/03 there was a 4% decrease in effort and an 11%

increase in catch rate for all species combined. Although the reports of discarding carcasses at sea are difficult to confirm, they nevertheless give cause for concern regarding the validity of the reported catch and hence could bias estimated catch rates.

Recreational component: Not assessed

STOCK ASSESSMENT

Assessment complete: Preliminary

As the demographic model developed for *C. plumbeus* operates independently of catch data, the possible under-reporting of catches will not have affected the assessment of the key target stock. However, if significant under-reporting is occurring, it not only undermines the reliability of the fishery's CPUE trends in recent years but also raises management issues over the sustainability of the catches of secondary stocks, particularly of the more *k*-selected species (i.e. those with slow growth and low fecundity) such as pigeye and lemon sharks.

Some of the uncertainties regarding the biological parameters used in the demographic model have been resolved as results from the FRDC-funded research project have become available. In particular, the reproductive periodicity has been determined as biennial (i.e. female sharks give birth every second year), not triennial as previously speculated, and the natal sex ratio as not significantly different from 1:1. However, until age at maturity and the age structure of the catch become available (results expected later this year), the demographic analysis used should continue to be regarded as preliminary.

Based on data to June 2002, results from the demographic model indicated that at current levels of exploitation, the rate of population growth (r) was positive and the stock would continue to replace itself. The model was run according to several different schedules of exploitation. Even under the most pessimistic scenario (that exploitation rates are under-estimated by 35%), the model suggested that levels of exploitation at that time were sustainable, although the rate of population growth under those circumstances was low ($r = 0.006\ yr^{-1}$). However, the possibility of under-reporting of catch and the relatively fast changes in the fleet dynamics in recent years suggest that the model results as of June 2002 should be used with caution, and any increases in effort minimised prior to a full reassessment of the data.

Exploitation status: Under-exploited

Breeding stock levels: Adequate

NON-RETAINED SPECIES

Bycatch species impact: Low

The fisheries have some scalefish catch which is generally retained for sale. There is some discarded bycatch of unsaleable species of sharks, stingrays and scalefish which the ESD risk assessment process has rated as a low to negligible risk.

Protected species interaction: Low

The northern shark fisheries have been rated as having a generally low risk of interacting with protected species.

Sharks and rays: Because these fisheries generally operate some distance offshore, they pose a negligible risk to the speartooth shark (*Glyphis* sp. A) 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 dropline gear.

Turtles: No turtle captures have either been observed or reliably reported in the northern shark fisheries and 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 is insufficient to impact breeding stocks.

Cetaceans: Given that pelagic gillnets are to be phased out following the introduction of the new management plan for the JANSF, the risk of interaction with cetaceans will be negligible.

ECOSYSTEM EFFECTS

Food chain effects: Negligible

Given the relatively small amount of total catch taken by this fishery, which is spread across a large number of species, each of which has a wide diet, the fishery is likely to be currently having only a negligible impact on trophic interactions within this region. If the recent increases in take of a variety of larger species continues, this view may need to be reconsidered.

Habitat effects: Negligible

The principal types of fishing gear (dropline and longline) are set so that they are only in intermittent contact with the seabed, and their physical impact on the seabed is minimal.

SOCIAL EFFECTS

Estimated employment in the northern shark fleet during 2002/03 was approximately 30 fishers.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002/03: $1.4 million

The combined value of the catch from the two managed sectors was approximately $1.4 million (including the estimated value of shark fins). As fishers do 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 a price of $45/kg. During the 2002/03 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

Acceptable catch range for next season:
Sandbar sharks < 117 tonnes

Owing to the large number of elasmobranch species caught in these fisheries, it is not feasible to formally assess each species. Because the effects of fishing are likely to be detectable in the primary target catch first, the catch of sandbar sharks is considered as a suitable indicator for monitoring the catch of secondary species.

The maximum acceptable annual sandbar shark catch in the northern shark fisheries of approximately 117 t was derived from the mean reported catches from 2000/01 and 2001/02 (which the model results suggest are sustainable) plus an allowance of 50%.

New management initiatives (2003/04)

In response to the International Plan of Action for the Conservation and Protection of Sharks, released in 1999 by the Food and Agricultural Organisation of the United Nations due to concern over the increase in shark catches and the consequences for shark populations, a National Plan of Action has been developed to address those issues specific to Australian shark species and fisheries.

The Department has conducted a review of shark fishing operations in the JANSF and a management proposal was circulated for stakeholder comment in early 2003. The Joint Authority has since approved the drafting of legislation based on the proposal and arrangements will be implemented by way of a gear prohibition order pursuant to Section 43 of the *Fish Resources Management Act 1994*. It is intended that the gear prohibition apply to the use of demersal gillnets, pelagic gillnets, demersal longlines and net hauling devices in Western Australian waters east of 123° 45′ E longitude. Recognised JANSF operators will be permitted to use either demersal longlines or pelagic gillnets, although the Department is considering phasing out pelagic gillnets in the future. Input controls such as hook limit and restrictions on lengths of pelagic gillnet will also be introduced. The take of mackerel by JANSF operators will be prohibited unless operators hold a licence to operate in the proposed mackerel fishery. The Section 43 Order is considered to be an interim management arrangement, and will give the Joint Authority an opportunity to consider the longer-term management of the JANSF.

The northern shark fisheries have now formed a Northern Shark Industry Association (NSIA) so as to streamline a move towards developing a formal management plan. The NSIA has suggested that effort reductions are required for their industry and the Department will be working with this association to determine what the appropriate effort levels should be. Concern was raised during the year that sharks in the northern fishery were not being fully utilised. As such, the Minister has requested that the northern shark fisheries indicate that they are making full and appropriate use of their shark catch. The ability to demonstrate full and appropriate usage will influence whether or not the fishery becomes formally managed.

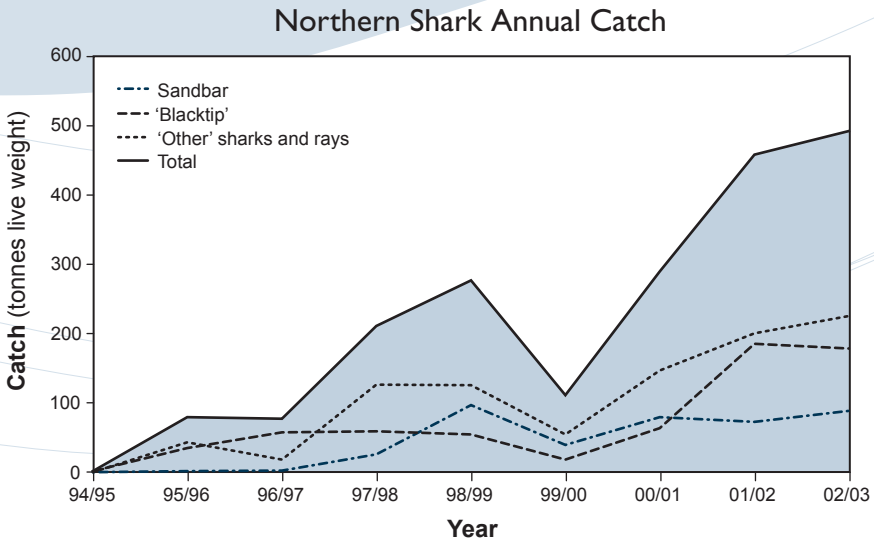
EXTERNAL FACTORS

A significant quantity of sharks are caught in the state's northern bioregion as by-product by vessels licensed to fish for other target species. This factor, in addition to the multi-species nature of the tropical shark fisheries, will make formal stock assessment of the minor species caught in these fisheries particularly difficult.

NORTHERN SHARK TABLE 1

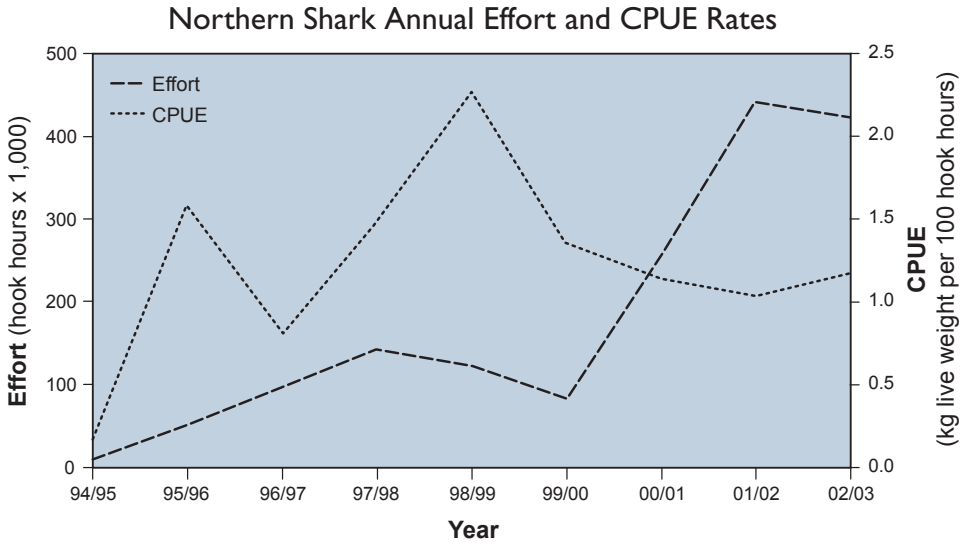
Elasmobranch catch species composition for the northern shark fisheries (WANCSF and JANSF) from 2000/01 to 2002/03.

SPECIES		CATCH (tonnes)		
		2000/01	2001/02	2002/03
Blacktip shark	*Carcharhinus spp.*	47	185	178
Sandbar (thickskin) shark	*Carcharhinus plumbeus*	79	72	88
Lemon shark	*Negaprion acutidens*	15	26	57
Hammerhead shark	Sphyrnidae	23	43	45
Tiger shark	*Galeocerdo cuvier*	34	37	43
Pigeye shark	*Carcharhinus amboinensis*	29	25	32
Shovelnose/fiddler rays	Rhinobatidae, Rhynchobatidae	3	11	11
Grey reef shark	*Carcharhinus amblyrhynchos*	7	6	7
'Bronze whaler' shark	*Carcharhinus obscurus*	9	6	7
Spot-tail shark	*Carcharhinus sorrah*	-	-	3
Other sharks/rays		26	45	19
TOTAL		**272**	**456**	**490**



NORTHERN SHARK FIGURE 1

Annual landings for the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2002/03.



NORTHERN SHARK FIGURE 2

Annual effort and catch per unit effort rates of all sharks and rays for the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2002/03. (Historical data has been updated using improved methodology.)

Pearl Oyster Managed Fishery Status Report

Prepared by A. Hart and D. Murphy, with management input by J. McCrea

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

Consultation process

Pearling Industry Advisory Committee and subcommittees
Department–industry meetings

Boundaries

The fishery is separated into four zones 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 the 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.

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 risk assessment was conducted for the pearl oyster fishery while developing the application for environmental sustainability certification. This process determined a number of performance indicators, which state that a review and possible management action will be triggered if:

- more than 60% of the distribution of the species is harvested;
- there is more than a 50% decrease in CPUE from the Zone 2 historical average of 29.5 shells/hr;
- there is more than a 50% decrease in CPUE from the Zone 3 historical average of 34.8 shells/hr; or
- more than 30% of the catch in Zone 1 is over 150 mm shell length.

The performance measures were all met in 2003.

Research summary

Current research is focused on stock assessment using catch and effort statistics and recruitment and length-frequency sampling to determine the total allowable catch. In 2003, preliminary data on discard rates of pearl shell and infestation of bioeroding sponges (Clionidae) were also collected to assess the overall health of the fishery. The FRDC project entitled 'Mother of pearl (*Pinctada maxima*) shell: Stock evaluation for management and future harvesting in Western Australia' was completed in 2003. This project investigated the status of mother of pearl (large oysters > 175 mm) stocks, whether their harvesting could be sustainable, and in what areas they could be harvested. One outcome has been the initiation of a collaborative venture with the CSIRO Marine Research Division to investigate larval sources, drift and sinks in *Pinctada maxima* populations in the Eighty Mile Beach region.

The Research Division's fish pathology group also provides a comprehensive disease testing program to monitor pearl oyster 'health' issues within the industry.

In addition to these Departmental projects, significant research and development on the pearl production cycle is undertaken directly by industry.

RETAINED SPECIES

Commercial production (season 2003): 479,119 shells

Landings

In 2003 the number of wild-caught pearl oysters was 479,119 shells (Pearl Table 1 and 2). The total allowable catch for the pearl oyster fishery was 512,000 shells (including a 2,000 shell special allowance for tourism purposes). The main disparity between the TAC and the shell caught was due to Zone 1 operators who elected to capture only 22,131 shells from the wild fishery, out of a total TAC of 55,000. The remainder was obtained from hatchery production. This conversion to the use of hatchery stock has been the result of a decrease in the economic viability of harvesting wild-stock culture shell in Zone 1 through lower availability of culture-sized shell and the increased effort required to fill wild-stock quotas in recent seasons.

The catch in Zone 2/3 for 2003 was 456,988 shells from a TAC of 457,000. This TAC was 5% less than 2002 (479,750) and remains the normal TAC for this region.

Some divers collect and retain specimen shell specimens during their normal fishing activities, and others retain marine fishes as live specimens for personal marine aquariums. Considering the size of the fleet and the areas covered by drift diving, exact numbers and variety of species in question are difficult to estimate, but are not considered substantial at this stage.

Fishing effort/access level

Total effort in all zones was 15,889 dive hours. The total effort for 2003 in Zone 2/3 was 14,242 dive hours, a 9% decrease on the 2002 Zone 2/3 effort of 15,661 dive hours. These levels of effort are more traditional figures for Zone 2/3. Effort level in 2000 of 9,258 hours was the lowest ever recorded.

The total effort in Zone 1 during 2003 was 1,647 dive hours, representing a 40% decrease on the 2002 total effort of 2,729 dive hours and the lowest level of effort in over 10 years.

Catch rate

The catch rate for the pearl oyster fishery (all zones) was 30.2 shells per dive hour (shells/hr) in 2003. This is a slight increase from the overall catch rate for last year (27.7 shells/hr). The CPUE for Zones 2/3 declined to 30.6 shells/hr during the 2002 season, which was lower than both 2001 (41.7 shells/hr) and 2000 (when CPUE at 54.2 shells/hr was the highest ever recorded). It was also lower than the 10-year (1993–2002) average of 38 shells/hr (see Pearl Table 1) for this region. The 2003 catch rate for Zone 2/3 has increased slightly from 2002 to 32.1 shells/hr and is approaching the 10-year average.

For Zone 1, the 2003 CPUE was 13.4 shells/hr which was an improvement compared to the 2002 CPUE of 10.7 and 2001 CPUE of 7.1 shells/hr (which was the lowest ever recorded; Pearl Table 2). The catch rate in the northern sector of Zone 1 decreased steadily from 26.4 shells/hr in 1998 to 6 shells/hr in 2001 but recovered in 2002 and 2003 to 14 and 15 shells/hr respectively. In the southern sector, catch rates fell to 3.3 shells/hr in 2001 but increased in 2002 to 7 shells/hr and again in 2003 to 10.4 shells/hr. Catch rates have increased over 100% in the middle sector from 7 to 16 shells/hr during 2003, and overall effort has been more evenly distributed over the three sub-sectors of Zone 1.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2003 fishing season based on catch and effort statistics, recruitment (120,000 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ abundance), length-frequency sampling (41,000 shells measured), shell discard rates by size and location, habitat effects on spat settlement, and a preliminary assessment 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 (TAC) for 2004 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, as with most bivalve fisheries, the *P. maxima* fishery is characterised by large variability in recruitment. In 2003, CPUE was at the lower end of the CPUE range for the past 10 years and was similar to 2002. This follows three years of elevated catch rates (1999–2001), which are hypothesised to be due to a large pulse of recruits passing through the size range targeted by the fishery. This elevated level of recruitment is expected to be due to the presence of favourable environmental conditions for larval and juvenile development that may be related to the ENSO (El Niño/Southern Oscillation) event of 1997–1998. Improvements in the on-board sampling scheme this year resulted in good estimates of size frequency from most spatial areas of the fishery. After three years of collection, the spat abundance data is showing promise, although it is still too early to draw substantial conclusions. The age 0+ spat data, if reliable, will give a prediction of abundance three years in advance, while the age 1+ spat data will give a prediction of abundance two years in advance. Preliminary results (from four years of data) showed a high statistical correlation between 0+ age cohorts in one year and 1+ age cohorts in the following year. However, further work is needed on spatial and habitat effects on spat settlement. The overall assessment is that pearl oyster stocks in Zone 2/3 are currently exploited at sustainable levels and the decision rule determined that TAC allocation for 2004 will not change from 2003, i.e. it will remain at 457,000 shells.

Zone 1: The Zone 1 fishery appears to remain in a depleted state, primarily as a result of the reductions in the middle and Exmouth Gulf sectors, which sustained an annual fishery of around 40,000–50,000 shell during the period 1984–1992. However, as wild-stock fishing in this zone has become uneconomical for experienced pearl divers, fishery data (i.e. CPUE) is often from inexperienced divers and therefore highly compromised as an index of abundance. The northern sector grounds have been unable to sustain the initially high catches and catch rates that occurred when the buffer zone was extended. These depletions can be attributed to both environmental factors (major cyclones impacting stocks in Onslow and Exmouth) and over-fishing (Exmouth Gulf experienced an average harvest of 70,000 shell between 1993 and 1998, despite no history of being able to sustain these catches). Subsequently, the 40,000 shell quota initiated in Exmouth Gulf from 1998 to 2003 has never been achieved, even in the years prior to substantial hatchery substitution, and it is questionable whether Exmouth Gulf is capable of sustaining the 40,000 shell quota. However, while the Zone 1 stock is being lightly fished (29,000 and 22,000 shell caught in 2002 and 2003 respectively; Pearl Table 2) and most of the wild-stock quota is being replaced by hatchery shell, there is no sustainability issue. Also, catch rates are increasing, which indicates that the stock is rebuilding. Under current practices, industry will continue with hatchery substitution for wild shell and the actual catch will remain well below the TAC, as it has for 2002 and 2003, and no major stock review is required.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

The FRDC-funded 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. 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 lower fishing effort during 2002 and 2003.

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.

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 fleet has been slowly reducing over the past seven years from 12–16 in 1997 (overall) to 7 vessels in 2003, due to the increased fleet efficiency and increased reliance on hatchery-produced shells. This looks set to reduce further in 2004. 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 2002/03: $124 million

The value of cultured pearls and by-products is considered to be approximately $124 million for the year 2002/03. However, a precise estimate of the value of product is difficult to achieve owing to the variable time lags that occur between harvesting and sale to offshore buyers, and the costs incurred in marketing before sales take place.

FISHERY GOVERNANCE

Acceptable effort range for next season: 14,071–20,551 dive hours

The acceptable effort range relates to the time required to achieve the set TAC in the pearl oyster fishery of 512,000 shells (457,000 shells in Zone 2/3 and 55,000 shells in 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. 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.

Zone 2/3 of the pearl oyster fishery achieved its 457,000 shell quota with 14,242 dive hours in 2003 (Pearl Table 1), which was within the acceptable range.

Zone 1 of the pearl oyster fishery only achieved 22,131 shell (40% of its 55,000 quota), consequently dive hours (1,647) were below the lower limit of the acceptable range (Pearl Table 1). Proportionately, this level of effort is appropriate, noting that the industry chose not to take the quota set.

The overall pearl oyster fishery effort of 15,889 hours was within the acceptable range.

Pending the performance of the Zone 1 fishery in 2004, it may be necessary to revise the acceptable range for this zone to account for the lower catches.

New management initiatives (2003/04)

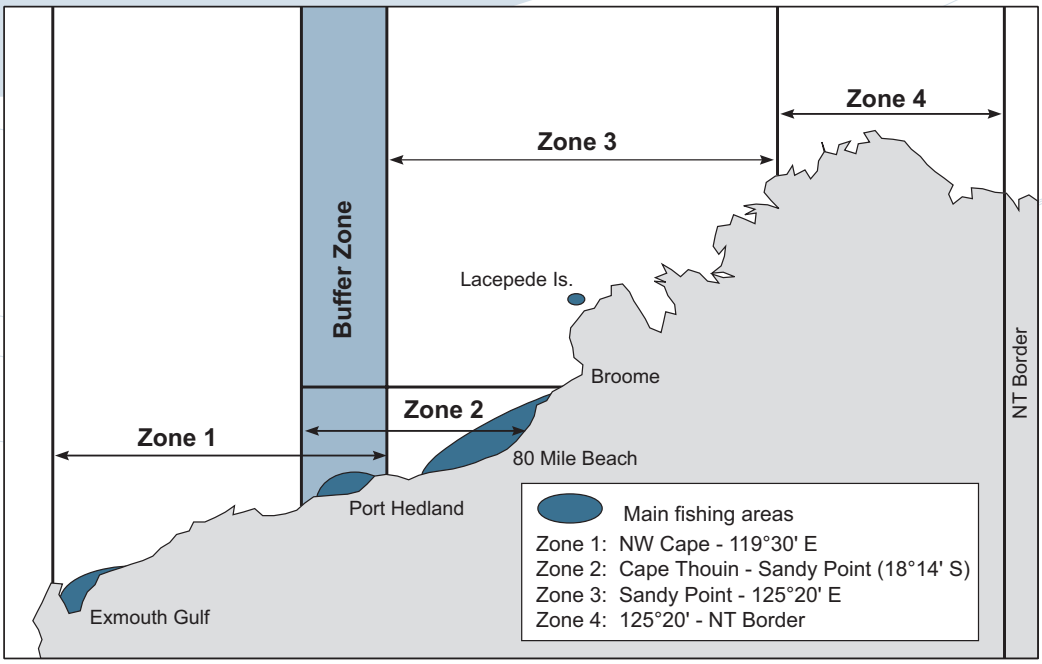
In September 2003, the Australian Government Department of Environment and Heritage certified the pearl oyster fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a number of conditions, certification allows product from the fishery to be exported from Australia for a period of five years before reassessment.

A number of new management initiatives are being developed for the pearling industry. A new Pearling Management Bill is in development to replace the existing *Pearling Act 1990*. It is expected that the Bill will be considered by Parliament in 2006. A new compliance strategy is being developed to recognise the greater activity the industry now has in hatchery production of pearl oyster and to provide for greater efficiencies in the delivery of compliance. Finally, the current Hatchery Quota Policy, which establishes hatchery production and the allocation of hatchery options and units among industry, expires at the end of 2005. The Department of Fisheries is currently reviewing the Hatchery Quota Policy and is developing a new policy for implementation at the commencement of 2006.

EXTERNAL FACTORS

The pearl oyster stocks underpinning the fishery continue to provide sufficient level of production to support this major Western Australian industry. However, international markets continue to be the main factor affecting pearl production value and sales.

North Coast Bioregion



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		25.0
1985	342,000	272,869	53,831	326,700	12,423	21.0		26.3
1986	360,000	337,566	10,929	348,495	16,478	20.5		21.2
1987	380,000	365,397	0	365,397	17,476	20.9		20.9
1988	445,000	379,657	0	379,657	14,600	26.0		26.0
1989	445,000	445,364	0	445,364	18,625	23.9		23.9
1990	457,000	453,705	0	453,705	23,263	19.5	15.3	19.5
1991	457,000	460,608	0	460,608	21,657	21.3	16.1	21.3
1992	457,000	461,599	0	461,599	19,455	23.7	13.9	23.7
1993	457,000	457,186	0	457,186	14,733	31.0	15.7	31.0
1994	457,000	456,832	0	456,832	12,384	36.9	11.4	36.9
1995	512,000	511,633	0	511,633	12,217	41.9	12.4	41.9
1996	512,000	511,756	0	511,756	12,774	40.1	16.8	40.1
1997	512,000	512,314	0	512,314	16,893	30.3	12.9	30.3
1998	457,000	457,266	0	457,266	14,499	31.5	12.6	31.5
1999	457,000	457,842	0	457,842	10,300	44.4	11.6	44.4
2000	502,500	501,419	0	501,419	9,258	54.2	11.2	54.2
2001	502,500	502,484	0	502,484	12,054	41.7	12.1	41.7
2002	479,750	479,562	0	479,562	15,661	30.6	13.4	30.6
2003	**457,000**	**456,988**	**0**	**456,988**	**14,242**	**32.1**	**13.6**	**32.1**

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 the 1993 quota increase.

YEAR	WILD STOCK QUOTA	No. of CULTURE SHELLS	No. of MOP SHELLS	TOTAL SHELLS	DIVE HOURS	CULTURE SHELLS/HR	MOP SHELLS/HR	TOTAL SHELLS/HR
1993	115,000	79,465	0	79,465	2,395	33.2	0	33.2
1994	115,000	132,316[1]	0	132,316	6,291	21.0	0	21.0
1995	115,000	121,312[1]	0	121,312	6,247	19.4	0	19.4
1996	115,000	80,163	0	80,163	5,013	16.0	0	16.0
1997	115,000	110,348	0	110,348	9,494	11.6	0	11.6
1998	115,000	108,056	0	108,056	6,094	17.7	0	17.7
1999	115,000	90,414[2]	0	90,414	4,789	18.9	0	18.9
2000	115,000	66,772[2]	0	66,772	5,893	11.3	0	11.3
2001	115,000	68,931[2]	0	68,931	9,480	7.3	0	7.3
2002	55,000	29,126[2]	0	29,126	2,729	10.7	0	10.7
2003	**45,000[3]**	**22,131[2]**	**0**	**22,131**	**1,647**	**13.4**	**0**	**13.4**

Notes

1. 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.
2. Hatchery stock used during 1999–2003 reduced the need for wild-stock shell.
3. In 2003, the 115,000 Zone 1 quota was still maintained, however only 45,000 could be caught from wild stock due to hatchery shell substitution.

Wetline Fishing

This assessment, which utilised the CAES database, indicates that around a quarter (22%) of the state's wetline catch during 2002/03 was reported from this bioregion, which includes waters off both the Kimberley and Pilbara coasts. The top 12 species comprised Spanish mackerel (*Scomberomorus commerson*) 398 t, giant threadfin (*Eleutheronema tetradactylum*) 77 t, unspecified shark 19 t, goldband snapper (*Pristipomoides multidens*) 10 t, grey mackerel (*Scomberomorus semifasciatus*) 9 t, spangled emperor (*Lethrinus nebulosus*) 8 t, pig-eye shark (*Carcharhinus amboinensis*) 8 t, unspecified mackerel (Scombridae) 7 t, blacktip shark (*Carcharhinus* spp.) 7 t, trevally (Carangidae) 6 t, red emperor (*Lutjanus sebae*) 5 t and narrow sawfish (*Anoxypristis cuspidatus*) 5 t. The latter is being increasingly targeted for its fins.

An interim management plan for the troll fishery for mackerel, details of which are reported on pp. 141-146, will commence later in 2004. 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.

RECREATIONAL FISHERIES

Regional Research Overview

Recreational fishing is a popular activity in the north coast bioregion, accounting for 5% of the state's fishing effort or an estimated 367,000 fishing days in 2003/04 (Baharthah 2004).

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., in prep.). The survey area incorporated the region from Onslow up to and including Broome.

The total recreational catch of all scalefish species for the region in 1999/2000 was estimated at 300 t, excluding charter vessel catches. This was approximately 12% of the commercial demersal scalefish catch (2,311 t) and commercial mackerel catch (130 t) for this region during the same period. The preliminary estimates do not include the recreational catches obtained at Thevenard Island and Barrow Island; these will be included in the research report which is being completed.

Important recreational species, in order of weight caught were trevally species (*Gnathanodon speciosus, Caranx ignobilis* and *Caranx sexfasciatus)* (17,100 fish or 50 t); mackerel (*Scomberomorus* spp.) (narrow barred Spanish mackerel 4,300 fish or 30 t, other mackerel 10,300 fish or 14 t); blue-lined emperor or grass emperor (*Lethrinus laticaudis*) (18,400 fish or 22 t); tuskfish (*Choerodon* spp.) (blackspot tuskfish 7,700 fish or 20 t, other tuskfish 700 fish or 1 t); threadfin salmon species (*Eleutheronema tetradactylum, Polydactylus macrochir* and *Polydactylus plebius)* (15,200 fish kept or 18 t); spangled emperor (*Lethrinus nebulosus*) (8,700 fish or 12 t); estuary cod (*Epinephelus coioides*) (5,300 fish or 12 t); stripey seaperch or Spanish flag (*Lutjanus carponotatus*) (20,800 fish or 11 t); coral trout (*Plectropomus leopardus*), coronation trout (*Variola louti*) and bar-cheeked coral trout (*Plectropomus maculatus*) (3,300 fish or 8 t); sweetlip emperor (*Lethrinus miniatus*) (4,700 fish or 7 t); red emperor (*Lutjanus sebae*) (1,700 fish or 6 t); blue swimmer crab (*Portunus pelagicus*) (72,000 crabs or 22 t); green mud crabs (*Scylla serrata*) (19,000 crabs or 17 t) and brown mud crabs (*Scylla olivacea*) (7,000 crabs or 4 t).

These data, integrated with the long-run commercial CAES databases and the current fishery-independent projects, will provide the basis for ongoing management of the most important recreational stocks in this region.

Fishing and Aquatic Tour Industry

Prepared by C. Telfer

At the end of 2003 the north coast bioregion had 97 licensed fishing tour operators, plus an additional 13 licensed restricted fishing tour or eco-tour operators.

During 2002, operators reported 3,628 tours, with an increase to 4,027 tours in 2003. Activities conducted on these tours included fishing, diving, snorkelling, wildlife observation and sightseeing.

Fishing effort

The number of tours on the north coast involving only fishing decreased slightly from 2,954 in 2002 to 2,846 in 2003. These tours are directly related to the catch information estimated in North Coast Fishing Tours Table 1. The total fishing effort reported by tour operators for the north coast bioregion in 2002 was 18,424 fisher days, with an increase of 6.5% to 19,604 fisher days in 2003.

Catch

Since issuing tour operators' licences, 10,022 daily catch and effort returns have been received for the north coast bioregion. These returns enable an estimate of the total catch by tour operators to be calculated.

Catches of the major finfish species for the north coast bioregion in 2002 and 2003 are shown in North Coast Fishing Tours Table 1. The estimated total finfish catch for 2003 was 93 t, which is a significant increase of 19% over the 78 t caught in 2002. These catches from tour operators' vessels are recreational in nature, and are in addition to reported commercial catches. In future years, where practicable, they will be included in the 'recreational catch share' for relevant species and fisheries.

NORTH COAST FISHING TOURS TABLE 1

Estimated catch of major finfish species reported by tour operators for 2002 and 2003.

SPECIES		ESTIMATED CATCH (tonnes) 2002	ESTIMATED CATCH (tonnes) 2003
Spangled emperor	*Lethrinus nebulosus*	7	9
Fingermark bream	*Lutjanus johnii*	4	5
Red emperor	*Lutjanus sebae*	3	10
Mangrove Jack	*Lutjanus argentimaculatus*	2	2
Saddletail (scarlet) seaperch	*Lutjanus malabaricus*	2	3
Spanish mackerel	*Scomberomorus commerson*	14	7
Chinaman fish	*Symphorus nematophorus*	5	7
Barramundi	*Lates calcarifer*	7	5
Other finfish		34	45
Total		**78**	**93**

AQUACULTURE

Regional Research and Development Overview

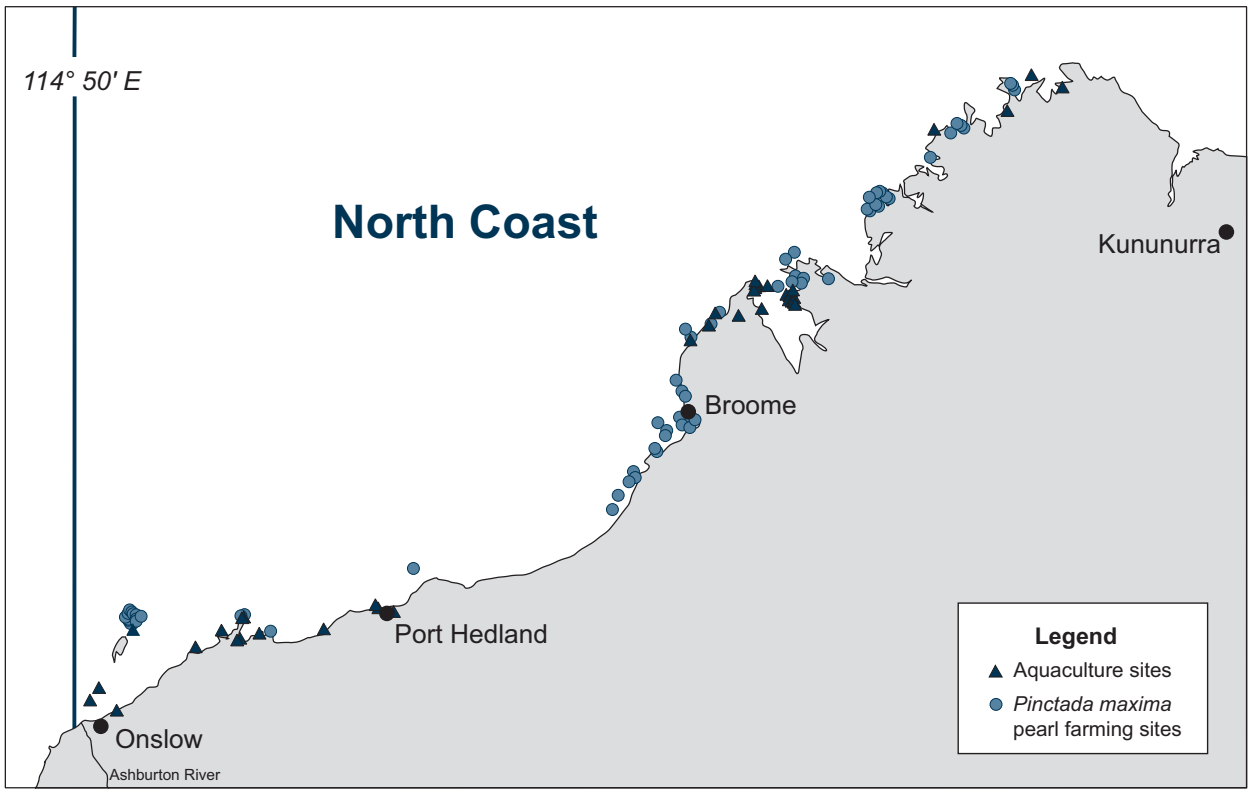
Aquaculture in the north coast bioregion is dominated by the production of pearls from the species *Pinctada maxima*. This industry utilises both wild-caught and hatchery-reared oysters for the production of cultured pearls. The wild-stock fishery is reported in the commercial fisheries section on pp. 150-155. The Department also has a major role in the management of pearl hatcheries and pearl oyster grow-out on farm leases. The Research Division's Fish Health Unit, led by B. Jones, is actively involved in assisting the commercial hatcheries in terms of disease control, and the annual certification of hatchery facilities is required under the *Fish Resources Management Act 1994*.

In other areas of aquaculture, a key management activity during 2003/04 has been to accommodate commercial interest in use of the Broome Tropical Aquaculture Park managed by the Department.

Research staff, including J. Bellanger, have taken on leading roles in an ongoing project funded by the Australian Centre for International Agricultural Research and managed by the Kimberley Aquaculture Aboriginal Corporation (KAAC). This project is evaluating the effectiveness of moving broodstock trochus (*Tectus niloticus*) to reefs to improve recruitment of juveniles in the Dampier Peninsula (north of Broome), Vanuatu and Western Samoa. Initial results have been encouraging locally. Assistance has also been provided with production and stocking of hatchery-produced trochus juveniles in this area.

Research staff, including G. Maguire, are also involved in a major Kimberley Sustainable Regions Program (KSRP) project managed by the KAAC. Broodstock surveys and collection of black tiger prawns (*Penaeus monodon*) have enabled significant hatchery production. Grow-out trials should commence next year when recently completed baseline environmental monitoring by research staff and a private company allows operation of commercial-scale ponds within the KSRP project.

Research and Regional Services staff were also involved in assessing a range of potential sites in areas occupied by local indigenous communities interested in aquaculture projects.



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

Regional Compliance and Community Education Overview

The vast north coast bioregion covers an area from Onslow in the Pilbara to the Western Australia/Northern Territory border and offshore to areas such as the Montebello Islands and Rowley Shoals. Extensive land and sea patrol activity is required to undertake the compliance role effectively. Officers regularly conduct extended 10-day remote patrols using specially equipped four-wheel-drive vehicles or on board the large fisheries patrol vessel (> 20 m) for offshore work. Officers also use 6.5–7 m patrol vessels and smaller dinghies and runabouts for inshore at-sea inspections.

Commercial fishery, pearling, recreational fishing and charter boat compliance inspections are conducted by Fisheries Officers based at the Broome and Karratha District Offices. Officers undertake dive team inspections, at-sea and on-land catch, licence compliance and gear checks, and point-of-landing and consignment inspections.

The intent of the program is to provide education, surveillance, inspection and prosecution functions. General patrol activities involve a high level of community and industry interaction and liaison. Officers promote the 'fish for the future' message with a range of individuals and groups, in the office, at sea, at the boat ramp and at community events.

Officers work closely with other agencies in search and rescue, marine safety, marine park survey, coastal surveillance and emergency management across the remote north.

Two state officers are based at Broome to respond specifically to illegal foreign fishing on behalf of the Australian Fisheries Management Agency (AFMA). Work includes patrol, apprehension and liaison with security and quarantine services. Their activity is subject to a separate reporting mechanism.

The use of satellite tracking via a vessel monitoring system has both enabled surveillance in remote waters and provided an important safety tool for fishers in case of emergency. VMS allows enforcement monitoring of fishery-specific management plan conditions related to zone closures and time-limited entry to certain zones. Violations trigger satellite alarms and officers respond and investigate.

Aside from recreational fishing and pearling, commercial fisheries serviced include the Northern Demersal Scalefish, Broome, Kimberley, Onslow and Nickol Bay Prawn, Kimberley Gillnet and Barramundi, Pilbara Fish Trawl and Pilbara Trap Managed Fisheries and the fishery for beche-de-mer.

Activities during 2002/03

During 2002/03, officers delivered 16,845 hours of compliance work as presented in North Coast Compliance Table 1 (excluding AFMA Commonwealth fisheries work). Officers used a risk-based approach to plan compliance priorities. The regional Fisheries Officers continued to deliver a high standard of professional compliance services, recording almost 4,000 field contacts (excluding pearling where this information is not readily available. It should also be noted that one contact with a vessel at sea is recorded as a single contact, regardless of the number of crew aboard.) The number of District Office contacts, where officers attend to telephone or counter enquiries to provide advice or further assistance, doubled to 1,751. Nineteen infringement warnings and 6 infringement notices were issued, and 15 cases resulted in prosecution action. These cases demonstrate intervention where other actions have not been successful.

Priority areas targeted were the timely provision of notices of pearling operations requiring pre-approval, wild stock pearling harvest scrutiny, lease compliance, gear compliance and bag limit compliance. Particular emphasis on the pearling sector was demonstrated this year. Overall results were sound given time lost in the region due to extensive travel demands.

Initiatives in 2003/04

Further refinement of a fishery-by-fishery risk-based assessment has been undertaken during 2003/04. This process will be utilised to target offence types on a risk analysis basis using sustainability criteria. The use of a targeted approach aims to increase apprehension rates while maintaining a strong liaison focus. The use of desktop audit is also being developed to assist field officers to maintain contact time in the field.

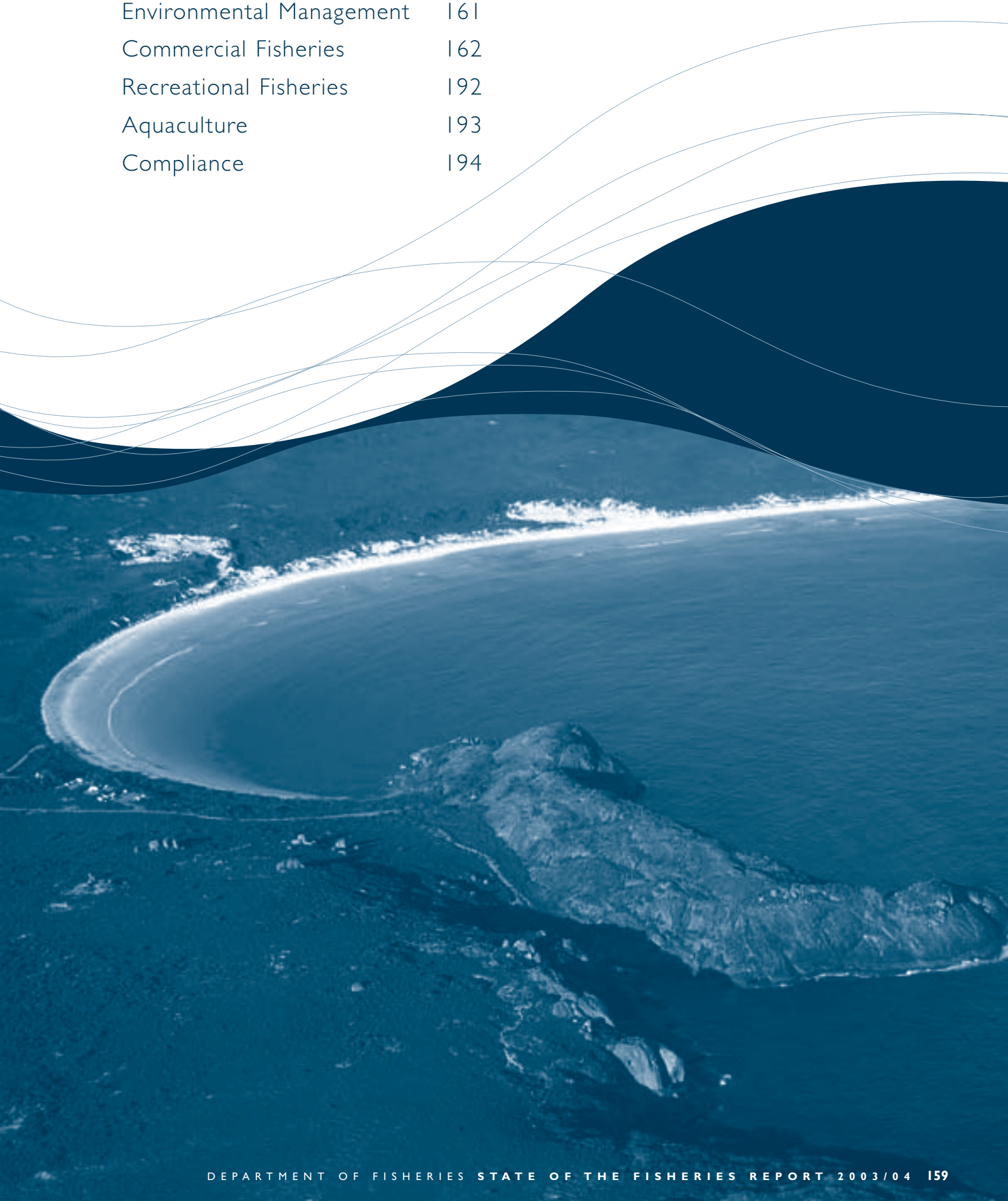
NORTH COAST BIOREGION TABLE 1

Summary of compliance and educative contacts and infringement types within the north coast bioregion during the 2002/03 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	*NUMBER*
Hours delivered in bioregion	4,155
Fisher field contacts by Fisheries Officers	44
District Office contacts by Officers	189
Fishwatch reports *	28
COMMERCIAL OFFENCES DETECTED	
Infringement warnings	2
Infringement notices	2
Prosecutions	2
CONTACT WITH THE PEARLING INDUSTRY	*NUMBER*
Hours delivered in north coast and Gascoyne bioregions	8,184
District Office contacts by Officers	251
PEARLING OFFENCES DETECTED	
Prosecutions	9
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	*NUMBER*
Hours delivered in bioregion	4,506
Fisher field contacts by Fisheries Officers	3,883
District Office contacts by Officers	1,311
RECREATIONAL OFFENCES DETECTED	
Infringement warnings	17
Infringement notices	5
Prosecutions	4

* This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

South Coast Bioregion

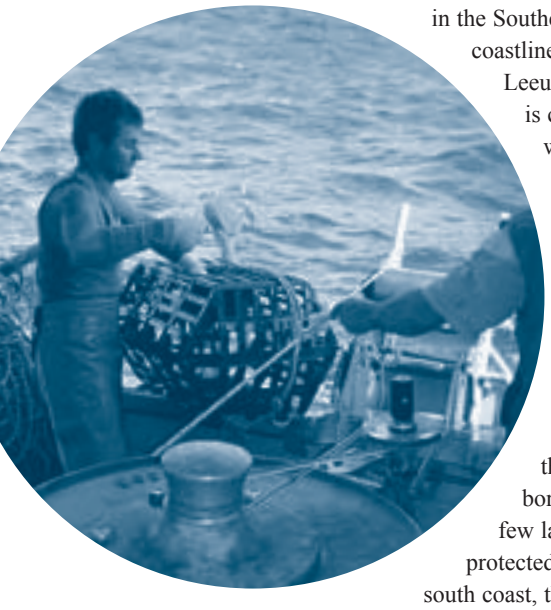


South Coast
BIOREGION

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.

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 subsurface 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 fisheries 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, red bightfish, 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 mariculture 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

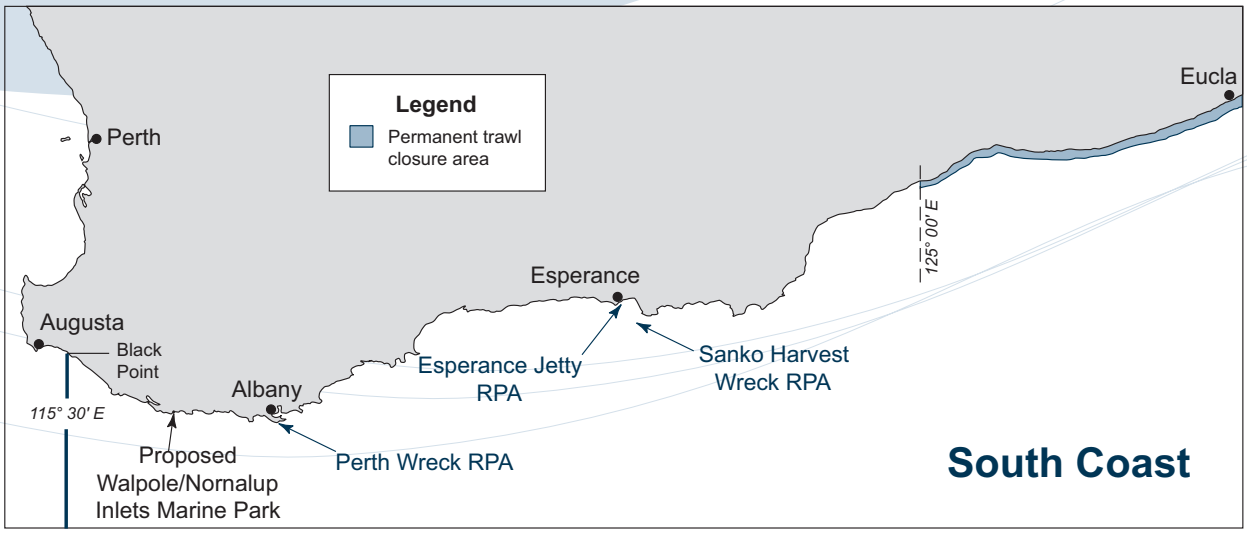
Regional Overview

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 farming 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 Australian Government. 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 Australian Government fisheries legislation, to ensure deep-sea trawlers do not venture into sensitive coastal areas (South Coast Habitat Protection Figure 1).

Reef protected area closures cover the *Sanko Harvest* wreck site, the end of the old Esperance Jetty and the HMAS *Perth* wreck site.

During 2003/04, the Department of Fisheries has provided advice to Government in relation to planning for the proposed Walpole/Nornalup Inlets Marine Park.



SOUTH COAST HABITAT PROTECTION FIGURE 1

Map showing areas permanently closed to trawl fishing and areas of protected fish habitat in the south coast bioregion.

COMMERCIAL FISHERIES

South Coast Crustacean Fisheries Status Report

Prepared by R. Melville-Smith, with management input by 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 authorisations
Fish Resources Management Regulations 1995
Regulation Licence granted under Regulations 125 and 126
Condition 105 on a Fishing Boat Licence

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 Esperance Rock Lobster Managed Fishery.

Management arrangements

These fisheries are managed primarily through input controls in the form of limited entry, pot numbers, size limits and seasonal closures.

In 2002/03, 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.

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. A project is currently underway (due to be finished towards the end of 2004) establishing the distribution and fishing potential of the newly discovered crystal crab fishery on the south coast.

RETAINED SPECIES

Commercial production (season 2002/03):
Southern rock lobster 61 tonnes

Landings

The total catch of southern rock lobsters was 61 t, down from 66 t in 2001/02. A catch of 30 t of southern rock lobsters was taken in the ERLF in 2002/03, a decrease of 9% on the catch taken in the 2001/02 season (34 t). The combined catch for the GAB and Albany southern rock lobster fishery zones in 2002/03 was 31 t, a decrease of 3% on the 2001/02 figure (32 t). Catches increased from 4 t to 8 t in the Albany zone and decreased from 28 t to 23 t in the GAB zone.

As a by-product of the rock lobster fishery, 5 t of giant crabs, a decrease of 50%, and 17 t of champagne crabs, an increase of 31%, were landed in the Albany zone. In the ERLF 7 t of giant crabs, an increase of 250% over the 2001/02 figure, and 1 t of champagne crabs, similar to the 2001/02 level, were landed. Fishing for crystal crabs in the Albany zone in 2001/02 and 2002/03 produced around 11 t before a moratorium (from late July 2002 until September 2003) was placed on further fishing pending research into the extent of the resource and sustainability of fishing.

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 zone, because an unknown proportion of the effort recorded may have targeted deep sea crabs rather than lobsters.

Catch rate

Catch per unit of fishing effort for southern rock lobsters in the 2002/03 season in the ERLF increased by 12%, from 0.49 kg/pot lift in 2001/02 to 0.55 kg/pot lift in 2002/03. The combined catch per unit of fishing effort for southern rock lobsters in the GAB and Albany zones in the 2002/03 season was 0.28 kg/pot lift, a decrease of 10% compared to the 2001/02 season. Catch rates in the Albany zone increased by 21% from 0.14 kg/pot lift in the 2001/02 season to 0.17 kg/pot lift in the 2002/03 season, but remained similar between the two seasons in the GAB zone at 0.36 kg/pot lift.

Recreational component: **< 14%**

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 10 t per year.

STOCK ASSESSMENT

Assessment complete: **Yes**

Prior to the two most recent assessments, model predictions were showing the ERLF fishery to be stable at annual catch levels of around 40 t. These levels had been achieved since 1998/99. Indications from the model were that the 60 t levels that were experienced in the early to late 1990s (South Coast Rock Lobster Figure 2) were not sustainable.

The two most recent catch rate (CPUE) data points suggest that the stock biomass has declined in recent years and is now at its lowest level on record. The most likely reason for the decline in biomass is that there has been reduced recruitment to the western extremities of the southern rock lobster distributional range. This hypothesis is supported by the recent downturn in catches and CPUE in the southern rock lobster fishery in the Northern Zone of South Australia (Ward et al. 2004). As is the case in the ERLF, biomass levels in the Northern Zone rock lobster fishery in South Australia are also at their lowest level in the history of that fishery (Ward et al. 2004).

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 shown an overall downward trend in recent years, despite a general increase in effort (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. Catches from this zone in the fishery appear to have stabilised at around 20–30 t annually (South Coast Crustacean Figure 2).

A major impediment to being able to assess the status of the stock is that there is little or no information on basic biological characteristics such as growth rates and size at maturity of southern rock lobsters in the WA fishery. Furthermore, it is difficult to use CPUE data for assessment purposes in this multi-species fishery, because catch rates can be biased depending on which species is being targeted.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

The stock of southern rock lobster in Western Australian waters is at the western edge of its distribution. Up to now it has been considered that puerulus settlement to this region was probably derived from the stock in South Australian, Tasmanian and Victorian waters and, as such, that the relatively small broodstock in WA waters (compared to that in the other states) was probably making an insignificant contribution to the larger southern rock lobster larval pool.

Recent 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 more local. Current flow velocities in the Bight region are weak and while the shelf-edge flow is eastward to South Australia, warm eddies turn back towards WA and possibly return larvae spawned in WA as well as transporting quantities of larvae from the Northern

Zone in South Australia towards the WA coast. The strength of the eastward current is influenced by the Leeuwin Current and hence the El Niño/Southern Oscillation events.

It is therefore not clear what proportion of larval recruitment to WA might be provided by South Australian broodstock, but published assessments for the Northern Zone of that state 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.

Similarly, for the WA component of the stock, catch rates of legal-sized animals (i.e. lobsters larger than 98.5 mm carapace length) in the ERLF in the last two seasons have been at their lowest levels on record, which suggests that breeding females (and egg production) are also at a low level.

The apparent low levels of egg production in the Northern Zone of South Australia and the ERLF, combined with the model-based larval distribution hypothesis, suggest that these parts of the southern rock lobster distribution will need to be managed more cautiously than has been the case in the past. If the recent downturn in catches in this region of the southern rock lobster distribution continues, it will need to be treated as a potential case of recruitment over-fishing and the breeding stock rating downgraded.

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 single-compartment design of the pots is such that they are unlikely to '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 alone cannot provide a livelihood. 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.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002/03: $2.3 million

The beach value of the southern rock lobster fishery was about $1.8 million in 2002/03, based on a beach price of $31/kg. Giant crabs ($25/kg) and champagne crabs ($9.50/kg) added an additional $470,000 to the catch figure.

The large amount of available pot fishing effort and resultant fishing competition, particularly in the Albany and GAB zones, discourages fishers from trying to specialise in this form of fishing or investing in the necessary fishing gear. In recent years, the increased interest in deep sea crabs has encouraged some fishers to focus more on this part of the fishery, particularly in the Albany zone, and to exploit areas and species not traditionally targeted by rock lobster fishing. As more fishers have exploited the crab stocks, yields have decreased, and it is expected that these resources will become just another small component of the fishery that is exploited on an occasional and opportunistic basis.

FISHERY GOVERNANCE

Acceptable catch range for next season: Southern rock lobster 50–80 tonnes

This range is simply based on the landings that have been reported for this fishery over recent years.

The ERLF is a more productive fishery than the outer zones. It would appear to be reasonably stable in the short to medium term, but landings are in the upper bounds of what is predicted to be sustainable by the model assuming constant recruitment. In the light of declining catches this assumption may need to be reassessed.

If the management objective were to fish the Albany and GAB zones to economically viable levels, then current effort levels would need to be drastically reduced. However, it has been accepted that reducing fishing effort in these zones to such levels is unattainable in the medium term and might have the undesirable consequence of encouraging fishers to believe that these zones have the potential to support a viable and profitable stand-alone lobster fishing operation. The Department of Fisheries prefers to promote the view that lobster and deep sea crab fishing on the south coast are best operated as part of diversified fishing operations or as an adjunct to fishers' other business activities.

New management initiatives (2003/04)

Interest in fishing for deep sea crabs is increasing and the Department is planning to develop more formalised management arrangements for these species. A preferred option is to combine all the current arrangements for rock

lobsters and deep sea crabs under a 'South Coast Crustacean Managed Fishery'.

The Australian Government Department of Environment and Heritage is currently considering an application to certify the south coast crustacean fisheries as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

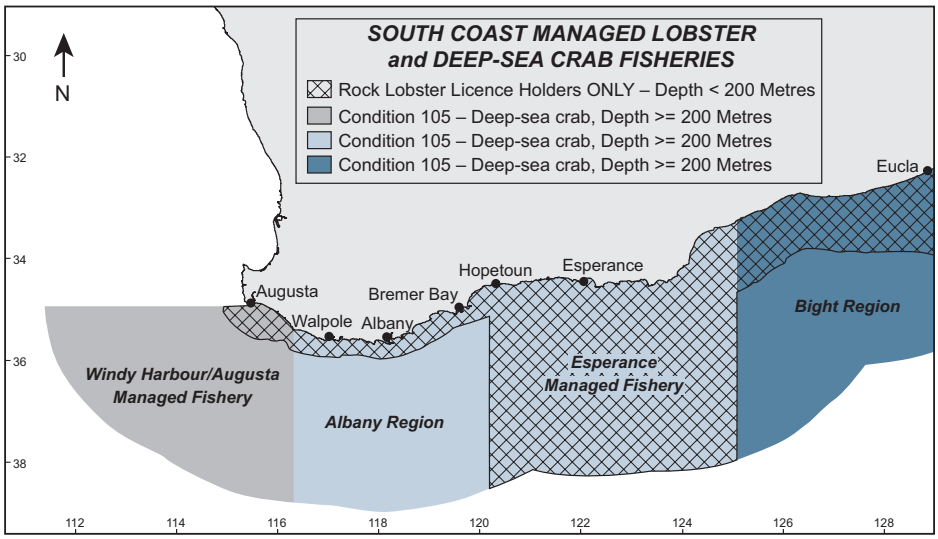
EXTERNAL FACTORS

Recruitment to the south coast rock lobster fishery may be irregular and sporadic in this area because the species is at the western edge of its distributional range. Good settlement might therefore be dependent on favourable environmental conditions.

SOUTH COAST CRUSTACEAN TABLE 1

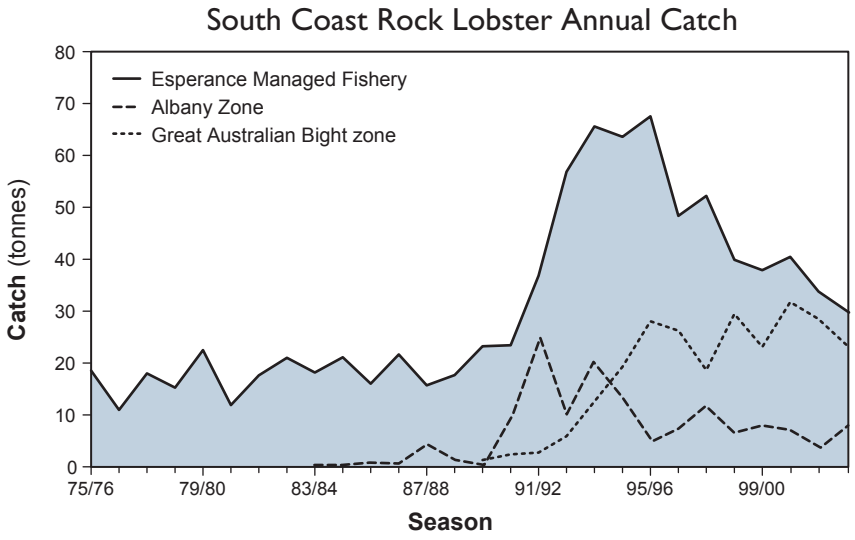
Comparisons of fishing effort and southern rock lobster catch in 2001/02 and 2002/03 in the south coast crustacean fisheries.

MANAGEMENT ZONE	SEASON	POT LIFTS	SOUTHERN ROCK LOBSTER CATCH (tonnes)
ERLF	2001/02	68,000	34
	2002/03	54,000	30
	difference	–21%	–9%
Albany	2001/02	25,000	4
	2002/03	45,000	8
	difference	+80%	+100%
GAB	2001/02	79,000	28
	2002/03	64,000	23
	difference	–19%	–18%



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 2002/03.

Abalone Managed Fishery Status Report

Prepared by A. Hart and F. Fabris, with management input by J. Kennedy

FISHERY DESCRIPTION

The Western Australian commercial 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 a diving 'iron' to prise abalone off rocks. Abalone divers operate from small fishery vessels (generally < 9 m). The fishery targets three species: greenlip abalone (*Haliotis laevigata*), brownlip abalone (*H. conicopora*) and Roe's abalone (*H. roei*). The larger greenlip and brownlip abalone are confined to the lower south-west and south coasts of the state, while Roe's abalone are found in commercial quantities from the South Australian border to Shark Bay, although they are not uniformly distributed throughout this range.

Governing legislation/fishing authority

Abalone Management Plan 1992
Ministerial Policy Guideline no. 10
Abalone Managed Fishery Licence

Consultation process

Abalone Management Advisory Committee
Department–industry meetings

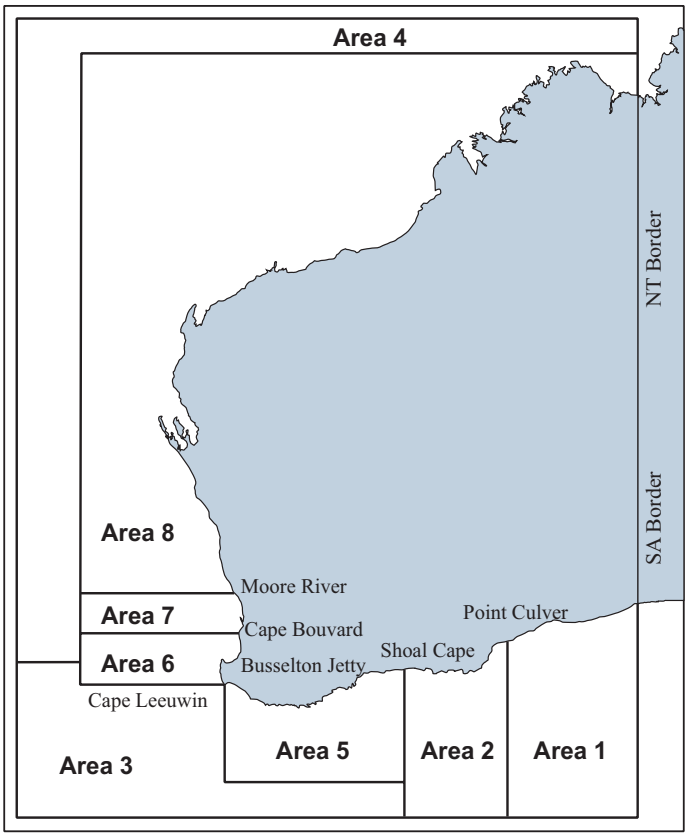
Boundaries

The abalone fishery is divided into eight management areas (Abalone Figure 1). The greenlip and brownlip abalone fisheries include Areas 1, 2 and 3 (from the South Australian border to Busselton Jetty), while Roe's abalone is fished in all areas.

Management arrangements

This fishery is managed primarily through output controls in the form of total allowable commercial catches, set annually for each species taken in each area and allocated to licence holders as individually transferable quotas. Currently the overall TACC (for 2003) is 350.9 t (whole weight), separated into 110.9 t for the Roe's abalone fishery and 240 t for the greenlip/brownlip fishery. The TACC is allocated across 16,100 ITQ units in the greenlip/brownlip fishery and 25,180 in the Roe's abalone fishery. A minimum unit holding (450 greenlip and or brownlip units; 800 Roe's units) applies to licences in the fishery, though there are some Roe's abalone licences which 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 for greenlip and brownlip abalone is 140 mm shell length. For Roe's abalone, the LML for the most part is 60 mm shell length (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.



ABALONE FIGURE 1
General map showing management areas used to set quotas for the commercial abalone fisheries of Western Australia.

Research summary

Abalone divers are required to provide daily catch information on the weight and number of abalone collected, the date and location of harvest and the name of the person 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. Preliminary performance indicators (based on catch, catch rates and meat weights) were negotiated at the end of 2003 for future assessment of TACC. Growth studies of greenlip abalone were initiated in 2003 at three locations, and detailed morphometric data collected from stunted stocks. The FRDC project entitled 'Digital video techniques for assessing population size structure and habitat of greenlip and Roe's abalone', which is designed to test the possibility of underwater video for monitoring density and size structure of abalone stocks, has had success in 2003. Conclusions from initial experiments were that video surveys by abalone industry divers (and research personnel) were capable of detecting a known change in abalone numbers, and average lengths measured by the video camera were comparable with traditional measures (caliper and slate) in most instances. Work is continuing on this project.

Greenlip and Brownlip Abalone

RETAINED SPECIES

Commercial production (season 2003): 212 tonnes (whole weight)

Landings

In 2003 the overall greenlip/brownlip catch was 212.3 t whole weight (Abalone Table 1), consisting of 180 t of greenlip and 32.3 t of brownlip. Overall catch was 9% higher than 2002, but still 28 t below quota. Historically, the Area 1 (Nullarbor fishery) quota (8.3 t) is never taken as fishing conditions are quite difficult, and in both Area 2 and Area 3 licensees elected not to take their full quota due to additional stock conservation efforts agreed within industry. Greenlip catch of 180 t whole weight was 8% higher than 2002 but 11% below quota.

The brownlip catch was 32.3 t whole weight (12.9 t meat weight) for the 2003 season (Abalone Table 1). This was 17% higher than in 2002 and 14% below quota. In Area 3, an industry decision to conserve stock capped the brownlip take at 84% of the quota, and in Area 2 an increase in TACC from 18 t to 20.4 t was not harvested.

Fishing effort/access level

Continuing the practice introduced last year, effort has been divided into the main and stunted stocks. Total effort for the main stocks in 2003 was 1,104 days fished for greenlip and brownlip abalone. This was 7% greater than the effort in 2002 (1,035 days), however more abalone were harvested in 2003, hence an increase in effort is to be expected.

For a greenlip and brownlip catch (main stocks only) of 188 t, the effort of 1,104 diver days was within the acceptable range (1,095–1,511 days) set for the season, indicating that stocks are within acceptable historic levels.

Catch rate

In 2003, the catch rate for the main greenlip stocks was 141 kg whole weight (53 kg meat weight) per diver day. This was a 7% increase from 132 kg whole weight (50 kg meat weight) per diver day in 2002. Although an increase which reverses the trend in recent years, it is still the second lowest catch rate in eight years. In particular, the Hopetoun region in Area 3 appears to have been a sensitive (and therefore useful) indicator for the overall state of the stocks. In this region, catch rates decreased from 87 kg meat weight/day in 1999 to 40 kg meat weight/day in 2002, but increased to 46 kg/day in 2003. A performance indicator of 50kg/day has been set for the Hopetoun stocks for 2004.

Recreational component: 7–13%

The 2003 estimate of recreational catch of greenlip/brownlip, based on telephone surveys of recreational licence holders, is 21.6 t (± 8.3 t), which is around 9% (range: 7–13%) of the total catch. Note that this is about half the 2002 estimate (range: 15–25%). More precise estimates of greenlip/brownlip recreational catch will be obtained during a phone diary survey of randomly selected recreational fishers commencing in October 2004 and continuing throughout the entire 2004/05 recreational season.

STOCK ASSESSMENT

Assessment complete: Yes

A stock assessment of the greenlip/brownlip abalone fishery was undertaken for the 2003 fishing season based on catch and effort statistics, length-frequency and shell morphometry sampling, biological growth studies for stunted greenlip stocks (growth and size at maturity), and some fishery-independent surveys.

In recent years industry has collaborated with the Department of Fisheries to develop strategies for the sustainable harvesting of 'stunted' populations of abalone and research effort has focused in this area to support this. The delineation of stocks as 'stunted' appears to be valid; recent growth studies show that less than 15% of a stunted stock population (Two-Mile, Hopetoun) reach the LML of 140 mm shell length. In 2003, 24.2 t of greenlip abalone (Abalone Table 1) were caught from stunted stocks (13% of greenlip catch in weight; 21% of catch in numbers). This is slightly lower than 2002, when catches from stunted greenlip stocks accounted for 18% of the entire commercial catch, compared to 11% in 2001 and 3% in 2000 (Abalone Table 1).

In Area 2, average catch rate and meat weight for greenlip stocks in 2003 were 50 kg/day and 182 g respectively. This compared favourably to 2002, in which they were 46 kg/day and 198 g. The average meat weight of brownlip abalone in Area 2 was 270 g in 2003, compared to 285 g in 2002. Lower meat weights this year are the result of a lower meat weight target in 2003, rather than reflecting the state of the stock.

In Area 3, the average meat weight of greenlip abalone taken in 2003 was 205 g, which was lower than the 2002 average (223 g), however catch rates increased from 52 kg/day in 2002 to 56 kg/day in 2003. Average meat weight of brownlip

abalone in Area 3 was maintained at 280 g in 2003, compared to 279 g in 2002.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Research has shown that greenlip abalone mature between 80 and 100 mm shell length, and brownlip abalone mature between 90 and 130 mm shell length, which are both well below the legal minimum size limit set across the fishery (140 mm shell length). The breeding stock for both species is further protected, as industry sets self-imposed length limits in excess of the minimum legal limits in areas of fast-growing stocks. For example, in Area 2 there is a general 145 mm minimum length across the fishing grounds. In Area 3, fishers have an imposed minimum size limit of 153 mm shell length for the faster-growing portions of the fishing grounds, and 150 mm for the remainder.

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, which has the secondary effect of reducing the incentive to harm this protected species.

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 close to 30 vessels in the Western Australian abalone industry. Of these, 14 vessels fish greenlip and brownlip abalone, 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 2003: $9.7 million

The estimated average price received by fishers was $126/kg meat weight (approx. $47/kg whole weight) for greenlip and $93/kg meat weight (approx. $37/kg whole weight) for brownlip abalone, resulting in a fishery valued at approximately $9.7 million. These prices were considerably lower than in 2002 when the average prices received by fishers were $146/kg meat weight for greenlip and $119/kg meat weight for brownlip abalone, and substantially lower than the high values of $163/kg meat weight for greenlip and $132.50/kg meat weight for brownlip abalone received in 2000.

FISHERY GOVERNANCE

Acceptable effort range for next season: 1,095–1,511 diver days for 225.5 tonnes whole weight

For fishing to remain at a historically sustainable level, the effort to take the 2004 quota from the main stocks should fall within the effort range (1,095–1,511 diver days) derived from a five-year (1994–1998) variation in catch rates that reflects the acceptable variation in the main stocks. While the effort range has not been adjusted, a slightly lower TACC in 2004 should result in the actual effort falling in the lower section of the effort range.

The overall greenlip/brownlip quota for 2004 has been set at 225.5 t whole weight, a decrease of 14.5 t from 2003. This is the result of small reductions in the quotas for Area 1 (from 8.4 t to 3.2 t) and Area 2 (from 103.6 t to 94.3 t).

Although no change in greenlip/brownlip quota for Area 3 occurred, the fishery will be administered under a series of trial performance indicators for the 2004 season. These will be reported on next year.

New management initiatives (2003/04)

The Australian Government Department of Environment and Heritage is currently considering an application to certify the abalone fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

There were no new management initiatives introduced in 2003/04, 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, the effect of technology changes such as the introduction of GPS, motorised underwater scooters and shark protection cages on diver efficiency is yet to be assessed. All these effects will need to be quantified in the future to improve the stock assessment.

ABALONE TABLE 1

Greenlip and brownlip abalone catch and effort[1] by quota period.

QUOTA PERIOD[2]	GREENLIP TAC kg whole weight	GREENLIP CAUGHT kg whole weight (all stocks)	GREENLIP CAUGHT kg whole weight (stunted stocks)	BROWNLIP TAC kg whole weight	BROWNLIP CAUGHT kg whole weight	COMBINED CATCH kg whole weight	DIVER DAYS (main stocks only)	GREENLIP kg whole (meat) wt per diver day (main stocks only)
1989	-	236,145	22,058	-	36,943	273,088	1,319	157 (59)
1990	126,500	114,414		-	18,768	133,182	670	162 (60)
1991	148,500	131,266		-	14,660	145,926	800	148 (56)
1992	192,500	175,054		-	30,285	205,339	1,110	152 (57)
1993	197,450	178,794		-	31,155	209,949	1,216	139 (52)
1994	200,750	177,166		-	32,223	209,389	1,328	129 (48)
1995	187,264	151,863		-	27,263	179,126	1,082	134 (50)
1996	189,750	176,668	11,517	-	21,933	198,601	896[3]	178 (67)[4]
1997	207,350	187,993		-	26,298	214,291	1,052	173 (65)
1998	200,750	187,644	7,884	-	22,198	209,842	1,040[3]	167 (63)[4]
1999	189,750	180,620	8,024	28,000[5]	27,673	208,293	920[3]	182 (68)[4]
2000	194,669	189,846	4,307	34,875	33,531	223,377	1,028[3]	178 (67)[4]
2001	194,669	187,459	21,243	34,875	31,089	218,548	992[3]	167 (62)[4]
2002	202,521[6]	166,721	29,931	35,893[6]	27,451	194,172	1,035[3]	132 (50)[4]
2003	**202,521[6]**	**180,018**	**24,164**	**37,400**	**32,260**	**212,278**	**1,104**	**141 (53)[4]**

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. The new data differs from previous years and impacts on the effort range provided in the Fishery Governance section
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 TACC 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.

Roe's Abalone

RETAINED SPECIES

Commercial production (season 2003): **95 tonnes whole weight**

Landings

The TACC for the 2003 quota year was 110.9 t whole weight for Roe's abalone. The catch of 95 t whole weight for the 2003 season (Abalone Table 2) was 2% lower than 2002 and lower than the TACC, as some stock in remote locations (primarily Area 1) subject to exploratory quota arrangements remained unfished.

Fishing effort/access level

Total effort for dedicated Roe's abalone divers in 2003 was 714 diver days, which was within the fishery governance range of 679–914 days, indicating that stocks are within acceptable historic levels.

Catch rate

The catch rate for dedicated Roe's abalone divers in 2003 was 120 kg/day, which was 8% below the 2002 catch rate of 131 kg/day, the second highest catch rate recorded since 1994.

Recreational component: **39–47%**

The recreational catch estimate for 2003 was 60–84 t, which represents about 39–47% of the total Roe's abalone catch. See Licensed Recreational Abalone Fishery Status Report, pp. 58-62.

STOCK ASSESSMENT

Assessment complete: **Yes**

The catch, effort, and catch rate statistics indicate that, overall, Roe's abalone stocks are in an acceptable state. The trend since 1999 is lower effort and increasing or stable catch rates in Areas 2–7. No fishing occurred in Area 1 in 2003 due to poor weather conditions and inaccessibility.

In Area 8, the most northerly margin of the fishery, quota was progressively reduced from 30 t in 1998 to 12 t in 2001 and 2002, returning to 15 t in 2003. The abundance of legal-sized Roe's abalone in this area had declined due to a combination of suspected El Niño-induced mortality (hot calm weather and extremely low tides) in 1997 and inappropriate distribution of fishing effort by less experienced fishers. The quota reductions in this area brought catch rates back from a low of 21 kg/hr in 2000 to 33 kg/hr in 2002, and they are now at 27 kg/hr for a TACC of 15 t.

Annual research stock surveys of the metropolitan stocks are reported in the Licensed Recreational Abalone Fishery Status Report, pp. 58-62.

Exploitation status: Fully exploited

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 40 mm (approximately 2.5 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.

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, which has the secondary effect of reducing the incentive to harm this protected species.

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 2003: $2.6 million

The estimated average price for Roe's abalone in 2003 was $27/kg, compared to $41/kg in 2002. On the basis of the average price the fishery was worth approximately $2.6 million, a substantial drop from $4 million in 2002. Overall, the price of Roe's abalone has dropped more than 50% since 2000, when it was $55/kg whole weight.

FISHERY GOVERNANCE

Acceptable effort range for next season: 679–914 diver days for 110.9 tonnes whole weight

To be fished at a historically sustainable level, the 2004 Roe's abalone catches should be taken within the five-year (1994–1998) range of effort (679–914 diver days) that reflects the acceptable variation in stocks.

New management initiatives (2003/04)

The Australian Government Department of Environment and Heritage is currently considering an application to certify the abalone fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

As part of this assessment process, a suite of regional performance indicators have been developed for the Roe's abalone fishery. These will be explicitly documented in next year's report. All indicators were met for 2003.

There were no other new management initiatives introduced in 2003/04, 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 upcoming 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.

ABALONE TABLE 2

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

QUOTA PERIOD[2]	ROE'S TAC kg whole weight[3]	ROE'S CAUGHT kg whole weight	DIVER DAYS[4] (Roe's divers only)	Kg WHOLE WEIGHT per diver day (roei divers only)
1990	105,000	117,558	881	120
1991	101,000	110,334	758	130
1992	105,000	112,275	644	155
1993	128,000	116,390	735	139
1994	125,960	119,849	804	128
1995	125,960	115,218	975	106
1996	125,960	122,065	950	117
1997	126,790	119,080	750	137
1998	93,960[5]	86,530	608	123
1999	119,900[6]	108,278	849	116
2000	115,900[6]	107,683	759[7]	120
2001	107,900[6]	99,173	681	127
2002	107,900	97,660	655	131
2003	**110,900**	**95,057**	**714**	**120**

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 CDR counts.

South Coast Trawl Fishery Status Report

Prepared by M. Kangas, with management input from J. Froud

FISHERY DESCRIPTION

The South Coast Trawl Fishery principally target 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 last 17 years, depending primarily on the strength of recruitment. While the fishery has theoretical access to a large section of the coastal waters, it is effectively restricted to small areas of higher scallop abundance.

Governing legislation/fishing authority

Trawling Prohibition (Whole of State) Notice 1992 (Order)
Surface Trawl Net Fishery (South Coast) Notice 1992
Trawling for Scallops (South Coast) Notice 1992
Condition 73 and/or 79 on Fishing Boat Licences

Consultation

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.

Research summary

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

RETAINED SPECIES

Commercial production (season 2003): 80 tonnes whole weight

Landings

The scallop catch of 80 t whole weight in 2003 was very low compared to catches seen in the last four years but similar to catches recorded in 1999. Less than 1 t each of squid, bugs and mixed fish species were also recorded.

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 2003, only 137 fishing days were recorded compared to 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 2003 was 12 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $0.3 million

FISHERY GOVERNANCE

Acceptable catch range for next season: Not available

New management initiatives (2003/04)

A review of management arrangements of this fishery will be undertaken in 2004/05.

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 2003 were very low, indicating both low levels of effort and lower scallop abundances in the region.

South Coast Estuarine (Interim) Managed Fishery Status Report

Prepared by G. Nowara and R. Lenanton, with management input by J. Froud

FISHERY DESCRIPTION

Thirteen estuaries and inlets located between Cape Beaufort and the WA/SA border are open to commercial fishing as part of the South Coast Estuarine (Interim) Managed Fishery (SCEF). The SCEF is a multi-species fishery targeting many finfish species, with the main fishing methods being gillnet and haul net. The main target species are generally cobbler (*Cnidoglanis macrocephalus*), King George whiting (*Sillaginodes punctata*), sea mullet (*Mugil cephalus*), Australian herring (*Arripis georgianus*) and black bream (*Acanthopagrus butcheri*).

Governing legislation/fishing authority

South Coast Estuarine Fishery (Interim) Management Plan 2001

South Coast Estuarine (Interim) Managed Fishery Permit

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 force in July 2002 and is due to expire in June 2005. Catch and effort in the fishery is managed by input controls such as limited entry, gear restrictions and spatial and temporal restrictions.

The new arrangements have better defined permitted fishing methods and times and have essentially limited the maximum potential effort in the fishery. The interim management plan has also better defined restrictions regarding the transferability of permits in the fishery.

Research summary

Research monitoring of fish stocks in south coast estuaries is primarily based on CAES returns provided by industry. These 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. The CAES database from commercial fishers also provides a valuable and consistent source of information for monitoring recreationally important stocks where they are harvested by both groups.

This report presents specific data for three of the most important estuarine fish stocks, namely black bream (*Acanthopagrus butcheri*), cobbler (*Cnidoglanis macrocephalus*) and King George whiting (*Sillaginodes punctata*).

RETAINED SPECIES

Commercial production (season 2003): 278 tonnes

Landings

The total reported landings of 277.9 t from the south coast estuaries in 2003 incorporate molluscs and crustaceans as well as finfish. The predominant finfish species caught are cobbler, black bream, sea mullet, leatherjacket (Monocanthidae), Australian herring, flathead (Platycephalidae), silver bream (*Rhabdosargus sarba*) and King George whiting (South Coast Estuarine Table 1). In total about 40 species of finfish, sharks, rays and invertebrates are represented in the annual catch from south coast estuaries.

The reported total commercial catch from south coast estuaries shows a decline from the peak catch in 1992, but has been relatively stable in the past five years. The reported 2003 catch figure has increased by 18 t over 2002 levels (South Coast Estuarine Figure 1). Catches in Gordon Inlet, Oyster Harbour, Princess Royal Harbour and Wilson Inlet were each more than 1 t greater than in 2002, while in Hamersley Inlet the catch was more than 1 t lower than in 2002. Beaufort Inlet, Broke Inlet, Irwin Inlet, Oldfield Inlet and Stokes Inlet showed only minor changes in catches from last year. There were no reported catches in 2003 from Culham Inlet and Jerdacuttup Lakes.

Black bream: In 2003, the reported catches of black bream in south coast estuaries increased by 7 t from 2002 levels, continuing a general trend towards an increased catch from a low in 1998 (South Coast Estuarine Figure 2). The increased catches were mainly in Oyster Harbour and Wilson Inlet.

Cobbler: During 2003, the cobbler catch was concentrated in three south coast embayments/estuaries, namely Wilson Inlet, Oyster Harbour and Irwin Inlet, with the highest catches (83%) reported from Wilson Inlet. In a number of estuaries, special regulations specific to the target fishing of cobbler have been introduced to protect spawning aggregations and areas. The 2003 catch in Wilson Inlet has increased by 2 t from the 2002 catch. This catch level represents the highest reported catch of cobbler in Wilson Inlet since 1985 (South Coast Estuarine Figure 3).

King George whiting: During 2003, the majority of catches (86%) were reported from Wilson Inlet and Oyster Harbour. The King George whiting catch from Wilson Inlet for 2003 was less than in 2002 but continues at levels similar to those reported during the early 1990s (South Coast Estuarine Figure 4). The very high 1998 catches resulted from high juvenile recruitment into Wilson Inlet several years earlier. This same trend was reflected for the King George whiting catch from all of the south coast estuaries.

Fishing effort/access level

There were 25 licensees in the SCEF during 2003.

Fishing effort has been reported 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 recorded, but it is not possible to determine effort targeted towards individual species from this measure.

Since 1993 (when the data set was refined by the exclusion of data from King George Sound), overall fishing effort in the SCEF has declined by approximately one-third, largely through management action including licence buy-backs. The average number of boats fishing during 2003 was 18.2 (South Coast Estuarine Figure 1).

Catch rate

Catch per unit effort closely followed the trend in catches overall in south coast estuaries until 1997 when the CPUE began to increase while fishing effort has decreased. The CPUE in 2003 rose to the highest level in the last 20 years (South Coast Estuarine Figure 1)

Recreational component: 40% (approx.)

The National Recreational Fishing Survey, conducted in the 12 months from May 2000 to April 2001 (Henry and Lyle 2003), reported that the species most commonly caught by both shore and boat fishers from the estuaries on the south coast (by weight) were black bream (31 t), King George whiting (14 t), blue swimmer crabs (11 t), pink snapper (8 t), skipjack trevally (8 t), prawns (7 t), WA salmon (6 t), mullet (4 t), Australian herring (3 t), mulloway (2 t), tailor (1 t), squid (1 t) and tarwhine (1 t). A total of 28 different species were

reported in the recreational catch, so this does not represent the entire catch from the estuaries. The estimated boat-based catches (63%) from this survey are possibly an over-estimate and may be revised at a future date.

The recreational component makes up approximately 40% of the combined recreational and commercial catch from the 2000 calendar year of these species from the estuaries.

STOCK ASSESSMENT

Assessment complete: Yes

Black bream: Black bream populations are genetically distinct within each south coast estuary. A preliminary yield-per-recruit stock assessment was developed for the black bream stock in the Wellstead Estuary using biological data from research by Sarre (1999), previously presented in the *State of the Fisheries Report 1999/2000*. Based on the trends in both catch and CPUE, the black bream stocks have increased in abundance since 1999, in keeping with lower effort.

Cobbler: The multi-species targeting aspects of the effort data from Wilson Inlet make a formal assessment of the state's major cobbler fishery in this estuary difficult. The average catch per vessel operating indicates that this valuable stock is trending to higher abundance over the past decade, although the 2003 figure may indicate that it has reached its peak.

King George whiting: Approximately half of the south coast commercial catch of King George whiting in 2003 was taken in Wilson Inlet, which provides critical nursery habitat for this species to the age of 3+ years. High catches during the late 1990s 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. Catches have now returned to pre-1998 levels. This indicates that the stock abundance is varying independently of fishing effort at this time.

Australian herring: See Australian Herring Fishery Status Report, pp. 180-182.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Black bream: A preliminary eggs-per-recruit model, previously presented in the *State of the Fisheries Report 1999/2000*, was developed for the black bream stock in the Wellstead Estuary using biological data from research by Sarre (1999). Because the size at maturity is lower than the legal minimum length, it is believed that breeding stock levels are adequate. As with the west coast stocks of black bream, this estuarine species exhibits different growth rates in different south coast estuaries. In all cases the size at maturity is lower than the legal minimum length, affording protection to the breeding stocks.

Cobbler: The breeding stock for cobbler in the Wilson Inlet stock is contained within the estuary. The legal minimum length for the capture of cobbler is 430 mm total length. Research by Laurenson et al. (1993b) on cobbler in Wilson Inlet demonstrated a length at maturity of approximately 425 mm, which corresponds to an age of 3+ to 4+ years. In this estuary, the breeding size and the legal minimum length are very similar. This important species is afforded some additional protection by a closed fishing area in Wilson Inlet. Cobbler exhibit different growth rates in different south coast estuaries, however the size at maturity is generally less than the legal minimum length of 430 mm, thus affording some protection to the breeding stock.

King George whiting: Catches of King George whiting from Wilson Inlet result from ocean spawning and subsequent settling of juveniles into estuarine nursery habitats. There is little commercial fishing pressure for this species in the ocean outside of Wilson Inlet, suggesting that the breeding stock is adequate for this species.

NON-RETAINED SPECIES

Bycatch species impact: Low

The selective fishing methods employing specific mesh sizes historically have not taken significant quantities of bycatch species.

Protected species interaction: Negligible

Occasional interaction with fur seals or sea lions occurs in this fishery, however it does not result in a significant negative impact on these species.

ECOSYSTEM EFFECTS

Food chain effects: Low

Recruitment-driven variations in abundance, independent of fishing in these estuarine systems, suggest that significant food chain effects due to fishing are highly unlikely.

Habitat effects: Low

The operation of the nets used is unlikely to have any significant impact on the benthic habitats in these estuaries.

SOCIAL EFFECTS

The SCEF involved an average of around 30 fishers during the 2003 fishing season, as well as generating additional regional employment. Most importantly, the catches from this fishery also provide fresh local fish to regional centres.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $943,000

FISHERY GOVERNANCE

Acceptable catch range for next season: 200–500 tonnes

The acceptable catch range under current management arrangements is 200–500 t (rounded to the nearest 50 t) and the catch of 278 t in 2003 was within this acceptable range.

The acceptable catch range was derived by a double exponential smoothed forecasting of the past annual catches through to 1998 and the variation of observations around the predictions. The confidence intervals are set at 80%. Future annual catch values which fall outside of this range will be investigated. Where consecutive values occur outside of the

range, changed management arrangements may need to be considered. Given the continuing trend for reduced effort in this fishery, mostly due to buy-backs funded through the Fishery Adjustment Scheme, the acceptable catch range may need to be recalculated.

New management initiatives (2003/04)

Following the implementation of the interim management plan for the SCEF in 2002, permit holders in the fishery raised a number of issues regarding fishing rules in the plan. The Department of Fisheries also identified some areas where previous arrangements were not properly carried over into the plan. The Department completed consultation with industry members with a view to correcting and resolving these issues. In addition, the Minister approved wider consultation between the Department and other user groups to ascertain other opinions regarding a number of proposed changes to the plan. There are 13 issues to be resolved. These include refining the definitions of boundaries and use of some gear, as well as providing for the limited use of garfish and ring nets in the fishery.

Resolution of these issues should be complete in early 2005. Consultation regarding the status of management arrangements for the fishery (noting that the interim plan is scheduled to expire on 30 June 2005) is also expected to occur in early 2005.

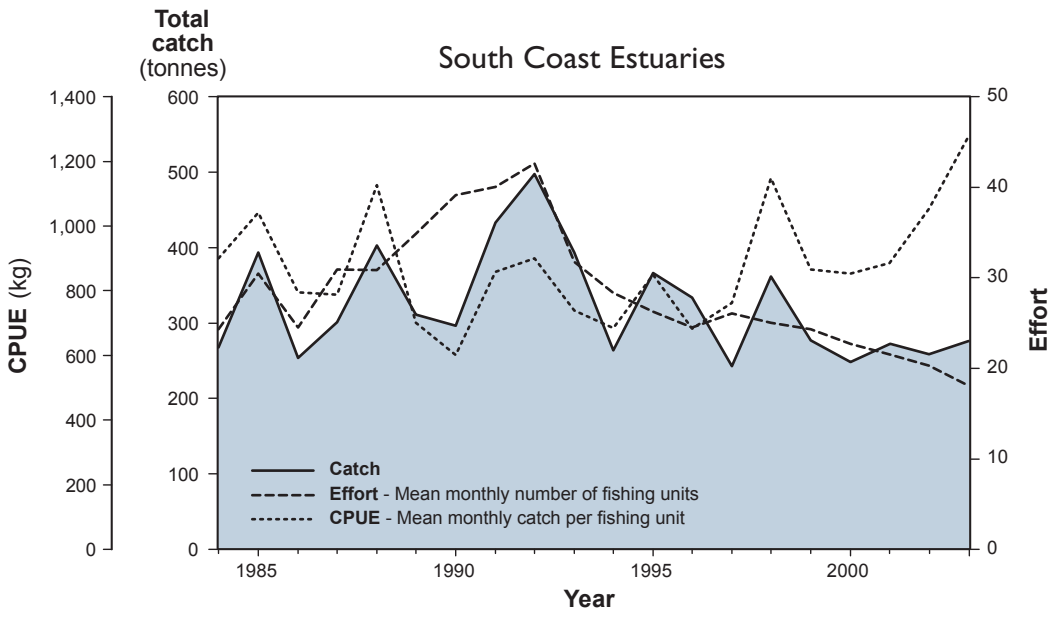
EXTERNAL FACTORS

Variation in fish abundance in these south coast estuarine stocks is largely driven by environmental influences on recruitment. This is further complicated by the natural closure of some estuaries and the practice of human intervention to breach estuarine bars, mostly for a range of reasons related to estuarine amenity coupled with ecosystem 'health'. 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.

SOUTH COAST ESTUARINE TABLE 1

The catch from the South Coast Estuarine Fishery for the year 2003.

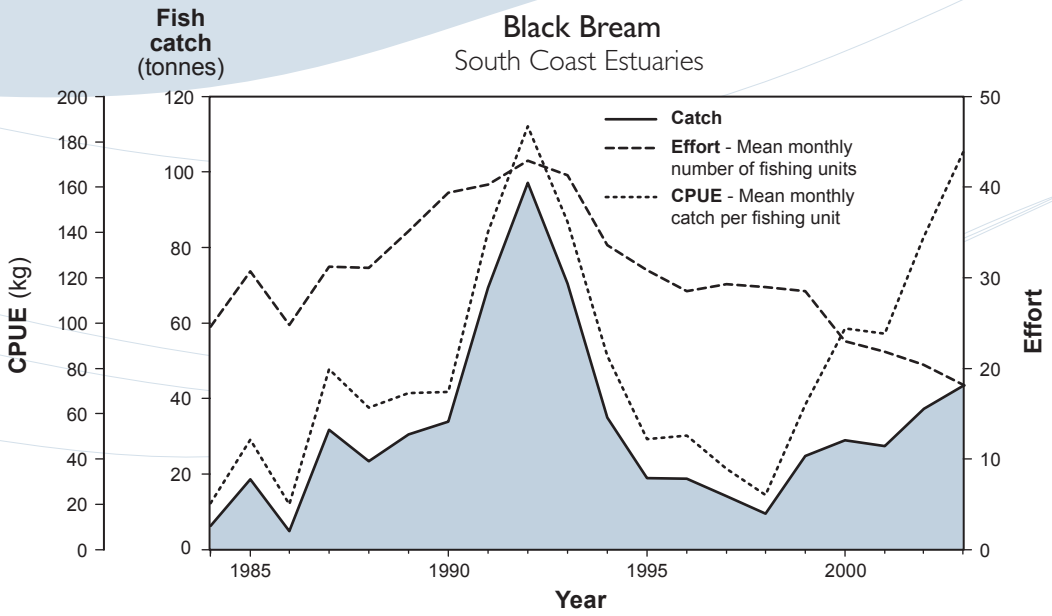
SPECIES	SCIENTIFIC NAME	CATCH (tonnes)
Cobbler	*Cnidoglanis macrocephalus*	94.3
Black bream	*Acanthopagrus butcheri*	43.9
Sea mullet	*Mugil cephalus*	35.8
Leatherjacket	Monocanthidae	20.0
Australian herring	*Arripis georgianus*	18.9
Flathead	Platycephalidae	10.8
Silver bream	*Rhabdosargus sarba*	8.5
King George whiting	*Sillaginodes punctata*	7.5
Pink snapper	*Pagrus auratus*	6.6
Yellow eye mullet	*Aldrichetta forsteri*	6.0
Blue swimmer crabs	*Portunus pelagicus*	3.6
Other species		22.1



SOUTH COAST ESTUARINE FIGURE 1

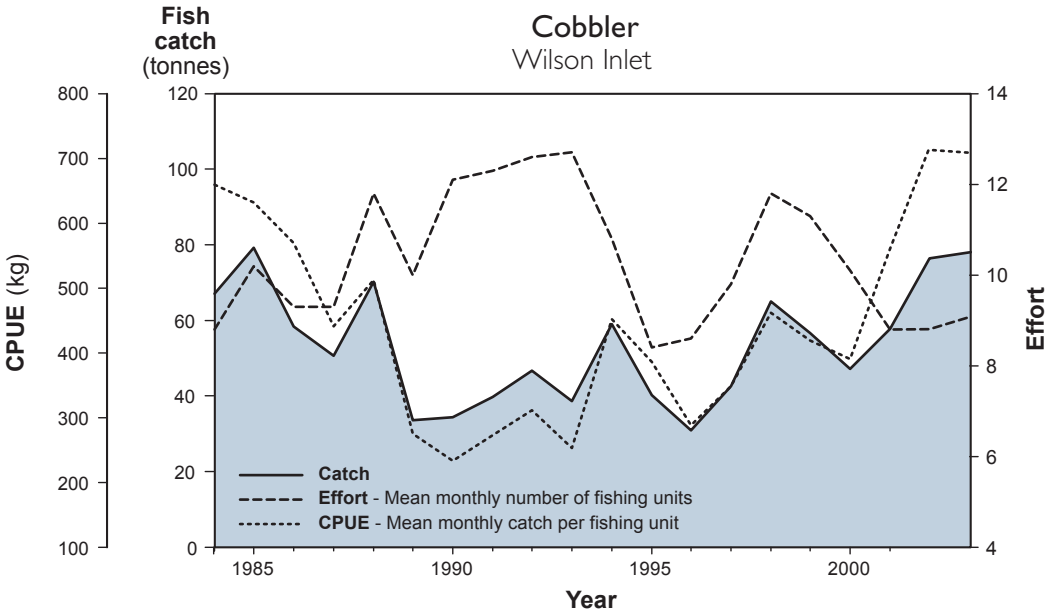
The annual catch, effort and catch per unit effort (CPUE) for the South Coast Estuarine Fishery over the period 1984–2003.

Note that 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.



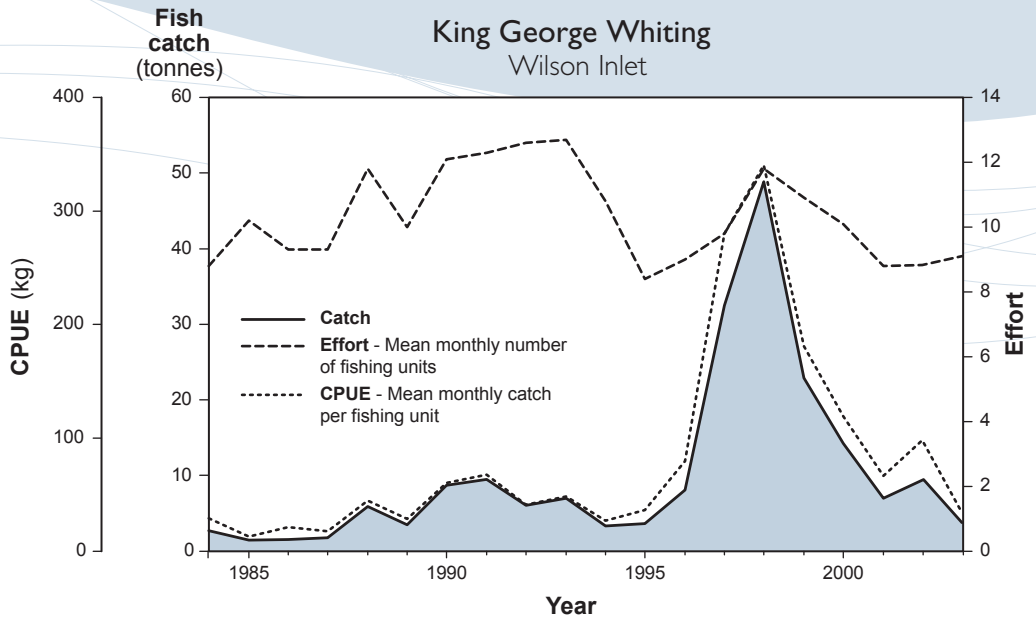
SOUTH COAST ESTUARINE FIGURE 2

The annual catch, effort and catch per unit effort (CPUE) for the black bream (*Acanthopagrus butcheri*) fishery in south coast estuaries over the period 1984–2003.



SOUTH COAST ESTUARINE FIGURE 3

The annual catch, effort and catch per unit effort (CPUE) for the cobbler (*Cnidoglanis macrocephalus*) fishery of Wilson Inlet over the period 1984–2003.



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 1984–2003.

Western Australian Salmon Managed Fisheries Status Report

Prepared by G. Nowara and R. Lenanton, with management input by J. Froud

FISHERY DESCRIPTION

The western Australian salmon (*Arripis truttaceus*) is targeted in WA 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 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

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

Consultation process

Department–industry meetings

Boundaries

The boundaries of the South Coast 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 Managed Fishery management plan provides for licence holders to operate from assigned beaches, with each fishing team having access to a single nominated beach.

In the South West Coast Salmon Managed Fishery, licence holders can operate from any beach within the boundaries of the fishery, and share the use of beaches amongst themselves under priority of netting rules specified in the regulations. In practice, only a few beaches are fished.

In addition, a small number of fishers are permitted via a condition on their fishing boat licence to fish for salmon between Busselton Jetty and Tim's Thicket.

These three categories are the only fishers with authority to land and sell western Australian salmon in Western Australia.

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.

Research summary

The main information used to monitor this important commercial and recreational stock is from the analysis of the commercial CAES data in conjunction with the substantial level of historical biological research available.

Additionally, two FRDC projects have been completed which focused on the development of a juvenile index of recruitment for Australian salmon in Western Australian waters and a time-series analysis to examine historic commercial catches. These two projects used different methods to assist in predicting future commercial Australian salmon catches.

RETAINED SPECIES

Commercial production (season 2003): 1,892 tonnes

Landings

The total state catch for the 2003 season was 1,892 t, which was about 730 t less than the previous year, but within the long-term catch range for this fishery (Salmon Figure 1). This lower overall catch may in part reflect limited market demand (see 'External factors').

The 2003 south coast commercial catch of Australian salmon was 1,157 t, a reduction of 838 t from 2002. Once again, almost the entire catch (97%) was taken between February and May, which coincides with the time of the spawning run along the south coast, and there was only a negligible 'back run' (June–December) catch.

The south coast catch was taken from the designated salmon beaches, with a minor catch component from the estuaries. The highest proportion of the catch (840 t or 73%) was taken from the western sector of the fishery (west of Albany to Windy Harbour), with 279 t (24%) from the central region (east of Albany to Cape Riche). The smallest proportion (38 t or 3%) was again taken from the eastern sector of the fishery (from Cape Riche eastwards).

The south-west coast catch for 2003 totalled 735.3 t, about 100 t more than in 2002.

Fishing effort/access level

In 2003 there were 18 south coast and 12 south-west coast fishing teams, plus three licensees with access from Busselton Jetty to Tim's Thicket. This is the same number that operated during the previous year. Their methods of operation (i.e. beach-based netting on a restricted number of beaches) preclude a more precise calculation of effective fishing effort.

Catch rate

During 2003, the average catch per fishing team was 64.3 t for the south coast (down from 110.9 t in 2002) and 49 t for the west coast (up from 41.8 t in 2002).

Recreational component: 6% (approx.)

An estimated catch of 136 t of Australian salmon was reported from the whole of Western Australia in the National Recreational Fishing Survey conducted in the 12 months from May 2000 to April 2001 (Henry and Lyle 2003). Most of the catch (117 t) came from the south coast (111 t from the ocean and 6 t from estuaries), and the remainder (19 t) from the west coast (17 t from the ocean and 2 t from estuaries). The recreational component makes up approximately 6% of the total catch (i.e. the recreational catch combined with commercial catches from the calendar year 2000).

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

The commercial fishing effort in the major part of the fishery on the south coast is largely fixed, therefore the higher levels of catch since the mid-1990s indicate that the overall abundance of the stock is being maintained. The higher catches taken on the west coast in recent years, coupled with a decline in catches on the south coast, are a reflection of the movement of more spawning-run fish from the south coast to the west coast. This indicates the influence of environmental factors rather than a higher stock level.

Outputs from a preliminary biomass dynamics model indicate that the long-term catch of salmon from both sectors (recreational and commercial) is in the vicinity of 2,500 t per year and as such the stock can be considered to be fully exploited.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Current commercial catches indicate that the breeding stock is currently at an acceptable level. However, the preliminary egg-per-recruit analysis indicates that the current exploitation level on the western Australian salmon population can be high owing to the nature of the fishery, where most migrating schools of pre-spawning salmon pass each of the fishing beaches in turn and may be taken. Any substantial increase in the catch from either commercial or recreational fishers, or significant reduction in recruitment due to unusual environmental effects, could therefore take the spawning stock below an acceptable biological reference point of 30% of virgin egg biomass.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

The fishery uses beach seine nets to specifically target schooling salmon, primarily during the annual 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 the beach seine, but they are released immediately by the fishers. This is due to the fact that the seine netting operation is labour-intensive and the fishing team immediately notices any seals caught in the net. The fishers are therefore able to release the seals from the seine net soon after capture without injury.

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. While the fishery has the potential to reduce the mortality on prey species, given the high natural variability in the western Australian salmon biomass, the effect of the fisheries is likely to be similar in magnitude to other factors contributing to the high natural variation on 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. Moreover, the fishing operators only shoot the nets when fish schools are seen; 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 will not impact significantly upon these habitats.

SOCIAL EFFECTS

The south coast fishery involved an average of 75 fishers and the south-west coast fishery involved an average of 40 fishers during the 2003 fishing season.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $814,000

The south coast catch in 2003 was received by five processors: Albany Bait Producers, Austral Fisheries, Bevans Fish Supplies, Bremer Fish Processors and Polar Group.

FISHERY GOVERNANCE

Acceptable catch range for next season: 1,200–3,350 tonnes

The acceptable catch range for this fishery has been amended slightly during 2003/04 using improved methodology. The revised range is derived by applying an autoregressive moving average (2,2) control quality procedure to 37 years of annual catches up to the year 2000. The confidence intervals are obtained by estimating the variation of the observations compared with the variation of the predictions from 1983 to 2000. The 2003 catch figure is within the acceptable catch range.

New management initiatives (2003/04)

The Australian Government Department of Environment and Heritage is currently considering an application to certify the two managed salmon fisheries as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

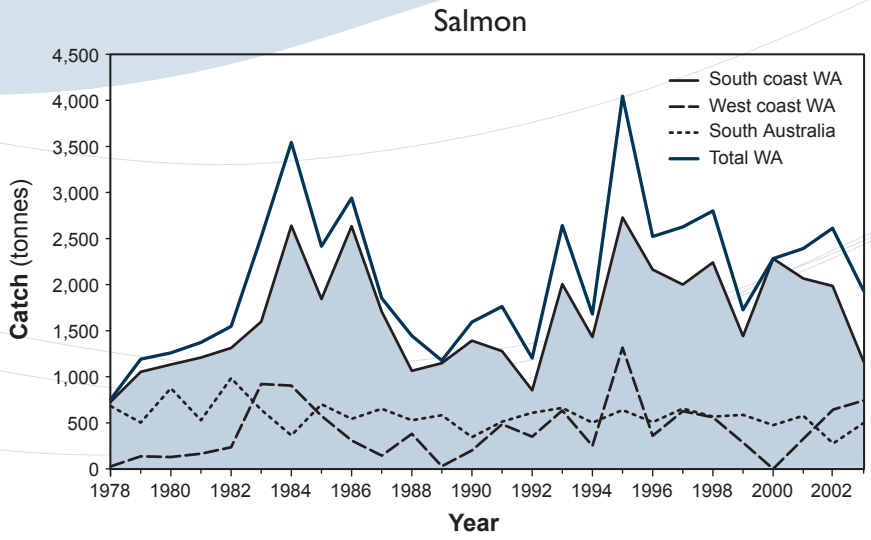
A Voluntary Fishery Adjustment Scheme (VFAS) is currently in progress for the South West Coast Salmon Managed Fishery. If the VFAS is successful in reducing the number of licences in the fishery, it will reduce both the catch and the potential for conflict between different user groups in the fishery.

Industry members have been working with the peak commercial fishing group (the Western Australian Fishing Industry Council) and the Department of Fisheries to develop a code of conduct for fishermen working in both salmon managed fisheries. Amongst other things, the code includes a section specifying that commercial salmon fishermen should only net salmon if a market has been established for the fish.

EXTERNAL FACTORS

Commercial fishers report that there has been limited market demand for salmon in recent years, with the result that they have not taken all of the fish available.

The movement of salmon on to the west coast during the 2002 and 2003 seasons has made more fish available in this area compared to the previous few years. These movements are thought to be associated with the behaviour and strength of the southward-flowing Leeuwin Current, which was relatively weak during the autumn period of both years. In this situation, coastal waters are cooler and the salmon typically migrate further up the west coast, becoming more vulnerable to the west coast recreational and commercial fisheries.



SALMON FIGURE 1

Australian salmon catches for South Australia and Western Australia for the period 1978 to 2003.

Australian Herring Fishery Status Report

Prepared by G. Nowara and R. Lenanton, with management input by J. Froud

FISHERY DESCRIPTION

Commercial fishing for Australian herring (*Arripis georgianus*) is primarily undertaken using herring trap nets (also known as 'G' trap nets) on south coast beaches. This takes place on a limited number of beaches mainly during the autumn migration of this species along the southern coast of Western Australia.

On the west coast, the Cockburn Sound (Fish Net) Managed Fishery includes fishing for Australian herring. In addition, small quantities of Australian herring are taken by 'wetline' vessels, and by some estuarine licensed fishers on both the south and west coasts.

Governing legislation/fishing authority

Fisheries Notice no. 478 of 1991 (Section 43 Order)
Fishing Boat Licence Condition 42

Consultation process

Department–industry meetings

Boundaries

Herring can be taken commercially by holders of an unrestricted fishing boat licence throughout the range of their distribution along the lower west and south coasts of Western Australia. The use of trap nets is restricted to 10 nominated beaches along the southern 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 take herring using 'G' trap nets on 10 separately nominated south coast beaches. There is a closed season (10 February to 25 March each year) which closely matches the peak salmon migration season along the south coast.

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 herring is considered a prime recreational species, resource-sharing issues are likely to be a major consideration in future management arrangements for this fishery, particularly on the west coast.

Research summary

The annual assessment of the status of the herring stock has been undertaken utilising CAES data supplied by industry and detailed biological information from a national research project conducted between 1996 and 1999.

A stock assessment model for this fishery has been developed using all available research data and CAES information from Western Australia and South Australia. However, final validation and testing of the model is still needed. Additionally, two FRDC projects have been completed which focused on the development of a juvenile index of recruitment for Australian herring and a time-series analysis to examine historic commercial catches. The latter of these has been used for the accurate prediction of herring catches and the results are presented in this report.

The following status report summarises the research findings for this fishery.

RETAINED SPECIES

Commercial production (season 2003): State 527 tonnes
South coast 415 tonnes

Landings

The total catch of Australian herring for the state in 2003 was 526.8 t, a decrease of approximately 73 t from the 2002 catch (Herring Figure 1). The south coast catch was 415 t, which comprised 79% of the total state catch. The south coast landings included 393 t from the ocean (377 t from trap nets and 16 t from other gear) and 22 t from estuaries and embayments. The south coast catch to the end of May 2003 (traditionally the end of the trap net fishing season) was 402.7 t, or 97% of the annual south coast catch. The west coast catch was 111.8 t and included 18.4 t from the ocean, 6.5 t from estuaries and 86.9 t from embayments (Geographe Bay and Cockburn Sound).

Fishing effort/access level

During 2003 there were 11 licensees (most of whom are also Australian salmon fishers) permitted to take herring using 'G' trap nets on nominated south coast beaches.

The number of herring trap net teams that operated during the season provides a broad index of fishing effort for the south coast herring trap net fishery. Over the period since the mid-1990s, the level of effort has been reduced by 47% through a series of Government buy-back initiatives, with the most recent in 2000 when three units (or 23% of the effort) were removed.

Catch rate

The average catch per south coast trap net fishing team during 2003 was 34.2 t, a reduction on the annual catch rate of the previous year. Some of this reduced catch may be attributed to the lack of available markets for the fish, resulting in lower catches being taken by the fishers. There is evidence that declining levels of recruitment since 2000 may also have contributed.

Recreational component: 40% (approx.)

Catch and effort figures are available from the National Recreational Fishing Survey, conducted for 12 months between May 2000 and April 2001. The estimated total catch of herring for Western Australia from this survey was 3,873,000 fish (± 339,000) or 523 t (Henry and Lyle 2003). The majority of the recreational catch (438 t) was taken on the west coast (399 t from the ocean and 39 t from estuaries), and 84.5 t were reported from the south coast (81 t from the ocean and 3.5 t from the estuaries). A small quantity (0.5 t) was reported from the oceanic waters of the Gascoyne region. The estimated boat-based catches (32%) from this survey are possibly an over-estimate and may be revised at a future date.

This recreational component makes up 80% and 11% respectively of the total catch (i.e. the recreational catch combined with the commercial catch from the calendar year 2000) of herring from the west and south coasts. Earlier data collected in 1994 and 1995 (Ayvazian et al. 1997) indicated that the recreational catch shares at that time for the west and south coasts were around 60% and 10% respectively. The total state recreational catch comprises approximately 40% of the combined catches.

STOCK ASSESSMENT

Assessment complete: Preliminary

An age-structured stock assessment model has been developed which explicitly considers the spatial distribution of the herring stock on the west coast of Western Australia and the south coast of WA and South Australia, using historic information and data gathered during the three-year Australian herring research project. The results of the modelling process suggest that the proportion of the stock on the west coast of WA is smaller than that on the southern coast of Australia. Available evidence also suggests that factors other than fishing may significantly influence fluctuations in the catch, and hence the breeding stock levels.

As is the case for Australian salmon, a proportion of the herring resource is recruited from South Australian nursery areas. In most years, 'local' recruitment is though to be far more important to the Western Australian fishery than recruitment from South Australia. For the west coast sector especially, it is believed that protected marine habitats such as Geographe Bay, rather than the south coast or South Australia, provide important nursery areas and a source of recruitment. However, updated historical catch records between 1976 and 2003 indicate that there is a significant relationship between the size of the west coast catch and the size of the south coast catch (correlation coefficient = 0.43; $p = 0.024$). Thus recruitment of maturing fish from the south coast on to the west coast is thought to be strongest in years of higher south coast abundance.

Declining trends in fishery-independent estimates of recruitment since 2000, declining commercial catches over the same period (in excess of the reduction to be expected due to licence buy-backs), and high recreational catches on the lower west coast around 2000, together suggest that a serious review of the status of this important resource is now needed.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

As is the case with Australian salmon, virtually the entire commercial herring catch consists of mature individuals with peak seasonal catches being taken during the annual autumn spawning migration. 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, in view of the recent declining trends in commercial catch and recruitment strength in both regions, there is now a need to reassess the status of the breeding stock.

NON-RETAINED SPECIES

Bycatch species impact: Low

The main south coast fishery operates primarily through fixed trap nets on 10 beaches which are manned daily during the main autumn fishing season. The operation of the fishing

gear generally allows any bycatch species to be removed and returned to the water. 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, this 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

The south coast trap net fishery involved an average of 38 fishers during 2003. Additional employment is created in the processing and distribution networks and retail fish sales sectors.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2003: $210,000

The estimated value to fishers of the whole state catch for the year 2003 is $210,000.

FISHERY GOVERNANCE

Acceptable catch range for next season:
South coast 475–1,200 tonnes
West coast 70–185 tonnes

The acceptable catch range for the south coast Australian herring trap net fishery under the current management regime is 475–1,200 t. This range has been amended slightly during 2003/04 using improved methodology. The revised range is derived by applying an autoregressive moving average (2,2) 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. Future annual catch values that fall outside of this range will be investigated. Where consecutive values occur outside of the range, management changes to protect the stock may need to be considered.

The 2003 catch of 415 t for the south coast fishery is lower than the range set, and data projections suggest that the catch for 2004 is likely to be lower than that of 2003.

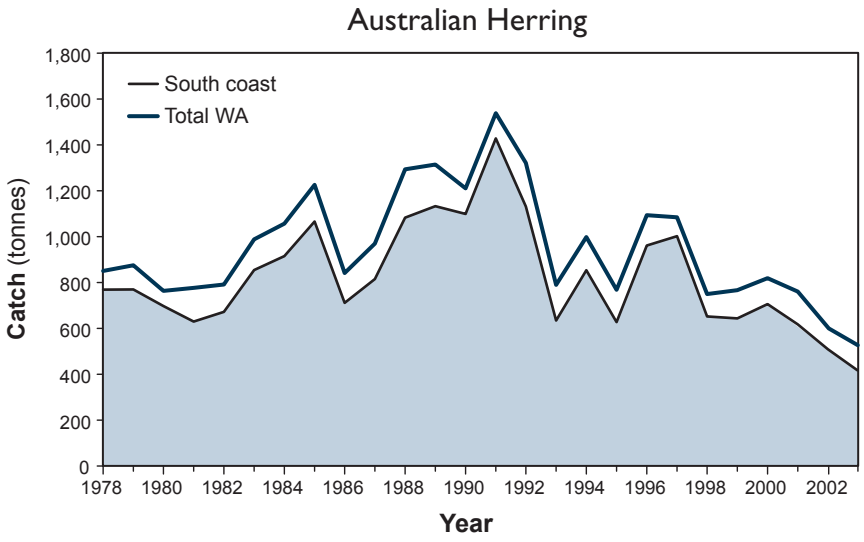
The acceptable catch range for the west coast, derived by the same methods, is 70–185 t. The 2003 catch of 112 t is within this range. Projections of the data indicate that the west coast catch is likely to be near the lower limit in the next year.

New management initiatives (2003/04)

The Department is currently reviewing the management arrangements for the use of herring 'G' trap nets, and the commercial fishing of herring generally.

EXTERNAL FACTORS

Exceptionally strong Leeuwin Currents in 1999 and 2000, together with much higher levels of predation of Australian herring by salmon in 2000 and 2001 (as a consequence of the pilchard mortality) may have contributed to declining catches in subsequent years.



HERRING FIGURE 1
Catches of Australian herring from the south coast and the total Western Australian catch for the period 1978 to 2003.

South Coast Purse Seine Managed Fishery Status Report

Prepared by D. Gaughan, T. Leary and P. Lewis, with management input by K. McCarthy

FISHERY DESCRIPTION

This fishery is based on the capture of pilchards (*Sardinops sagax*) by purse seine nets in the waters off the south coast of Western Australia between Cape Leeuwin and the WA/SA border. However, the management plan also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus teres*).

Governing legislation/fishing authority

South Coast Purse Seine Management Plan 1994
South Coast Purse Seine Managed Fishery Licence

Consultation process

Purse Seine Management Advisory Committee
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 stock assessment data. 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 amounts 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 continues to focus on fishery-independent spawning biomass surveys, which are completed as part of a five-year FRDC-funded project examining the regrowth of the pilchard stocks in Western Australia. A survey was carried out in the Albany/Bremer Bay region in July 2003 and another in the Esperance region early in 2004. Analysis of the data collected is currently underway. Monitoring of catches from each region is undertaken monthly to provide robust 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 and compilation of the following status report. A second FRDC project to assess any future threat from the virus disease which decimated pilchard stocks in the 1990s is also being undertaken by the Research Division's Fish Health Unit.

RETAINED SPECIES

Commercial production (season 2002/03): 1,592 tonnes

Landings

As the pilchards have recovered on the south coast from the mass mortality of 1999, the TACs have increased. For 2002/03 the TACs were set at 909 t for Albany, 1,230 t for Bremer Bay and 1,500 t for Esperance. Catches of pilchards achieved in the 2002/03 season were:

Albany zone: 757 t
Bremer Bay zone: 594 t
Esperance zone: 241 t

Thus the increased TACs have led to increased landings at Albany, and to a lesser extent at Bremer Bay, but as for last year, the pilchard catch in Esperance remains low (South Coast Purse Seine Fishery Figure 1). The low catches in this region remain attributable to low availability of market-sized pilchards in the traditional fishing grounds around Esperance. Low availability of market-sized pilchards has also been a factor limiting catches in Bremer Bay and Albany. Inconsistent availability has meant that onshore processors have been unable to have their operations running at optimal levels, and this in turn has impacted on the industry's ability to regain traditional markets.

Catches of other small pelagic species in the 2003 quota period were insignificant (< 5 t).

Fishing effort/access level

Fishing effort changes annually in response to changes in the TAC for each region and local availability of market-sized fish. Fishing effort increased in Albany by 267% and in Bremer Bay by 119%, reflecting the increased TACs and the reasonable availability of pilchards in these zones. In contrast, although Esperance also had a higher TAC, the low availability of market-sized fish led to lower effort being applied. In contrast to the effort increases at Albany and Bremer Bay, that for Esperance decreased by 33% from the previous year.

Albany zone: The recorded number of CAES days in 2002/03 was 841 compared to 314 in 2001/02.

Bremer Bay zone: The recorded number of CAES days in 2002/03 was 514 compared to 431 in 2001/02.

Esperance zone: The recorded number of CAES days in 2002/03 was 201 days compared to 320 in 2001/02.

Catch rate

The catch rates in all three zones were similar to those in the previous year, but note that catch rate information for this fishery is a relatively poor indicator of stock abundance.

Albany zone: The 2002/03 catch rate for the Albany zone was 900 kg/day compared to 886 kg/day in 2001/02.

Bremer Bay zone: The 2002/03 catch rate for the Bremer Bay zone was 1,156 kg/day compared to 1,138 kg/day in 2001/02.

Esperance zone: The 2002/03 catch rate for the Esperance zone was 1,197 kg/day compared to 1,253 kg/day in 2001/02.

Recreational component: Nil

STOCK ASSESSMENT

Assessment complete: Yes

The fishery-independent estimates of spawning biomass and the age-composition data for each primary zone are analysed together within a population simulation model that provides a forecast of 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 biomass to ensure that the model outputs are as robust as possible. This assessment indicates that the spawning biomass in each region, and the lower and upper bounds for the estimate, were:

Albany zone: 22,146 t (15,903–31,674 t)
Bremer Bay zone: 18,829 t (10,639–9,178 t)
Esperance zone: 43,202 t (21,459–65,890 t)

These estimates indicate that the pilchard spawning biomass for each south coast region is close to 100% of virgin biomass.

Exploitation status: Under-exploited

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 2003 the model indicated that spawning biomass (i.e. the breeding stock) of pilchards in each of the three primary management zones was at healthy levels, being close to 100% of the virgin biomass level in each case. This represents a considerable increase over the 69% of virgin level biomass estimated in 2002.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

This fishery specifically targets schools of pilchards, so unwanted bycatch is insignificant. Other similar-sized pelagic fish which may be caught in small quantities and sometimes discarded include yellowtail scad, maray, anchovies and blue mackerel.

Protected species interaction: Low

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 and may die. The impact of these incidental captures on their respective populations is unlikely to be significant.

ECOSYSTEM EFFECTS

Food chain effects: Moderate

Small pelagic fish, typically pilchards or anchovies, occupy a pivotal position of energy transfer in food webs in which they occur and are often the main link between primary (phytoplankton) and secondary (zooplankton) production and larger predators. Any significant or prolonged reduction in the biomass of pilchards is likely to have a significant impact on predatory species such as seabirds, mammals and tuna. The quota for pilchards is however generally set at a maximum of 5–10% of the spawning biomass, thus leaving 90–95% available to natural predators.

Habitat effects: Negligible

Purse seine nets are designed to operate in mid-water and have very little effect on the habitat. Although the purse seine gear used in Western Australia can contact the sea floor in some shallow areas, the relatively light construction of the gear suggests that there is no significant impact occurring to, for example, seagrass beds.

SOCIAL EFFECTS

Currently there are 8 vessels fishing in Albany providing income for about 22 people. Local factories employ about 15 casual and full-time staff to process and package pilchards. There have been 4 vessels fishing in the Bremer Bay zone for the season employing 12 crew. The processors in Bremer Bay provide work for between 15 and 18 casual and full-time workers. In Esperance, where there was a low availability of market-sized fish, there were only 2 vessels working in 2002/03 season, employing approximately 8 people. The local factory that received the catch employed approximately 5 casual staff as well as 3 full-time staff, including the owners. In total there were approximately 80 people directly employed in this industry.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002/03: $1.59 million

The higher-value angling blocks/trays and individually quick frozen (IQF) fish continue to represent almost the entire catch. The different product types for each zone are shown in South Coast Purse Seine Table 1. At an average price of $1,000/tonne, the total catch value for 2002/03 was $1.59 million, significantly more than last year's $1.17 million. Loss of markets during the periods of very low TACs from 1999 to 2001 continues to impact on the industry. The bait market remains the preferred destination for the catch, but demand for pilchards from Western Australia has not recovered to the previously high levels of the 1990s.

FISHERY GOVERNANCE

Acceptable effort range for next season: Not available

Catches are governed by changes in the TAC for each of the primary management zones. For the 2003/04 season, the TAC for each of three zones has been set at 1,500 t, giving a maximum expected catch for the fishery of 4,500 t. If the

trend, particularly at Esperance, over recent years for low availability of market-sized fish continues, then it is likely that this total TAC will not be caught. The fleet and infrastructure for this fishery also remain in a state of flux following the 1999 mass mortality event, and this may also 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 difficult to estimate an acceptable effort range for the fishery.

New management initiatives (2003/04)

A new management approach, following the post-mass-mortality period when the fishery was essentially closed in some regions, was originally presented to the Management Advisory Committee during 2001. This initiative proposed to cap TACs at levels that would enable the fishery to endure severe downturns in recruitment. In addition, annual changes in TACs, whether up or down, would not be allowed to exceed 25% from the preceding year's TAC unless a drastic and sudden stock crash occurred due to abnormal circumstances, such as another mass mortality event. Under this relatively conservative management approach, TACs could be set for three-year periods with appropriate trigger points, thereby providing a significantly more stable fishery than is presently the case, allowing industry to make better informed business decisions. While this initiative was further developed during 2002, little progress was made in formalising these new arrangements during the current year due to other priorities. Nonetheless, the new approach is being used as a guide for making decisions for this fishery within the current management framework.

EXTERNAL FACTORS

The loss of stock due to the mass mortality event associated with the pilchard herpes virus during 1998/99 raised serious concerns about the survival of pilchard stocks in Western Australia, but stocks continue to recover. There are still significant gaps in our knowledge of the pilchard herpes virus, therefore it is not known if, or when, there may be another outbreak of the disease. Further work on this is currently being undertaken by the Department's Fish Health section, which will help assess the future risks that disease may pose for the pilchard stocks. The rebuilding process of the industry and the future viability of the fleet appear encouraging.

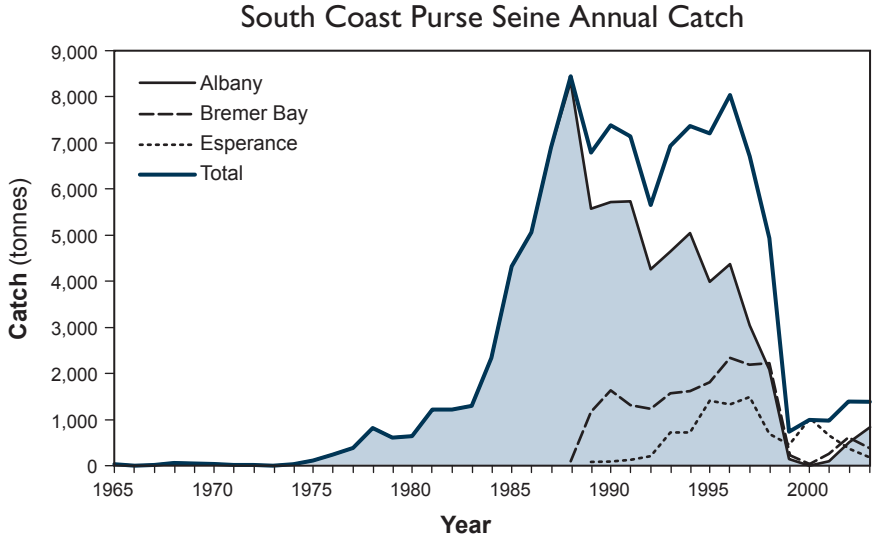
The South Australian pilchard fishery, which is now considerably larger than the WA fishery, continues to compete with WA's traditional east-coast bait markets. This is viewed by some industry members as the biggest current threat for the south coast purse seine industry.

Environmental factors such as variations in the Leeuwin Current flow are likely to be affecting both the distribution and the biology of the species, and will be assessed further as more years of data become available. Research on the nutrient dynamics of the south coast pelagic ecosystem, in collaboration with the University of Western Australia and Murdoch University, aims to investigate some aspects of the environmental variability that may impact on the pilchard stocks. The possibility that global warming may be causing longer-term changes, on a time scale unrelated to the normal inter-annual environmental variations, cannot be discounted.

SOUTH COAST PURSE SEINE TABLE 1

Processing details (in tonnes) from Albany, Bremer Bay and Esperance for 2002/03.

PRODUCT	ALBANY	BREMER BAY	ESPERANCE	TOTAL SOUTH COAST
Trays	545.6	396.8	191.4	1,133.8 (71.3%)
IQF	170.5	115.2	22.8	308.5 (19.4%)
Pet food/ Other	41.2	82.1	26.4	149.7 (9.4%)
Total	**757.3**	**594.1**	**240.6**	**1,592.0**



SOUTH COAST PURSE SEINE FIGURE 1

Annual catches of pilchards along the south coast, by fishing zone.

Demersal Gillnet and Longline Fisheries Status Report

Prepared by D. Gaughan and J. Chidlow, with management input by D. Griffiths

FISHERY DESCRIPTION

There are two managed fisheries using vessels that deploy demersal gillnets or demersal longlines with power-hauled net reels along the south and lower west coasts. These are the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF) and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF). The majority of operators use demersal gillnets and the fisheries primarily target shark, with a scalefish component in the catch. The three main shark species targeted by fishers on both the south and west coasts are the dusky whaler shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and gummy shark (*Mustelus antarcticus*). The two fisheries are reported together here because extensive past research indicates that they share this key series of unit stocks. The sandbar or thickskin shark (*Carcharhinus plumbeus*) is also targeted by commercial fishers on the west coast.

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 Licence

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 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 latitude 26° S.

Management arrangements

The south and west coast fisheries are controlled through two similar management plans.

The JASDGDLF was declared a limited entry fishery in 1988 and is managed under a joint authority with the Australian Government. This fishery is managed primarily through effort controls in the form of time/gear units. One unit allows a fisher to use one 'net' for one month. This management strategy was introduced in 1992 and net length has been modified to reduce effort in a series of stages through to 2000/01 (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. Implementation of the full management plan is currently awaiting the outcomes of legal challenges to the proposed unit allocation.

Research summary

Major FRDC-funded studies of the shark fishery on the south and west coasts of Western Australia, undertaken over the period 1993/94 to 1998/99, provided a detailed basis for managing the fishery. The extensive information from these studies was incorporated in two FRDC final reports, and the data sets incorporated into the Department of Fisheries' research data records. A further three-year FRDC-funded project focusing on the sandbar (thickskin) shark component of the fishery is due for completion in late 2004. Age-specific exploitation rates and biological data from this sandbar shark research have been incorporated into a preliminary demographic analysis, to determine the likely response of the stock to current levels of exploitation.

Research monitoring of the fishery involves analysis of CAES data and biological sampling of commercial catches. In 2002/03 a new computer program was written which reapportioned incorrectly reported catches from earlier seasons using modified criteria to account for improved species identification and reporting in recent years.

These research data are used to provide the status report on the fishery.

RETAINED SPECIES

Commercial production (season 2002/03):

All sharks 1,244 tonnes
Key species 847 tonnes

Landings

The total shark catch of 1,244 t from these fisheries in 2002/03 comprised 875 t from the JASDGDLF and 369 t from the WCDGDLF, made up as follows:

SPECIES	*JASDGDLF*	*WCDGDLF*
Dusky whaler*	182 t	95 t
Gummy shark*	380 t	27 t
Whiskery shark*	133 t	30 t
Sandbar shark†	30 t	134 t
Other shark	150 t	83 t
Total shark	**875 t**	**369 t**

* Original key target species subject to stock assessment.
† Sandbar (known locally as thickskin) shark was not reported separately prior to 2001/02, but has emerged as an important commercial species on the west coast and is the subject of a research project that commenced in July 2000.

Variations from the previous year in catches for the key species are described below under 'Stock assessment'.

In addition to these shark landings, approximately 13–20% of the overall demersal gillnet and longline catch is composed of finfish species that are retained for sale. In 2002/03, scalefish landings totalled 130 t in the JASDGDLF and 89 t in the WCDGDLF. For a detailed breakdown of catch species composition 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).

Apart from the two dedicated fisheries, sharks are also caught by other commercial fishers and these catches are reported here because of their importance to an understanding of the true harvest rates. During 2002/03, vessels licensed in other managed fisheries operating in the same overall area (i.e. between North West Cape and the South Australian border) reported catches of sharks and rays totalling 16 t. An additional 179 t catch of sharks and rays was taken by 'wetline' vessels without access to managed fisheries.

Fishing effort/access level

There were 57 licences in the JASDGDLF in 2002/03, 24 in Zone 1 and 33 in Zone 2, although only 8 Zone 1 vessels (2 fewer than in 2001/02) and 24 Zone 2 vessels (4 more than in 2001/02) reported active fishing returns during the year. There were 26 licences in the WCDGDLF in 2002/03, although only 12 (2 fewer than in 2001/02) reported active fishing returns during the year.

Data validation procedures that were implemented last year continue to provide a more reliable record of catch and effort than was previously available and therefore a higher degree of confidence in the assessment of the status of the stocks. Because in previous years, data were not validated according to these same procedures, catch and effort data presented in this and the previous report are not comparable to data provided in earlier status reports. The revised data indicate that effort had been previously over-estimated for these fisheries, particularly in the years leading up to the implementation of the JASDGDLF management plan in 1988. The effort expended in 2002/03 was:

JASDGDLF: 160,250 kilometre gillnet hours
(Zone 1: 39,524; Zone 2: 120,726)
WCDGDLF: 57,317 kilometre gillnet hours

Effort is expressed as standardised kilometre gillnet hours and takes into account the historically small amount of longline effort still employed in the fisheries (Demersal Gillnet and Longline Figure 2). Effort in the JASDGDLF increased by 5.7% in 2002/03, while that in the WCDGDLF increased by 3.5%.

While this method of combining gillnet and longline effort into a single measure of effort will continue, an increase in the use of longlines on the west coast has been sufficient to change the dynamics of the fishery. As such, the trends in longline catch effort alone are also provided in this report (Demersal Gillnet and Longline Figure 3). Two spikes in catch and effort in the WCDGDLF are evident. The 1997/98 effort of around 400,000 hooks was targeted towards neonate dusky shark and scalefish, with a resulting shark catch of about 50 t. By contrast, the 2003/04 effort of 250,000 hooks was targeted towards adult sharks and resulted in a shark catch of 170 t. This dramatic increase in catch, despite the fact that the effort expended was considerably less than the 400,000 hooks deployed in 1997/98, highlights the need for changes in targeting practices to be documented and standardised in the fishery database.

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 species caught recreationally are 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 commencing 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 report (pp. 146-150).

Dusky whaler: The total catch of dusky sharks in the JASDGDLF and WCDGDLF during 2002/03 was 276.9 t, 17.1% higher than last year. The catch in Zone 1 of the southern fishery was 100.4 t, 4% less than last year, and in Zone 2 was 81.2 t, 12.9% more than last year. The most obvious change was in the WCDGDLF, where the catch increased by 35.3 t or 58.9%. Catch rates decreased by 11% in Zone 1 of the JASDGDLF and increased by 7.6% and 53.5% in Zone 2 and the WCDGDLF respectively. Dusky shark CPUE also increased by 8.8% in 2002/03. Since the demographic analysis was completed in the mid-1990s, ongoing monitoring of the dusky shark stock has largely involved examination of catch rate data from the target fisheries. However, because the relative contribution of neonates to the fisheries' catch appears to have declined and catches of older juveniles have increased since exploitation rates were measured in the mid-1990s, analysis of CPUE data for this species has become complicated. Further complicating the ongoing assessment of the status of this stock has been the increased targeting of large dusky sharks by 'wetline' hook methods for the value of their fins, both within

and outside the managed shark fisheries. Not only has the reported wetline catch of dusky shark (recorded as 'bronze whaler') outside the target fisheries doubled since the mid-1990s but it is believed that a significant proportion of demersal gillnet vessels' large hook-caught sharks are being included within their reported gillnet catch. This artificial inflation of the gillnet catch seriously biases the gillnet fishery's historical catch rate data, and provides an overly optimistic trend in the CPUE for recent years. The apparent decline in catch rates of neonates throughout south-western Australia strongly suggests that the size of the breeding population has been depleted and recruitment has declined. There is thus a strong possibility that there are fewer adult females pupping over a smaller geographic range. This view is supported by the most recent stock assessment of dusky sharks, which concluded that the demersal gillnet fisheries' catch of primarily neonate (first year) sharks was sustainable as long as mortality of sharks older than 6 years was less than 4%. Department of Fisheries research data show that there is a continuing bycatch of adult dusky sharks in other fisheries and mortality from entanglement in plastic packing straps. Thus the collective mortality of dusky sharks beyond that generated by the managed shark fisheries remains a major cause for concern.

Whiskery shark: The combined catch of whiskery sharks in the JASDGDLF and WCDGDLF during 2002/03 was 163.1 t, a 5.2% decrease from the previous year. Landings declined by 7.6% in Zone 1, by 4.3% in Zone 2 and by 1.2% in the WCDGDLF. The effective area catch rate declined by 12.4% in 2002/03 and, regionally, catch rates decreased by 14.3%, 8.8% and 4.5% in Zone 1, Zone 2 and the WCDGDLF respectively. The model indicates that the biomass of whiskery sharks in 1975, when catch and effort reporting began, was 99% of its unexploited (virgin) level, with 99% confidence that it was between 96% and 100%. Estimated total biomass declined steadily between 1975/76 and 1993/94, after which the rate of decline slowed and is now almost stable. Since 1996/97, the estimated rate of biomass decline has averaged 1.2% per year and was only 0.9% in 2002/03. Based on the latest data, current whiskery shark biomass is estimated to be higher than previously calculated at between 33.7% and 36.3% of virgin level, with a best estimate of 35.1%. Mature female biomass is also estimated to be higher than previously thought at 21.8% (with 95% confidence that it is between 20.6% and 22.8%), and is calculated to have increased by 1.6% since 2001/02, the second year running that mature female biomass has increased.

At the 2002/03 level of effort, the risk assessment model estimated that the probability of the stock being at its target level of 40% of virgin biomass by 2010 was 30.3% and the probability that biomass would increase was only 24.4%, significantly less than last year's estimate of 41.9%. Even though biomass was calculated to be higher than previously determined, these results demonstrate that increased fishing efficiency, albeit within the current management constraints, is seriously undermining the chances of rebuilding the whiskery shark stock. Additional management measures are therefore required to ensure that the temperate demersal gillnet and longline fishery can demonstrate that it is harvesting this stock in a sustainable manner.

Gummy shark: The total catch of gummy sharks increased by 48 t in 2002/03 to 407.1 t, the highest catch since 1992/93 and outside the acceptable range for this season (250–350 t). The total catch was 13% higher than in 2001/02, which together with the 45% increase between 2000/01 and 2001/02 appears indicative of a healthy stock. This is supported by a further 13.4% increase in the catch rate of gummy shark following the 39.3% increase in the previous year. Nonetheless, despite this apparent increase in abundance of gummy shark, there is a possibility that increased targeting of effort towards this species may be providing an over-optimistic interpretation of the trends. Because the most recent modelling of gummy shark population was in 1997/98, a new assessment that incorporates the catch and effort data since that time needs to be conducted.

Exploitation status:
Dusky whaler and whiskery sharks over-exploited
Gummy sharks fully exploited

Breeding stock levels:
Dusky whaler declining
Gummy shark adequate
Whiskery shark 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. Following ESD risk assessment of these fisheries, all impacts on bycatch species are considered to be low.

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 gillnet hours, seabirds at 4 captures per 100,000 km gillnet hours and turtles at 1 capture per 100,000 km gillnet hours.

The numbers of white sharks (*Carcharodon carcharias*) and grey nurse sharks (*Carcharias taurus*) caught are small (< 20/yr and < 80/yr respectively) and a high proportion of these are released alive.

The likelihood of this fishery significantly impacting the viability of populations of protected species is 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. 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.

SOCIAL EFFECTS

Estimated employment during 2002/03 was 50 skippers and crew in the JASDGDLF and 20 in the WCDGDLF.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002/03: $5.5 million

JASDGDLF:	$3.3 million (shark and scalefish) $875,000 (shark fins)*
WCDGDLF:	$950,000 (shark and scalefish) $350,000 (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

Acceptable catch range for next season: Key species 725–1,175 tonnes

Previously, acceptable annual catch ranges for the key species were based on 10-year averages. The acceptable ranges for dusky sharks have now been revised to reflect the more recent status of the stocks. Catch ranges for dusky shark changed for 2003/04 to reflect the need for lower catches of this species, which are subject to exploitation in other fisheries. The acceptable ranges for gummy shark increased to reflect the healthier status of this stock. As with dusky shark, the sandbar shark stock is more resilient to exploitation when only a narrow range of ages are targeted. The acceptable catch range for sandbar has therefore been reduced as a precaution due to the increased targeting of adults by longliners at the northern end of the WCDGDLF. The acceptable ranges are as follows, noting that the lower limit for sandbar shark is not specified and has thus not been included in the overall range for key species provided above:

Whiskery shark	175–225 t (same as previously)
Dusky whaler	200–300 t (previously 300–400 t)
Gummy shark	350–450 t (previously 250–350 t)
Sandbar shark	< 200 t (previously < 250 t)

Catches of whiskery shark remain close to, but below, the acceptable range, reflecting their over-exploited status despite the fact that the stock is slowly increasing. The catch of dusky shark is within the revised acceptable range. Proposed management changes (see 'New management initiatives' below) are expected to alleviate current pressures and allow a lower, sustainable catch. The catches of gummy and sandbar sharks are both within the revised acceptable ranges.

New management initiatives (2003/04)

In response to the International Plan of Action for the Conservation and Protection of Sharks released in 1999 by the Food and Agricultural Organisation of the United Nations (FAO) due to concern over the increase in shark catches and the consequences for shark populations, a National Plan of Action has been developed to address those issues specific to Australian shark species and fisheries.

A discussion paper (Fisheries Management Paper no. 180) outlining potential strategies to deal with a variety of sustainability concerns, primarily the significant levels of latent effort and the poor status of the dusky shark stock, will be released in July 2004. This paper is the starting point from which future changes to management arrangements for the temperate shark fisheries within Western Australian waters will be developed, in conjunction with stakeholders. Once the public comments received on this discussion paper have been considered, the Minister will make a decision on the most appropriate measures to ensure sustainability of the temperate shark fishery resources.

In addition to ongoing monitoring of catch and effort data from the demersal gillnet and longline fisheries, collection of the following data should be considered as a high priority in the short to medium term:

- Updated dusky shark age-specific harvest rates from a new tagging project.
- Improved shark catch data, with emphasis on correct species identification and accurate reporting of shark catch from other commercial, recreational and charter fishing sectors.
- Size/age composition of the demersal gillnet and longline fisheries' catch.
- Fishery-independent monitoring (employing commercial fishing techniques), which has the potential to mitigate many of the problems associated with the use of fishery-dependent CPUE data.

Other issues with lower priority include the development of a new model and updated stock assessment advice for gummy sharks and research into the biology and ecology of high conservation-value species such as grey nurse sharks.

EXTERNAL FACTORS

The level of demersal gillnet and demersal longline exploitation of dusky whaler sharks was assessed as sustainable in 1998 (using 1994/95 exploitation rates), provided the exploitation of mature animals did not exceed 1% annually. Continued observed and anecdotal evidence suggests that significant numbers of large dusky whaler sharks have been taken over the past 5–10 years by fishers operating outside the target fisheries. Unpublished catch data from Australian Government-managed pelagic longline vessels and other WA-licensed vessels support this conclusion. There is thus an urgent need to quantify the take of breeding dusky whaler sharks by these sectors to determine to what extent this catch contributes to the apparent decline in dusky whaler breeding stocks.

DEMERSAL GILLNET AND LONGLINE TABLE 1

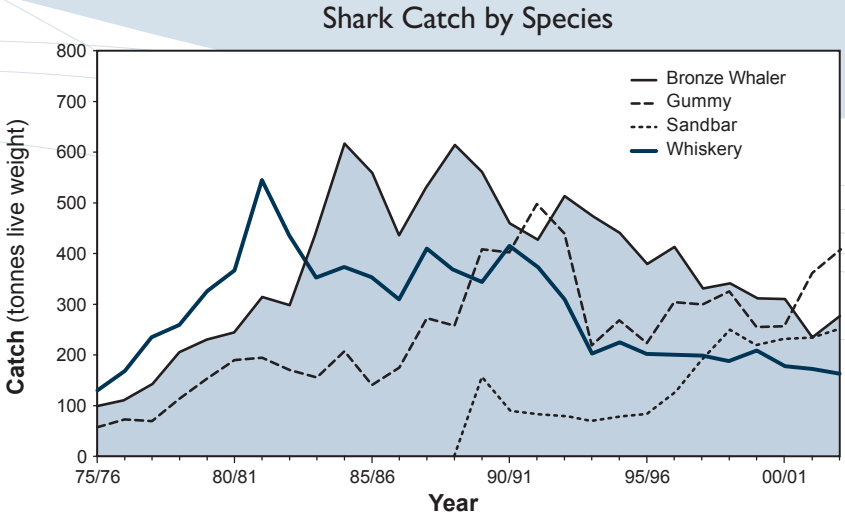
Shark catch species composition for the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF), 2002/03.

SPECIES		CATCH (tonnes)				
		JASDGDLF			WCDGDLF	STATE TOTAL
		Zone 1	Zone 2	Total		
Gummy	*Mustelus antarcticus*	31	349	380	27	407
Dusky	*Carcharhinus obscurus*	101	81	182	95	277
Sandbar (thickskin)	*Carcharhinus plumbeus*	29	< 1	30	134	164
Whiskery	*Furgaleus macki*	69	64	133	30	163
Hammerhead	Sphyrnidae	12	24	36	21	57
Wobbegong	Orectolobidae	27	5	32	22	54
Blacktip	*Carcharhinus* spp.	7	< 1	7	27	34
School	*Galeorhinus galeus*	0	14	14	0	14
Shovelnose rays	Rhinobatidae, Rhynchobatidae	0	0	0	6	6
Skates and rays		<1	4	4	0	4
Copper	*Carcharhinus brachyurus*	0	0	0	4	4
Pencil	*Hypogaleus hyugaensis*	<1	2	2	0	0
Other sharks		32	22	54	4	58

DEMERSAL GILLNET AND LONGLINE TABLE 2

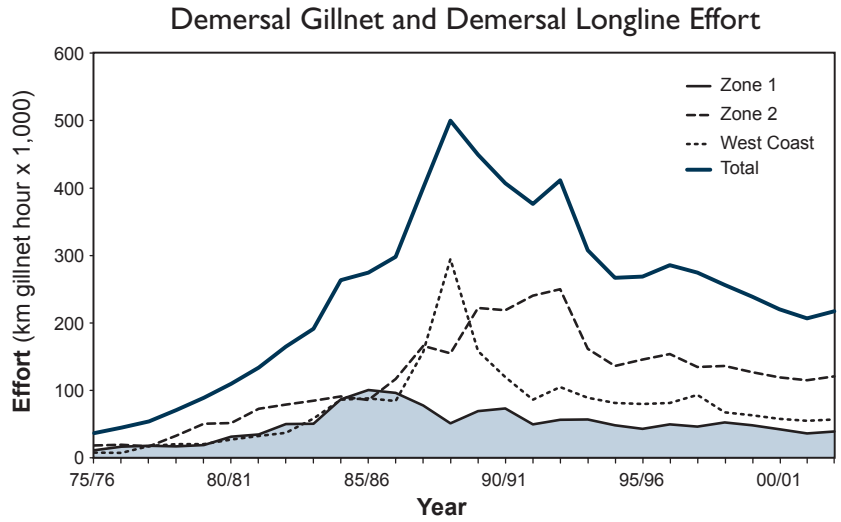
Scalefish catch species composition for the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF), 2002/03.

SPECIES		CATCH (tonnes)				
		JASDGDLF			WCDGDLF	FISHERY TOTAL
		Zone 1	Zone 2	Total		
Queen snapper	*Nemadactylus valenciennesi*	9	24	33	6	39
Blue groper	*Achoerodus gouldii*	9	15	24	4	28
Dhufish	*Glaucosoma hebraicum*	7	1	8	14	22
Pink snapper	*Pagrus auratus*	2	5	7	13	20
Samson fish	*Seriola hippos*	2	1	3	11	14
Sweetlip emperor	*Lethrinus miniatus*	0	0	0	11	11
Mulloway	*Argyrosomus hololepidotus*	0	0	0	8	8
Redfish	*Centroberyx* spp.	1	3	4	0	4
Leatherjacket	Monacanthidae	0	4	4	0	4
Boarfish	Pentacerotidae	<1	3	3	0	3
Other scalefish		35	8	43	20	63



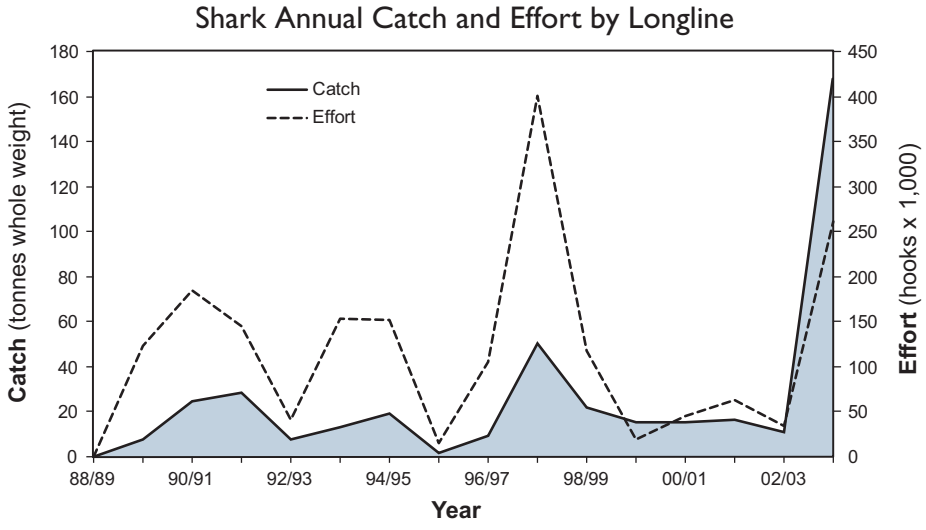
DEMERSAL GILLNET AND LONGLINE FIGURE 1

Annual catches of target shark species in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2002/03.



DEMERSAL GILLNET AND LONGLINE FIGURE 2

Effort in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2002/03.



DEMERSAL LONGLINE CATCH AND EFFORT FIGURE 3

Catch and effort by longline in the WCDGDLF for the period 1988/89 to 2003/04.

Wetline Fishing

The CAES database indicates that a small proportion (7%) of the wetline catch in 2002/03 was reported from the south coast bioregion. The top 10 species comprised redfish (*Centroberyx* spp.*) 34 t, hapuku (*Polyprion oxygeneios*) 22 t, pink snapper (*Pagrus auratus*) 20 t, samson fish (*Seriola hippos*) 15 t, cod (primarily grey-banded cod, *Epinephelus septemfasciatus*) 11 t, Australian herring (*Arripis georgianus*) 10 t, trevalla (*Hyperglyphe antarctica*) 10 t, wobbegong (*Orectolobus* spp.) 6 t, queen snapper (*Nemadactylus valenciennesi*) 6 t and leatherjacket (Monocanthidae) 4 t.

Fisheries along the south coast are concentrated around Albany, Bremer Bay and Esperance. Hapuku, redfish, grey-banded cod and trevalla are targeted in deeper waters at the edge of the continental shelf.

*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, recording about 20% of the state's fishing effort or an estimated 1.7 million fishing days in 2003/04 (Baharthah 2004).

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. 172-177.

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 (*Pseudocaranx dentex*), yellowfin whiting (*Sillago schomburgkii*), southern school whiting (*Sillago bassensis*) and King George whiting. The fieldwork for an additional survey to estimate the impact of recreational fishing on key species in the south coast estuaries has been completed, and will be reported in 2005.

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*), red snapper (*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 (see p. 186). The first estimates of recreational catches for these species are now 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

Prepared by C. Telfer

The south coast bioregion has the smallest number of licensed tour operators in the state, with 20 fishing tour operators, plus an additional 3 restricted fishing tour or eco-tour operators, licensed at the end of 2003.

During 2002, operators reported 752 tours, decreasing to 692 tours in 2003. Activities conducted on these tours included fishing, diving, snorkelling, wildlife observation and sightseeing.

Fishing effort

The number of tours on the south coast involving only fishing decreased from 404 in 2002 to 328 in 2003. These tours are directly related to the catch information estimated in South Coast Fishing Tours Table 1. The total effort reported by fishing tour operators in 2002 was 3,037 fisher days, with a 21.5% decrease in effort to 2,386 fisher days in 2003.

Catch

Since issuing tour operators' licences, 1,882 daily catch and effort returns have been received for the south coast bioregion. These returns enable an estimate of the total catch by tour operators to be calculated.

Catches of the major finfish species for the south coast bioregion in 2002 and 2003 are shown in South Coast Fishing Tours Table 1. The estimated total finfish catch for 2003 was 23 t, which is a decrease of 18% from 28 t in 2002. These catches from tour operators' vessels are recreational in nature, and are in addition to reported commercial catches. In future years, where practicable, they will be included in the 'recreational catch share' for relevant species and fisheries.

SOUTH COAST FISHING TOURS TABLE 1

Estimated catch of major finfish species reported by tour operators for 2002 and 2003.

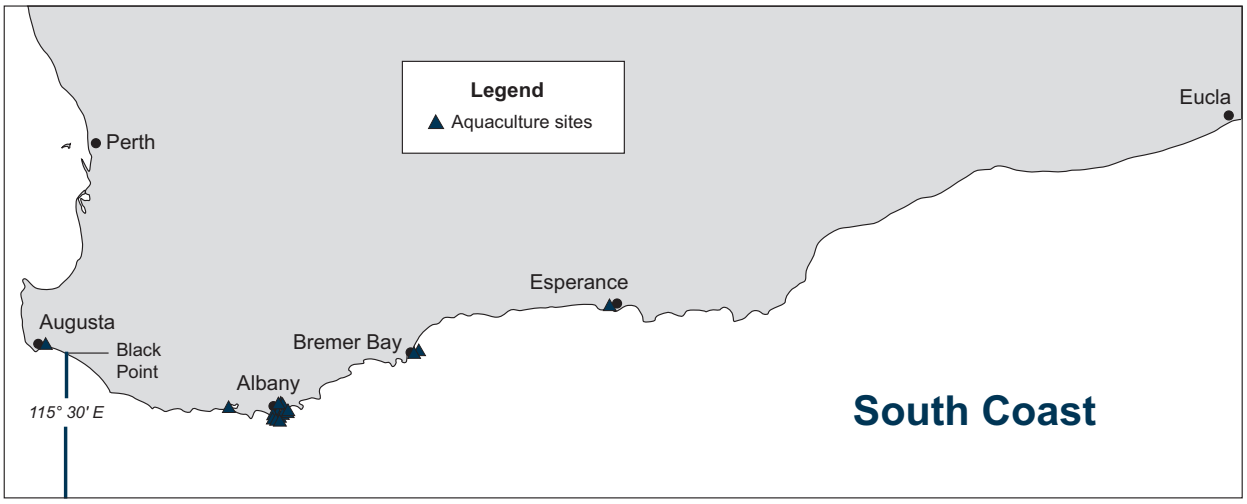
SPECIES		ESTIMATED CATCH (tonnes) 2002	ESTIMATED CATCH (tonnes) 2003
Bight redfish (red snapper)	*Centroberyx gerrardi*	4	6
Swallowtail	*Centroberyx lineatus*	1	1
Queen snapper	*Nemadactylus valenciennesi*	7	6
Breaksea cod	*Epinephelides armatus*	1	1
Skipjack trevally	*Pseudocaranx dentex*	1	1
Samson fish	*Seriola hippos*	6	3
Pink snapper	*Pagrus auratus*	2	1
Sea sweep	*Scorpis aequipinnis*	0.5	0.5
Other finfish		5.5	3.5
Total		**28**	**23**

AQUACULTURE

Regional Research and Development Overview

A high priority for the Department during 2003/04 has been supporting the abalone aquaculture industry in the development of a strategic development plan and an Environmental Management Strategy for this emerging industry.

FRDC-funded research led by S. Daume has assessed better ways of feeding captive greenlip abalone (*Haliotis laevigata*) broodstock held over long periods. Extensive national consultation led to the design of specific lipid-enhanced feeds and a seaweed diet for broodstock being conditioned within a commercial hatchery in Albany (in conjunction with the University of Western Australia). In another component of that FRDC research project, new potential algal species (macroalgal germlings and chain-forming diatoms) are being assessed for use in the advanced nursery stage of the greenlip abalone production cycle (in conjunction with Murdoch University). Other activities have included developing a formulation for a locally produced commercial abalone feed, estimating waste outputs from abalone growout tanks and assisting with producing genetic lines of greenlip abalone within an FRDC-funded national selective breeding project.



SOUTH COAST AQUACULTURE FIGURE 1

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

COMPLIANCE

Regional Compliance and Community Education Overview

Fisheries Officers based at Albany and Esperance undertake a range of compliance and education activities in the south coast bioregion. Compliance activities include land and sea-based inspections of vessels, processors, licences, catches and fishing gear.

Activities during 2002/03

Regional Services personnel undertook 5,784 hours of commercial compliance work and 3,456 hours of recreational compliance work in the south coast bioregion (South Coast Compliance Table 1).

Fisheries Officers recorded 455 commercial field contacts and 1,653 commercial office contacts. During the year, 7 infringement warnings and 2 infringement notices were issued, and a further 14 cases resulted in prosecution of commercial fishers.

A total of 10 'Fishwatch' reports relating to both recreational and commercial activities were received for the bioregion.

The major commercial compliance effort was directed to the abalone fishery, with the remainder worked in the wide range of minor commercial fisheries operating in the bioregion.

Illegal (unlicensed) commercial abalone operations continued to be a major concern, while minor commercial breaches relating to quota management and incorrect completion of catch and disposal records were detected within the licenced fishery.

The illegal sale of fish by unlicensed individuals or groups continued to be of concern in the region and 4 prosecutions were initiated for these offences during this period.

The majority of recreational compliance activities concentrated mainly on checking shore- and boat-based anglers, net fishers and shellfish collectors. Compliance patrols in recreational fisheries principally involved checks to ensure that fishers were 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 in the future.

Fisheries Officers recorded 1,527 recreational field contacts and 1,362 recreational office contacts. During the year 21 infringement warnings and 24 infringement notices were issued to recreational fishers.

The compliance and education program in this bioregion is supported by Volunteer Fisheries Liaison Officers who conduct interactive education programs within the school system and present static displays at various community events throughout the region. In 2002/03 the VFLO program involved 12 volunteers in the Albany and Denmark areas and 6 in Esperance, accounting for 1,256 contacts during the year. Community education activities conducted in the bioregion included attendance and presentations by Fisheries Officers and VFLOs at regional shows and festivals, primary and high schools and community group meetings, and fishing competitions.

Initiatives in 2003/04

The proposed statewide recreational fishing rule changes introduced in October 2003 have had considerable impact on compliance activities in the areas of recreational abalone restrictions and fish possession and filleting. A comprehensive community education strategy has been implemented across the bioregion.

Following the completion of the south coast recreational fishing survey in 2002/03, a review of recreational fishing arrangements for the bioregion was undertaken during 2003/04. This included a review of the size and bag limits for key southern bioregion finfish species. A discussion paper outlining a five-year strategy for the management of recreational fishing for the south coast incorporating the outcomes of the review will be released for public comment in July 2004. At the completion of the public comment period all submissions will be considered and the final recommendations for the strategy will be submitted to the Minister for Fisheries for his consideration.

Fisheries Officers continue to place priority on compliance checks in the commercial shark fishery aimed at preventing breaches of finning regulations and undertaking spot checks of net lengths on these vessels. At-sea inspections of deep sea crab and rock lobster vessels are conducted when possible.

SOUTH COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types within the south coast bioregion during the 2002/03 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	5,784
Fisher field contacts by Fisheries Officers	455
District Office contacts by Fisheries Officers	1,653
Fishwatch reports *	10
COMMERCIAL OFFENCES DETECTED	
Infringement warnings	7
Infringement notices	2
Prosecutions	14
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	3,456
Fisher field contacts by Fisheries Officers	1,527
District Office contacts by Fisheries Officers	1,362
RECREATIONAL OFFENCES DETECTED	
Infringement warnings	21
Infringement notices	24
Prosecutions	0

* This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

Northern Inland Bioregion

Northern Inland
BIOREGION

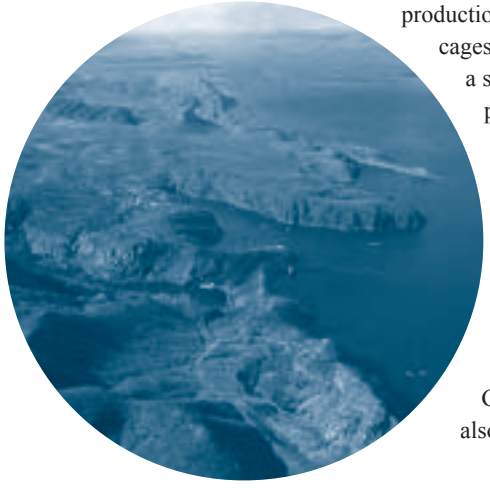
ABOUT THE BIOREGION

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 amphibians, 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 catfish or silver cobbler, together with a processing facility supplying predominantly WA and interstate markets. The lake and its associated river system also support recreational fishing for the freshwater component of the barramundi stock and cherabin or freshwater prawns.

Aquaculture development operations in the region include a significant production of barramundi in cages 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, Water and Rivers Commission and the Department for Environmental Protection.

COMMERCIAL FISHERIES

Lake Argyle Freshwater Catfish Fishery Status Report

Prepared by S. Newman, with management input by D. Harvey

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 shovel-nosed catfish or silver cobbler (*Arius midgleyi*).

Governing legislation/fishing authority

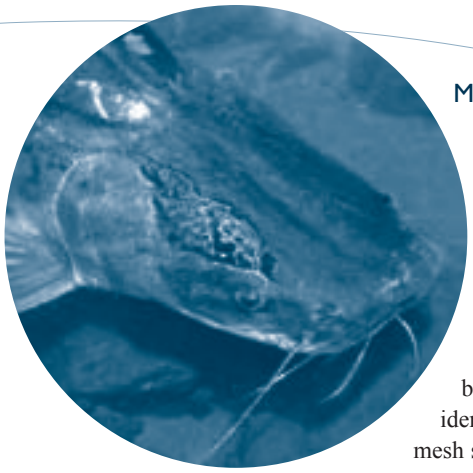
Fisheries Notice no. 665 (Section 43 Order)
Condition 55 on a Fishing Boat Licence

Consultation process

Department–industry meetings

Boundaries

The Lake Argyle Freshwater Catfish Fishery (LAFCF) 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, and during 2003 six licensees had access. 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 LAFCF are not permitted to take barramundi (*Lates calcarifer*).

As a result of conflict with charter operators as well as the general public and conservation groups, Lake Argyle catfish endorsement holders developed an industry code of practice that was implemented in 2001. The code specifies the accepted means of operation in the fishery, and outlines contingency procedures for fishing gear that has been lost or abandoned.

A research report released to industry in April 2000 outlined the Research Division's concerns over the future of the fishery if catch and effort levels remained high. Since 2000, operators have responded by voluntarily reducing effort and hence the levels of catch. Nevertheless, the latent effort remaining in this fishery is of biological concern because of the specialised reproductive behaviour and low fecundity of the species, which may predispose the stock to recruitment over-fishing.

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.

Research summary

Data for assessing the status of the freshwater catfish 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.

RETAINED SPECIES

Commercial production (season 2003): 165 tonnes

Landings

The primary target species in the fishery is the shovel-nosed catfish or silver cobbler. 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 Catfish 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. The 2003 level of catch has increased to 165 t, and is now above the acceptable catch range for this fishery (Lake Argyle Catfish 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'. The fishing effort for 2003 was 5,070 units (100 m net days), which is higher than the 2002 fishing effort of 4,698 units (Lake Argyle Catfish 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 Catfish Figure 1). The factors contributing to the increase in CPUE in 2003 are not known.

Recreational component: Not assessed

Limited data are currently available. The reported charter boat catch for Lake Argyle in 2002 and 2003 was less than 1 t of freshwater catfish annually.

STOCK ASSESSMENT

Assessment complete: Yes

The catch and effort returns 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, and the available data are not sufficiently detailed to determine whether or not these assumptions are valid. 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 fishery 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 not sustainable.

The catches in 2001 and 2002 were at more appropriate levels, with the 2002 level of catch within the acceptable catch range for this fishery. However, the 2003 level of catch is once again above the acceptable catch range for this fishery. While the increasing level of catch in the fishery in 2003 is cause for concern, it is confounded by an increase in catch rate within the fishery which appears to reflect increased recruitment.

Exploitation status: Over-exploited

Breeding stock levels: Depleted

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 catches that occurred in 2001 and 2002 may have assisted in the recovery of the breeding stock. However, on the basis of the results of earlier stock assessments, the increase in catch in 2003 is likely to result in a decline in the level of breeding stock that would be considered adequate to maintain recruitment.

NON-RETAINED SPECIES

Bycatch species impact: Low

Minimal fish bycatch occurs in this fishery as a result of the large mesh size used relative to the species present in the lake.

Protected species interaction: Low

There is an incidental capture of freshwater or Johnston's crocodiles (*Crocodylus johnstoni*) and some tortoises by the freshwater catfish 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. We can assume that the crocodile population has increased in response to the creation of the dam in an otherwise arid environment, however 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.

ECOSYSTEM EFFECTS

Food chain effects: Not assessed

Habitat effects: Negligible

The surface gillnets used have minimal impact on the habitat.

SOCIAL EFFECTS

During 2003, six vessels fished in the LAFCF with an average crew level of two people per vessel, indicating that 12 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 2003: $440,000

The LAFCF landed a total of 165 t of fish in 2003 for a catch value of over $440,000. This estimate is based on the landed weight of silver cobbler recorded in the CAES system and the 2000/01 average price per kilogram of whole weight of silver cobbler as supplied by fish processors.

FISHERY GOVERNANCE

Acceptable catch range for next season: 95–155 tonnes

The acceptable catch range under the current management regime is considered to be in the range of 95–155 t of Lake Argyle catfish. This range has been amended slightly during 2003/04 using improved methodology. The revised range is derived by applying an autoregressive moving average (2,2) control quality procedure to the annual catches from 1990 to 2002. The confidence intervals are obtained by estimating the variation of the observations compared with the variation of the predictions using the 13 years of catch data. The catches from 1998 to 2000 exceeded this range (Lake Argyle Catfish Figure 1) and were driven by the utilisation of latent effort. The 2001 and 2002 catches were within the acceptable catch range as a result of voluntary decreases in effort in this fishery. However, the 2003 level of catch has increased and is once again above the acceptable catch range as a result of an increase in effort utilisation and CPUE within the fishery.

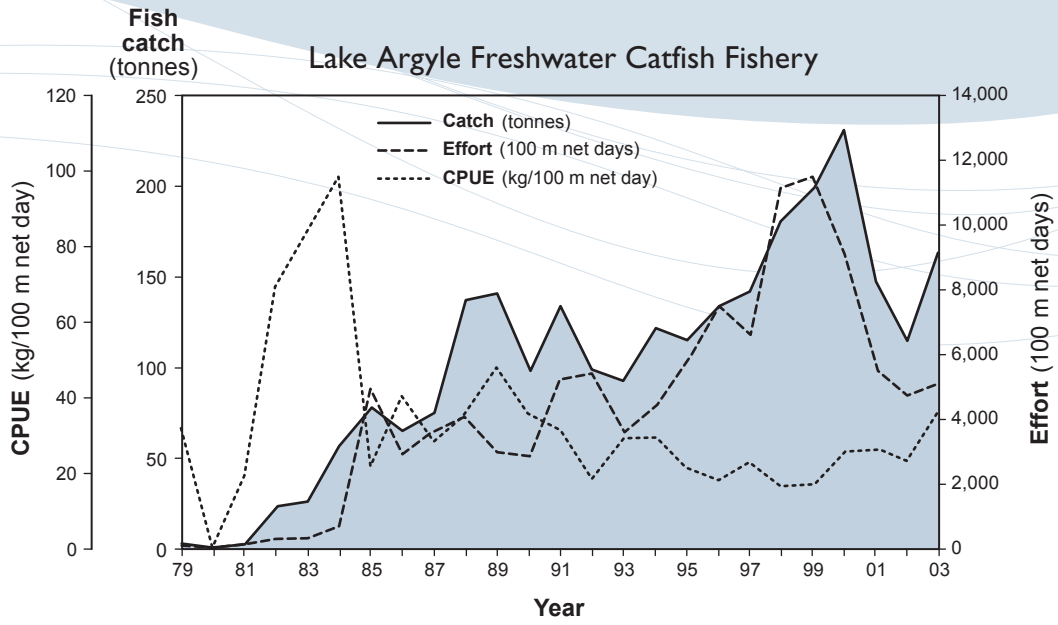
New management initiatives (2003/04)

The 2004 annual management meeting for the fishery will focus on issues such as the growing concern over interactions with non-target species and the fishery exceeding its acceptable catch range. It is expected that this meeting will lead to new management initiatives for the fishery.

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 age and growth structure of the freshwater catfish, 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 freshwater catfish stock is the development of barramundi farming within the lake, which indirectly provides some additional (waste) food utilised by the catfish and its prey species.

Fishers head and gut the catfish for transport to Perth markets in order to reduce freight costs, thus it is difficult to cost-effectively sample the size and age composition of the catch. The remote location of this fishery also means that it is a costly exercise to use observers to gain a better understanding of the catchability of this species.



LAKE ARGYLE CATFISH FIGURE 1

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for the Lake Argyle Freshwater Catfish Fishery over the period from 1979 to 2003.

RECREATIONAL FISHERIES

Regional Research Overview

Fishing in the fresh waters of the Kimberley accounts for around 1% of the state's recreational fishing effort, with an estimated 95,000 fishing days for 2003/04 (Baharthah 2004).

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. 122-127. In addition to barramundi, Lake Argyle catfish (*Arius midgleyi*) and cherabin or freshwater prawns (*Macrobrachium rosenbergii*) are also taken in this inland bioregion. Catch and abundance data for the catfish stocks are available via the commercial fishery statistics, but no data are available for cherabin, which are not taken commercially.

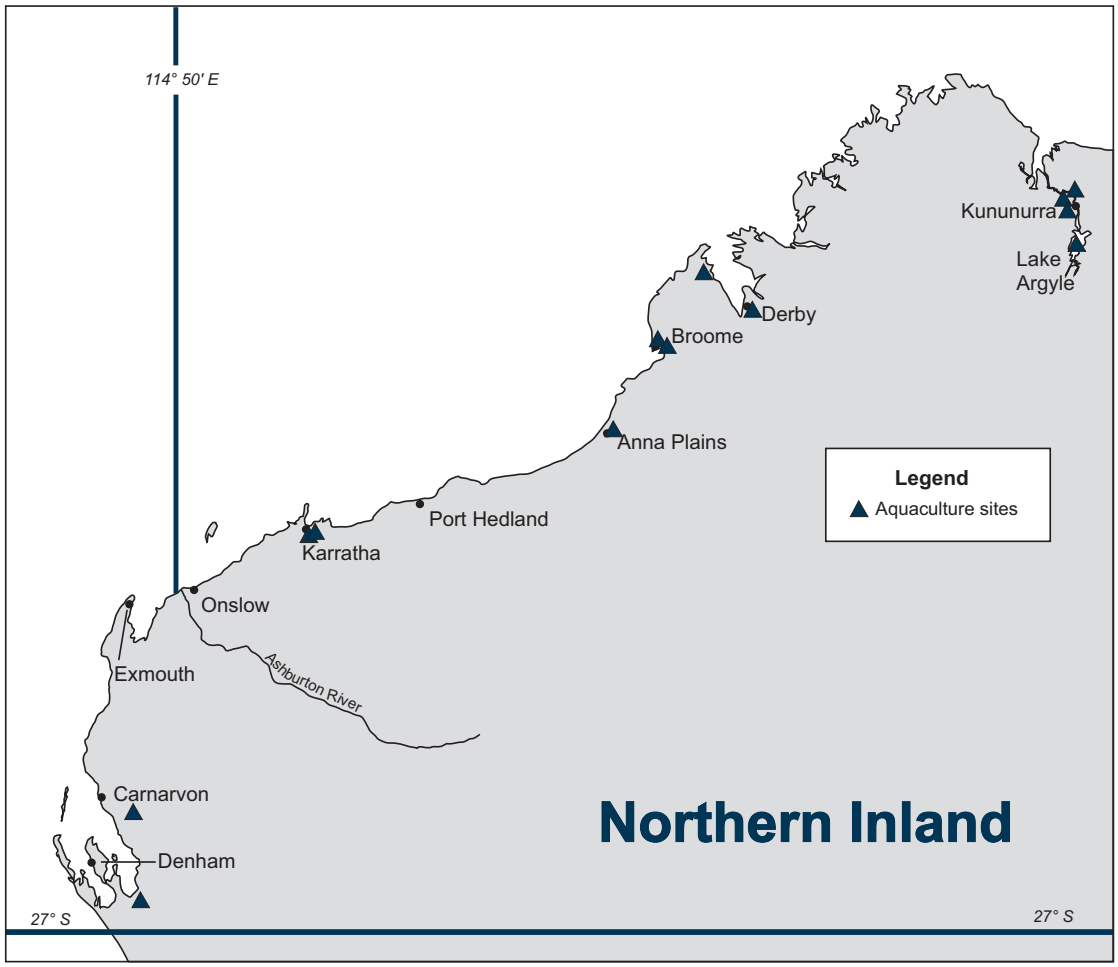
AQUACULTURE

Regional Research and Development Overview

Key issues for the Department during 2003/04 included providing support to overcome environmental and fish health challenges with the farming of barramundi (*Lates calcarifer*) in Lake Argyle, and supporting inland indigenous freshwater aquaculture projects.

Research staff led by B. Glencross have produced an independent report on 12 months of environmental monitoring for the major barramundi farm in cages in Lake Argyle. The results were very encouraging in terms of minimal impact on this complex aquatic system. A major report has been prepared for the Aquaculture Development Fund which characterises the annual Lake Argyle 'turnover event', when bottom water containing little oxygen moves to the surface where the cages are located. This has been combined with local measurements of oxygen consumption by barramundi to help model carrying capacity of different cage designs for different months, taking into account seasonal changes in oxygen content of surface waters. Current emphasis is on assessing effects of blue-green algae in the lake.

Research and Aquaculture Development staff have worked closely with the Kimberley Aquaculture Aboriginal Corporation to help progress indigenous aquaculture projects based on cherabin (*Macrobrachium rosenbergii*), barramundi and redclaw (*Cherax quadricarinatus*).



NORTHERN INLAND AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture sites of the northern inland bioregion.

Barramundi Farming Status Report

Prepared by C. Lawrence

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.

Production areas

Barramundi is currently produced in cages in Lake Argyle or intensively in recirculating systems in the southern half of the state. Interest in producing barramundi is growing strongly.

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 for Environmental Protection must also be developed and maintained.

AQUACULTURE PRODUCTION

Production current year (2002/03): 188 tonnes

Number of producers for year 2002/03: 12

Production projection next year (2003/04): 200–250 tonnes

Barramundi production has grown significantly in 2002/03 with a 318% increase in production compared to the previous year (Barramundi Farming Figure 1). As anticipated in 2001/02, increases in production (that had been delayed by a combination of marketing and production issues) have now been realised. This has largely been achieved through significant capital investment by a farming company in Lake Argyle.

Further increases in production will be subject to:

- appropriate management during periodic fluctuations in water quality in Lake Argyle;
- periodic reviews of licence conditions which specify maximum production in that lake;
- intense competition (particularly from Northern Territory farms) that can depress profitability;
- development of new farms; and
- shifts in species chosen by operators of intensive recirculating fish production systems.

In January 2004, at a Lake Argyle barramundi farm, there was a large fish kill due to a bacterial infection associated with a reduction in water quality. This may have a major impact upon barramundi production next year.

ECOSYSTEM EFFECTS

With correct management, barramundi farming is considered to present a moderate risk to the environment. Cages within protected coastal areas and lakes can be operated with low environmental impact if appropriately located in deeper water with good current flow and if modern feeding practices and feed designs are used to minimise uneaten food and soluble nutrient release. Native fish present around the cages can 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 for Environmental Protection, 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. The Department of Fisheries recommends use of swirl separators and/or settlement/reed ponds to improve the quality of water discharge from land-based farms prior to release or reuse.

SOCIAL EFFECTS

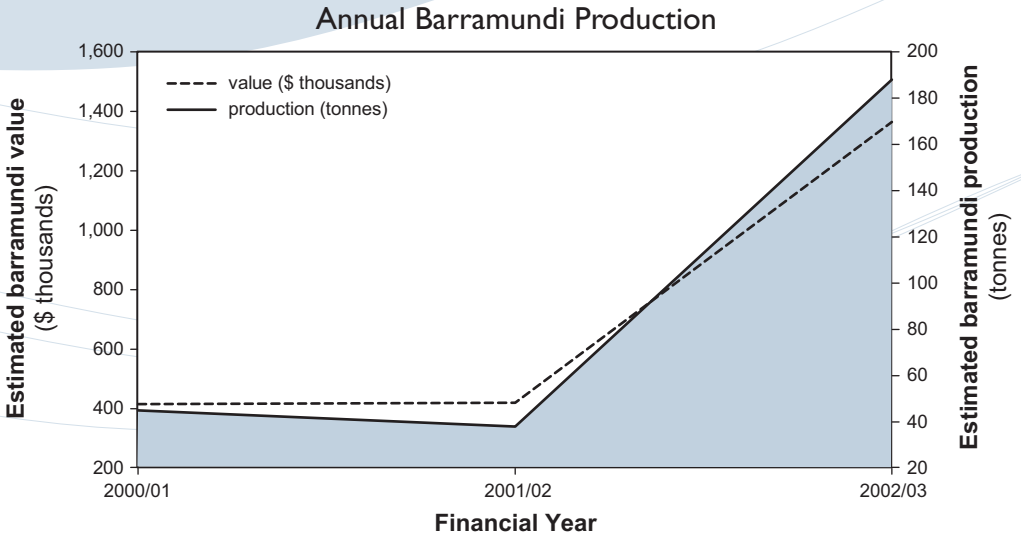
This rapidly growing industry has become a valuable source of regional employment, and has local tourism potential at Lake Argyle.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2002/03: $1.36 million

EXTERNAL FACTORS

A limiting factor in barramundi farming may be depressed prices as production increases rapidly, particularly in the Northern Territory. A greater emphasis on export markets may be required. For freshwater systems, purging of most species of farmed fish is desirable to avoid 'off' flavours caused by natural algae growing in the water.



BARRAMUNDI FARMING FIGURE 1

Estimated barramundi production and value from 2000/01 to 2002/03.

COMPLIANCE

Regional Compliance and Community Education Overview

Activities during 2002/03

During 2002/03, 171 fisher contacts were recorded in inland areas by regionally based Fisheries Officers. The majority of these contacts occurred on the Fitzroy and Ord Rivers due to the introduction of new barramundi catch legislation, which included revised possession and maximum size limits. The contacts occurred on 15 recreational patrol days conducted by two officers each month for the months of July–November and March–June. Twelve of the northern inland contacts originated from the Pilbara at Paraburdoo, Roebourne and Miaree Pool. Travel to these remote areas is conducted by well equipped and experienced patrol officers.

To effectively promote the legislative changes to local and seasonal visitors, a program was undertaken by the region to maximise educative compliance contact. Key target inland waters including the Fitzroy and Ord Rivers were built into this patrol program. Using their local knowledge, officers concentrated on local areas known for camping and fishing such as Telegraph Pool, Langis Crossing, Willens Pool, Camballin, Mambi Crossing, Diversion Dam, and Ivanhoe Crossing on the Lower Ord. Of note were the increased numbers of campers residing for longer periods beside the Fitzroy River, as camping was free of charge.

The inland waters surrounding Derby, such as the May and Meeda Rivers, were also targeted for illegal netting as well as barramundi. In many of these remote areas access is difficult, but key sustainability compliance measures are still very important. Compliance and education was also undertaken in the Lake Argyle area, and where officers checked commercial catfish fishers and aquaculture sites to ensure compliance with management and environmental objectives.

Initiatives in 2003/04

The region has continued to concentrate on consolidating the barramundi legislative changes through inspection and education during 2003/04. The focus has been to target identified ‘hot spot’ areas through officer-led risk assessment processes. The main aims are to make contact with fishers to explain the legal changes and the rationale behind them, and to build a strong sense of community ownership. These messages are being promoted with the keen support of the Regional Recreational Fishing Advisory Committees and our committed Volunteer Fisheries Liaison Officers.

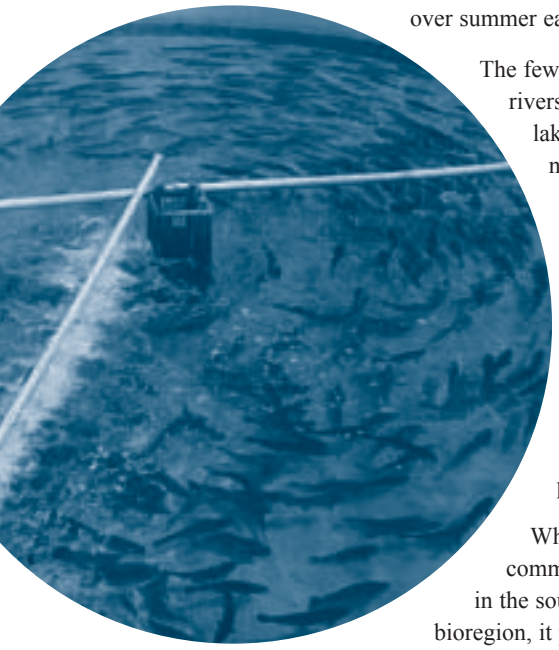
Southern Inland Bioregion

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. Residual freshwater 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 tonnes per year and has the potential to expand significantly.

Trout have historically been the mainstay of finfish aquaculture production in this region, originating from heat-tolerant stock maintained at the Department's Pemberton Freshwater Research Centre. Currently most of the trout produced in the south-west are used to stock private dams for 'put and take' fishing which provides a value-added product compared with traditional aquaculture.

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 now 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 and freshwater angling species. In 2003/04, around 21,000 licences were issued for these two activities; however, this includes a large number of 'umbrella' licences (covering all licensed recreational fisheries), which generally correlates with a lower participation rate.

Research for managing and enhancing the fisheries for marron (*Cherax tenuimanus*) and trout (both rainbow trout, *Oncorhynchus mykiss* and brown trout, *Salmo trutta*) has been largely undertaken by the Department of Fisheries. In addition, collaborative university projects have provided data on redfin perch (*Perca fluviatilis*) and freshwater cobbler (*Tandanus bostocki*) and their relationships to the small native freshwater species.

Additional research is now underway to assist the recovery of the Margaret River ('hairy') marron species, which was previously part of the recreational fishery.

Licensed Recreational Marron Fishery Status Report

Prepared by B. Molony, with management input by C. Syers

FISHERY DESCRIPTION

Marron (*Cherax tenuimanus*) are endemic to Western Australia and are the third largest freshwater crayfish in the world. Recreational fishing for marron occurs in freshwater dams and rivers using scoop nets, drop nets or snares.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

Recreational Fishing Licence

Consultation process

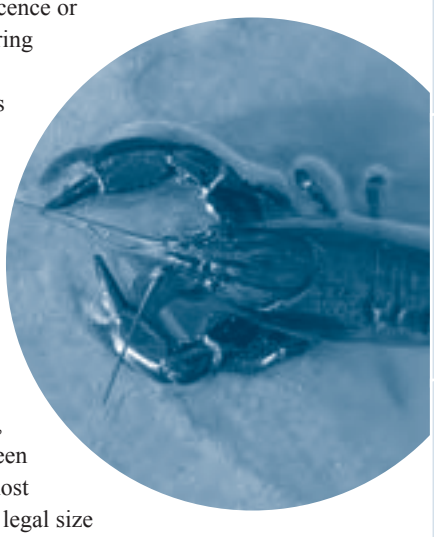
Recreational Fishing Advisory Committee

Boundaries

The recreational marron fishery extends from the Hutt River north of Geraldton to waters near Esperance. The fishery operates in both dams and rivers, although access to water supply dams servicing the Perth metropolitan area is closed to the public and monitored by the Water Corporation.

Management arrangements

This fishery is managed through input controls in the form 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.



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 24 January to 9 February 2003. 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 legal size of 76 mm carapace length and a bag limit of 10 marron per day. For Harvey Dam, however, the minimum legal size is 90 mm carapace length with a daily bag limit of 5 marron.

Research summary

Detailed research on the marron stocks in south-west rivers and estuaries has been undertaken since the 1970s. Current research involves the scientific monitoring of stock levels both before and after the summer fishing season, 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. Data are reported in an annual fisheries assessment document. The following status report is based on these research findings.

Southern Inland Bioregion

A major FRDC research project commenced in July 2003 which aims to quantify the various factors that are influencing the marron fishery, and re-design long-term monitoring so as to provide better management advice to sustain this important fishery for the future.

RETAINED SPECIES

Recreational catch estimate (season 2003): 5.8 tonnes

Landings

The total catch for the 2003 season was estimated at approximately 46,400 ± 6,100 marron, which equates to about 5.8 t. This was greatly reduced from previous seasons (2002: 135,700 ± 12,900 marron or about 17 t). This decline in catch is most likely due to the reduction in season length from 55 days to 16 days for the 2003 season, with a significant reduction in effort and therefore catch. (Note that these tonnages are under-estimates of possible legal catch as it has been assumed that the average catch size equals the minimum legal size.)

Fishing effort/access level

Total effort for the 2003 season was estimated at around 9,100 days. Fishing effort was greatly reduced compared to previous seasons (e.g. 2002: 32,400 days), and this reduction was directly correlated with season length.

Catch rate

Probably as a result of the reduction in season length and total effort, the CPUE recorded by fishers was higher in 2003 at approximately 5.11 marron per fisher per day compared to the previous season (2002: 4.19 marron per fisher per day).

Commercial share: Nil

STOCK ASSESSMENT

Assessment complete: Yes

Current assessment data is derived from scientific monitoring of stock levels both before and after the summer fishing season, telephone surveys of recreational licence holders, log books completed voluntarily by some recreational fishers, and joint sampling with individual catchment groups.

Assessment of the 2003 season data shows that fishers did not respond to the shorter season by fishing more frequently, but did achieve a higher catch rate (22% higher than in 2002) due to the lower effort. The catch achieved, estimated at 5.8 t, primarily reflects the shorter season, although this result is also a function of reduced availability of stock, with Harvey Dam recovering from reconstruction and Waroona Dam closed for repairs. Lower catching efficiency as a result of snare fishing rules may also have interacted with the shorter season to further constrain the 2003 catch.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

As the fishery operates on a large number of stocks (approximately 100), data on breeding stock levels for most stocks are not available. From the small number of stocks surveyed, the breeding stock levels are adequate (based on percentage of berried females). The exception is the stock in Harvey Dam, where the percentage of breeding females is very low (less than 5%). Overall, however, marron breeding stocks are maintained by the minimum legal size, which is above the size at maturity.

Projected catch next season (2004): 6.9 tonnes

Future catches are predicted based on a relationship with rainfall, with data supplied by the Bureau of Meteorology. 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. At this stage the relationship is a simple correlation.

As rainfall in 2003 was higher than for 2002 (by 12.5%), the projected catch for 2004 is higher than for the 2003 season. The predicted catch for 2004 is 6.9 t (range: 5.6–8.1 t) or 55,230 marron (range: 45,000–65, 000).

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 predominantly operates on the common 'smooth' marron species native to most south-west rivers and dams. However, a second, possibly distinct 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. In late 2002, recreational marron fishing above Cane Break Road on the Margaret River was prohibited to remove the impacts of fishing on the remaining Margaret River marron stocks. However, illegal fishing is still reported in this reach of the Margaret River. A recovery plan, developed jointly between the Department of Fisheries, the Department of Conservation and Land Management 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 2003 season involved approximately 3,364 licence holders and their families undertaking about 9,100 fishing days, and provided a major recreational activity in regional areas of the south-west of the state.

ECONOMIC EFFECTS

The value of the 2003 season recreational marron catch was in the approximate range $139,000–$248,000 (based on an average sale price of marron from aquaculture farms of approximately $24/kg, and a range of tonnage based on minimum legal size and estimated average size of marron captured as calculated from log book returns). Revenue from licence sales was estimated at approximately $228,000, which is used to support recreational fishery management, research and compliance. Although much reduced from 2002, the estimated 9,100 days of marroning in regional locations still provided a significant benefit to regional towns in the south-west.

FISHERY GOVERNANCE

The primary management control on the catch from the marron stocks is currently the duration of the fishing season.

The expected 2004 catch of approximately 7 t, estimated from the rainfall–catch relationship, was calculated on the assumption that the short season would be maintained for the 2004 fishery and that fishing effort would remain low.

New management initiatives (2003/04)

The Minister has approved the formation of a recreational freshwater fisheries stakeholder sub-committee of the Recreational Fishing Advisory Committee to ensure that future issues relating to the viability and sustainability of marron, trout and other recreational freshwater species are addressed in an integrated manner. The sub-committee will be appointed 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.

EXTERNAL FACTORS

The three main external factors which affect the marron fishery are winter rainfall, access to dams, and introduced species.

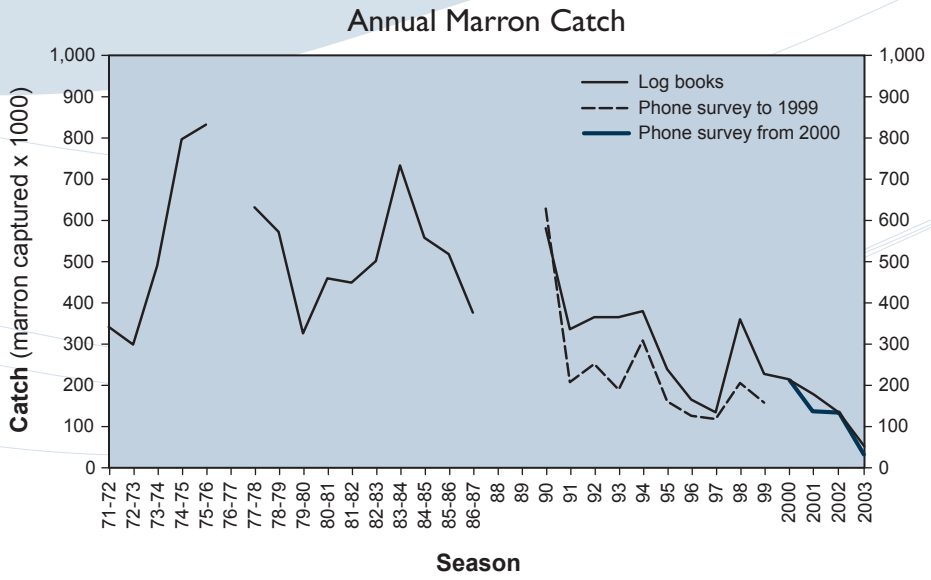
Winter rainfall plays a major role in marron reproduction and growth. Rainfall increases the quality of areas for marron by transporting leaf litter into streams (providing food sources for marron growth and reproduction) and by maintaining water volume and quality. It may also affect the ease with which fishers can access the water bodies, reducing pre-season illegal fishing.

A second major issue in this fishery is access to irrigation dams. The Water Corporation closed access to Stirling Dam (Harvey River catchment) in 2001 owing to the diversion of this water to the metropolitan water supply. The Corporation has recently opened the new Harvey Dam (formally Harvey Weir), where full recovery of the marron stocks may take several years, and has completed refurbishment of Waroona Dam, which involved the complete draining of the dam. Thus a redistribution of fishing effort occurred during the 2003 season, with extra effort applied to other water bodies, most notably Wellington Dam. The Department of Fisheries is working closely with the Water Corporation to ensure the refurbished and refilled dams will provide a high-quality marron fishery by installing refuges, adding marron and controlling introduced species.

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 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 control has been attempted at Waroona Dam as part of the refurbishment process.

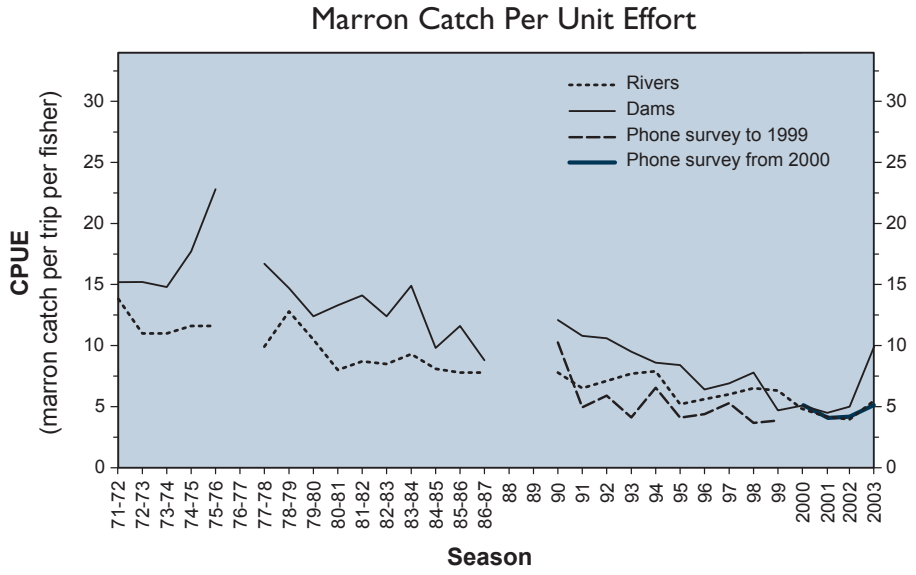
Trout also predate on marron, but to a much lesser extent than redfin owing to the wider diet of trout, particularly rainbow trout, which prey predominantly on freshwater insects.

Yabbies, a direct competitor and a potential threat to marron, have been recorded from a number of areas within the marron recreational fishery, but at low abundances.



RECREATIONAL MARRON FIGURE 1

The entire catch history of the recreational marron fishery, 1971 to 2003.



RECREATIONAL MARRON FIGURE 2

Catch per unit effort in the recreational marron fishery for the past 31 seasons. Note that the catch rate has levelled out in the past few seasons, with some recovery observed in all three indices.

Licensed South-West Recreational Freshwater Angling Status Report

Prepared by B. Molony, with management input by C. Syers

FISHERY DESCRIPTION

Recreational anglers in the state's south-west primarily target introduced species such as rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and redfin perch (*Perca fluviatilis*) as well as the native freshwater cobbler (*Tandanus bostocki*). Anglers may only use a single rod, reel and line or a single handline to fish for these species.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

Recreational Fishing Licence

Consultation process

Recreational Fishing Advisory Committee

Trout Stocking 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 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.

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 the return of any redfin to the water is not encouraged, as this species is feral and negatively affects the marron fishery.

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 focuses on public waters where trout have been stocked or have occurred since the 1930s. All trout stocked into public waters are produced at the Department's Pemberton Freshwater Research Centre (PFRC), formerly known as the Pemberton hatchery. A trout stocking committee comprising representatives of the Department, the WA Trout Fishing Association, Recfishwest and licence holders meets bi-annually to determine locations and quantities for stocking.

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 addition, a number of research projects are currently being undertaken at the PFRC. A survey of licence holders was performed for the 1998/99 season which provided information on catch and effort within the fishery, together with other data. An annual telephone survey, which commenced in 2001, now provides regular information about this important recreational fishery. Research is being undertaken to produce sterile trout with enhanced growth to provide superior angling fish. Further, comparison of the success of stocking fry versus stocking yearlings is being evaluated to reduce the predation rate of stocked fish, thus providing more angling opportunities. Genetic research has also been completed on enhancing the quality of trout from the Department's hatchery facility, particularly their tolerance to heat. This work, which is progressively being published, compares the tolerances of the PFRC strain and a natural strain of rainbow trout. Research information from these projects and the annual report from the manager of the PFRC have been used to compile this status report.

RETAINED SPECIES

Recreational catch estimate (season 2002/03): 15.9 tonnes

Landings

An estimated 15.9 ± 2.77 t of fish were landed in this fishery by recreational anglers in the 2002/03 season, including 11.9 t of retained fish (32,800 fish) and 3.8 t of captured and released fish (19,000 fish). The estimated catch was composed of 16,300 rainbow trout (4.8 t), 2,300 brown trout (0.6 t), 28,000 redfin perch (9.3 t) and 4,700 freshwater catfish (1.1 t). Small numbers of black bream are also captured in this fishery. The reported catch is lower than for the previous season, which was 20.8 t. This drop is partly due to a concentration of effort into fewer areas, as a result of dam refurbishments and closures, and two years of poor rainfall prior to the season.

Fishing effort/access level

Estimates of fishing effort are based on telephone surveys of licence holders. Total effort for 2002/03 was estimated at 22,000 days, slightly down from the previous season (24,600 days).

Catch rate

A catch rate of 2.55 fish of all species per day was estimated for the 2002/03 season. This included 1.54 retained fish and 1.01 released fish per angler per day. This is lower than for the 2001/02 season (3.6 fish per angler per day, being 1.99 retained fish and 1.61 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 indicate that survival of fry is negligible in the presence of high redfin perch numbers, whereas survival rates of yearlings can be very high. Survival rates are also being assessed for ex-broodstock fish in Harvey Dam. In future years, catches will be assessed relative to numbers stocked in each category (fry, yearlings and ex-broodstock) across all areas in order to provide a performance indicator for the trout fishery.

Exploitation status: Not applicable

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 dominate all fresh water. Little is known about the breeding stock levels of native cobbler.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

Protected species interaction: Low

Currently, no species of south-west native fish is protected, although four species are currently proposed for protection. In areas where the interaction of trout and native fish has been identified as a concern, 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 suggest 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 consume trout, native fishes and crayfishes (including marron). Further, redfin breed throughout the fishery and are the most dominant fish in this region, leading to stunted fish with little or no angling value. The release of redfin is illegal and the Department of Fisheries' education program strongly encourages anglers to retain any redfin caught, regardless of size. Survey data indicate that the release rates of redfin by anglers are declining.

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. Thus, the numbers of trout can 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 and are thus more acceptable as an introduced recreational species.

Stocking in future will be influenced by a translocation policy currently being finalised. Further, detailed research on the survival of fry and yearling trout and an analysis of the diets of trout and redfin have been completed and are in the process of being published. This information will allow the environmental impact of trout and redfin to be evaluated and compared.

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 anglers, with possible subsequent bank erosion.

SOCIAL EFFECTS

A large number of freshwater angling licences are sold annually. For the 2002/03 season, a total of 15,984 licences were sold, including 'umbrella' licences. This represents a slight decrease from the 16,315 licences in 2001/02.

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 $205,000 of revenue which is used to support breeding, stocking, research, management and monitoring activities.

FISHERY GOVERNANCE

When sufficient years of survey catch data become available (currently four surveys have been completed), an acceptable catch range (relative to numbers stocked) will be set for the trout component of the fishery.

New management initiatives (2003/04)

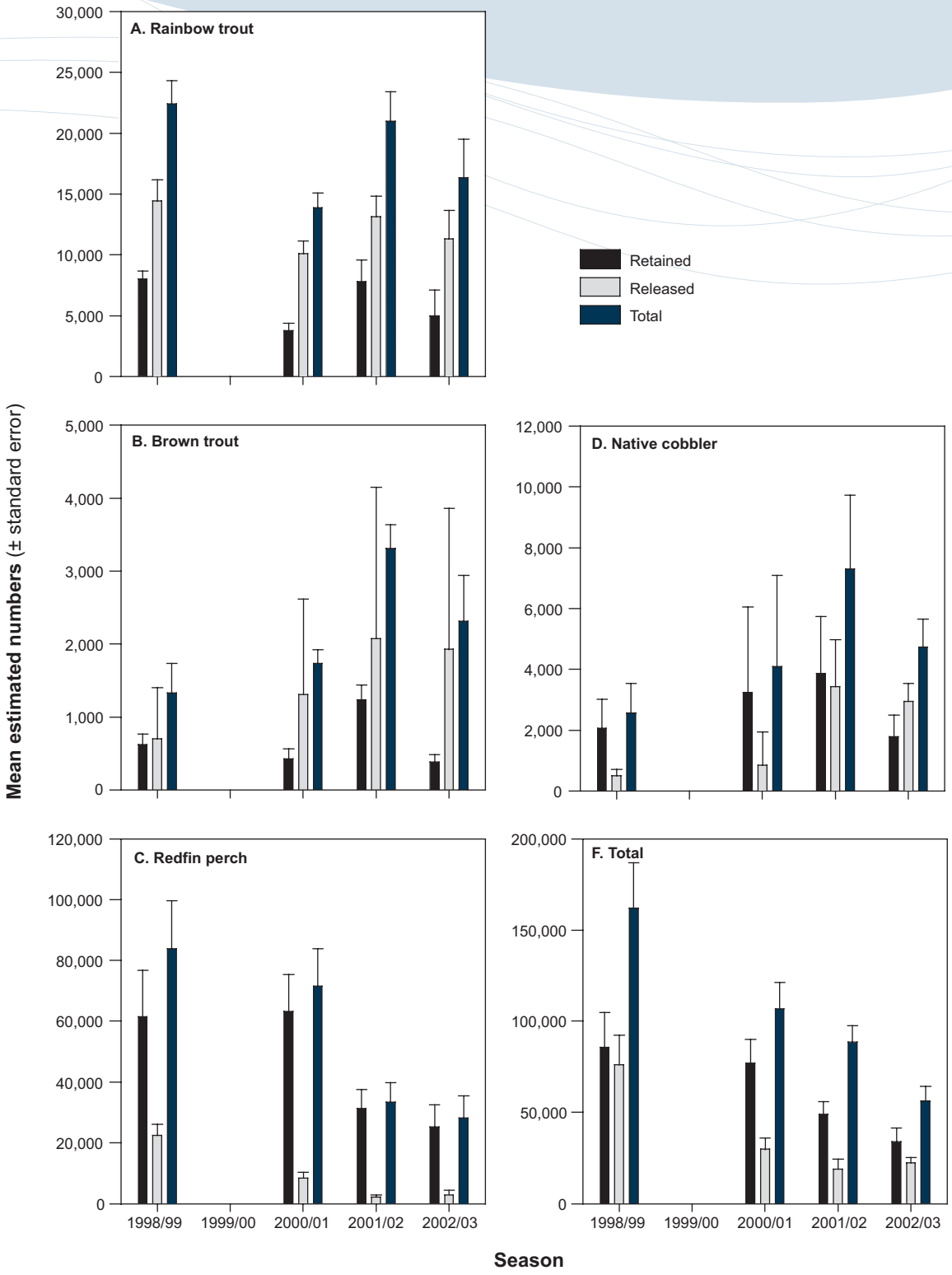
The Minister has approved the formation of a recreational freshwater fisheries stakeholder sub-committee of the Recreational Fishing Advisory Committee to ensure that future issues relating to the viability and sustainability of trout, marron and other recreational freshwater species are addressed in an integrated manner. The sub-committee will be appointed in the second half of 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 sub-committee will also assume the former role of the trout stocking committee.

EXTERNAL FACTORS

The extent and success of the freshwater angling fishery in the south-west is dependent mainly upon availability of high-quality fresh waters for stocking. The availability of water is dependent on rainfall and access to irrigation dams. Thus low rainfall and reduced access to permanent water bodies are having a negative influence on the freshwater angling fishery.

The Water Corporation closed access to Stirling Dam in 2001 owing to the diversion of this water to the metropolitan water supply. Further, construction of the new Harvey Dam resulted in limited access to this water by recreational anglers and a disruption of the freshwater fish stocks within the basin. Waroona Dam has also undergone refurbishment, with stocking to recommence in 2004. A consequent redistribution of fishing effort away from Harvey, Stirling and Waroona Dams was recorded from the telephone survey. The Department of Fisheries is working closely with the Water Corporation to reduce the impacts to recreational fishing by enhancing stocks in refurbished dams.

The intermittent flow and general condition of most rivers make many areas 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 undertaken in the USA have produced better stream quality and better angling, and similar initiatives may be considered in Western Australia, particularly in irrigation dams. The installation of artificial habitats is already being trialled in Harvey and Waroona Dams.



FRESHWATER ANGLING FIGURE 1

Estimates of the total number of fishes retained or released and their combined total by species in the south-west freshwater angling fishery since 1998/99.

AQUACULTURE

Regional Research and Development Overview

Key activities for the Department during 2003/04 have included running workshops to support farmers considering aquaculture as a form of farm diversification. Aquaculture techniques have also been used to support freshwater fisheries and conservation initiatives that were a priority for other Programs.

Research and Aquaculture Development staff activities have focused on work to assist marron (*Cherax tenuinmanus*), yabby (*C. albidus*) and rainbow trout (*Oncorhynchus mykiss*) farming and aquaculture feeds industries. Research staff based at Perth and Pemberton provided advice to many farmers, particularly through publications, workshops and major field days at research facilities and commercial farms.

Marron research trials, led by C. Lawrence, involved commercial farms and the research facilities at Shenton Park and Pemberton. These have shown great potential for improving the quality of commercial marron farming lines. The next phase of this FRDC genetic improvement project has pedigree selection and mass selection lines produced for evaluation, where possible both in this state and South Australia. Husbandry research in that project and in a Regional Assistance Program project have supported the view that the husbandry procedures developed by the Department are quite adequate and that genetic improvement is the best strategy for reducing size variation in marron. Researchers have used commercially available software to show that marron farming, carried out efficiently, can be an attractive form of farm diversification.

Commercialisation of fast-growing hybrid yabby technology has not progressed well. Mass production of one of the parental species has proved to be difficult in the wheatbelt and environmental concerns have prevented movement of broodstock out of quarantine areas. Fortunately, less challenging farming methods, also developed by C. Lawrence, are being viewed favourably by industry leaders as the yabby industry attempts to recover from the drought.

A further collaborative effort, led by B. Glencross, involved the Department of Agriculture, the University of Western Australia and feeds production and grain processing companies, with funding support from the Grains Research and Development Corporation. The aim is to improve and evaluate local agricultural products such as lupins and canola in aquaculture feeds. This includes processing trials to enhance protein content and digestibility of lupin kernel meals. Much of the product evaluation work is being conducted at the Pemberton Freshwater Research Centre in an upgraded, temperature-controlled finfish feeds research system stocked with rainbow trout. Complementary research, funded by FRDC, is to be conducted with interstate researchers using Atlantic salmon (*Salmo salar*) and black tiger prawns (*Penaeus monodon*) as there is a larger world market for these feeds than for trout feeds.

Marron Farming Status Report

Prepared by C. Lawrence

INDUSTRY DESCRIPTION

Production methods

The majority of marron (*Cherax tenuimanus*) farming occurs in purpose-built earthen ponds. These ponds average 1,000 m^2 in surface area and each pond is equipped with aeration, water supply and a drain to facilitate harvesting. 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 bulk of farms are, however, concentrated in the higher-rainfall south-west coastal areas.

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 m2 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 (2002/03): 48 tonnes

Number of producers for year 2002/03: 187

Production projection next year (2003/04): 50–60 tonnes

Marron production has been relatively static (Marron Farming Figure 1) but has been impacted by the drought conditions experienced over the past several years, which extended well into 2002/03. A significant number of new purpose-built marron farms have been developed recently, and other existing farms have constructed more ponds. This should progressively contribute to expansion in state production, as will ongoing improvements in husbandry. Production capacity is increasing and production should be rising, even allowing for water supply issues. However, while some farmers have recognised the need for high feed rates, production gains may not be evident at some locations unless efficient aeration techniques are used to support increased pond biomass. Electric fences and bird exclusion netting should also be installed to exclude water rats and birds as these can cause high mortality rates. A longer-term problem is inefficient selection of broodstock leading 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, should also be 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.

Escape of farmed stock into natural waterways is of concern, particularly if genetically selected stocks are used for the production of this native species. The demonstration facility includes designs for electric fences, which are eco-efficiency tools because they prevent escapes while improving profitability by deterring predators such as water rats. Bird exclusion netting is also strongly recommended to avoid losses caused by native avian predators. As marron farms currently experience few disease problems, they pose little immediate threat to the health of wild stocks.

SOCIAL EFFECTS

Marron farming allows diversification of farm usage away from other, sometimes unprofitable or less profitable, agricultural uses. The industry involves a large number of family-based farms, and has the potential to provide additional regional employment as production increases.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2002/03: $1.1 million

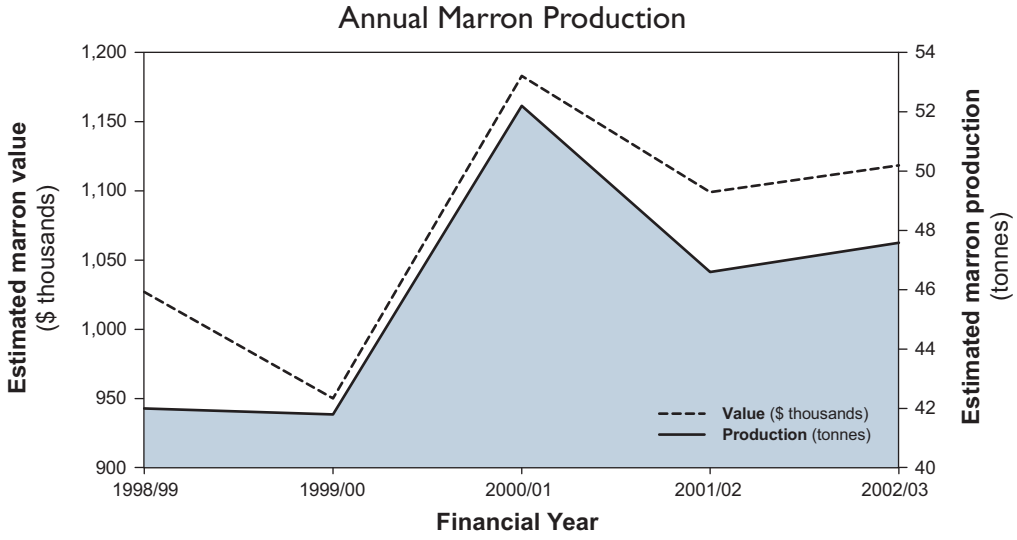
(Note that this estimate excludes ornamental marron.)

Even though there has been considerable competition with other luxury crustacean products, ex-farm market price for marron has remained high, at an average farm gate value of $23.50/kg in 2002/03 (Marron Farming Figure 1).

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 2002/03.

Yabby Farming Status Report

Prepared by C. Lawrence

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 (2002/03): 75 tonnes

Number of producers for year 2002/03: 12

(This number refers to licensed farmers or processors. Note most farmers do not require licences.)

Production projection next year (2003/04): 70–80 tonnes

Yabby production has been impacted by the drought conditions experienced over the past years that extended well into 2002/03. This has contributed to a 27% decrease in yabby production this 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.

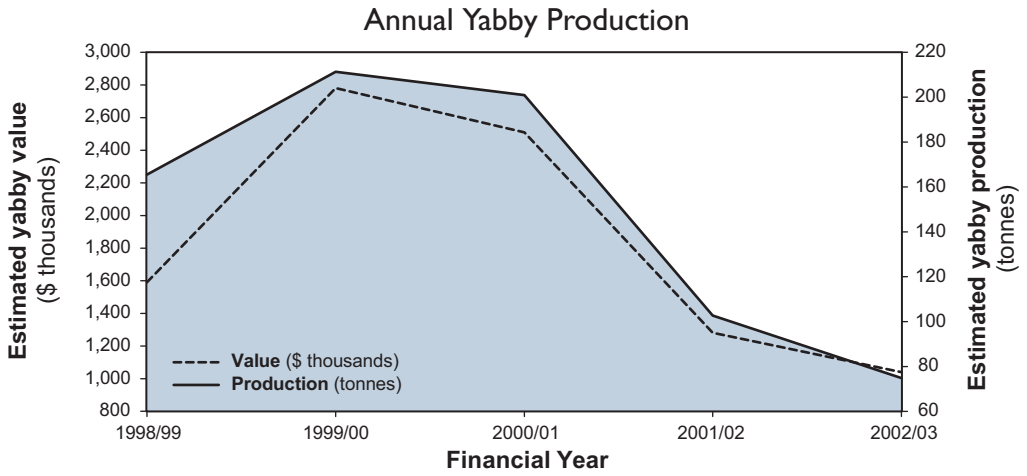
ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2002/03: $1.04 million

Even in the presence of competition from other luxury crustaceans, the market price for yabbies has increased slightly to an average farm gate value of $13.91/kg, most likely due to the farming of larger and therefore more valuable yabbies. Emphasis is also being placed on more winter harvesting.

EXTERNAL FACTORS

Drought is a key issue as most farmers rely on surface runoff to fill stock watering dams. Few purpose-built yabby ponds are used. Yabbies use the dam wall slopes, particularly in deeper dams where bottom waters contain little oxygen. 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, particularly on warm days.



YABBY FARMING FIGURE 1

Estimated yabby production and value from 1998/99 to 2002/03.

Trout Farming Status Report

Prepared by C. Lawrence

INDUSTRY DESCRIPTION

Production methods

The majority of trout (both rainbow trout, *Oncorhynchus mykiss* and brown trout, *Salmo trutta*) are produced in purpose-built ponds for the food market. In addition, some large gully dams and ponds are stocked with trout for pay fishing by recreational fishers and tourists. Some farmers located in salt-affected regions have constructed ponds to trial trout production in saline groundwater.

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 underground water are evaluating the performance of rainbow trout, stocked as yearlings and grown out in dams or ponds 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 (2002/03): 29.4 tonnes

Number of producers for year 2002/03: 10

Production projection next year (2003/04): 30–35 tonnes

Semi-intensive trout production increased by 25% last year, continuing the gradual growth this industry has experienced since the late 1990s. However, the drought conditions during the last three years have restricted the demand from inland farmers for yearlings and curtailed inland saline farming trials.

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 trout fishing 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.

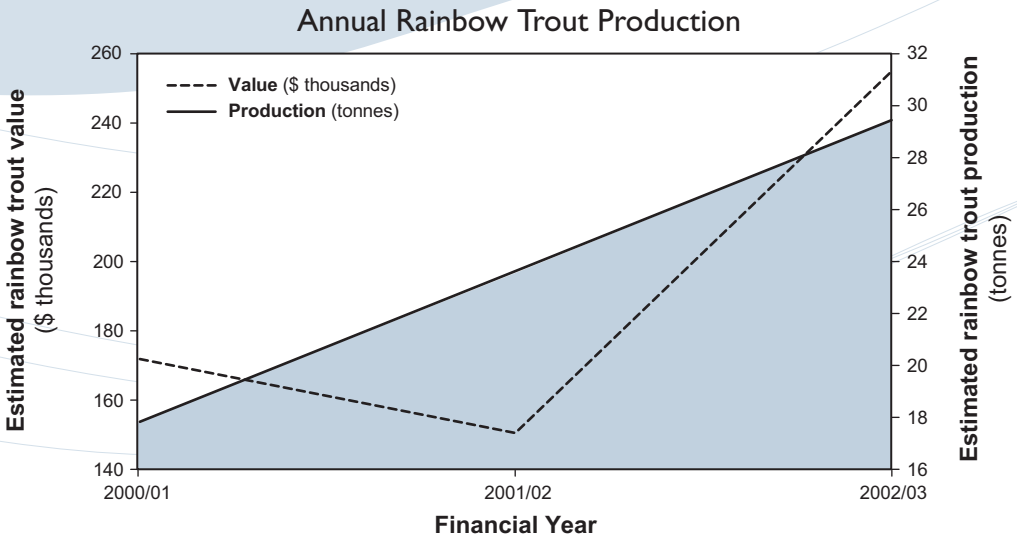
ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2002/03: $254,000

(Note this estimate includes the value of yearlings provided to inland saline farmers but not production by these farmers, as the smaller farms are not licensed and hence do not provide aquaculture returns.)

Internationally, prices for farmed trout and salmon (salmonids) are being depressed by massive increases in production, particularly in Norway and Chile. 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. Consequently, while trout production increased by 25% last year, the value of farmed trout in Western Australia increased by 69% (Trout Farming Figure 1). This is due to a 36% increase in the price per kilogram received by farmers, which may reflect niche marketing.

The PFRC trout hatchery provides support for the commercial trout farming industry as a by-product of producing trout fry for recreational stocking programs. Fry and yearlings are also supplied to private buyers who stock private dams within tourist complexes. Trout sold via tourist fishing ventures do not usually appear within the commercial production records, although they add significant commercial benefits to that sector and the regional economy. There is a trend for major trout producers to move towards tourist fishing ventures, effectively 'adding value' to the trout grown in these systems. While there is no reliable method of estimating the value of this sector, its tourism value within the south-west may exceed that of the trout grown for the general fish market trade.



TROUT FARMING FIGURE 1

Estimated rainbow trout production and value from 2000/01 to 2002/03.

Silver Perch Farming Status Report

Prepared by C. Lawrence

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 (2002/03): 24.3 tonnes

Number of producers for year 2002/03: 17

Production projection next year (2003/04): 25–35 tonnes

Silver perch production has increased rapidly over the past few years, mainly due to improved hatchery supply of juveniles (Silver Perch Farming Figure 1). However, growth slowed during 2002/03 due to insufficient juvenile supply and changes in farm ownership.

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

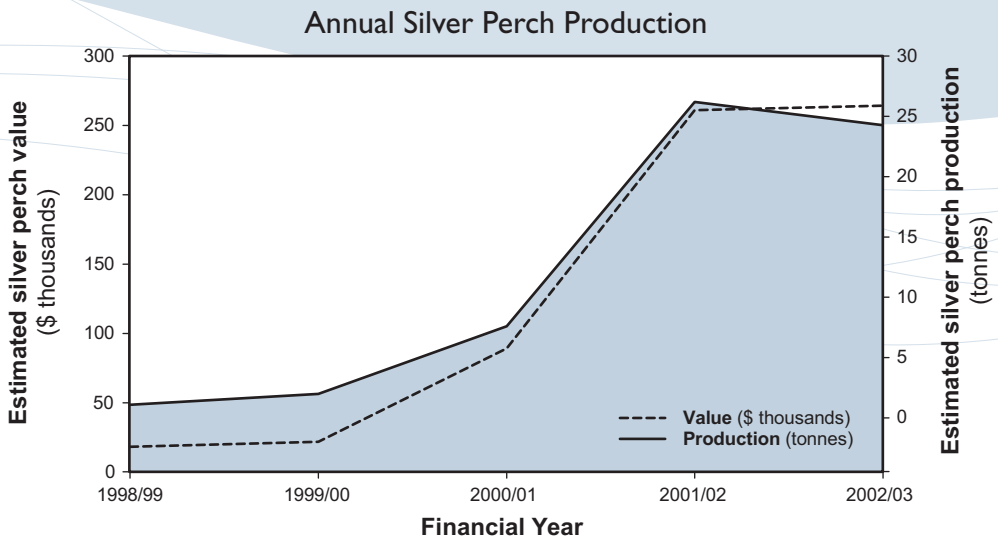
Silver perch farming allows diversification of farm usage away from other, sometimes unprofitable, agricultural uses.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2002/03: $264,000

EXTERNAL FACTORS

While the industry was limited by availability of imported juveniles in earlier years, local juvenile production is now increasing to meet demand. This is largely due to the adoption by industry of spawning techniques developed by researchers in New South Wales.



SILVER PERCH FARMING FIGURE 1

Estimated silver perch production and value from 1998/99 to 2002/03.

Ornamental Fish Farming Status Report

Prepared by C. Lawrence

INDUSTRY DESCRIPTION

Production areas

Production of ornamental finfish and crustaceans occurs throughout the state, but is mainly focused in metropolitan areas adjacent to the main markets. Both native and non-native species are produced.

Production methods

Dedicated small ponds and aquaria are used to breed and rear juveniles for live sales.

Management arrangements

Specific licence approvals are needed for commercial production.

AQUACULTURE PRODUCTION

Production current year (2002/03): 124,600 fish

Number of producers for year 2002/03: 25

Production projection next year (2003/04): 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 decreased dramatically (down 66%), along with declines in ornamental non-native fish (down 18%) and koi carp (down 15%). In contrast, goldfish production increased 24%. 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. From 2001/02, ornamental marron are included in this production sector and these are now a significant component of the total value of production for this sector.

ECOSYSTEM EFFECTS

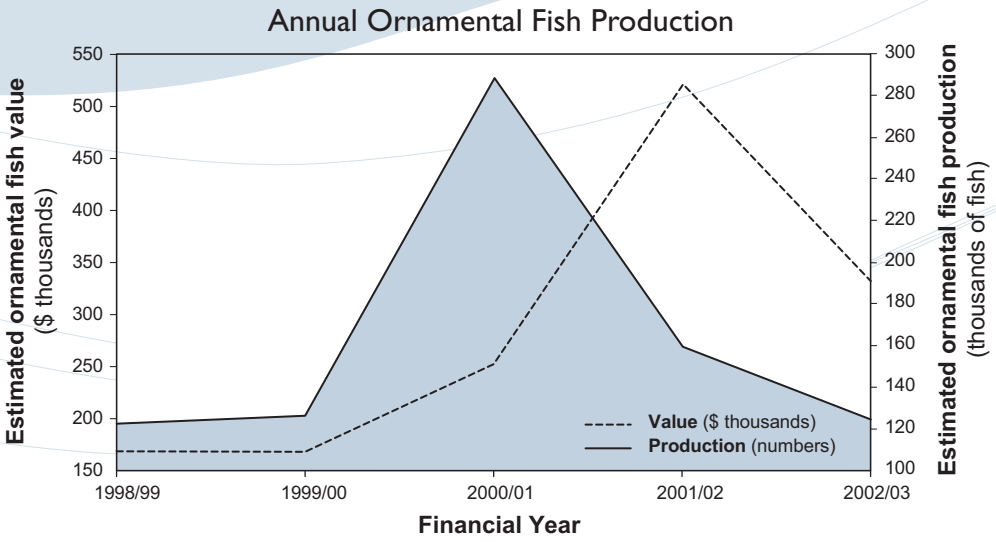
Ornamental fish farming is considered to present a low risk to the environment because there is relatively little water discharged from ornamental fish farms. Operators are required to ensure that stock does not escape into natural waterways.

SOCIAL EFFECTS

This industry provides part-time employment for numerous small-scale producers and has potential as a form of farm diversification for future entrants to the industry.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 2002/03: $330,000



ORNAMENTAL FISH FARMING FIGURE 1

Estimated ornamental fish production and value from 1998/99 to 2002/03. The ornamental fish category includes ornamental native and non-native fish, koi carp and goldfish. (Ornamental crustaceans are included in the 2001/02 and 2002/03 production years.)

COMPLIANCE

Regional Compliance and Community Education Overview

Fisheries Officers based in Geraldton, Dongara, Jurien, Lancelin, Fremantle, Mandurah, Bunbury, Busselton, Albany and Esperance conduct fisheries compliance and education activities in the southern inland bioregion. Volunteer Fisheries Liaison Officers (VFLO) located in major coastal centres also assist these officers with education and research activities. Please note that, as the records of VFLO activities do not differentiate between coastal and inland regions, they have been reported under the south coast bioregion.

The recreational marron fishery presents the highest risk of non-compliance with the management arrangements in this region. These risks include illegal fishing during the closed season (February–December), the use of illegal fishing gear, use of scoop and drop nets in 'snare only' waters, illegal fishing in closed Water Corporation catchment dams, and the theft of marron from dams on private property and licensed aquaculture sites.

The other main fishery in the southern inland bioregion is the recreational trout fishery. Compliance and education in this fishery focuses on the illegal use of baits in 'artificial lure only' waters, exceeding bag limits, fishing without a current licence, and the taking of trout during the closed season.

Activities during 2002/03

During 2002/03 Fisheries Officers delivered 2,862 hours of compliance work to recreational fisheries in the southern inland bioregion (Southern Inland Compliance Table 1), recording 1,856 field contacts and 1,518 office contacts with recreational fishers. A total of 14 'Fishwatch' reports were received for this bioregion.

During the year, 48 infringement warnings and 17 infringement notices were issued and a further 10 cases resulted in prosecution of recreational fishers.

The marron fishery was again the major focus for the compliance and education program in this bioregion. The introduction of a Recreational Mobile Patrol in the southern region greatly assisted with compliance service delivery and the implementation of new fishing rules. 882 hours of compliance patrol time was delivered to the marron fishery.

Due to extremely low water levels, environmental factors leading to habitat loss and research concerns about marron stocks, the 2003 marron season was reduced to 16 days from 55 days in 2002. Special bag, size and possession limits were also introduced for Harvey Dam in 2003. Additionally, fishing for marron was banned in the waters of the Margaret River upstream from the Ten Mile Brook junction, to protect the recently identified new species known as 'hairy marron'. To maximise compliance with these new restrictions, patrols were used to conduct an extensive education campaign in the lead up to the season on Harvey Dam and the Margaret River.

The majority of prosecutions initiated during the year related to the taking of marron during the closed season, including several cases which also involved fishing in closed Water Corporation dams.

Fisheries 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.

Initiatives for 2003/04

District Fisheries Officers and the Recreational Mobile Patrol continue to work closely with local police to combat marron poaching during the closed season and the theft of marron from dams on private property and aquaculture farm dams.

The regional Community Education Officer is continuing to expand the community education program in inland areas and in particular popular marron and trout fishing areas.

SOUTHERN INLAND COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types within the southern inland bioregion during the 2002/03 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	*NUMBER*
Hours delivered in bioregion	2,862
Fisher field contacts by Fisheries Officers	1,856
District Office contacts by Fisheries Officers	1,518
Fishwatch reports *	14
RECREATIONAL OFFENCES DETECTED	
Infringement warnings	48
Infringement notices	17
Prosecutions	10

* This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

Statewide
FISHERIES

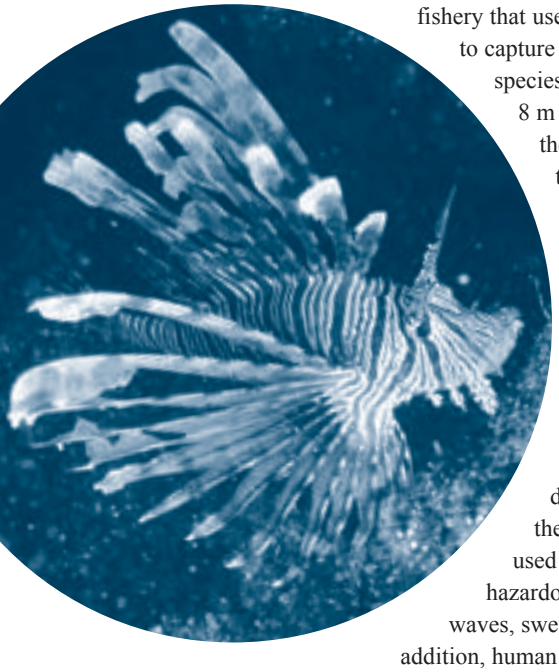
COMMERCIAL FISHERIES

Marine Aquarium Fish Managed Fishery Status Report

Prepared by S. Newman, with management input by 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 endorsements the fishery also takes coral, live rock 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

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. During the past two 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 the Ningaloo Marine Park, or in any waters closed to fishing (e.g. Rowley Shoals, reef observation areas, sanctuary zones). The fishery is permitted to operate in general-purpose zones of other marine parks provided licensees obtain prior written approval from the Department of Conservation and Land Management. Recently, a Section 43 Order which prohibits fishing was placed on Cleaverville Reef to prohibit the take of coral and associated organisms.

Fish caught in this fishery may not be used for food purposes, and operators are not permitted to take species covered by other specific commercial management arrangements or management plans.

The MAF is permitted to take 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.

Research summary

Information provided by the fishery in the form of statutory monthly catch and effort returns are used as the basis to provide research advice for fisheries management.

RETAINED SPECIES

Commercial production (season 2003): 130,740 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 2003 levels of catch is provided in Marine Aquarium Fish Table 1.

Fishing effort/access level

Effort in the fishery has been relatively stable over the past three years at an average of 929 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 WA 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

Exploitation status: 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. At least six species of syngnathids have been retained by the fishery, although only four are generally targeted: the western spiny seahorse (*Hippocampus angustus*), common or weedy seadragon (*Phyllopteryx taeniolatus*), short-snouted seahorse (*Hippocampus breviceps*) and spotted pipefish (*Stigmatopora argus*). These species are widely distributed in WA waters and occur in both shallow and deep waters in both urban and remote locations. It is estimated that 80% of populations occur in areas that receive little to no impact from fishing. While in general, some species of syngnathids may be vulnerable to over-fishing because they reproduce relatively slowly, have low rates of dispersal and are highly habitat-dependent, there is no evidence of decline for any syngnathid species retained by the MAF (Pogonowski et al. 2002).

ECOSYSTEM EFFECTS

Food chain effects: Negligible

Habitat effects: Negligible

SOCIAL EFFECTS

Under clauses 9 and 10 of the Marine Aquarium Fish Management Plan 1995, a licensee (or his nominated operator) may fish with two nominated divers, thus permitting up to 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 2003: Not assessed

FISHERY GOVERNANCE

Acceptable catch range for next season: Not assessed

New management initiatives (2003/04)

The management plan for the MAF is currently under review, with changes expected to be introduced during 2005. Among the changes under consideration are more equitable access for all licensees to invertebrates, coral and 'live rock', and a finer spatial resolution in compulsory catch and effort returns.

The Australian Government Department of Environment and Heritage is currently considering an application to certify the MAF as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Managed Fishery and associated endorsements in 2003.

COMMON NAME	QUANTITY (numbers)	WEIGHT (Kg)
Fish	130,740	
Hermit crabs	128,935	
Invertebrates	40,893	
Algae		5,503
Coral		3,307
Living rock, living sand, soft coral, sponge, other		4,324

Specimen Shell Managed Fishery Status Report

Prepared by A. Hart, with management input by F. Wells

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

Consultation process

Department–industry meetings

Boundaries

The fishery operates around the entire Western Australian coastline, 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.

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 in 60 x 60 nm grids), days and hours fished by month and year. These data are used as the basis to provide research advice for fisheries management.

RETAINED SPECIES

Commercial production (season 2003): 19,670 shells

Landings

In 2003 the total number of specimen shells collected was 19,670, distributed over a wide range of species. In the past four years, nearly 550 separate species of molluscs have been collected, each in very low numbers. There is some focus of effort on families most popular with shell collectors, such as cowries, cones, murexes and volutes.

(Note this reported total excludes *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 three years at an average of around 1,100 days fished.

Catch rate

Not applicable.

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 substantial, but consists mostly of dead shells washed up on beaches.

STOCK ASSESSMENT

Assessment complete: Not assessed

Exploitation status: 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 (*Cypraea* spp.) and two volutes (*Amoria* spp.).

All species collected in WA, including these prized sub-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.

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 has no interaction with protected species.

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 2002/03: Not assessed

FISHERY GOVERNANCE

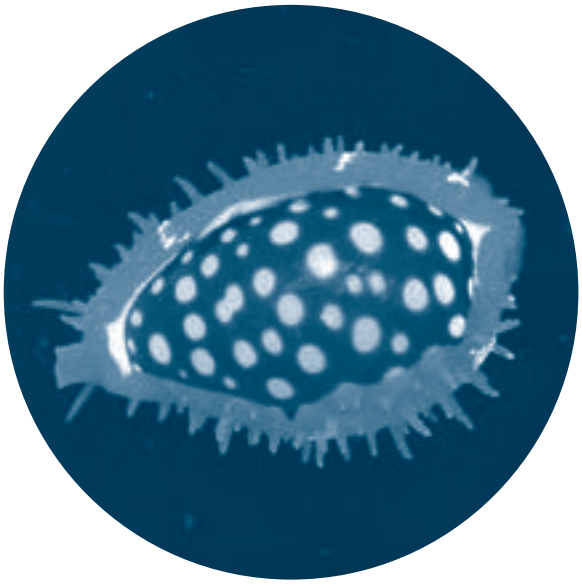
Acceptable catch range for next season: 10,000–25,000 shells

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.

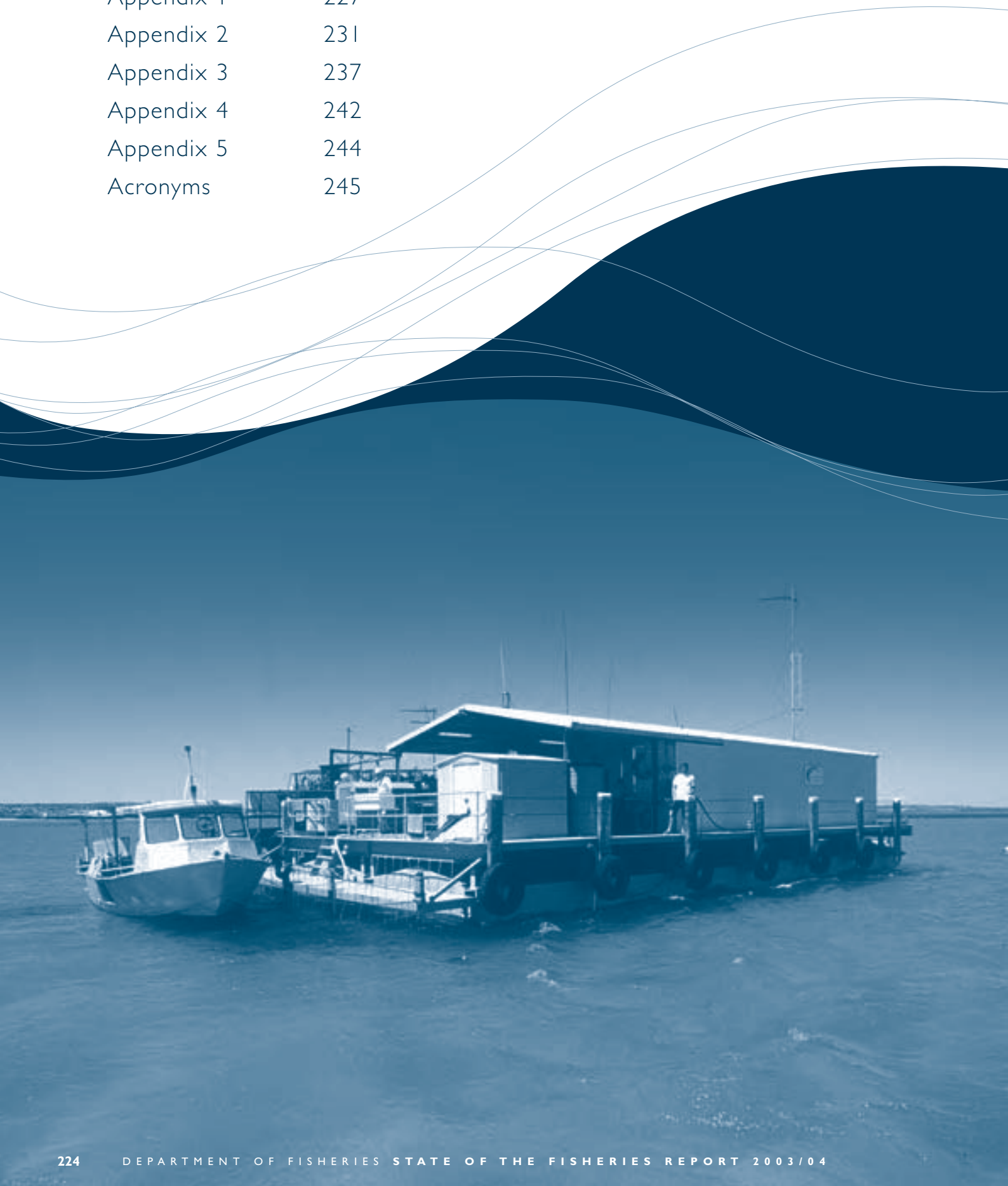
New management initiatives (2003/04)

Commencing in August 2004, the SSF will report catch and effort on a finer spatial scale of 10 x 10 nm blocks. This finer-scale reporting is being implemented to provide more accurate information on the distribution of certain species. In addition, the licensees will voluntarily report the number of shell seen versus the number of shell taken for those eight species identified as vulnerable.

The Australian Government Department of Environment and Heritage has considered a draft application to certify the Specimen Shell Managed Fishery as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. The final application is being prepared for submission in early 2005.



References and Appendices



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APPENDIX 1

Stock exploitation status and catch ranges for major commercial fisheries

(Appendix 6 from Annual Report 2003/04[1])

Fishery	*Stock assessment complete*	*Exploitation status*	*Breeding stock assessment*	*Previous acceptable catch (and effort) range in tonnes (days)*	*Catch (tonnes) for season reported*[2]	*Season reported*[2]	*Acceptable catch (and effort) range in tonnes (days) for next season*[3]	*Comments on catch in reported season*
WEST COAST BIOREGION								
Western rock lobster	Yes	Fully exploited	Adequate	8,166-14,523	11,387	2002/03	8,166-14,523	The above-average catch due to good puerulus settlement 3-4 years previously.
Roe's abalone	Yes	Fully exploited	Adequate	107.9 (Q) (679-914 days)	95 (714 days)	2003	110.9 (Q) (679-914 days)	Exploratory quota (9.9 t) was not utilised in Area 1.
South West trawl	NA	NA	NA	Not available	Prawns 20 Scallops 12	2003	Not available	
Abrolhos Islands and Mid West trawl	Yes	Fully exploited	Adequate	50-600	5,840	2003	95-1,830	The annual recruitment (and therefore catch) of scallops is highly variable depending upon environmental conditions. The 2003 catch is the highest recorded for this fishery.
West coast purse seine	Yes	Fully exploited	Adequate	Not available	1,164	2003	3,000 (Q)	Pilchards, scaly mackerel and other small pelagics are now subject to total allowable catches. Acceptable effort level not available.
West coast beach bait	Yes	Fully exploited	Adequate	106-331	103	2003	60-275	Whitebait only. Low abundance has resulted from several years of weak to moderate flow of the Leeuwin Current, which has caused catch to drop just below the acceptable range.
Estuarine fisheries (west coast)	Yes[4]	Fully exploited	NA	Not available	211	2003	75-220	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.
Deep sea crab	NA	NA	Adequate	NA	193	2003	NA	Developing fishery, still undertaking test fishing.

Fishery	Stock assessment complete	Exploitation status	Breeding stock assessment	Previous acceptable catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Acceptable catch (and effort) range in tonnes (days) for next season[3]	Comments on catch in reported season
GASCOYNE COAST BIOREGION								
Shark Bay prawn	Yes	Fully exploited	Adequate	1,501-2,330	1,632	2003	1,501-2,330	
Exmouth Gulf prawn	Yes	Fully exploited	Adequate	771-1,276	1,089	2003	771-1,276	
Shark Bay scallop	Yes	Fully exploited	Adequate	1,250-3,000	775	2003	1,250-3,000	Catch below acceptable range due to low recruitment in main area combined with a shift in effort to the Abrolhos fishery.
Shark Bay snapper	Yes	Over-exploited	Inadequate	563.7 (Q) (709-930 days)	429 (906 days*) *June-July period only	2003	338.3 (Q) (425-558 days)	Age-based stock assessment has confirmed the breeding stock is below acceptable levels. The 2004 quota has been reduced by 40% and the management arrangements of other fisheries affecting this stock are being reviewed.
Shark Bay beach seine & mesh net	Yes	Fully exploited	Adequate	210-353	307 (key species)	2003	235–335	The catch for the four target species was within their individual acceptable ranges except for yellowfin bream which was greater higher than acceptable and may require review.
NORTH COAST BIOREGION								
Onslow prawn	Yes	Fully exploited	Adequate	60-130	193	2003	60-130	Tiger prawn catch higher than acceptable range which probably reflects highly favourable environmental conditions.
Nickol Bay prawn	Yes	Fully exploited	Adequate	90-300	248	2003	90-300	
Broome prawn	Yes	Under-exploited	Adequate	55-260	201	2003	55-260	
Kimberley prawn	Yes	Fully exploited	Adequate	240-500	390	2003	240-500	
Pearl oyster	Yes	Fully exploited	Adequate	512,000 oysters (Q) (14,071-20,551 dive hours)	479,119 oysters (15,889 dive hours)	2003	512,000 oysters (Q) (14,071-20,551 dive hours)	Reduced catch and effort of oysters in Zone 1 offset by hatchery-produced oysters.

Fishery	Stock assessment complete	Exploitation status	Breeding stock assessment	Previous acceptable catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Acceptable catch (and effort) range in tonnes (days) for next season[3]	Comments on catch in reported season
NORTH COAST BIOREGION (cont.)								
Pilbara trawl	Yes	Fully exploited	Adequate	1,900-2,200	2,860	2003	2,000-2,800	Increased catch due to increased stocks, catch diversification and efficiency gains.
Pilbara demersal trap & line	Yes	Fully exploited	Adequate	150-300 (trap)	363 (trap) 81 (line)	2003	160-360 (trap) 50-115 (line)	As above.
Northern demersal	Yes	Fully exploited	Adequate	600-1,000	552	2003	600-1,000	Catches remain around 500 t due to significant levels of effort that remain unutilised.
Kimberley gillnet & barramundi	Yes[4]	Fully exploited	Adequate	25-40 (barramundi)	45 (barramundi)	2003	25-40 (barramundi)	The catch increase was a result of increased levels of effort.
Northern shark	Yes[4]	Under-exploited	Adequate	< 117 (sandbar only)	88 (sandbar only)	2002/03	< 117 (sandbar only)	The catch of sandbar sharks is considered suitable to monitor fishery
Spanish mackerel	Yes	Fully exploited	Adequate	275-417	457 (Spanish mackerel)	2003	246-410	Catches continued to exceed acceptable ranges in Kimberley and west coast regions due to good recruitment. New management measures will cap catches. New catch range applies to all species other than grey mackerel.
SOUTH COAST BIOREGION								
South coast rock lobster	Yes	Fully exploited	Adequate	50-80	61	2002/03	50-80	Includes Esperance, GAB and Albany management zones.
Abalone (greenlip/ brownlip)	Yes	Fully exploited	Adequate	238.4 (Q) (1,095-1,511 days)	212 (1,104 days)	2003	225.5 (Q) (1,095-1,511 days)	Small TAC reductions (5%) taken for 2004 due to stock concerns.
WA salmon	Yes	Fully exploited	Adequate	1,300-3,600	1,892	2003	1,200-3,350	Environmental factors (e.g. Leeuwin Current) are considered the main influence on recruitment and catch levels in subsequent years.
Australian herring trap	Yes	Fully exploited	Adequate	450-1,200	415	2003	475-1,200	South Coast only. Low catch in 2003 due to limited market demand.

Fishery	Stock assessment complete	Exploitation status	Breeding stock assessment	Previous acceptable catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Acceptable catch (and effort) range in tonnes (days) for next season[3]	Comments on catch in reported season
SOUTH COAST BIOREGION (cont.)								
Southern & west coast demersal gillnet & longline	Yes[4]	Over-exploited (dusky and whiskery only)	Declining (dusky only)	725-975	847	2002/03	725-1,175	The breeding stock of dusky shark is still declining and of concern. The acceptable catch ranges for three species have been adjusted which has affected the overall range.
Estuarine fisheries (south coast)	Yes	Fully exploited	Adequate	200-500	278	2003	200-500	Includes fish. molluscs and crustaceans.
Albany/King George Sound purse seine	Yes	Under-exploited	Adequate	909 (Q)	757	2002/03	1,500 (Q)	Quotas are adjusted annually. Acceptable effort levels not available.
Bremer Bay purse seine	Yes	Under-exploited	Adequate	1,230 (Q)	594	2002/03	1,500 (Q)	Quotas are adjusted annually. Acceptable effort levels not yet available. The low catch this season due to fishing operations just recommencing and the need to re-establish markets.
Esperance purse seine	Yes	Under-exploited	Adequate	1,500 (Q)	241	2002/03	1,500 (Q)	As above.
NORTHERN INLAND BIOREGION								
Lake Argyle catfish	Yes	Over-exploited	Depleted	100-140	165	2003	95-155	Catch levels are above the acceptable range and need to be reviewed

1 The information in this table is also used in Appendix 6 of the Department of Fisheries' Annual Report 2003/04, where it underpins some of the Department's Performance Indicators. Appendix 6 in the annual report utilised an early draft of the table and may vary slightly from this version. However, the Performance Indicators calculated from the information have not changed.

2 Catch figures supplied for latest year/season available.

3 Following the adoption of a more robust statistical approach, a number of the acceptable catch ranges have changed for the next season.

4 For key species only.

NA Not assessed.

Q Quota management.

APPENDIX 2

Fisheries Research Division staff publications 2003/04

SCIENTIFIC PAPERS

Arthur, J., Ritar, A.J., Dunstan, G.A., Nelson, M.M., Brown, M.R., Nichols, P.D., Thomas, C.W., Smith, E.G., Crear, B.J. and Kolkovski, S. 2004. Nutritional and bacterial profiles of juvenile *Artemia* fed different enrichments and during starvation. *Aquaculture* 239: 351-373.

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APPENDIX 3

Table of catches from fishers' statutory monthly returns for 2002/03

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*	6,628	6,628
Anchovy	*Engraulis australis*	1,559	1,559
Barracuda (northern pike)	Sphyraenidae	1,144	1,159
Barramundi (giant perch)	*Lates calcarifer*	31,246	44,812
Bigeye (not tuna)	Priacanthidae	69,459	69,459
Boarfish	Pentacerotidae	3,326	3,800
Bream, black	*Acanthopagrus butcheri*	36,948	36,948
Bream, buffalo	Kyphosidae	3,160	3,160
Bream, monocle	*Scolopsis* spp.	12,419	12,419
Bream, Robinson's	*Gymnocranius grandoculis*	59,391	59,391
Bream, sea	*Gymnocranius* spp.	7,039	7,039
Bream, silver (tarwhine)	*Rhabdosargus sarba*	12,817	12,817
Bream, western yellowfin	*Acanthopagrus latus*	22,532	22,532
Catfish, sea (golden cobbler)	Ariidae	9,726	10,201
Chinaman fish (not cod)	*Symphorus nematophorus*	11,241	11,241
Cobbler	*Cnidoglanis macrocephalus*	74,279	104,519
Cobbler, silver	*Arius midgleyi*	96,741	173,820
Cod	Serranidae	79,523	80,678
Cod, bar (grey-banded, 8-bar)	*Epinephelus octofasciatus*	27,043	27,162
Cod, breaksea	*Epinephelides armatus*	8,618	9,122
Cod, chinaman	*Epinephelus rivulatus*	6,445	6,446
Cod, maori	*Epinephelus cyanopodus*	504	504
Cod, Rankin	*Epinephelus multinotatus*	65,992	66,577
Cod, spotted	*Epinephelus microdon/areolatus/bilobatus*	46,247	46,265
Dhufish, West Australian (jewfish)	*Glaucosoma hebraicum*	244,177	259,074
Dolphinfish	*Coryphaena hippurus*	800	800
Emperor, blue-lined (grass, black)	*Lethrinus laticaudis*	1,667	1,667
Emperor, blue-spot	*Lethrinus hutchinsi*	394,542	394,542
Emperor, red-spot (snapper)	*Lethrinus lentjan*	82,488	82,488
Emperor, red	*Lutjanus sebae*	277,051	277,309
Emperor, spangled	*Lethrinus nebulosus*	125,211	126,083

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
FISH (cont.)			
Emperor, sweetlip	*Lethrinus miniatus*	92,393	92,395
Flagfish (Spanish flag)	*Lutjanus vitta, L. quinquelineatus, L. carponotatus, L. lutjanus*	252,088	252,088
Flathead	Platycephalidae	13,903	13,904
Flounder	Bothidae	2,357	2,357
Footballer (footballer sweep, banded sweep)	*Scorpis georgianus*	633	687
Foxfish (hogfish, pigfish)	*Bodianus* spp.	970	982
Garfish, sea	*Hyporhamphus melanochir*	33,842	33,842
Groper, baldchin	*Choerodon rubescens*	42,636	46,251
Groper, blue	*Achoerodus gouldii*	25,878	32,863
Groper (wrasses)	Labridae	7,588	7,876
Gurnard	Triglidae	607	607
Halibut	*Psettodes erumei*	5,656	5,656
Hapuku	*Polyprion oxygeneios*	28,493	28,820
Herring, Australian	*Arripis georgianus*	531,207	531,207
Herring, Perth	*Nematalosa vlaminghi*	10,801	10,801
Javelin fish	*Pomadasys* spp.	13,459	13,489
Jobfish	*Pristipomoides* spp.	37,556	37,556
Jobfish (goldband snapper)	*Pristipomoides multidens*	449,467	450,437
Jobfish, rosy	*Pristipomoides filamentosus*	118,724	118,724
Jobfish (sharptooth snapper)	*Pristipomoides typus*	6,393	6,393
Kingfish, black (cobia)	*Rachycentron canadum*	42,805	43,527
Kingfish, yellowtail	*Seriola lalandi*	2,151	2,320
Knifejaw	*Oplegnathus woodwardi*	1,895	2,065
Leather jacket	Monacanthidae	41,482	65,576
Ling, pink (rock)	*Genypterus tigerinus*	704	704
Mackerel, blue	*Scomber australasicus*	2,693	2,693
Mackerel, grey (broad-barred)	*Scomberomorus semifasciatus*	21,958	26,889
Mackerel, other	Scombridae	18,264	19,631
Mackerel, scaly	*Sardinella lemuru*	1,801,101	1,801,101
Mackerel, shark (salmon)	*Grammatorcynus bicarinatus*	811	839
Mackerel, Spanish	*Scomberomorus commerson*	355,679	477,650
Mangrove jack	*Lutjanus argentimaculatus*	12,992	13,022
Maray	*Etrumeus teres*	119,737	119,737
Mullet, other	Mugilidae	3,451	3,579
Mullet, red	Mullidae	120,473	120,473
Mullet, sea	*Mugil cephalus*	325,595	326,653
Mullet, yellow-eye	*Aldrichetta forsteri*	51,475	52,759
Mulloway	*Argyrosomus hololepidotus*	57,852	60,538
Mulloway, northern (black jew)	*Protonibea diacanthus*	3,903	4,561
Parrot fish	Scaridae	12,806	12,910
Perch, darktail sea (maroon sea)	*Lutjanus lemniscatus*	11,771	11,816
Perch, Moses	*Lutjanus russelli*	58,592	58,592
Perch, pearl	*Glaucosoma buergeri*	44,238	44,239
Perch, red	*Lutjanus* spp	1,399	1,399

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
FISH (cont.)			
Perch, scarlet sea (saddletail sea)	*Lutjanus malabaricus*	166,627	166,628
Perch, yellowtail	*Amniataba caudavittatus*	1,431	1,431
Perches, other	Lutjanidae	12,931	12,931
Pike, sea	*Sphyraena novaehollandiae*	1,708	1,708
Pilchard	*Sardinops sagax ocellatus*	2,063,619	2,063,619
Pomfret, black	*Parastromateus niger*	3,053	3,060
Queenfish	*Scomberoides commersonnianus*	276	820
Redfish	*Centroberyx* spp	86,771	87,912
Redfish, Bight	*Centroberyx gerrardi*	18,299	18,501
Salmon, western Australian	*Arripis truttaceus*	1,856,839	1,857,118
Samson fish (sea kingfish)	*Seriola hippos*	108,460	115,302
Sawfish	Pristidae	1,722	6,306
Sawfish, green	*Pristis zijsron*	650	1,517
Sawfish, narrow	*Anoxypristis cuspidata*	2,220	5,175
Scad, yellowtail	*Trachurus novaezelandiae*	12,262	12,262
Scorpion fishes	Scorpaenidae	10,158	10,158
Shark, blacktip	*Carcharhinus* spp.	103,140	248,125
Shark, bronze whaler (dusky whaler)	*Carcharhinus obscurus*	186,542	296,773
Shark, creek whaler	*Carcharhinus fitzroyensis*	843	1,341
Shark, eastern school	*Galeorhinus galeus*	9,211	14,643
Shark, golden (copper whaler)	*Carcharhinus brachyurus*	23,059	36,371
Shark, graceful	*Carcharhinus amblyrhynchoides*	500	796
Shark, grey nurse	*Carcharias taurus*	1,118	1,781
Shark, grey reef	*Carcharhinus amblyrhynchos*	3,966	6,917
Shark, gummy	*Mustelus antarcticus*	247,708	393,541
Shark, hammerhead	Sphyrnidae	70,156	116,628
Shark, lemon	*Negaprion acutidens*	36,990	59,690
Shark, mako (shortfin)	*Isurus oxyrinchus*	7,617	12,109
Shark, oceanic whitetip	*Carcharhinus longimanus*	1,300	3,372
Shark, other		98,059	158,177
Shark, pencil	*Hypogaleus hyugaensis*	1,914	2,919
Shark, pigeye	*Carcharhinus amboinensis*	31,953	61,232
Shark, saw	*Pristiphorus* spp.	472	1,099
Shark, silvertip	*Carcharhinus albimarginatus*	320	509
Shark, spinner (long-nose grey)	*Carcharhinus brevipinna*	1,250	1,992
Shark, spot-tail	*Carcharhinus sorrah*	2,835	4,413
Shark, thickskin (sandbar)	*Carcharhinus plumbeus*	164,312	261,118
Shark, tiger	*Galeocerdo cuvier*	41,190	72,492
Shark, whiskery	*Furgaleus macki*	110,257	165,275
Shark, wobbegong	Orectolobidae	74,536	117,446
Shovelnose (fiddler rays)	Rhinobatidae, Rhynchobatidae	6,874	23,883
Skates and rays, other		12,088	23,475
Smelt (hardyhead)	Atherinidae	1,330	1,330
Snapper, bullnose (variegated emperor)	*Lethrinus ravus*	2,913	2,913
Snapper, frypan	*Argyrops spinifer*	49,225	49,225

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
FISH (cont.)			
Snapper, long nose	*Lethrinus olivaceus*	21,148	21,148
Snapper, north-west	Lethrinidae	73,868	76,946
Snapper, north-west (large)	*Lethrinus* spp.	15,170	15,170
Snapper, north-west (small)	*Lethrinus lentjan, L. choerorhynchus* etc	105,975	105,975
Snapper, pink	*Pagrus auratus*	830,622	842,079
Snapper, queen	*Nemadactylus valenciennesi*	43,091	51,179
Snapper, red (swallowtail)	*Lutjanus erythropterus*	268,366	268,368
Snapper, ruby	*Etelis* spp.	11,470	11,528
Sole	Cynoglossidae, Soleidae	805	805
Sprat, blue	*Spratelloides robustus*	23,024	23,024
Sweep	*Scorpis aequipinnis*	1,230	1,346
Sweetlip	Haemulidae	96,789	98,101
Tailor	*Pomatomus saltatrix*	32,073	32,073
Threadfin	Polynemidae	14,602	17,360
Threadfin bream (butterfish)	Nemipteridae	449,708	449,708
Threadfin, giant (king salmon)	*Eleutheronema tetradactylum*	147,128	156,274
Trevalla, deepsea	*Hyperoglyphe antarctica*	14,244	14,274
Trevally, golden	*Gnathanodon speciosus*	9,895	10,141
Trevally, other (skippy)	Carangidae	207,746	207,923
Trevally, skipjack	*Pseudocaranx dentex*	3,471	3,559
Tripletail	*Lobotes surinamensis*	916	1,033
Trout, coral	*Plectropomus maculatus*	23,854	24,206
Trout, spotted (duskytail groper)	*Epinephelus bleekeri*	4,463	4,463
Tuna, mackerel	*Euthynnus affinis*	944	949
Tuna, other	Scombridae	31,722	31,841
Tuna, skipjack (striped)	*Katsuwonus pelamis*	490	535
Tuna, yellowfin	*Thunnus albacares*	3,793	4,222
Tuskfish, bluebone	*Choerodon* spp.	17,332	17,332
Wahoo	*Acanthocybium solandri*	846	913
Whitebait	*Hyperlophus vittatus*	173,908	173,908
Whiting, golden-lined	*Sillago analis*	3,324	3,324
Whiting, King George	*Sillaginodes punctata*	18,227	18,239
Whiting, other	Sillaginidae	2,617	2,617
Whiting, western sand	*Sillago schomburgkii*	148,913	148,929
Other fish varieties		104,543	113,438
Total fish		**15,153,462**	**16,377,392**
CRABS			
Crab, coral	*Charybdis feriata*	1,446	1,446
Crab, giant (king)	*Pseudocarcinus gigas*	16,266	16,266
Crab, mud	*Scylla serrata*	2,528	2,528
Crab, blue swimmer (blue manna, sand)	*Portunus pelagicus*	1,002,626	1,002,626
Crab, crystal (snow)	*Chaceon bicolor*	186,505	186,505
Crab, champagne (spiny)	*Hypothalassia acerba*	20,254	20,254
Total crabs		**1,229,625**	**1,229,625**

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
PRAWNS			
Prawn, banana	*Fenneropenaeus merguiensis*	418,133	418,133
Prawn, brown tiger	*Penaeus esculentus*	1,312,176	1,312,176
Prawn, coral	*Metapenaeopsis* spp.	267,297	267,297
Prawn, endeavour	*Metapenaeus endeavouri*	290,281	290,281
Prawn, western king	*Melicertus latisulcatus*	1,768,751	1,768,751
Other prawns	Penaeidae	179	179
Total prawns		**4,056,817**	**4,056,817**
LOBSTERS			
Rock lobster, southern	*Jasus edwardsii*	61,192	61,192
Rock lobster, western	*Panulirus cygnus*	11,416,176	11,416,176
Bugs	Scyllaridae	24,710	28,617
Total lobsters		**11,502,078**	**11,505,985**
MOLLUSCS			
Abalone, brownlip	*Haliotis conicopora*	11,248	28,151
Abalone, greenlip	*Haliotis laevigata*	52,857	140,739
Abalone, Roe's	*Haliotis roei*	88,084	100,816
Cockles	*Katelysia* spp.	1,533	1,533
Cuttlefish	Sepiidae	105,907	105,979
Mussel	*Mytilus edulis*	4,000	4,000
Octopus	*Octopus* spp. (mainly *O. tetricus*)	125,324	242,924
Scallop, saucer	*Amusium balloti*	1,389,026	6,821,802
Squid	*Sepioteuthis* spp., *Loligo* spp.	148,518	148,518
Other molluscs		79	79
Total molluscs		**1,926,576**	**7,594,541**
OTHER CLASSES			
Beche de mer	Holothuridae	44,430	123,348
Other		57	57
Total other classes		**44,487**	**123,405**
GRAND TOTAL		**33,913,045**	**40,887,765**

1. *Landed weight:* refers to the mass (or weight) of a product at the time of landing, regardless of the state in which 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. In fact it is often referred to as the 'live weight equivalent of the landings' or 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=root&xml=ontology/index.xml.

Reported catches from collectors' licences for 2002/03

COMMON NAME	SCIENTIFIC NAME	QUANTITY	WEIGHT (kg)
Aquarium fish		116,828	
Hermit crabs	*Coenobita variabilis*	156,405	
Specimen shells*		12,927	
Invertebrates		31,525	
Corals	Order Scleractinia		4,300
Soft corals, living rock, living sand, algae			7,375

*Excludes *Trochus hanleyanus* taken for other purposes.

APPENDIX 4

Pemberton Freshwater Research Centre activities 2003/04

The Pemberton Freshwater Research Centre (PFRC) on Lefroy Brook remains an important node for recreational fishery, environmental, conservation and aquaculture research in Western Australia. The main PFRC site contains 10 earthen ponds, 22 concrete ponds, the trout hatchery and the nutrition research facilities, while the Thomson's Flat Annexe features 25 earthen ponds (including three 1,000 m^2 ponds), 28 above-ground pools and a post-harvest handling facility. The annexe also includes a leased site currently being utilised for marron processing and marketing, plus two other sites that may be leased in the future. The PFRC supports a range of significant freshwater research projects and acts as a model demonstration farm for marron and for water reuse and discharge treatment.

The PFRC has six major projects currently underway, each of which is briefly discussed below.

Trout production and research

A major activity of the PFRC is the production of rainbow and brown trout for stocking public and private fisheries in the state. Approximately 700,000 fry, 40,000 yearlings and 3,100 ex-broodstock fish were produced by the PFRC in 2003/04. Of these, approximately 420,000 fry, 29,000 yearlings and 3,100 ex-broodstock fish were stocked into public waterways to support recreational fishing (i.e. approximately 61%), with the balance sold to individuals and clubs to support private fishing opportunities (10%) and the commercial aquaculture grow-out of trout (29%). To avoid competition with commercial producers, large orders of yearling trout are not met for farmers in inland saline areas, but fry are sold to a yearling producer in the wheatbelt. It should also be noted that the PFRC has a national reputation for producing rainbow trout of a very high quality for all life-stages.

PFRC staff are responsible for transporting the trout to and stocking them into public waters, and also prepare trout for sale and transport to private and commercial ventures. They also provide extension support for commercial and private operators, especially advice about stocking densities, water quality and feeding.

Several trout research projects, led by B. Molony, are underway at the PFRC. These include the evaluation of tagging techniques to allow trout captured in the fishery to be identified to year class, permitting the evaluation of stocking success rates. Other tagging studies are collecting vital information on trout movements post-stocking to optimise stocking operations. A project evaluating the heat tolerance of the PFRC line of rainbow trout has recently been finalised and has been submitted to an international journal. This project clearly shows the increased heat tolerance of PFRC rainbow trout, which may lead to interstate and international demand for PFRC trout eggs.

Marron aquaculture development

The PFRC hosts part or all of two externally funded marron aquaculture projects. An FRDC project led by C. Lawrence has produced a second generation of mass-selected marron for evaluation in ponds. Further, hybrids of different natural river lines are being assessed in order to identify a rapidly growing, sterile line. A rapidly growing line has the potential not only to increase marron production in the state but also to develop a private commercial breeding company for the supply of juvenile marron from the fastest-growing lines for commercial on-growing.

A second marron project led by G. Maguire is nearing completion and has been funded by the Regional Assistance Program (RAP) and the South West Development Commission. This project is testing summer stocking and harvesting of marron in order to provide a consistent supply of marron throughout the year as the industry expands in the future. Further, the grow-out of marron at different densities and under different grading strategies is being evaluated, as are post-harvesting handling facilities and techniques. The marron used in the trial were of the better performing 'Pemberton' line, and have been sold as broodstock by tender to private growers, or as live edible product through a processor. The 'Pemberton' line is also being maintained for future use in genetics research. An additional component of the RAP work has shown that holding marron under favourable pond conditions does not overcome pre-existing symptoms of tail blister syndrome, which is a significant problem for the marron industry (research led by B. Jones).

Aquaculture feeds development

The feeds research area, comprising a shed and 48 independent tanks, is continuously available for a project led by B. Glencross. Nutrition experiments involving rainbow trout have been undertaken to develop new diets based on Western Australian grains. Results to date have delivered an increase in international sales of Western Australian grains to overseas markets for incorporation into salmonid diets. More research is being undertaken and an expansion of the program has resulted in the appointment of an additional staff member through Grains Research and Development Corporation funding. Ongoing interest in and support for these projects from international feeds companies demonstrate the high standing that feeds research at the PFRC has internationally.

Water supply dam stock management and conservation

The production of marron and native fish for restocking into the refurbished Waroona Dam is now complete, with the last of the stocks held at PFRC restocked into Waroona Dam in May 2004. This has been a jointly funded project involving the Department of Fisheries, Murdoch University, Alcoa and the Water Corporation, led by B. Molony. The project

involved the destocking of Waroona Dam, the establishment of marron populations at the PFRC for breeding, and restocking back into the dam after refurbishment works have been completed. This was the first such project in Australia and future projects are likely to occur as the Water Corporation is undergoing a major refurbishment of many of its south-western dams.

Conservation research

The PFRC is also a major centre for conservation research. Current projects include a breeding program for the threatened Margaret River marron, as part of a community-based strategy for saving this species. Research into native fish, particularly into their breeding, is also underway, with future research to include an evaluation of the use of native fishes as mosquito control agents. The PFRC was used as a base for artificial habitat trials in Big Brook Dam and will also be the base for the FRDC-funded project assessing the recreational marron fishery against environmental change and human interactions, both led by B. Molony. The PFRC also acts as a fish kill response centre for the region.

Aquaculture extension

Aquaculture extension roles of the PFRC include supporting trout and marron farming enquiries. Further, the Thomson's Flat Annexe acts as a demonstration farm for aquaculture technology and an eco-efficiency demonstration centre, especially in the areas of water conservation and reuse. The model ponds not only provide facilities for strategic experiments, but have been used to demonstrate new techniques in marron aquaculture and aquaculture in general. A major workshop for marron farmers was also held at the PFRC in March 2004.

APPENDIX 5

Fish Health Unit activities 2003/04

The Fish Health Unit of the Department of Fisheries was formed in 1988 and is based at South Perth within the Animal Health Laboratories of the Department of Agriculture. The unit is staffed by one full-time and two part-time fish pathologists, one research scientist, one laboratory manager and two part-time technical staff and is led by B. Jones.

The unit 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 2003/04 were as follows.

- The fish health laboratory received a total of 228 diagnostic cases during 2003/04, about 10% down on the previous year. During the year the notifiable disease viral encephalopathy and retinopathy was detected in farmed barramundi and four cases of the bacterial disease *Streptococcus iniae* were found in barramundi farms, all of which had imported fry from an eastern state. This prompted a review of import testing requirements for live fish from interstate. Twenty-one export certificates for yabbies and marron were processed, down more than 50% from last year, and 22 pearl translocation certificates were provided. Follow-up testing was also conducted for the undescribed intracellular ciliate that occurs only in small *Pinctada maxima* pearl oysters in Zone 1.
- In collaboration with staff from the Water and Rivers Commission, 7 reports of fish kills throughout the State were investigated, including follow-up sampling for a major and protracted fish kill in the Swan River during May and June 2003. The Swan River deaths were reported to be due to anoxia following a large algal bloom, in turn caused by a flush of fertilisers after heavy rain. However, additional testing was carried out to eliminate the possibility of toxic substances as a contributory cause.
- In collaboration with the Department of Agriculture and Murdoch University, work continued on a project funded by FRDC and the Australian Government Department of Agriculture, Forestry and Fisheries (DAFF) to develop Australian standard diagnostic techniques for the endemic notifiable disease EUS and the exotic disease crayfish plague (both caused by fungi of the genus *Aphanomyces*). Crayfish plague has not been recorded in Australia and development of a standard diagnostic technique is a precautionary step.
- A two-day simulated emergency incident response exercise, funded through FRDC/DAFF, was held with marron and yabby producers and the Aquaculture Council of Western Australia in February 2004.
- Work continued on the Western Australian component of an FRDC-funded national survey of wild and farmed abalone for parasites and disease.
- Work continued on an FRDC-funded project 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.
- Work was finalised on an FRDC-funded investigation of the disease status of prawn stocks on the North West Shelf. An encouraging outcome, after examination of over 150 wild *Penaeus monodon* from Western Australian waters plus additional samples of post-larvae from hatcheries, was the apparent absence from WA of gill associated virus (GAV), a serious disease of *P. monodon* in aquaculture in Queensland.
- The expertise of the Fish Health Unit is frequently sought by the national Aquatic Animal Health Committee and Biosecurity Australia. This also reflects the greater emphasis on national coordination and consultation in aquatic animal health issues.

GLOSSARY OF ACRONYMS

AIMWTF	Abrolhos Islands and Mid West Trawl Managed Fishery
BRD	bycatch reduction device
CAES	catch and effort statistics
CPUE	catch per unit effort
CW	carapace width
DAFF	(Australian Government) Department of Agriculture, Forestry and Fisheries
DEH	(Australian Government) Department of Environment and Heritage
ENA	extended nursery area
ERLF	Esperance Rock Lobster Managed Fishery
ENSO	El Niño/Southern Oscillation
ESD	ecologically sustainable development
EUS	epizootic ulcerative syndrome
FED	fish escapement device
FHPA	fish habitat protection area
FRDC	Fisheries Research and Development Corporation
GAB	Great Australian Bight
GPS	global positioning system
IBSS	independent breeding stock survey
IMP	interim management plan
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
KAAC	Kimberley Aquaculture Aboriginal Corporation
KGBF	Kimberley Gillnet and Barramundi Managed Fishery
KPF	Kimberley Prawn Managed Fishery
KSRP	Kimberley Sustainable Regions Program
LAFCF	Lake Argyle Freshwater Catfish Fishery
LML	legal minimum length
MAF	Marine Aquarium Fish Managed Fishery
MOP	mother-of-pearl
MSC	Marine Stewardship Council
NBPF	Nickol Bay Prawn Managed Fishery
NDSF	Northern Demersal Scalefish Managed Fishery
NPF	Northern Prawn Fishery
NSIA	Northern Shark Industry Association
PFRC	Pemberton Freshwater Research Centre
PFTF	Pilbara Fish Trawl (Interim) Managed Fishery
RLIAC	Rock Lobster Industry Advisory Committee
RPA	reef protected area
SCEF	South Coast Estuarine (Interim) Managed Fishery
SFD	standard fishing day
SRR	spawning stock–recruitment relationship
SSF	Specimen Shell Managed Fishery
TAC	total allowable catch
TACC	total allowable commercial catch
TAE	total allowable effort
TL	total length
TPSA	tiger prawn spawning area
VFAS	Voluntary Fishery Adjustment Scheme
VFLO	Volunteer Fisheries Liaison Officer
VMS	vessel monitoring system
WAFJA	WA Fisheries Joint Authority
WANCSF	WA North Coast Shark 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