STATE OF THE FISHERIES REPORT

2002/2003

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

Fish for the future

To the Hon. Kim Chance MLC
Minister for Agriculture, Forestry and Fisheries

Sir

In accordance with Section 263 of the *Fish Resources Management Act 1994*, I submit for your information and presentation to Parliament the report *State of the Fisheries* which forms part of the Annual Report of the Department of Fisheries of Western Australia for the financial year ending 30 June 2003.

Peter P Rogers

Edited by J.W. Penn, W.J. Fletcher and F. Head

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

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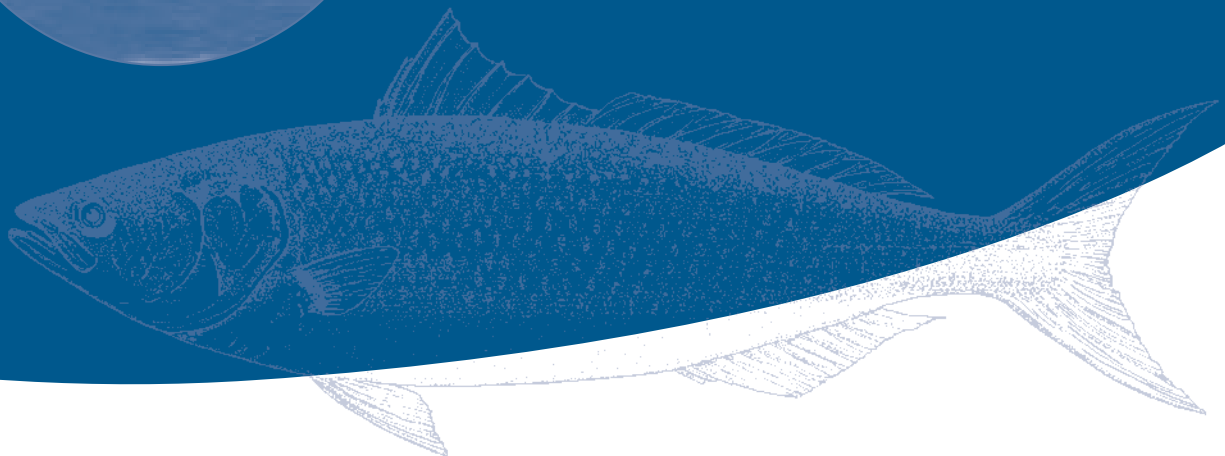
STATE OF THE FISHERIES REPORT

2002/2003



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OVERVIEW FROM THE EXECUTIVE DIRECTOR

The State of the Fisheries *document is designed as an essential supplement to the Annual Report to Parliament and provides a more detailed level of information to support the Department of Fisheries' non-financial performance measures. 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. Information relevant to the State's developing aquaculture industries and the Department's Fish and Fish Habitat Protection Program is also provided.*

This year's report follows the ecologically sustainable development (ESD) format established in 2000/01 and reflects Department's commitment to sustainable management and reporting of Western Australian fisheries. The status reports on individual fisheries, which have now been provided since the mid-1990s, also form the basis of a number of key performance indicators for the Department's management programs set out in our Annual Report.

These reports indicate that the majority of the State's fish stocks continue to be in a healthy condition and are producing at sustainable levels. It is pleasing to note also that the State's pilchard fisheries, which were severely depleted by an exotic virus in 1999, have recovered substantially, assisted by the significant quota reductions under their management plan. This success, and the good recovery of the previously depleted eastern Shark Bay pink snapper stock, have however been tempered by ongoing difficulties in maintaining the other pink snapper stocks in the Gascoyne coast bioregion, where reduced commercial quotas and additional recreational controls have become necessary. These events highlight the ongoing and increasing need for research monitoring and active management, particularly of our more accessible coastal fisheries. Current initiatives to develop integrated fisheries management regimes are designed to meet these challenges, but will require strong community support for their successful implementation. Similarly, active resolution of the increasing number of resource-sharing issues will be required over the next 3–5 years, so that management can focus on ensuring total catches by all sectors do not exceed sustainability targets.

I would like to take this opportunity to acknowledge the commitment and dedication of all Divisions of the Department in ensuring that this important annual assessment of our fisheries performance has been completed. Both commercial and recreational fishers are also to be commended for their high degree of support for the Department's research and management programs, without which our fisheries cannot be managed sustainably.

Peter P. Rogers
EXECUTIVE DIRECTOR

EDITOR'S INTRODUCTION

State of the Fisheries *reports in detail on the activities and impacts of the commercial and recreational fishing sectors which utilise the wild fish stocks in Western Australia. In addition, the status of the developing aquaculture industries is recorded to enable the public of Western Australia to follow the development of this emerging sector. The work of the Fish and Fish Habitat Protection Program, which provides environmental coordination for the Department's fisheries management activities and habitat reserves, is also reported to complete the coverage of the Department's responsibilities.*

For all of the fisheries management programs covered by this report to be successful, a high degree of cooperation is necessary between the users of the State's fish resources and the Department's Divisions of Fisheries Research and Fisheries Management Services. The level of cooperation and active collaboration between fishers and Departmental staff continues to be excellent, and is a major factor in keeping the State's fish harvest at sustainable levels.

Of particular value is the ongoing contribution of data by commercial fishers through catch reporting and detailed voluntary research logbooks, which provides the critical long-run time-series data sets essential to determine the status of many fish stocks. Similarly, the increasing contribution of data by recreational fishers, charter boat operators and Volunteer Fisheries Liaison Officers is improving our capacity to monitor this increasingly significant fishing sector.

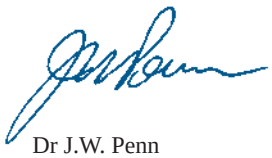
Aquaculture research and development information and programs reported in each of the State's bioregions also rely heavily on collaboration with aquaculturists, who provide access to farms and facilities for experimental projects.

Data from all of these sources, together with a range of fishery-independent research projects which are used to validate and enhance fishery data, provide the basis for sustainability assessments. These ESD assessment reports for fisheries, introduced several years ago, indicate that the majority of the State's fish stocks continue to be harvested at sustainable levels, and that few fisheries are at risk of significantly impacting on the marine environment. This assessment reflects the long and unique history of applying management controls and research evaluation processes to commercial fishing in Western Australia, and the positive support by industry for sustainable management practices.

These *State of the Fisheries* 'report cards' now link to the comprehensive set of ESD and associated environmental risk assessment reports which have been generated for all of the State's major export fisheries during 2002/03. These documents, submitted to Environment Australia in response to the requirements of the Federal *Environment Protection and Biodiversity Act 1999*, are providing an independent evaluation process to confirm the sustainability of these major commercial fisheries.

While *State of the Fisheries* helps meet these statutory requirements, the volume also provides the general public and interested fishers with a ready reference to the State's performance in managing fisheries over time. The document is also available on the Department of Fisheries website at http://www.fish.wa.gov.au/sof/index.html.

I would like to thank my colleagues in the Fisheries Management Services and Fisheries Research Divisions of the Department for their extensive contributions. Special thanks are also due to my editorial team members, Dr Rick Fletcher and Ms Fran Head, who have respectively taken on the roles of scientific editing and collation/copy-editing of the full document, and to my publications officer, Mrs Sandy Clarke, who has undertaken the layout and production of the volume.



Dr J.W. Penn
DIRECTOR – FISHERIES RESEARCH

HOW TO USE THIS VOLUME

In using this report, readers need to understand the various terms used in the text and summary table (Appendix 1) in assessing stock status.

EXPLOITATION STATUS

Fully exploited: relates to stocks where harvesting is in the general 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.

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.

SEASON REPORTED

Readers should also be aware that the individual fishery and aquaculture status reports 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 status

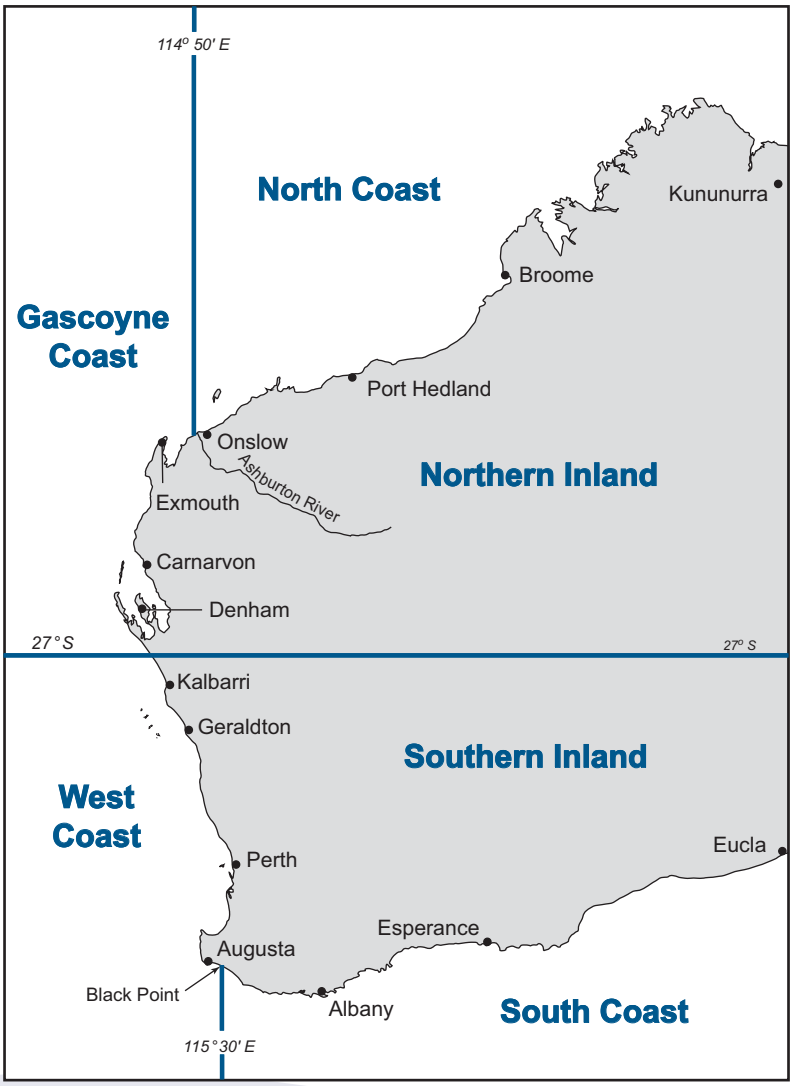
reports in this volume generally refer to the financial year 2001/02 or the calendar year 2002. Similarly, the statistics on compliance and educational activities are also for 2001/02, following analysis of data submitted by Fisheries Officers and VFLOs.

In contrast, the reports 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 2003.

A number of Australian Government departments changed their names on 1 July 2003. As this report deals with the period prior to the change, the former names have been used throughout.

BIOREGIONS

This report is organised by 'bioregions', which are the four major oceanographic regions around the Western Australian coastline, plus the two inland regions (north and south) where major freshwater environments occur (Introduction Figure 1). The bioregional boundaries 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.



INTRODUCTION FIGURE 1

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

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COMMERCIAL FISHERIES

COMMERCIAL FISHERIES

General Overview

The Commercial Fisheries Program is responsible for the management of commercial fisheries throughout Western Australia. This work is undertaken by a team of Commercial Program Officers located in the Department of Fisheries Head Office in Perth as well as Regional Policy Officers in Albany, Fremantle, Geraldton, Carnarvon and Broome. Management of most aspects of the major fishing activities is achieved through formal management plans declared under the *Fish Resources Management Act 1994* (*FRMA*), while other forms of fishing activity are managed through a combination of controls derived from the *Fish Resources Management Regulations 1995*, orders under the FRMA and conditions attached to fishing boat and commercial fishing licences.

The major commercial fisheries rely on relatively high-value, low-volume products for their viability. Tight management controls ensure that each fishery is sustainable. These management controls may be input controls, such as limitations on the number of licences, gear restrictions, seasonal closures and limits on fishing time (effort quotas), or output controls (catch quotas) which directly limit the quantity of fish that can be landed. There are often also permanent closed areas or other measures, under both effort and catch quota regimes, to protect juvenile or breeding fish or to protect important habitats.

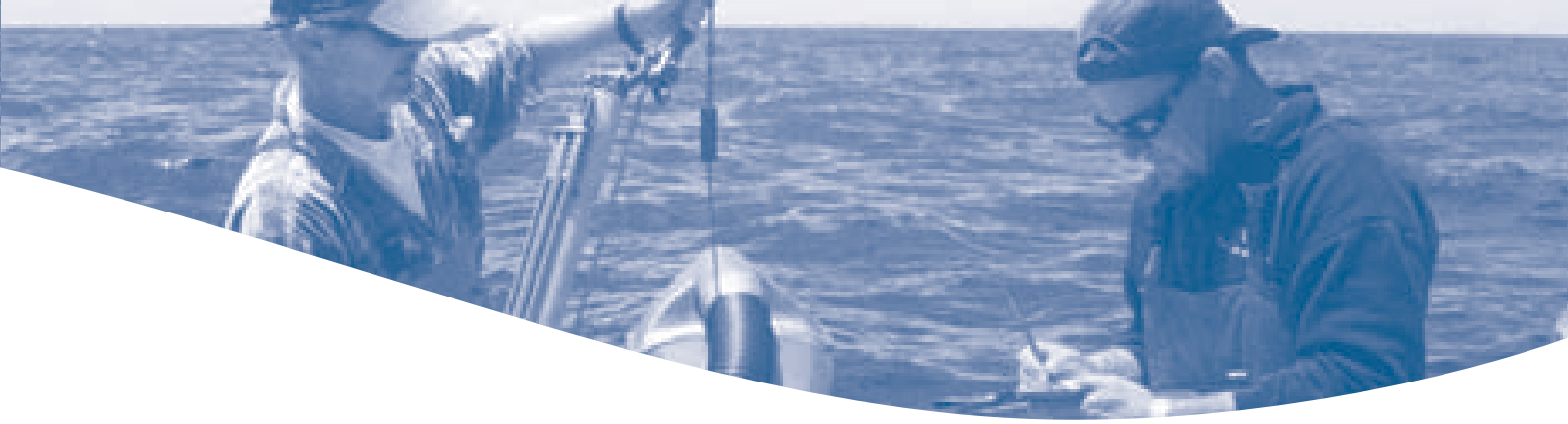
Key factors in the successful management of fisheries are the rational implementation of advice on management issues and industry support for sustainable fishery management practices. Consultation with industry is a key factor in achieving management approaches which have strong support, and this is undertaken through a variety of forums. In the major managed fisheries, management advisory committees (MACs) provide key advice to the Minister for Fisheries, while in the smaller fisheries the Department's Commercial Program and Regional Policy Officers meet directly with industry. Consultation also takes place through the production of discussion papers on proposed fisheries management arrangements. MACs currently provide advice on the West Coast Rock Lobster, Shark Bay Prawn, Shark Bay Scallop, Exmouth Gulf Prawn, Abalone, Purse Seine, Demersal Gillnet and Longline and Northern Demersal Scalefish Managed Fisheries.

The five major commercial fisheries (West Coast Rock Lobster, Abalone, Exmouth Gulf Prawn, Shark Bay Prawn and Shark Bay Scallop) operate in a fully cost-recovered management environment, which requires that licensees in these fisheries pay fees to cover the total cost of management. Cost recovery has been phased in over a number of years, with the final stage of cost recovery (100% cash costs plus capital accruals and employee entitlements) being reached in 2001/02.

The remaining fisheries paid a contribution towards their management costs of 2.17% of their gross value of production (GVP) in 2002/03. All fisheries also contributed to the Development and Better Interest Fund, which in 2002/03 was levied at a rate of 0.655% of their GVP to ensure that the fund achieved $3.5 million in contributions.

There was continued and significant progress in 2002/03 in the production of ecological sustainability reports to Environment Australia (EA) for continued listing of species taken in various export fisheries under Section 303 DB of the *Environment Protection and Biodiversity Conservation Act 1999*. The reports for the West Coast Rock Lobster, Shark Bay Prawn, Shark Bay Scallop and Exmouth Gulf Prawn Managed Fisheries resulted in those fisheries being accredited as ecologically sustainable and five-year exemptions were granted for species taken in those fisheries. Final reports for the Abalone, Pearl Oyster (wild harvest) and Shark Bay Snapper fisheries were submitted and draft reports produced on 16 other fisheries.

The ongoing requirements of maintaining the Marine Stewardship Council (MSC) certification for the West Coast Rock Lobster Managed Fishery involved a significant level of input from rock lobster managers and researchers. The main focus of this effort has been the development of an

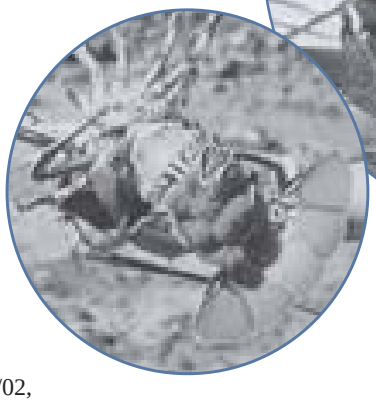


environmental management strategy, which is expected to be completed in the second half of 2003 for consideration by the MSC auditors. Another key area of focus in the rock lobster fishery was implementation of the Government's decisions on regulatory changes in response to National Competition Policy requirements. This resulted in removal of the regulatory limitations on the domestic processing sector and the abolition of the 150 pot operating limit.

In the State's trawl fisheries there was continued progress in the implementation of bycatch reduction devices (BRDs). By the commencement of the 2003 fishing season all trawl fisheries except the South West Trawl Managed Fishery had fully implemented grids designed to allow the escapement of turtles and other large species and had identified strategies to trial and implement fish escapement devices (FEDs), typically square mesh panels designed to allow the escapement of smaller fish species (except in the scallop fisheries where the large mesh size makes FEDs unnecessary). An extensive review of the effects of prawn trawling on pink snapper stocks in Denham Sound was undertaken and a comprehensive scientific assessment submitted for peer review. A Fisheries Research and Development Corporation (FRDC) funded project to assess the impacts of trawling on biodiversity was also commenced. There was an extensive assessment of options for dealing with the excessive levels of latent effort in the Kimberley Prawn Managed Fishery, with the result that management has now moved to an effort pool system.

In the finfish area there was significant progress in the development of management plans for the Mackerel Fishery and the West Coast Estuarine Fishery and revised management options for the state's shark fisheries. Perhaps the major initiative in the finfish area, however, was the commencement of a review of wetline fishing. Not all commercial fishing in Western Australia is subject to specific management regulation, and fishing activities undertaken under the authority of a fishing boat licence are referred to as wetline fishing. Usual methods include handlining, droplining, trolling and hand-hauled netting, while less commonly used methods include drop netting, squid jigging, lift netting and diving. In total 2,524 t of fish were reported as wetline catch during 2001/02, comprising 1,440 t (57%) from the west coast bioregion, 605 t (24%) from the north coast, 313 t (12%) from the Gascoyne and 164 t (7%) from the south coast.

The review of wetline fishing was announced in September 2002 and in March 2003 the Minister announced that two panels would undertake different aspects of the review in the west coast and Gascoyne bioregions. A Commercial Access Panel will examine matters surrounding access to the wetline fishery and a Management Planning Panel will consider management arrangements for the fishery. The implementation of more effective management for the wetline fishery will be a key element of giving effect to the principles of Integrated Fisheries Management.



WEST COAST BIOREGION

REGIONAL MANAGEMENT OVERVIEW

The principal commercial fishery in this region targets the western rock lobster, but there are also significant fisheries for scallops, sharks, blue swimmer crabs, pilchards, and coastal and estuarine finfish, with many of the inshore fish resources shared with the recreational sector.

The size and importance of the West Coast Rock Lobster Managed Fishery make it a key focus of the activities of the Department on the west coast. In particular, the accreditation of the fishery for export approval under the *Environment Protection and Biodiversity Conservation Act 1999* was a key event during 2002/03. There was also a high level of focus on the ongoing requirements of maintaining Marine Stewardship Council accreditation for the fishery and, in particular, the development of an environmental management strategy. Implementation of the Government's National Competition Policy decisions, including removal of the 150 pot rule and deregulation of the domestic processing sector, were also major areas of activity.

There was significant progress in the development of a management plan for the west coast estuaries, and it is expected that the Swan/Canning and Peel/Harvey estuaries will come under more formal management in late 2003.

In Cockburn Sound the West Coast Beach Bait, Cockburn Sound Fish Net and Cockburn Sound Line Fisheries Adjustment Scheme closed on 28 March 2003. This scheme saw significant reductions in the number of fishing units with 8, 1 and 12 fishing units respectively withdrawn from the three fisheries.

Access to the southern zone of the Mandurah–Bunbury Inshore Crab Fishery was finalised, with four entrants authorised to use a total of 240 crab pots. The access arrangements for the northern zone (Comet Bay) are under review. The Geographe Bay Crab Mediation process continued, involving representatives from the commercial and recreational fisheries, community members and the Department. A final report has been prepared and submitted to the Minister for Fisheries for consideration.

The wetline fishery in the west coast bioregion operates mainly in the areas of demersal line fishing, beach seining and near-shore gillnetting. The demersal line fishery takes a range of demersal fish species including dhufish, snapper, baldchin groper and emperors from boats operating purely as wetliners (i.e. no form of access other than a fishing boat licence) and boats which hold managed fishery licences (e.g. west coast rock lobster) in addition to a fishing boat licence. There is also a take of fish by beach seining and near-shore gillnetting using hand-hauled nets. A review of the wetline fishery was announced by the Minister in September 2002 to develop more effective management controls and to prepare the fishery for Integrated Fisheries Management.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Commercial fishery compliance inspections on the west coast are conducted by Fisheries Officers working from District Offices located in Geraldton, Dongara, Jurien, Lancelin, Hillarys, Fremantle, Mandurah, Bunbury and Busselton. These officers undertake a variety of activities, including sea- and land-based inspections of licences, catch, fishing gear, fish processing factories, retail outlets and catch consignments.

The major single focus for commercial fishery compliance monitoring is the West Coast Rock Lobster Managed Fishery, and the outcomes for this fishery are reported separately on pp. 7–9. Compliance services are also delivered to fisheries targeting abalone, blue swimmer crabs, pilchards, scallops, sharks, prawns, coastal and estuarine finfish, and offshore demersal species (e.g. dhufish and snapper). Many of the inshore fish resources are shared with the large number of recreational fishers operating out of the metropolitan and south-west areas, and this increases the need for rigorous compliance monitoring in some areas.

Inshore at-sea compliance is generally conducted using patrol vessels up to 8 m, while two dedicated large patrol vessels (> 20 m), based in Fremantle and Geraldton, undertake offshore patrol duties. A third large patrol vessel periodically operates from Fremantle to assist with compliance duties in the rock lobster and inshore trawl fisheries. In addition to duties conducted by district-based Fisheries Officers, the Serious Offences Unit conducts investigations into serious fishery offences.

Activities during 2001/02

During 2001/02, Regional Services personnel undertook 39,776 hours of compliance work in commercial fisheries in the west coast bioregion (West Coast Commercial Compliance Table 1), excluding work conducted for the Australian Fisheries Management Authority in Commonwealth fisheries. Of these approximately 80% of the hours consisted of duties performed in the commercial rock lobster fishery, with the remainder dedicated to the wide range of other commercial fisheries within the bioregion.

Fisheries Officers recorded 7,578 field contacts with commercial fishing operations and 4,257 office contacts with commercial fishers. A percentage of these contacts resulted from information received through the 24-hour Fishwatch hotline, a toll-free statewide telephone service to allow the public to report incidences of suspected illegal activity. There were a total of 568 commercial and recreational Fishwatch

reports received during 2001/02. During the year, 336 infringement warnings and 93 infringement notices were issued, and a further 76 cases resulted in prosecution of commercial fishers.

WEST COAST COMMERCIAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in commercial fisheries within the west coast bioregion during the 2001/02 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	39,776
Fisher field contacts by Fisheries Officers	7,578
District Office contacts by Fisheries Officers	4,257
Fishwatch reports *	568
OFFENCES DETECTED	
Infringement warnings	336
Infringement notices	93
Prosecutions	76

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

There continued to be concerns over interference with commercial fishing gear in the Cockburn Sound and Peel/Harvey crab fisheries during peak periods. This was despite increased levels of surveillance, including joint patrols with police, during 2001/02. The Department is working with industry on a number of compliance and management initiatives aimed at minimising interference with gear.

A number of targeted compliance operations were conducted in Zone D (Comet Bay) of the South West Trawl Managed Fishery to ensure vessels were not fishing outside of their authorised trawl areas.

The overall level of compliance in the estuarine, purse seine, shark and wetline fisheries was good, with only a small number of compliance issues arising. Some stakeholders questioned the activities of certain fishing operations, however compliance checks found no illegal activity occurring.

Further north, the Mid West Regional Office conducted a pre-season briefing for operators in the Abrolhos trawl fishery. The use of VMS in the fishery will enable closer scrutiny of where vessels are operating to ensure fishing activities do not extend to closed areas at the Abrolhos Islands.

Initiatives in 2002/03

The Department, in its attempts to minimise the offence of gear interference, has continued the development and testing of new technologies to assist in the detection of illegal interference with fishing gear.

The Department's database system for recording field-related compliance activities has become a valuable tool for compliance planning, targeting of repeat offenders, and ensuring all vessels are regularly inspected. This tool has helped to improve the efficiency and effectiveness of compliance service delivery.

REGIONAL RESEARCH OVERVIEW OF WETLINE FISHING

The catch and effort statistics (CAES) database indicates that over half (57%) of the wetline catch in 2001/02 was reported from the west coast bioregion, which includes the waters of the populous lower west coast and the Abrolhos Islands. The top ten species comprised pink snapper (*Pagrus auratus*) 250 t, West Australian dhufish (*Glaucosoma hebraicum*) 219 t, whitebait (*Hyperlophus vittatus*) 125 t, sweetlip emperor (*Lethrinus miniatus*) 77 t, samson fish (*Seriola hippos*) 72 t, Australian herring (*Arripis geogianus*) 64 t, sea mullet (*Mugil cephalus*) 63 t, western sand whiting (*Sillago schomburgkii*) 41 t, redfish (*Centroberyx affinis*) 40 t and copper shark (*Carcharhinus brachyurus*) 39 t. With wobbegong (*Orectolobus* spp., 35 t) as the next most abundant species in the catch, it is interesting to note the increasing prominence of shark in the wetline catch.

Catches of dhufish, pink snapper and emperor are the main product of the demersal scalefish operations reported on pp. 41–46, noting that catches of emperors are mostly from the Abrolhos Islands. Whitebait, Australian herring, sea mullet, and western sand whiting comprise most of the catch of the beach bait fishers who operate between Tim's Thicket and Augusta (see pp. 35–37).

West Coast Rock Lobster Managed Fishery

Management Summary

Operators in the West Coast Rock Lobster Managed Fishery target western rock lobsters (*Panulirus cygnus*) between Shark Bay and Cape Leeuwin using baited traps (pots). The fishing season runs from 15 November to 30 June of the following year and most of the catch, which has averaged 11,300 t per season over the past 10 years, is exported to Asia, North America and, to a lesser extent, Europe.

This catch makes the fishery Australia's most valuable single-species fishery, with a seasonal gross value of production between $300 and $350 million.

The fishery is divided into two major zones, Zone B (north of Green Head) and Zone C (south of Green Head), with another zone (Zone A, which is effectively a subset of Zone B) for those fishing the Abrolhos Islands between March and June.

Following record catches of 13,000–14,000 t in 1998/99 and 1999/2000, the catch fell to around 9,000 t in 2001/02, but has returned in the current season to approximately 11,300 t. Such variations in catch are not unusual, and largely reflect the level of puerulus settlement four years earlier, which is in turn dependent upon environmental factors such as the Leeuwin Current.

This fishery has a well-developed catch prediction system based on the puerulus settlement index (see following fishery status report). The ability to predict future catches is very important for the fishery's management because arrangements and options can be assessed against the established objectives in the context of predicted catch trends.

The safe breeding stock level required to provide the necessary recruitment is estimated to be between 20% and 25% of the virgin or unfished breeding biomass. In more recent times this biological reference point has been equated to a more tangible reference point – the size of the breeding biomass in 1980.

All the biological indicators for this fishery show that the breeding stock levels remain in good condition, a result that is attributed to the management action taken in the early to mid-1990s. This action was prompted by advice from the Research Division that the breeding stock of rock lobster had been fished down to about 15% of the unfished or virgin size.

To address this potential breeding stock problem, a new management package was implemented at the beginning of the 1993/94 season. The core components of the package included:

- an 18% reduction in the number of lobster pots allowed to be used across the fishery;
- a total ban on taking females in breeding condition (setose and tarspot);
- an increase in the legal minimum size of lobsters from 76 mm to 77 mm from 15 November to 31 January; and
- separate maximum sizes for female lobsters in the north and south of the fishery (105 mm and 115 mm respectively) to reflect the geographical differences in both growth rate and size at maturity of the lobsters.

All of the above elements of this management package have been maintained because they continue to be relevant in ensuring that the stock does not fall below the established biological reference point.

At the commencement of the 2001/02 season a major amendment to the West Coast Rock Lobster Management Plan 1993 came into effect, resulting in formal expression of the unitisation of the fishery's capacity (measured as a number of pots per zone) and the entitlement associated with individual managed fishery licences. The licences of commercial fishers now refer to a number of units and a unit value, which is currently set at 0.82 pots per unit. The product of the number of units and the unit value determines the maximum quantity of gear that the individual licensee can use.

The Department is currently working on an extension of the current security register better designed to recognise levels of investment in units of entitlement. A decision rules framework was also further developed this year, which will assist the long-term sustainability of the fishery as well as providing greater access to management tools for industry and other stakeholders.

In 1999/2000 the West Coast Rock Lobster Managed Fishery became the world's first fishery to receive Marine Stewardship Council certification, and since then the management process has moved on to address the MSC's annual audit requirements. As part of this audit process, an environmental risk assessment and more recently an environmental management strategy have been completed. A number of risks were identified in the risk assessment at either a moderate or low level. In their assessment of the report, the MSC certifiers highlighted two key issues: the interaction of the fishery with protected fauna such as sea lions and leatherback turtles, and the lack of research data about the ecological impacts of removing rock lobster biomass from the environment, particularly from deep water. These issues have been the focus of additional research projects and reporting during 2002/03.

The process of addressing the MSC requirements both complements and is complemented by work being done to satisfy the Commonwealth Government's environmental legislation. Environment Australia has declared the fishery as being managed in an ecologically sustainable manner under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a variety of recommendations, this approval allows product from the fishery to be exported for a five-year period.

The evaluation of the fishery under an ecologically sustainable development (ESD) framework is becoming very much a part of rock lobster management. This is now evident through a number of key initiatives under consideration for the coming seasons, in particular:

- the increasing need to research, address and mitigate interactions with specially protected species as listed in the *Wildlife Conservation Notice 2002*, such as sea lions and leatherback turtles;
- the development of an explicit harvest strategy in the form of fisheries management decision rules; and
- a review of the composition of, and process for appointing members to, the Rock Lobster Industry Advisory Committee (RLIAC) in response to a Labor Party commitment before the 2001 State Government election.

The Government's commitment to legislative reform in response to the requirements of the National Competition Policy has seen a number of changes implemented during 2002/03, including:

- removal of restrictions on 'domestic' rock lobster processing authorisations;
- development of a rock lobster aquaculture policy; and
- removal of the 150 maximum unit holding entitlement from the legislation.

The 2002/03 season has seen dramatic variability in the beach price (price paid to fishers) of rock lobsters. The season started with an average price of $36/kg, which is considered to be an inflated price for the 'whites'. The prices then dropped to significantly lower levels due to a number of influences, which included:

- elevated beach prices at the start of the season (in the 'whites' phase) that could not be maintained;

- realistic competitive behaviour between processors and catching sector to secure best beach prices for the available product;
- the severe acute respiratory syndrome (SARS) epidemic in south-east Asia and the consequences for demand in that market;
- loss of market share in past lucrative markets as increased volumes of cheaper, comparable product are imported from countries that previously were a minimal threat; and
- world currency exchange rates and the weakening of the US dollar.

The season finished on an average beach price of $14/kg, with an overall average price for the season of $23/kg.

Although many of these factors were external to the fishery, the Western Rock Lobster Council (the peak industry body), with input from industry representatives and processors, will be developing strategies designed to mitigate the risk of such large price fluctuations occurring in future seasons.

The Rock Lobster Industry Advisory Committee regularly considers strategic management issues, along with other matters that affect the management of the State's rock lobster fisheries. This multi-sector committee is the Minister's primary source of expert advice on rock lobster-related matters. The committee engages stakeholders through regular open forum meetings, quarterly newsletters and an annual coastal tour conference. In 2002/03 RLIAC met four times, held two stakeholder open forum meetings and conducted a coastal tour visiting Fremantle, Geraldton and Jurien.

Governing Legislation/Fishing Authority
West Coast Rock Lobster Management Plan 1993
West Coast Rock Lobster Managed Fishery Licence

Consultation Process
Rock Lobster Industry Advisory Committee
Annual RLIAC coastal tour
Stakeholder open forum meetings
Bi-annual newsletter
Department–industry meetings

Compliance and Community Education Summary

The West Coast Rock Lobster Managed Fishery is Western Australia's largest and most valuable fish resource, and a comprehensive compliance program is in place to ensure its long-term sustainability and promote equity between commercial fishers and other members of the fishing community. A major part of the management package involves making sure participants and community members understand, accept and adhere to the management rules.

The Regional Services Branch provides a range of at-sea and land-based compliance services in the west coast bioregion, with Fisheries Officers stationed in Denham, Geraldton, Dongara, Jurien, Lancelin, Fremantle, Mandurah, Bunbury and Busselton. Officers conduct offshore inspection work aboard the patrol vessels *Baudin*, *Hamelin*, *McLaughlin* and *Walcott* (noting that the *Hamelin* replaced the *Baudin* during the season). Offshore inspection work principally involves ensuring that fishers adhere to zone and closed-water requirements, gear restrictions and seasonal closures.

Fisheries Officers from the Serious Offences Unit also conduct targeted specialised operations related to suspected serious offences in the commercial rock lobster fishery, and may provide specialist operational support as required.

Services provided by land-based officers include processing, landing and gear inspections, licence checks, wholesale/retail inspections and inshore sea-based patrols utilising vessels ranging in size from 5 to 12 m. They also provide support to the Department's larger seagoing vessels. Fisheries Officers conduct a wide variety of education and extension services, formally and informally, to commercial fishers, fishing organisations, schools and general community members.

Activities during 2001/02

In 2001/02 the approach to management in partnership with industry continued, with the second rock lobster compliance risk assessment workshop conducted prior to the season opening. Industry members and Departmental staff, including Fisheries Officers, managers, fishers, and processing factory representatives, attended the independently facilitated workshop. The objectives for the day were to identify and evaluate compliance risks within the fishery, thereby allowing effective targeting of limited compliance resources. The major risks identified that continue to be of concern included illegal sale into the restaurant trade, interference with commercial fishing gear, over-potting, and holding of rock lobsters over 76 mm prior to the change in the minimum legal size.

The risk assessment process was reviewed and a decision made to continue this joint industry/Department approach on a bi-annual basis. A review of the risks identified during that assessment will be conducted in the alternate year.

Continuing with a planned compliance model, the Rock Lobster Compliance Coordinator conducted several across-region operations. These focused on the illegal trade of rock lobster in restaurants throughout the metropolitan area, over-potting at the Abrolhos Islands, and major roadside checkpoints targeting the transportation of illegally caught rock lobsters. Additionally, mobile factory patrols continued to operate throughout the season to complement increased time spent in the field by district-based Fisheries Officers. The patrol teams, based in Fremantle and Geraldton, travel throughout the fishery and primarily inspect landed catch at processing establishments.

The conservation of totally protected fish is a critical component of the management arrangements for the rock lobster fishery, and the emphasis on ensuring they are not caught and consigned for sale continued in 2001/02. The entire fleet had catch checked at least once, with an average of seven inspections (or nearly 20 baskets) per vessel checked during

the season. It is estimated that Fisheries Officers checked between 3.3% and 4% of the catch consigned to processing factories (West Coast Rock Lobster Table 2).

Regional Services officers in the west coast bioregion delivered 31,526 hours to the West Coast Rock Lobster Managed Fishery in 2001/02. While compliance in the fishery was generally good, 323 infringement warnings and 70 infringement notices were issued. A total of 48 prosecutions were initiated or conducted (West Coast Rock Lobster Table 1).

Fisheries Officers reported 6,680 field-based contacts and 2,963 contacts in District Offices with commercial fishers during the year (West Coast Rock Lobster Table 1).

WEST COAST ROCK LOBSTER TABLE 1

Summary of compliance and educative contacts and infringement types in the West Coast Rock Lobster Managed Fishery during the 2001/02 financial year. Note these data are included in the overall totals given in West Coast Commercial Compliance Table 1.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	*NUMBER*
Hours delivered in fishery *	31,526
Fisher field contacts by Fisheries Officers	6,680
District Office contacts by Fisheries Officers	2,963
OFFENCES DETECTED	
Infringement warnings	323
Infringement notices	70
Prosecutions	48

* This figure has increased slightly compared with the previous financial year due to the inclusion of patrol vessel hours.

WEST COAST ROCK LOBSTER TABLE 2

Summary statistics of factory inspections of commercially captured western rock lobster in the 2001/02 fishing season.

STATISTIC	*VALUE*
Number of unique vessels checked	Entire fleet at least once
Average number of inspections per vessel	7
Average number of baskets checked per vessel *	20
Proportion of total commercial catch inspected	3.3%–4%
Non-compliance rate (per-animal basis) **	0.0014–0.0022
Total consigned commercial catch ('000 kg)	8,962
Estimated total illegal catch consigned ('000 kg)	13–19.7

* 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.

In the Metropolitan Region (principally Zone C), factory consignment compliance was generally good, though there was a 50% increase in the number of totally protected rock lobster detected. Minor infringement notices and warnings continued to be issued, with the majority for under-size animals, and a small amount for setose lobsters. A small number of prosecutions were also instigated for the consignment of under-size rock lobster. There was a significant increase in unlicensed commercial offences involving black market lobsters in restaurants in the metropolitan area. A number of closed-waters offences were again detected around Rottnest Island.

In the Mid West Region (principally Zones A and B), factory consignment compliance was similar to the previous season, though the number of totally protected fish detected was significantly higher than in the Metropolitan Region. A drop in the number of under-size animals detected was offset by a significant increase in setose animals being consigned. Minor infringement notices and warnings continued to be issued, and a number of prosecutions instigated for consignment of under-size rock lobster.

In the Southern Region, a good run of lobsters led to a migration of vessels to fish the area between Capes Leeuwin and Naturaliste, resulting in a corresponding increase in Fisheries Officer activity in that area.

Initiatives in 2002/03

In the Southern Region, a community consultation process has begun to address issues of community concern relating to the increase in effort by the rock lobster fleet in the Cape-to-Cape area (Leeuwin to Naturaliste).

A proactive approach to raising compliance issues in the fishery has been developed, and open discussions are regularly held in industry meetings to raise fishers' awareness of particular issues. Targeted activities have been identified to deal with some of the issues, such as early pulling and failing to release totally protected fish within five minutes of removal from the water, before they become a major compliance concern.

As an outcome of the risk assessment process, for the first time a major compliance operation was conducted in inland areas throughout the South West Land Division. This operation targeted the many retail establishments selling seafood in country towns throughout the region.

Research Summary

During the year, research activities continued to focus on the core business activities of forecasting future catch levels, monitoring levels of puerulus settlement, monitoring of breeding stock levels, monitoring of catches through both fishers' and processors' returns, promoting the voluntary logbook scheme and modelling and stock assessment. Research advice was provided to a range of clients including the Rock Lobster Industry Advisory Committee, Western

Rock Lobster Council, Western Rock Lobster Development Association, WA Fishing Industry Council, various fishermen's associations and the general public. New core business of ensuring the fishery complies with ecologically sustainable development principles focused on reporting to Environment Australia on issues arising from Commonwealth environment and biodiversity legislation and developing an environmental management strategy to be used in the assessment of the impacts of rock lobster fishing in the context of ESD and Marine Stewardship Council certification.

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

West Coast Rock Lobster Managed Fishery Status Report

Prepared by C. Chubb

FISHERY DESCRIPTION

Boundaries and access

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.

Main fishing method

Rock lobster pots.

RETAINED SPECIES

Commercial production (season 2001/02): 8,966 tonnes

Landings

Trends in the annual catches from the West Coast Rock Lobster Managed Fishery (WCRLF) are shown in West Coast Rock Lobster Figure 1. The Australian Bureau of Statistics catch recorded from 1944/45 to 1970/71 was replaced by processors' production figures in 1971/72.

The predicted 2001/02 catch range for the WCRLF, forecast from the puerulus settlement 3–4 years previously, was 9,550–10,350 t. The information from processor returns shows, however, that the catch from the WCRLF for the 2001/02 season was only 8,966 t. This was 17.1% less than the long-term average catch of 10,820 t and 20.4% lower than the previous season's catch of 11,266 t. In 2001/02, the catches in A Zone, B Zone and C Zone were 1,651 t (1.3% lower), 2,800 t (20.1% lower) and 4,515 (25.8% lower) respectively.

The catch in B and C Zones did not reach the forecast landings because of the extraordinary environmental conditions (calm conditions, little swell, low water temperature) present during November and part of December. These water conditions restricted the migration of 'whites' from the shallows to the deeper water and even though some of these lobsters were available to the fishery from March to June at a larger size following a moult, the total landings were still lower than expected. The proportions of 'whites' to the total catches in B and C Zones for the 2001/02 season were 40% and 37% respectively. The mean proportions of 'whites' to the total catches in B and C Zones from the introduction of the pot reduction in 1993/94 to 2000/01 were 43% and 48% respectively. A time-series model was developed as a prediction tool for intra-seasonal 'whites' and 'reds' catches. The model incorporates the puerulus indices and the management intervention in 1993/94. The model gave forecasts of 47% and 42% for the proportions of 'whites' to the total catches in B and C Zones respectively. While the model forecasts indicated a poor 'whites' catch in C Zone, environmental conditions contributed to a lower 'whites' catch than expected in both zones.

The 2001/02 survey of recreational rock lobster fishers estimated that they caught approximately 545 t, which was only a 3% decrease on the estimated catch of 564 t for the previous season (2000/01). The restricted 'whites' migration resulted in many lobsters remaining in the shallows and therefore being available to the recreational fishery for a longer period than is usual. Consequently, whilst a lower catch was forecast, recreational landings were relatively similar to the previous season.

The total catch of western rock lobster from this fishery (commercial and recreational) was approximately 9,510 t, 19.6% lower than the previous season's total catch of 11,830 t.

Octopus may be caught in rock lobster pots, generally in shallow water (0–20 fathoms or 0–37 m), and a catch rate of 0.039 octopus per pot lift was recorded in the 2001/02 voluntary research logbook data. This was 32.9% above the average of 0.029 per pot lift over the period 1985/86 to 2000/01. This translates to an estimated 400,000 octopus caught in the fishery during 2001/02. Octopus catches in B Zone were about 40% greater than those in C Zone, with those in A Zone estimated at approximately 26,000.

Fishing effort

The nominal fishing effort for 2001/02 was 10.33 million pot lifts, 1.2% lower than the 10.46 million pot lifts for 2000/01 (West Coast Rock Lobster Figure 1). The nominal effort for the A, B and C Zones of the WCRLF was 1.21 million, 3.79 million and 5.33 million pot lifts respectively, which was 0.8% less, 0.3% more and 2.4% less than the previous season's 1.22, 3.78 and 5.46 million pot lifts.

Effort equivalent to 0.61 million commercial pot lifts was used by the recreational fishery to land its catches. This was 17.3% higher than the 0.52 million pot lifts used in 2000/01.

The total effort used in the WCRLF during 2001/02 was 10.94 million pot lifts, 0.4% lower than the 10.98 million pot lifts made in 2000/01.

The reduced level of pot usage maintained since 1993/94 had the secondary effect of 'encouraging' a reduction in fleet size as vessels purchased additional pot entitlements to improve their economic efficiency. Under new legislation introduced in 2000/01, new WCRLF licences could be created if a minimum pot holding 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, respectively 146, 147 and 291 A, B and C Zone vessels (584 out of 594 in total) actually fished for lobster in 2000/01, with two A Zone, four B Zone and four C Zone licences dormant. Due probably to lower forecast catches in 2001/02, the number of dormant A, B and C Zone licences increased from 2 to 6, from 4 to 7 and from 4 to 17 respectively. In addition, six new licences were created in C Zone. Thus, in comparison to the 584 active boats in 2000/01, a fleet of 570 vessels fished in 2001/02, with 142 and 144 respectively carrying A and B Zone licences and 284 operating in C Zone (West Coast Rock Lobster Table 3).

WEST COAST ROCK LOBSTER TABLE 3

Number of rock lobster licences by category.

ZONE/CATEGORY	2000/01	2001/02
A Zone licences	148	148
A Zone licences with 1 pot	2	6
A Zone licences fishing	146	142
B Zone licences	151	151
B Zone licences with 1 pot	4	7
B Zone licences fishing	147	144
C Zone licences	295	301
C Zone licences with 1 pot	4	17
C Zone licences fishing	291	284

Catch rate

A further decline in the abundance of rock lobsters from the record 1999/2000 season was forecast for 2001/02. Trends in catch rates show a 'cyclical' pattern (West Coast Rock Lobster Figure 2) due to environmental effects on levels of puerulus settlement which are reflected in catches three and four years later. Accordingly, catch per unit of fishing effort in 2001/02 was forecast to be low. In fact, the environmentally driven poor 'whites' catch resulted in a catch rate even lower than expected, at 0.87 kg/pot lift. This was 19.4% less than the previous season (1.08 kg/pot lift) (West Coast Rock Lobster Figure 2) and 18.7% less than the average since the introduction of the current management arrangements in 1993/94 (1.07 kg/pot lift).

Recreational component: **6% (approx.)**

See information in 'Landings' and 'Fishing effort' above, and the Recreational Western Rock Lobster Fishery Status Report (pp. 149–150).

Stock assessment completed: **Yes**

The stock remains fully exploited and under the current management arrangements introduced in 1993/94, which included an 18% pot reduction, the breeding stock remains at or above the target levels of the late 1970s and early 1980s (West Coast Rock Lobster Figures 3 and 4).

Whilst some effort increase was evident between 1993/94 and 1998/99, nominal effort levels have now returned to 1993/94 levels: that is, an 18–19% reduction in nominal fishing effort when data from 1991/92 and 2001/02 are compared. The maintenance of these lower effort levels, in combination with other measures, has ensured that the exploitation rate of the stock remains lower than pre-1993/94 levels and has allowed the rebuilding of the breeding stock (see below). Nevertheless, effective fishing effort continues to increase as new technology and learning is incorporated into the catching sector. This is monitored and is factored into stock assessment modelling and management advice.

Post-larval recruitment to the fishery is monitored continuously and annual puerulus settlement fluctuates in response to 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 2001/02 were below average at the Abrolhos Islands and average to above average in the centre of the fishery (West Coast Rock Lobster Figure 5). These reductions from the previous season's level of settlement were consistent with neutral El Niño/La Niña conditions in the tropical Pacific (which affect the strength of the Leeuwin Current) during the period of larval life and subsequent settlement. Fluctuations in catches are due primarily to variations in puerulus settlement three and four years prior to the season in which the catch was taken. The 2001/02 season was an exception where local environmental drivers resulted in poor catching conditions at the start of the season which produced lower landings than had been forecast from the levels of puerulus settlement.

Stock assessment is undertaken using existing models and a new approach using depletion estimates which provided good estimates of exploitation rates 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, since about 1996. Exploitation rates in the shallow (< 20 fathoms) and deeper (> 20 fathoms) waters are being investigated.

A journal article published in late 2001 (Hall and Chubb 2001) fully 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 egg production levels were well above those before the 1993/94 package was introduced.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

It is well known that water temperature and swell have an effect on the catchability of lobsters leading to the sometimes highly variable catch rates measured during the independent breeding stock survey (IBSS). Whilst these and other variables (such as moon phase) are included within the analyses, not all the impacts on catchability are known, which causes the IBSS catch rates and therefore the breeding stock indices to vary by 60%–120% between successive years. The effects of these changing environmental conditions on the fishery-dependent indices are not as large because the monitoring data used in these calculations cover the entire season. Consequently, 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.

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 index, are presented in West Coast Rock Lobster Figure 3. The Abrolhos Islands index from the IBSS is presented in West Coast Rock Lobster Figure 4.

Following the introduction of the management arrangements in 1993/94, the egg production indices and breeding stock increased quite dramatically and within five years had returned to target levels. Successive years of very high levels of recruitment (predicted from puerulus settlement and reflected in the high catches) provided a major boost to egg production during 1999/2000 and 2000/01. The egg production indices declined during 2001/02 but the significantly lower water temperatures present at the beginning of that season may have been responsible for considerably lower catch rates during the breeding survey which could have affected the calculations (West Coast Rock Lobster Figure 3).

The Abrolhos Islands breeding index has also declined but is not considered problematical since approximately 70% of the egg production there comes from sub-legal-sized lobsters. The 1993/94 management arrangements were designed to focus on improving the coastal levels of egg production that had declined to very low levels by the early 1990s (West Coast Rock Lobster Figure 3).

Whilst the declines in egg production warrant surveillance, the current levels of egg production are still considered to be above the target levels set in 1993/94.

Indices of egg production derived from fishery-based data may become distorted as a result of the effects of technology and increases in fishing efficiency; variations in the distribution of fishing effort in response to annual variations in puerulus settlement and subsequent recruitment to the fishery; fishers' responses to the regulations (e.g. the setose regulation); and/or market-driven factors. Therefore, fishery-independent breeding stock surveys to assess the strength of egg production will continue to act as a calibration for indices derived from fishery data. The pre-season breeding stock survey was expanded in October 2002 to include the original six locations (Fremantle, Lancelin, Jurien, Dongara, Kalbarri and the Abrolhos Islands) compared to the three representative sites (C Zone – Lancelin, B Zone – Dongara and A Zone – Abrolhos Islands) that had been sampled for the previous four seasons. Only the three representative sites will be sampled in 2003.

Projected catch next season (2002/03): **10,600–11,700 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 (Dongara) (B Zone) and Alkimos (C Zone) (West Coast Rock Lobster Figure 5). 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 2002/03 and 2003/04 are expected to produce commercial catches of around 10,600–11,700 t and 13,450–13,750 t respectively, resulting from the high levels of puerulus settlement in 1999/2000 and 2000/01 (West Coast Rock Lobster Figure 5). Forecast recreational catches indicate that total rock lobster landings (commercial and recreational) will be in the range of 11,300–12,500 t in 2002/03.

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. Such incidents appear to be infrequent and restricted to one or two isolated areas where sea lion pups forage. An ecological risk assessment has identified this issue as a moderate risk until further data are collected to quantify the risk to the sea lion population. Whilst the mortality rate from lobster potting is expected to be very small and perhaps insignificant when compared to the reported highly variable mortality suffered by pups up to five months old in Western Australia (Shaughnessy 1999), a strategy for eliminating the accidental capture through minor pot modification is being developed.

Preliminary research data suggest that turtles occasionally can become entangled in the ropes of rock lobster pots, but that nearly all are being released alive and unharmed. Turtle deaths as a direct result of this interaction 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. The entanglement of, specifically, leatherback turtles (*Dermochelys coriacea*) was identified as a moderate risk by the risk assessment and data are being collected through as

many sources as possible to establish the level of mortality caused by rock lobster fishing. The entanglement of marine turtles in pot ropes, leading to a very occasional death, is unlikely to be a significant cause of mortality for any turtle species when compared to a number of reports of bycatch from egg robbing and nest destruction and major gillnet, longline and purse seine operations in other parts of the world. Nevertheless, the leatherback turtle is a critically endangered species with populations in decline worldwide and any mortality from accidental entanglement is considered by some as inappropriate. An environmental management strategy for the WCRLF will include attempts to minimise this accidental mortality wherever practicable.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The fishery is unlikely to cause significant trophic ('food web') cascade effects, as the sub-legal-sized lobsters and protected breeding stock components form a relatively constant significant proportion of the biomass (> 80%) from year to year. 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 formal ecological risk assessment conducted as part of the Marine Stewardship Council certification and Environment Australia assessment processes. Some proposals for research on the ecology of deep-water reefs inhabited by lobsters are being 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 FRDC, estimated that potting might impact on between 0.1% and 0.3% of the surface area of fragile habitat (corals) at the Abrolhos. Generally, throughout the fishery, rock lobster fishing occurs 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. Fishing is not allowed in four and a half months of the year.

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 $300 million. Employment is seasonal, the fishing season covering seven and a half months from 15 November to 30 June. A total of 570 vessels and 1,597 people were engaged directly in fishing for rock lobster in 2001/02. This equates to one skipper and an average of about 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 (2001/02): $300 million

In 2001/02 the catch declined but the beach price improved dramatically. The price fishermen received for western rock lobster in 2001/02 was an estimated average of $33.75/kg in all zones of the fishery, which was well above the beach price of $27/kg paid in A and B Zones and the $26.50/kg paid in C Zone in 2000/01. These prices were maintained by a reduced catch and the low value of the Australian dollar against the US dollar in particular. The value of the catch (ex-vessel) in the WCRLF in 2001/02 was approximately $300 million and equivalent to the previous season's value. Approximately 95% of product was being exported to Japan, Taiwan, Hong Kong/China, the United States and Europe. Foreign exchange earnings from the fishery exceed the ex-vessel value by a considerable amount.

FISHERY GOVERNANCE

Acceptable catch range: **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.

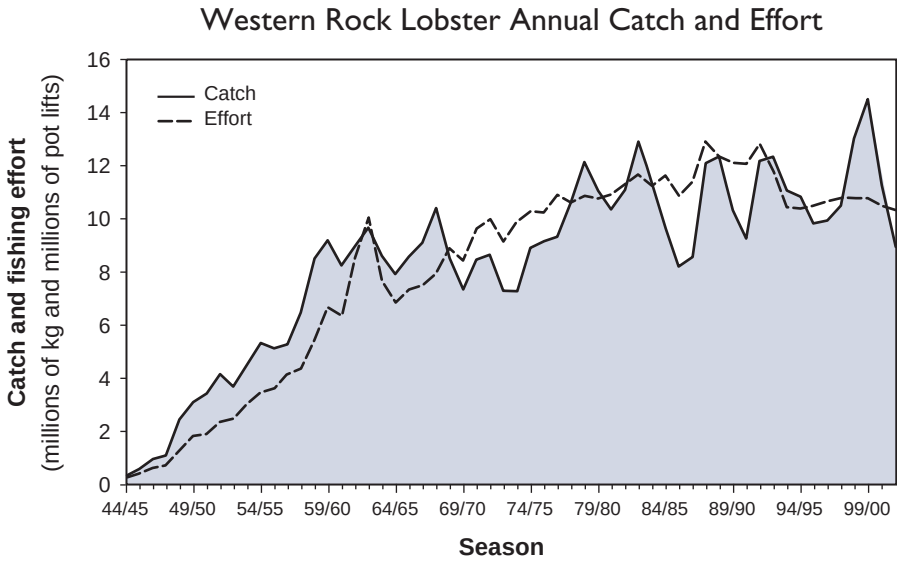
EXTERNAL FACTORS

Following the record catch of 14,523 t in 1999/2000, successive declines in catches led to a below-average catch of 8,966 t in 2001/02. Good catches are forecast for the next two seasons. The variations in catch are a result of variable levels of puerulus settlement due to changes in the balance of El Niño Southern Oscillation/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. For example, very calm and very clear conditions for one month at the commencement of the 2001/02 season led to a limited migration and very poor catches during the 'whites'.

However, once conditions returned to normal those lobsters not previously caught were available during the 'reds', with some at a larger size following the February moult.

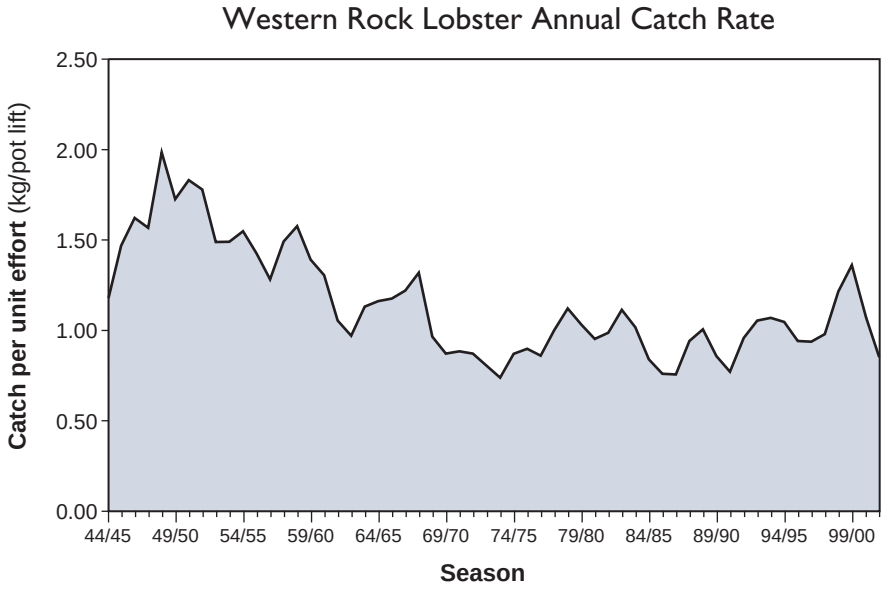
It is noteworthy that whilst the increases in fishing effort seen since the mid-1990s have abated for the present, nominal fishing effort remains about 3% higher than it was in 1993/94 when an 18% temporary pot reduction came into effect as part of the new management package. Nevertheless, increases in effective effort continue and will be taken into account in stock assessments.

Both the Department of Fisheries and the rock lobster industry have been addressing issues raised by the Marine Stewardship Council's annual audit to maintain the world's first MSC certification. Similar issues arising from Commonwealth legislative requirements to ensure an ecologically sustainable fishery were dealt with successfully during 2001/02.



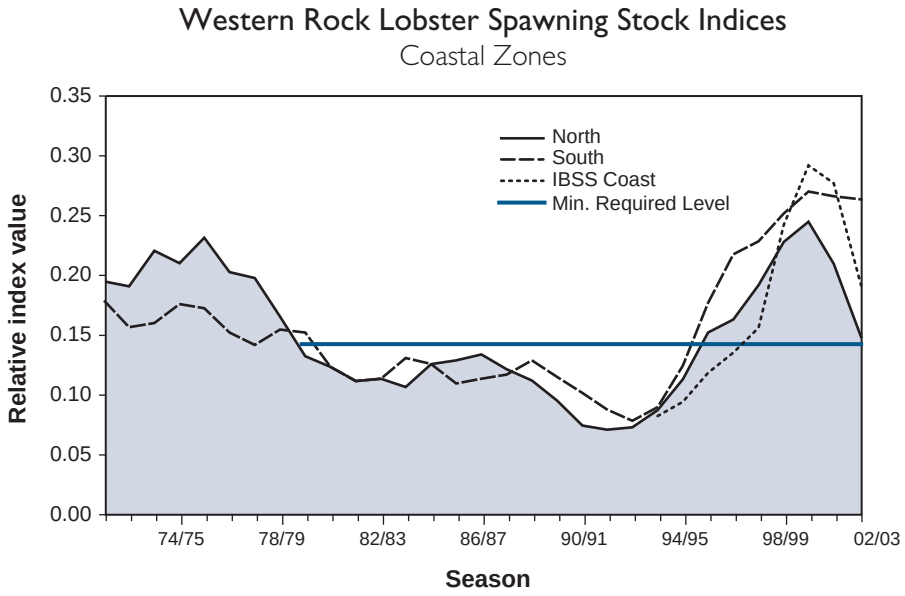
WEST COAST ROCK LOBSTER FIGURE 1

Annual catch and nominal fishing effort from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2001/02.



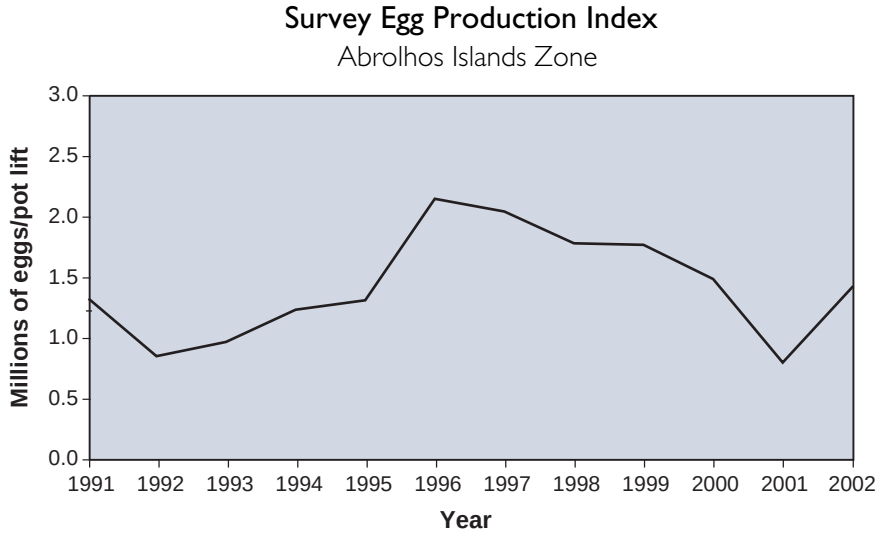
WEST COAST ROCK LOBSTER FIGURE 2

Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2001/02.



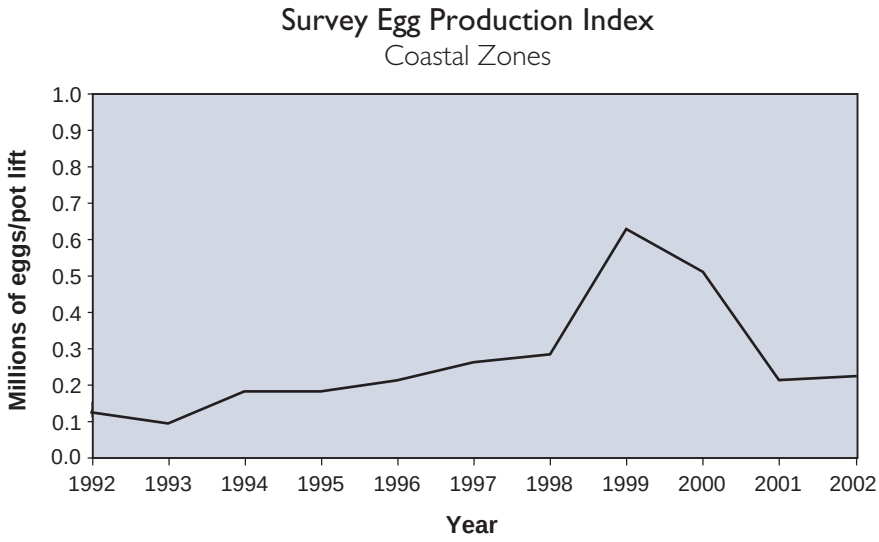
WEST COAST ROCK LOBSTER FIGURE 3

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 to reduce the large variation seen in successive individual points caused by changes in catchability (moving average of three).



WEST COAST ROCK LOBSTER FIGURE 4

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



WEST COAST ROCK LOBSTER FIGURE 5

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

Minor Scallop Fisheries

Management Summary

Several minor trawl fisheries contribute to the Western Australian scallop catch – primarily the Abrolhos Islands and Mid West Trawl Managed Fishery (AIMWTF), the South West Trawl Managed Fishery (SWTF) and the small South Coast Trawl Fishery. Each fishery takes saucer scallops (*Amusium balloti*), which typically have highly variable recruitment. As a consequence, the catch in these fisheries varies greatly from year to year. In particular, the catch in the South Coast Trawl has shown large variations in recent years with significant catches being taken in 2000 and 2001.

All scallop fisheries operate under input controls, with restrictions on boat numbers and gear as well as seasonal and area closures.

The South West Trawl Management Plan was amended during 2002/03 to allow for the unitisation of fishing gear, which took effect on 1 October 2002.

Bycatch reduction devices were fully implemented in the AIMWTF as a licence condition for the 2002 Abrolhos Islands season.

The Vessel Monitoring System (VMS), a satellite tracking system used to monitor the movement of vessels within the waters of a fishery, was introduced into management arrangements for the AIMWTF in April 2001.

A draft application has been submitted for the AIMWTF and the South Coast Trawl as part of Environment Australia's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

Governing Legislation/Fishing Authority

Abrolhos Islands
Abrolhos Islands and Mid West Trawl Management Plan 1993
Abrolhos Islands and Mid West Trawl Managed Fishery Licence

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

South Coast
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

Research Summary

Research monitoring of the scallop stocks in each fishery is undertaken utilising fishers' monthly returns data, and an industry-based pre-season survey in the case of the Abrolhos sector.

Advice on the status of stocks and appropriate season opening and closing dates is provided to industry advisory bodies.

The following status reports summarise the research findings for these smaller scallop fisheries.

Abrolhos Islands and Mid West Trawl Managed Fishery Status Report

Prepared by E. Sporer and M. Kangas

FISHERY DESCRIPTION

Boundaries and access

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'*.

The permitted fishing area opened on 4 April and closed on 31 May but all boats had ceased fishing by 10 April 2002. In this fishery, the fishing gear (net size) is unitised, with one headrope unit converting to 4 fathoms. For the 2002 season, 182 fathoms of the entire entitlement of 46 headrope units, or 184 fathoms, were utilised by 15 boats that operated in the fishery.

The Port Gregory trawl fishery operates as part of the AIMWTF. The permitted fishing area opened on 1 March for prawns and 4 April for scallops, and was closed on 31 October 2002.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002):
195 tonnes whole weight

Landings

The total landings for the 2002 season were 195 t whole weight of scallops compared to 1,182 t whole weight in 2001 (Abrolhos Islands Scallop Figure 1). The catch prediction for the 2002 season, based on pre-season survey, was between 200 and 300 t whole weight. The catch was just below this predicted catch range but still within the defined acceptable catch range for this fishery. In 2002, 1.1 t of king prawns and 0.6 t of coral prawns were reported as landed in the Port Gregory area.

Fishing effort

A total of 1,048 trawl hours (nominal effort) were recorded for the 2002 season, equivalent to 912 standardised trawl hours (standardised to 14 fathoms headrope length). This is much lower than the 3,998 standardised trawl hours recorded in 2001 owing to the much lower abundance of scallops in 2002 (Abrolhos Islands Scallop Figure 1). This effort level represents a fishing season of 6 days' duration in 2002, compared to 21 days in 2001.

Catch rate

The catch rate in 2002 was 218 kg/hr (whole weight, standardised effort), compared with 296 kg/hr for 2001.

Recreational component: **Nil**

Stock 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 survey has occurred since 1997 and is planned to continue. A preliminary investigation of the relationship between catch rates during surveys and subsequent catch has been undertaken for six years of surveys (1997–2002). The spatial distribution of the recruitment is very patchy and not all possible recruitment areas are covered by the survey. Derivation of a more 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 adequate, and recruitment is dependent only on environmental conditions each year.

Projected catch next season (2003):
2,900–4,350 tonnes whole weight

Using the November 2002 survey data, the projected catch range for 2003 is likely to be 2,900–4,350 t whole weight for the surveyed areas, which should result in a record catch for the Abrolhos Islands. During the survey, all areas showed evidence of moderate to high levels of recruitment.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The trawl fleet operates over a very small portion of the licensed fishing area, focusing on scallop aggregations on the relatively bare sand habitat associated with this species. On average over the last five years (1998–2002) only 8% of the area of the main trawl grounds has been fished, which represents just 4% of the total fishery area. Owing to the focused nature of this fishery and the large mesh size (100 mm), little bycatch is taken during the typically short 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 because water temperatures are too low. Consequently, interactions with turtles are already minimal, and with grids becoming compulsory in the fishery during 2003 their capture should be eliminated. Few other protected species occur in this area.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

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

Habitat effects: **Low**

The fishers operate over a very small proportion (4%) of the licensed area and therefore few areas are impacted by trawling. Moreover, the areas associated with scallops are sandy habitats and these are not impacted significantly by trawl gear. 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 2002 was 200 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002: **$600,000**

The estimated value of the catch has been based on the average wholesale price per kilogram obtained in the Shark Bay fishery, that is $3.30/kg whole weight or $16.50/kg meat weight. Meat weight is approximately 20% of the whole weight.

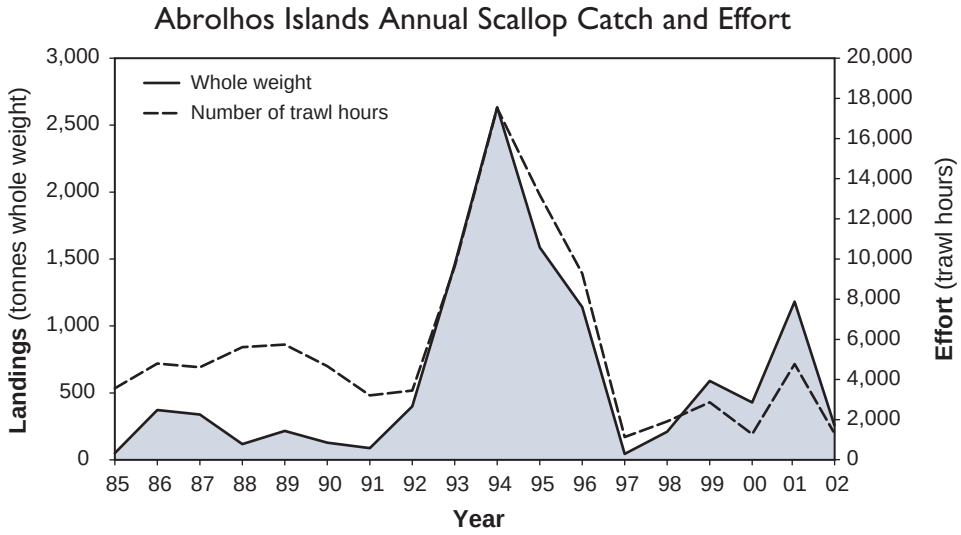
FISHERY GOVERNANCE

Acceptable catch range: **50–600 tonnes whole weight**

Apart from the exceptional catches of the mid-1990s, which were due to unusual environmental conditions increasing the success of recruitment, the catch range for this fishery has been 50–600 t whole weight. This range is predicted to be exceeded during the 2003 season due to the observed good pre-season recruitment, which resulted from favourable environmental conditions.

EXTERNAL FACTORS

The high level of recruitment seen in 2002 following a very low catch season highlights the dependence of recruitment success upon environmental conditions such as the Leeuwin Current rather than spawning stock levels, and illustrates the extreme annual variability in recruitment. As more years of pre-season survey and catch/effort data become available, the relationship between environmental factors and recruitment will be further evaluated.



ABROLHOS ISLANDS SCALLOP FIGURE 1

Annual scallop landings for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985–2002.

South West Trawl Managed Fishery Status Report

Prepared by M. Kangas and E. Sporer

FISHERY DESCRIPTION

Boundaries and access

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 (4 boats)
Zone D Comet Bay off Mandurah (3 boats)

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, access to Zone C occurs between 1 July and 30 September, and Zone D boats can fish all year round. Eight boats operated in the fishery during 2002.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002): Prawns 15 tonnes
Scallops 6 tonnes whole weight

Landings

The total landings for the season were 15 t of western king prawns (*Penaeus latisulcatus*) and 6 t whole weight of scallops. The catch of king prawns was 50% up on the catch of 2001 and at average catch levels for the last five years (15.5 t). The scallop catch was down from the 23 t caught in both 2001 and 2000. The fishery also lands a mixture of by-product species, of which the most abundant species recorded were 11 t of redfish (*Centroberyx* spp.), 8 t of western sand whiting (*Sillago schomburgkii*), 4 t of blue swimmer crabs (*Portunus pelagicus*), 2 t each of squid and mixed skates and rays and 1 t each of sole, flounder and flathead.

Fishing effort

A total of 258 days were recorded as being fished by 8 boats in 2002.

Catch rate

Not available.

Recreational component: **Nil**

Stock 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) consider that the fishery has minimal impact on the benthic sand habitats involved.

SOCIAL EFFECTS

The estimated employment for the year 2002 was 24 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002:
Prawns $200,000
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 $13.40/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 $3.30/kg whole weight or $16.50/kg meat weight. Meat weight is approximately 20% of the whole weight.

FISHERY GOVERNANCE

Acceptable catch range: **Not available**

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.

South Coast Trawl Fishery Status Report

Prepared by M. Kangas and E. Sporer

FISHERY DESCRIPTION

Boundaries and access

Access to the south coast trawl zone is limited, with only four boats currently endorsed to take scallops in the fishery. These endorsements are governed by two fishing boat licence conditions. Condition 73 authorises the use of demersal trawl nets off the south coast of Western Australia in State waters east of 115° E longitude (Cape Leeuwin) and is attached to all four licences. Condition 79 authorises demersal trawling for scallops within the Recherche Archipelago and is attached to only three of the current licences.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002): 669 tonnes whole weight

Landings

The scallop catch of 669 t whole weight in 2002 was a 180% increase compared to 2001, and second only to the very high catch of 2,722 t recorded in 2000. While the south coast trawl is principally a scallop fishery, two licence holders reported landings of mixed finfish during 2002, of which the main species recorded were 8 t of blue mackerel (*Scomber australasicus*), 3 t each of trevally (*Pseudocaranx dentex*) and redfish (*Centroberyx* spp.) and 2 t of leatherjacket (Monacanthidae).

Fishing effort

The annual effort expended in this scallop fishery is an outcome of initial fishing surveys used 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 2002, 425 fishing days were recorded.

Catch rate

Not available.

Recreational component: Nil

Stock 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 2002 was 16 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2002): $4.4 million

FISHERY GOVERNANCE

Acceptable catch range: Not available

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 2002 continue to be higher than those seen in the fishery in general over the last 10 years (except the very high catch seen in 2000), indicating the presence of additional localised spawning stock to replenish stocks after the very strong settlement in 2000.

West Coast Blue Swimmer Crab Fishery

Management Summary

Blue swimmer crabs (*Portunus pelagicus*) are found along the entire Western Australian coast and comprise the major portion of the State's inshore crab catches. Crabs may be targeted by a variety of fishing gear with crab traps and drop nets being the main methods used by commercial fishers. Crabs are also taken by trawl gear in several prawn and scallop trawl fisheries.

The principal management tool to ensure sustainability in the commercial crab fisheries is maintaining minimum size limits well above the size of sexual maturity of crabs. Blue swimmer crabs become sexually mature below 100 mm (carapace width) while legal minimum sizes range from 127 mm to 135 mm in the different commercial crab fisheries. Maintaining legal minimum sizes above the size at sexual maturity ensures adequate egg protection for blue swimmer crab stocks.

Additionally, commercial access to oceanic areas with blue swimmer crab stocks is controlled under a series of separate management arrangements which regulate the numbers of licensees, fishing methods and gear specifications, and seasonal and daily time restrictions. In Cockburn and Warnbro Sounds, access is managed via two separate management plans, while in other areas it is controlled by way of subsidiary legislation under the *Fish Resources Management Act 1994*, or through exemptions.

Recreational fishers also take significant quantities of crabs, particularly in the south-west of the State. While the sustainability of crab stocks is a primary concern, the commercial management arrangements have also been designed to ensure that any likely adverse impact on recreational fishing activities in the respective areas is minimised.

Management arrangements for the Mandurah and Swan/Canning Estuarine Fisheries have been reviewed and will be incorporated in the West Coast Estuarine Fishery (Interim) Management Plan, to be gazetted later in 2003. While gillnets will continue to be the main fishing method used in the Swan/Canning Estuarine Fishery, for the Mandurah Estuarine Fishery the management plan will formalise the use of crab traps, formerly utilised on a trial basis.

Management arrangements for the southern zone of the Mandurah–Bunbury Inshore Crab Fishery have now been finalised, with four exemptions issued to operate a total of 240 crab traps for a five-year period commencing in October 2002. After the five-year period a review will be undertaken to assess the viability and sustainability of the fishery and will consider if the fishery should progress to more formal management or should cease to operate. This timeframe will allow the appropriate research data to be collected and any wider impacts of the fishery to be considered. The access arrangement for the northern zone (Comet Bay) is currently also under review.

The Geographe Bay Crab Mediation Group has provided recommendations to the Minister for Fisheries who has agreed, in principle, with the recommendations. A discussion paper will be released for public comment in 2003.

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 meeting

Research Summary

Research monitoring of fishing activity for blue swimmer crabs was initially based on monthly returns 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. The FRDC has funded a further three-year project to enable the development of stock allocation and assessment techniques in Western Australian blue swimmer crab fisheries. The following status report summarises the research findings for this fishery.

West Coast Blue Swimmer Crab Stock Status Report

Prepared by L. Bellchambers and D. Harris

FISHERY DESCRIPTION

Boundaries and access

Blue swimmer crabs inhabit coastal waters throughout Western Australia. The majority of commercially fished stock is concentrated in coastal embayments between Geographe Bay in the south and Port Hedland in the north. Blue swimmer crabs are found in a wide range of inshore and continental shelf areas, from the intertidal zone to at least 50 m in depth.

There are two managed commercial crab fisheries, namely the Cockburn Sound and Warnbro Sound (Crab) Managed Fisheries. The Cockburn Sound fishery includes all waters within a line drawn 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 fishery includes Warnbro Sound itself and adjacent waters, extending from Becher Point to John Point. The Warnbro Sound managed fishery supports a single licence. Currently, 11 licence holders have access to the Cockburn Sound managed fishery, sharing a total allocation of 840 crab traps. During 2002, however, the full allocation of traps was fished by just six vessels operating between 80 and 180 traps each.

Licence holders in the Exmouth Gulf Beach Seine Fishery, Shark Bay Beach Seine and Mesh Net Managed Fishery, and the west and south coast estuarine fisheries, are permitted to take blue swimmer crabs by drop net or set net. An exemption to fish the waters of Exmouth Gulf using crab traps in an experimental capacity is currently being formalised. Seven licence holders have been issued an exemption to take crabs using traps (40 traps each) in the waters of Geographe Bay. These exemptions expire on 31 December 2004. Two commercial fishers are permitted to take crabs by traps (80 traps each) in the waters of Comet Bay.

Development has continued in the Carnarvon Experimental Crab Trap Fishery (Shark Bay), where exemptions to operate are granted on an annual basis. A third licence to take crabs in this fishery was issued for the 2002 season. Each licence was also allocated an additional 100 traps, taking to 300 the maximum number of traps that can be used on each licence. Currently, however, the extra allocation has yet to be issued to one licence pending resolution of several matters. One Shark Bay beach seine fisher (200 traps) and one Cockburn Sound crab fisher (300 traps), with long-standing histories of targeting crabs in these waters, are also permitted to use traps to take crabs in Shark Bay.

During 2001/02, fishing for blue swimmer crabs commenced in the Pilbara region with the issue of two exemptions to fish between Onslow and Port Hedland. Exploratory fishing was undertaken by both exemption holders intermittently throughout the year.

Main fishing method

Purpose-designed crab traps.

RETAINED SPECIES

Commercial production (season 2001/02): 754 tonnes

Landings

The commercial catch of blue swimmer crab taken in Western Australian waters during 2001/02 was 754 t. This catch represented a 2.4% increase from 2000/01 (736 t), and fell within the acceptable range of 600–800 t.

Shark Bay recorded a 59% increase in catch (478 t compared to 301 t in 2000/01) as the Carnarvon Experimental Crab Trap Fishery continued to develop. Some 336 t were caught by dedicated crab fishermen using traps, with the Shark Bay trawl fleet taking 141 t (29% of the catch). Commercial catches decreased, however, in both Cockburn Sound (104 t, a 51% decrease) and Peel/Harvey Estuary (68 t, a 3% decrease) (Blue Swimmer Crab Figure 1). The catch in Cockburn Sound was the lowest in eight years, well below the accepted range of 200–350 t. The low catch was most likely attributable to unfavourable environmental conditions experienced during the period between spawning and recruitment of juvenile crabs to the fishery. Experimental fishing in the Pilbara region during 2001/02 contributed 39 t to the total catch.

Fishing effort

The commercial crab catch is taken using a variety of fishing methods (Blue Swimmer Crab Figure 2). In the past year, traps accounted for 74% of the commercial catch, with the remainder taken primarily by trawling (22%), gillnetting (3.6%) and drop netting (0.4%). Overall fishing effort decreased by 4% for traps, while increasing by 1.9% for trawling, 2.3% for gillnets and 0.8% for drop nets in the last year.

Effort in Shark Bay increased during 2001/02, consistent with the ongoing development of the Carnarvon Experimental Crab Trap Fishery. Dedicated crab trap fishermen made 226,092 trap lifts over 856 fishing days, up from 140,430 trap lifts in 707 fishing days during 2000/01 (Blue Swimmer Crab Figure 3).

Effort in Cockburn Sound decreased considerably in 2001/02, with only three fishermen operating past March as the available commercial stock was substantially depleted well before the end of the season. During 2001/02, 156,497 trap lifts were reported from 1,471 fishing days, down from 222,970 trap lifts over 2,128 fishing days the previous year (Blue Swimmer Crab Figure 4).

Catch rate

Because of the variety of fishing methods used to take blue swimmer crabs and the diversity of areas that are fished, a single catch rate statistic has not been produced. Comparative rates are given here for the three areas contributing the majority of the blue swimmer crab catch for the past year. The trap catch rate in Cockburn Sound decreased significantly for the second year in a row, falling some 31% from 0.95 kg/trap lift in 2000/01 to 0.66 kg/trap lift for the 2001/02 season (Blue Swimmer Crab Figure 4). Trap catch rates in the Peel/Harvey Estuary dropped marginally from 1.41 kg/trap lift to 1.38 kg/trap lift in 2001/02, while the trap catch rate in Shark Bay also fell, down some 16% from 1.77 kg/trap lift to 1.48 kg/trap lift (Blue Swimmer Crab Figure 5).

Recreational component: 40% (approx.)

Recreational catches of blue swimmer crabs have been surveyed in the west coast bioregion, as reported in *State of the Fisheries 1999/2000*, and were estimated to be about 40% of the total catch at that time. The recreational take was dominated by the catch from the Peel/Harvey Estuary. A survey of recreational crabbing in Nickol Bay estimated a recreational blue swimmer catch of 20 t for the 2000 calendar year (Williamson et al., in prep.). Surveys quantifying recreational catch are currently being conducted in Cockburn Sound, Geographe Bay and along the south coast of Western Australia.

Stock assessment completed: **Preliminary assessment**

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 almost a five-fold increase since the commencement of the Carnarvon Experimental Crab Trap Fishery in 1998, while effort and catch per unit effort (CPUE) have only increased three and 0.5 times respectively. The increases in catch and effort reflect the more efficient fishing of blue swimmer stocks as the fishers' knowledge of the fishery has increased over time, with further sustainable increases in catch possible as the fishery continues to develop.

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.

Peel/Harvey: 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, with a moderate increase in catch and CPUE evident in 2000/01.

Yield-per-recruit analysis has indicated that yields may be increased by lowering the legal minimum size or carapace width (CW) (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 (< 80 mm) crabs and severely limited the catch of sub-adult (< 120 mm) crabs, 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, Peel/Harvey Estuary)
Not assessed (Shark Bay)

Breeding stock levels: **Adequate**

As the legal size at first capture (127 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 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. Bycatch reduction devices are currently being implemented in Western Australian trawl fisheries, mainly to reduce the take of sharks and rays, which damage the quality of the target catch, but also to prevent the capture of turtles occasionally taken by conventional trawls.

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 2001/02, approximately 48 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 (2001/02): $3.4 million

The state blue swimmer crab catch for the 2001/02 season was valued at approximately $3.4 million, representing a small increase on the $3.1 million generated in 2000/01. Beach prices varied between $4.50/kg and $6/kg live weight. 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.

FISHERY GOVERNANCE

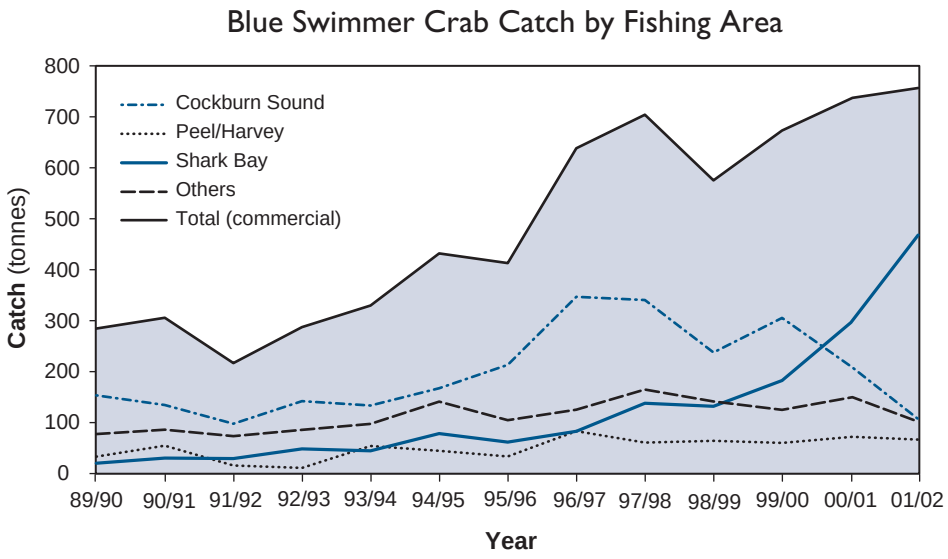
Acceptable catch range: 600–800 tonnes

Commercial catches are expected to be in the range 600–800 t, based on catches in the years 1997/98 to 2001/02. 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.

The blue swimmer crab fishery is expanding into currently unexploited grounds such as Exmouth Gulf and Nickol Bay in the north, and the coastal zone between Mandurah and Bunbury (excluding the key recreational areas) in the south. Acceptable catch rates for these areas are not available as yet due to the lack of a sufficient time series of commercial fishery data to allow ranges to be set.

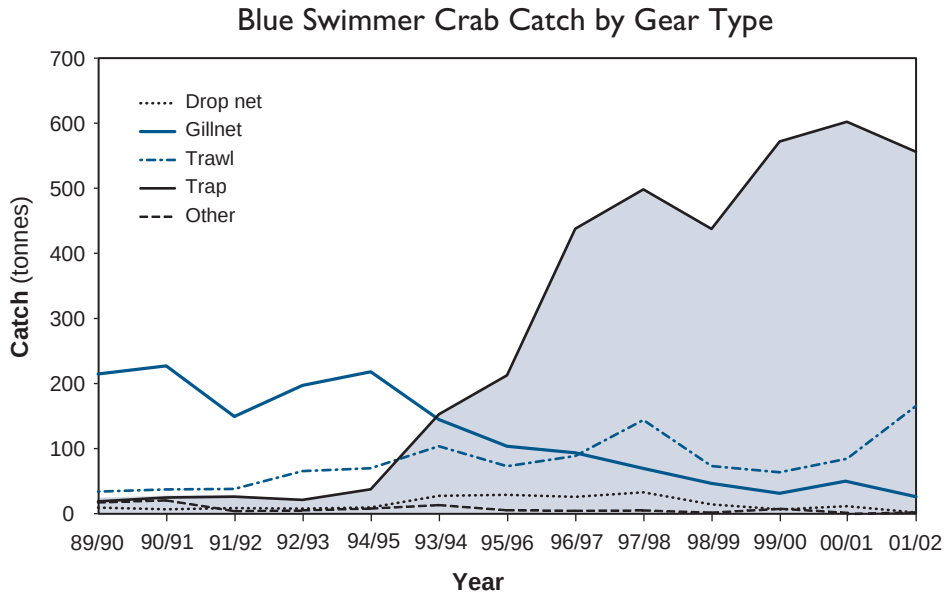
EXTERNAL FACTORS

The commercial fishery has expanded since 1995/96, when the main commercial sectors converted from set nets to dedicated crab traps, and there is still potential for future commercial expansion in more remote areas not currently exploited. Currently, new commercial fishing grounds are being explored along the State's northern coastline. This will allow the further expansion of blue swimmer crab catches without impacting on the more heavily fished south-western areas of the State where recreational and commercial competition remains a concern. The commercial pressure on stocks in these areas, together with increasing demand from the recreational sector, has resulted in a number of management changes to maintain catch shares between the two sectors, such as the Cockburn Sound catch share arrangement. Given the pressure from both the commercial and recreational sectors of this fishery, catch allocation has become a major issue and there is research under way to provide an information basis to review these arrangements in both Cockburn Sound and Geographe Bay.



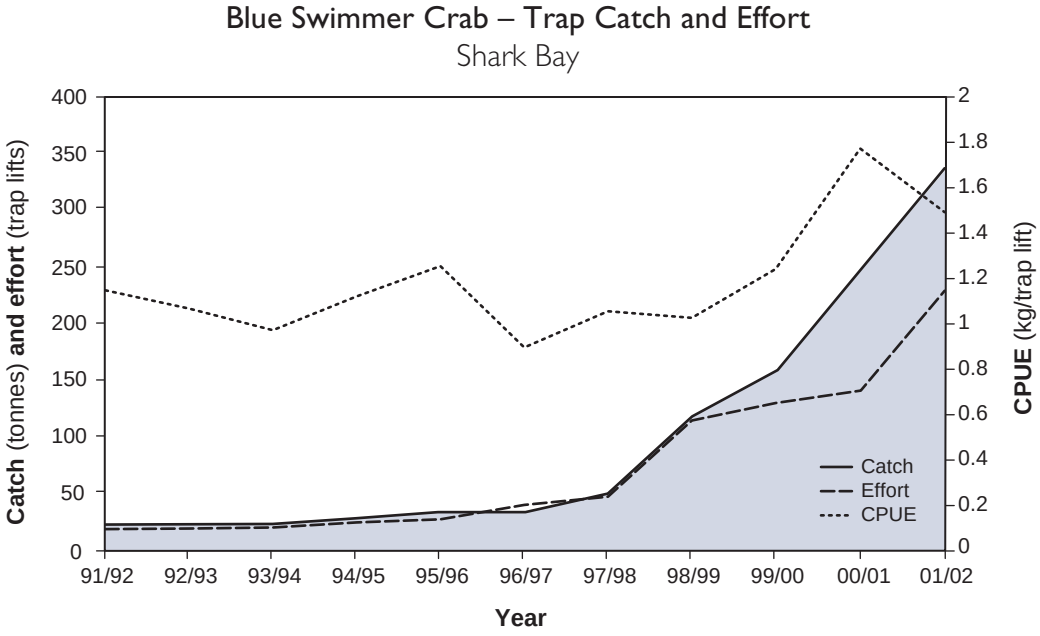
BLUE SWIMMER CRAB FIGURE 1

Commercial catch history for the blue swimmer crab (Portunus pelagicus) in Western Australia between 1989/90 and 2001/02, indicating main regions of commercial catches.



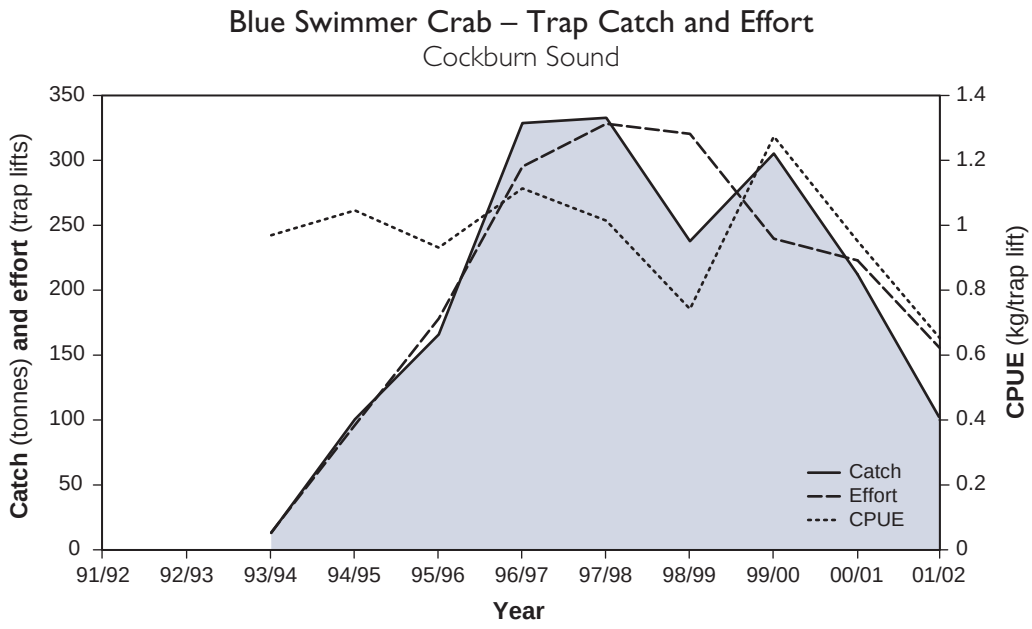
BLUE SWIMMER CRAB FIGURE 2

Blue swimmer crab catch taken by different gear types in Western Australia during the period 1989/90 to 2001/02.



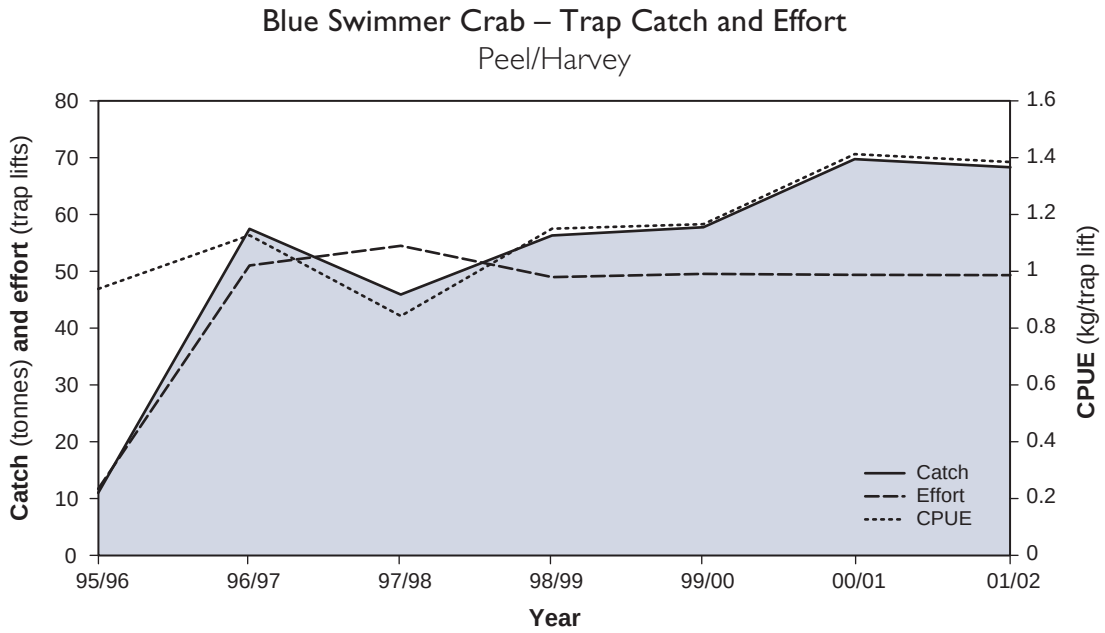
BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (t), effort (traplifts x 1,000) and catch per unit effort (kg/traplift) in Shark Bay during the period 1991/92 to 2001/02 using traps.



BLUE SWIMMER CRAB FIGURE 4

Blue swimmer crab catch (t), effort (traplifts x 1,000) and catch per unit effort (kg/traplift) in Cockburn Sound during the period 1991/92 to 2001/02 using traps.



BLUE SWIMMER CRAB FIGURE 5

Blue swimmer crab catch (t), effort (traplifts x 1,000) and catch per unit effort (kg/traplift) in the Peel/Harvey Estuary during the period 1995/96 to 2001/02 using traps.

West Coast Deep-Sea Crab (Interim) Managed Fishery

Management Summary

The West Coast Deep-Sea Crab (Interim) Managed Fishery is a '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. Between 50 and 100 pots are attached to a main line marked by a float at each end.

Fishers target giant (king) crabs (*Pseudocarcinus gigas*), crystal (snow) crabs (*Chaceon bicolor*) and champagne (spiny) crabs (*Hypothalassia acerba*). For all species of deep-sea crabs the Department either has in place, or is currently introducing, regulations to protect breeding females and establish minimum size limits.

This fishery was previously accessed through various endorsements on a Western Australian fishing boat licence, but in 2003 an interim management plan was gazetted creating five zones in the fishery and replacing the former conditions with permits. Under the interim plan, access is limited to seven permit holders. At the time of writing the Department was about to issue five full-time (Class F) permits and two part-time (Class P) permits. Full-time licensees may operate for up to 12 months per year, while part-time licensees may fish a maximum of three months in the fishery. The Department is intending to issue Class F permits for each of Areas 1 to 5 and part-time permits for Areas 3 and 4.

Provided the fishery continues to demonstrate sustainability, the Department plans to provide equal access to all seven licensees when the interim plan expires in December 2004. However, given the vulnerability of deep-sea crab stocks to over-exploitation, and concerns about the ability of the fishery to support all licensees on a full-time basis, the Department is currently giving consideration to means to reduce and control effort under any new plan introduced after December 2004.

A final application has been submitted to Environment Australia for the fishery as part of EA's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. Following the public comment period, formal assessment by EA will be undertaken.

Governing Legislation/Fishing Authority
West Coast Deep Sea Crab Fishery (Interim) Management Plan 2003

Consultation Process
Department–industry meetings

Research Summary

Research in this sector involves assessing the current status of the west coast deep-sea crab stocks based on commercial catch returns, logbook 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 snow crabs. Final reports for these research projects are due in the second half of 2005.

West Coast Deep-Sea Crab Stocks Status Report

Prepared by R. Melville-Smith

FISHERY DESCRIPTION

Boundaries and access

The West Coast Deep-Sea Crab Fishery, which during the season being reported (2002) was still in its developmental phase, operates between Cape Leeuwin and the Northern Territory border. Vessels are only permitted to fish outside the 150 m depth contour.

There are seven licences in this fishery.

Main fishing method

Moulded plastic pots operated in longline formation.

RETAINED SPECIES

Commercial production (2002): 205 tonnes

Landings

A catch of 205 t of snow crabs was taken in the fishery in 2002, a decrease of 8% on the catch taken in the 2001 season (223 t), but nevertheless high compared to all previous years (Deep Sea Crab Figure 1). As in 2001, catches of champagne (Deep Sea Crab Figure 1) and giant crabs on the west coast were negligible.

Fishing effort

Effort increased by 14% from an estimated 96,500 pot lifts in the 2001 season to 110,400 pot lifts in the 2002 season. This effort estimate is based on a combination of compulsory catch and effort and research logbook data.

Catch rate

The catch per unit of fishing effort for snow crabs decreased by 17%, from 2.3 kg/pot lift in 2001 to 1.9 kg/pot lift in 2002. This catch per unit effort estimate is based on research logbook 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 completed: Not assessed

No stock assessment results are yet available, as research on the snow crab fishery only commenced in July 2001, and the

small landings of champagne and giant crabs do not justify an assessment. Catch rates in the snow crab fishery have fallen by 32% between 2000 and 2002. However, it is recognised that the fishery is new and long-term yields have yet to be established.

Exploitation status: **Not assessed**

Breeding stock levels: **Adequate**

In snow, 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 snow 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 snow and champagne crabs are well below the 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 snow 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 design of the pots is such that they do not 'ghost fish' if lost.

Protected species interaction: **Negligible**

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

ECOSYSTEM EFFECTS

Food chain effects: **Negligible**

Catches of the three species of deep-sea crabs landed represent a very small biomass, and any impact of fishing on the general food chain is expected to be minimal.

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 (2002): **$2.7 million**

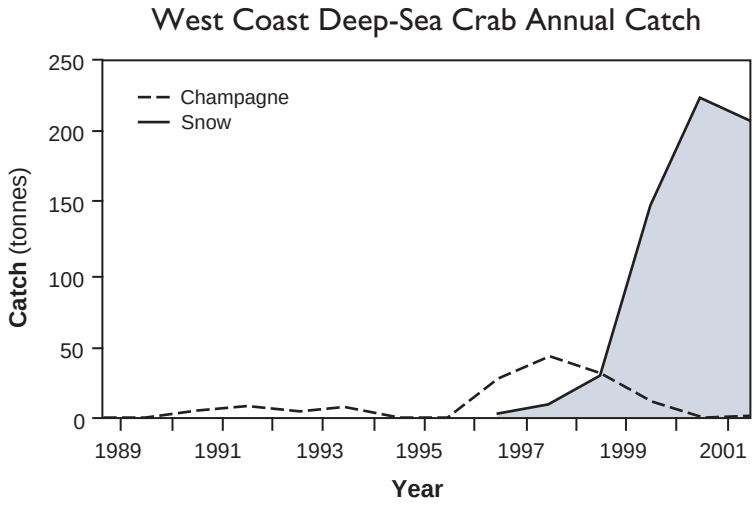
The beach value of the fishery was about $2.7 million in 2002, based on an average beach price of $13/kg for snow, $9.5/kg for champagne and $25/kg for giant crabs. The majority of the catch is exported live to south-east Asia.

FISHERY GOVERNANCE

Acceptable catch range: **Not assessed**

The effort in this developing fishery during 2002 was restricted to three full-time and four 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 interim 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.



WEST COAST DEEP-SEA CRAB FIGURE 1

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

West Coast Estuarine Fisheries

Management Summary

There are three restricted entry estuarine fisheries operating in the metropolitan and south-western regions of the Western Australian coastline, as follows:

- Swan/Canning Estuarine Fishery
- Mandurah Estuarine Fishery (Peel/Harvey Estuary)
- Hardy Inlet Estuarine Fishery

It is expected that the West Coast Estuarine Fishery (Interim) Management Plan, which will provide a more comprehensive management framework for the Swan/Canning and Mandurah estuarine fisheries, will be gazetted in 2003. Existing management arrangements that will be carried over into the new plan include gear restrictions, seasonal and time closures, area closures and boat restrictions. Many of the seasonal and time closures are designed to provide spatial separation between user groups and equitable sharing arrangements for the fish resource.

A discussion paper on alternative management options for the Hardy Inlet Estuarine Fishery will be released for comment in September 2003. It is anticipated that the changes to the management arrangements for this fishery will be finalised in 2003/04.

Estuarine fishing areas, fishing practices and resource-sharing issues are increasingly becoming the subject of community interest. In order to maintain a level of commercial presence and production, while encouraging a resource shift towards the recreational sector, a number of Voluntary Fisheries Adjustment Schemes have been run in the last five years. The outcome of these schemes has seen a significant reduction in the number of commercial fishing units in these estuarine fisheries and the total removal of commercial fishing units in the Leschenault Estuarine Fishery.

Governing Legislation/Fishing Authority

West Coast Estuarine Fishery (Interim) Management Plan (to commence 2003)
Condition 19 on a Fishing Boat Licence
Condition 17 on a Commercial Fishing Licence
Closed Waters and Permitted Gear Orders under Section 43 of the *Fish Resources Management Act 1994*
Directions to Licensing Officers

Consultation Process

Department–industry meetings

Research Summary

Research monitoring of fisheries and fish stocks in the west 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 during the 1970s and 1980s. 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 groups.

The following status report summarises the research findings for these fisheries.

West Coast Estuarine Fisheries Status Report

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

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 May 2002. Unit holders in the three west coast estuaries are endorsed to fish a single west coast estuary system only.

The status of the fishery in each of the above estuaries is reviewed annually. Please note that where fewer than five 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. This report presents information for three indicator finfish species from the three 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.

Main fishing method

Gillnet/haul net.

RETAINED SPECIES

Commercial production (season 2002): 230 tonnes

Landings

The total landings from west coast estuaries of 230 t during the 2002 season include the following catches of key target species:

Blue swimmer crabs	*Portunus pelagicus*	78.8 t
Sea mullet	*Mugil cephalus*	75.0 t
Yellow-eye mullet	*Aldrichetta forsteri*	26.7 t
Western sand whiting	*Sillago schomburgkii*	17.2 t
Australian herring	*Arripis georgianus*	3.8 t
Tailor	*Pomatomus saltatrix*	3.7 t
Cobbler	*Cnidoglanis macrocephalus*	2.2 t
Other species		22.6 t

Swan/Canning: The 2002 catch level showed a decrease of approximately 10 t from 2001, following a generally declining trend throughout the 1990s (actual figure not available as there were fewer than five operators). The catch from the Swan/Canning Estuary during 2002 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. Moreover, the total catch for 2002 of 172.1 t represents a further decrease by approximately 24 t from the 2001 catch figure. Approximately 48% of the finfish catch comprised sea mullet and yellow-eye mullet during 2002, with approximately 37% of the total 2002 catch consisting of blue swimmer crabs.

Hardy Inlet: The 2002 catch declined by approximately 7 t from the 2001 catch level (actual figure not available as there were fewer than five operators). 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 2002.

In addition to these three main west coast estuaries, a catch of less than 10 t of sea mullet was reported from the Wonnerup Estuary for 2002.

Key indicator species

Black bream: Catches of black bream were reported from the Swan/Canning Estuary and the Hardy Inlet during 2002. The reported catches from these estuaries showed a minor increase from the 2001 catches. The actual catches cannot be reported as there are fewer than five operators.

Cobbler: Minor catches of cobbler were reported from the Swan/Canning Estuary, Peel/Harvey Estuary and Hardy Inlet during 2002. The reported catches of cobbler in the Swan/Canning Estuary have been declining from the late 1980s, with 2002 being similar to 2001 and the lowest on record (< 100 kg). The 2002 catch in the Peel/Harvey Estuary is also at the lower end of historical catches. The small 2002 catch of cobbler (< 100 kg) from the Hardy Inlet was the first time this species was reported from the catch since 2000.

King George whiting: King George whiting catches for 2002 were reported from the Peel/Harvey Estuary only. Whilst slightly higher than in 2001, they were still much lower than the exceptionally high catches reported during the late 1990s.

Fishing effort

Fishing effort has been 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 2002.

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 2002.

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 2002.

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. 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 abundance of the suite of species that make up the overall catch has remained constant.

Peel/Harvey: The catch rate has generally followed the downward trend in catches in this fishery. During the past 10 years, however, the CPUE has remained relatively stable even though the catch and effort have declined, particularly since1997. 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 overall catch has remained constant, 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 2002 CPUE has decreased from the 2001 value.

Recreational component: Not assessed for all estuaries

The most recent recreational catch survey data, for the year 1998/99, were reported in the *State of the Fisheries Report 2000/2001*.

In summary, the recreational catch at that time in the Swan/Canning Estuary was estimated to be of a similar magnitude to the commercial catch. For the Peel/Harvey Estuary, the recreational finfish catch at that time was estimated to be about 20% of the total, while for blue swimmer crabs the recreational catch was about 80% of the total. With the cessation of commercial fishing in Leschenault Inlet, the recreational sector takes all of the catch.

Stock assessment completed: Yes

Basic assessments have been undertaken previously for select indicator species (black bream, cobbler and King George whiting). Annual monitoring assessment of stock trends 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), the results of which were presented in the *State of the Fisheries Report 1999/2000*. In the last few years the catch data for the Swan River stock have indicated a slightly increased catch associated with a decline in the number of units actively fishing.

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), the results of which were presented in the *State of the Fisheries Report 1999/2000*. The low level of catch in 2001 and 2002 of this once important species suggests that cobbler stocks are no longer a target of the commercial fishers in either the Swan/Canning or Peel/Harvey Estuaries. The decline in catch appears to be the result of both fishery and fishery-independent factors, including lower numbers of fishers operating in the estuaries, and a shift in target species to blue swimmer crabs, particularly in the Peel/Harvey Estuary.

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 reported in the *State of the Fisheries Report 1999/2000*. The lower catches of King George whiting during 2002 appear to be due to lower recruitment generally 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), the results of which were 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.

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), the results of which were 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, affording protection to the breeding stock.

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, the current inshore exploitation rate appears to afford some protection for these stocks. Targeted recreational fishing for these fish will need to be monitored to ensure overall fishing mortality does not reduce breeding stock 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

During 2002, there was an average of about 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 (2002): **$683,000**

FISHERY GOVERNANCE

Acceptable catch range: **Not available**

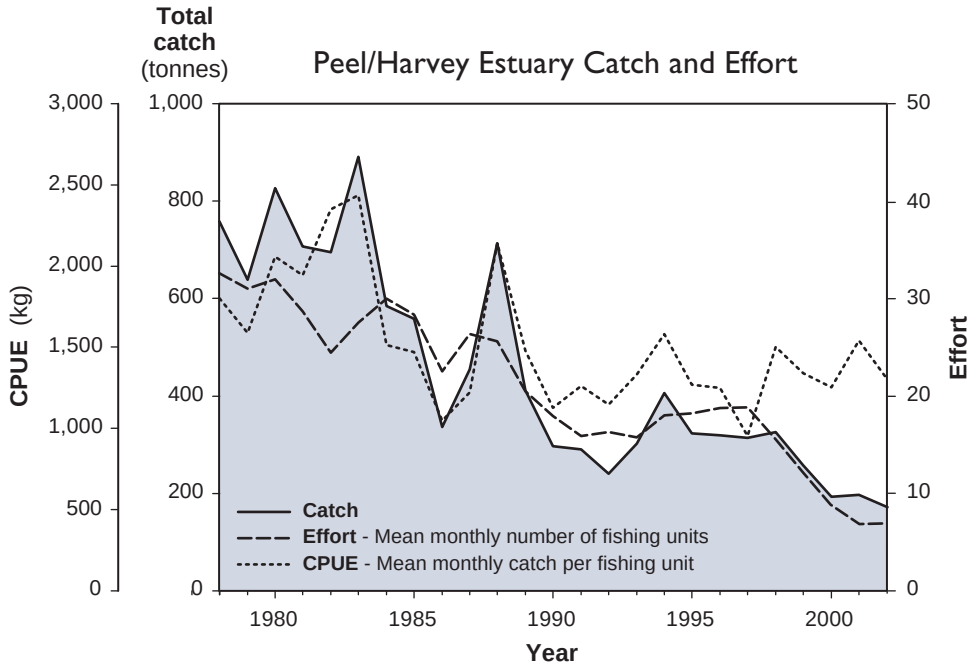
The appropriate ranges cannot be assessed at this time given the limited data available from the decreasing number of commercial fishers operating in these fisheries.

EXTERNAL FACTORS

The estuarine catches since 2001 have generally been lower than in previous years. This appears to be related to a decline in the mean monthly number of boats actively fishing in the estuaries. These reduced levels of fishing activity as a result of voluntary buy-back of commercial access 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 cooperation 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.



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 1978–2002.

Lower West Coast Beach and Embayment Fisheries

Management Summary

Within this sector there are five managed fisheries focused mainly in the Cockburn Sound area, details of which are listed below.

West Coast Beach Bait Managed Fishery: The fishery primarily targets small pelagic fish by the beach seine method within the coastal waters between Moore River and Tim's Thicket, south of Mandurah. The major target species is whitebait, with small quantities of other species being taken.

Continued beach access remains the main management issue relevant to this fishery, particularly where coastal developments restrict vehicle access. A Voluntary Fisheries Adjustment Scheme (VFAS) was implemented during 2002/03 which reduced the number of fishing units from 11 to 3. Consideration will be given to the feasibility of moving to a purse-seine-based fishery in 2003/04.

The review of beach seine fishing in the south-west has prepared recommendations for future management arrangements for consideration by the Minister for Fisheries. Increased development, tourism and marine recreational activities in the area have led to increased resource-sharing pressure and a need to introduce more formal fishery management. A VFAS is also being considered to address some of the resource-sharing issues.

The major target species for the beach seine fisheries is whitebait, with small quantities of other species being taken. As the whitebait stock in the south-west of Western Australia is found mainly in a thin coastal strip close to the coast and the stock size is relatively small, it is considered that the exploitation rate by commercial fishers should not be permitted to increase above current levels.

Cockburn Sound (*Crab*) *Managed Fishery:* See West Coast Blue Swimmer Crab Fishery, p. 20.

Cockburn Sound (*Fish Net*) *Managed Fishery:* Fish are taken in this fishery by gillnet, beach seine and haul net and the main species targeted are garfish and Australian herring. Other

fish species, including shark, whiting and mullet, are taken opportunistically.

The catch of garfish and Australian herring has been rising steadily since the 1970s. The rate at which the catch of these two species is increasing is of some concern as they are both also important recreational species. The implementation of a VFAS in 2002/03 withdrew one licence from the fishery.

Cockburn Sound (*Mussel*) *Managed Fishery:* Fishing activity in this wild-capture fishery continues to be minimal due to the integration of the fishery with the mussel aquaculture operations in Cockburn Sound.

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.

The management arrangements for the fishery are being reviewed to introduce transferability while maintaining catch and effort at historical levels. A Voluntary Fisheries Adjustment Scheme was implemented in 2002/03 which withdrew 12 licences from the fishery. There remains considerable latent effort in the fishery that needs to be considered in the management review.

Governing Legislation/Fishing Authority
West Coast (Beach Bait) Management Plan 1995
Cockburn Sound (Crab) Management Plan 1995
Cockburn Sound (Fish Net) Management Plan 1995
Cockburn Sound (Mussel) Management Plan 1995
Cockburn Sound (Line and Pot) Management Plan 1995
Warnbro Sound Crab Management Plan 1995
Subsidiary legislation under the *Fish Resources Management Act 1994*

Consultation Process
Department–industry meeting

Research Summary

Data for monitoring the status of the various coastal stocks exploited in the southern half of the west coast bioregion are obtained primarily from the CAES records provided by industry. These data, together with biological knowledge from historical research, provide the basis for the following two status reports.

Cockburn Sound Finfish Fisheries Status Report

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

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 in this report are for finfish only and are mainly from the Cockburn Sound (Line and Pot) and the Cockburn Sound (Fish Net) Managed Fisheries. As at May 2002 there were 2 licensees in the fish net fishery and 25 licensees in the line and pot fishery.

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. 35–37, 38–40, 184 and 20–25 respectively).

Main fishing method

Gillnet (set net), haul net, handline, beach seine and purse seine.

RETAINED SPECIES

Commercial production (season 2002): 61.4 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 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.

Over the past 10 years, the finfish catches have generally declined from the peak catch in 1992. The 2002 catch of 61.4 t of finfish is, however, an increase over the 2001 catch by 15 t (Cockburn Sound Figure 1). The composition of the 2002 catch included about 20 finfish and elasmobranch species. As found in previous years, over 90% of the total catch consisted of Australian herring (*Arripis georgianus*), sea garfish (*Hyporhamphus melanochir*), pink snapper (*Pagrus auratus*), sea mullet (*Mugil cephalus*) and skates and rays.

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 and 30 t per year. The catch for 2002 was 22 t (Cockburn Sound Figure 2).

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

The contribution of the catch of skates and rays to the total landings has increased from 2.5% in 2001 to 5.6% in 2002.

Fishing effort

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 only provides 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 722 boat days for 2002 (Cockburn Sound Figure 1).

Catch rate

The catch rate for the different fisheries and the various fishing methods has averaged around 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. The 2002 catch rate was 85 kg/boat day. The 2002 catch rate for Australian herring was 30.9 kg/boat day (Cockburn Sound Figure 2).

Recreational component: **56% (approx.)**

The most recent Cockburn Sound recreational shore- and boat-based fishing survey data are 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 in Cockburn Sound and Owen Anchorage, with the key recreational finfish species being 31 t of Australian herring, 19 t of whiting and King George whiting (Sillaginidae), 5 t of tailor (*Pomatomus saltatrix*), 4 t of pink snapper, 4 t of garfish, 3 t of skipjack trevally (*Pseudocaranx dentex*) and 2 t of silver bream (*Rhabdosargus sarba*). (This species composition is similar to that reported for the Cockburn Sound area during the Augusta to Kalbarri recreational boat-based fishing survey during 1996/97.) During the calendar year 2002, the commercial catch of these same species was approximately 53 t. Thus the recreational fishery takes approximately 56% of the combined recreational and commercial catch of these key recreational finfish species. This proportion appears to have increased since the 1996/97 creel survey for the same region, but the increase may be due in part to the more extensive survey of recreational fishers which included morning and night fishing for pink snapper.

Stock assessment completed: **Not assessed**

For an assessment of Australian herring stocks, see p. 126.

Exploitation status: **Not assessed**

For an assessment of Australian herring stocks, see p. 126.

Breeding stock levels: **Not assessed**

For an assessment of Australian herring stocks, see p. 126.

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 on the habitat.

SOCIAL EFFECTS

During 2002, 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 (2002): **$138,000**

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

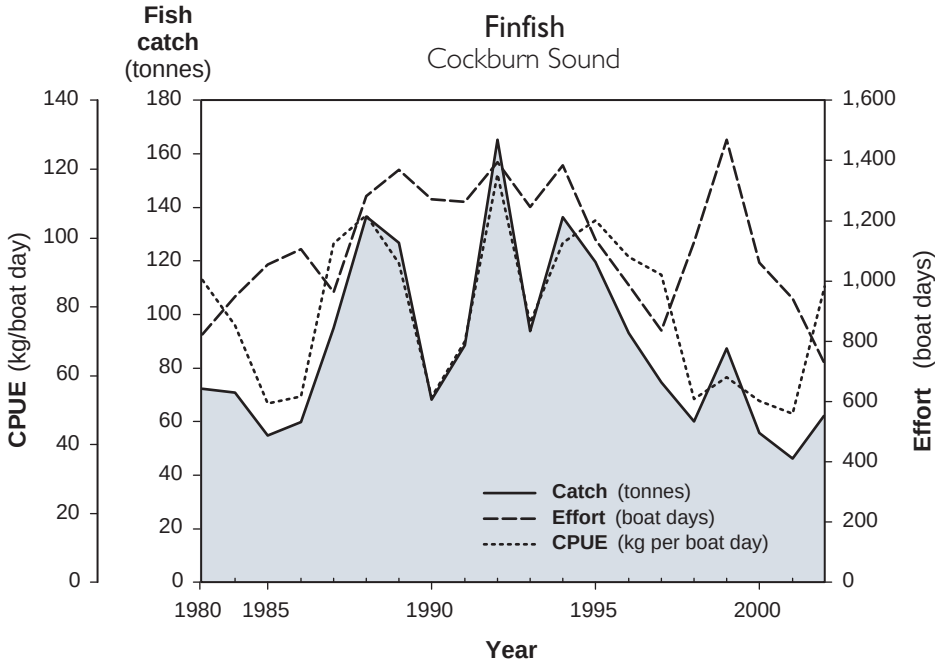
FISHERY GOVERNANCE

Acceptable catch range: **40–95 tonnes**

The expected catch range under the current management regime is 40–95 t of finfish. This projection is derived by double exponential smoothed forecasting of the annual catches to 1998 and the variation of observations around the predictions. The confidence intervals are set at 80%. The current annual catch of 61.4 t is in the middle of the acceptable catch range.

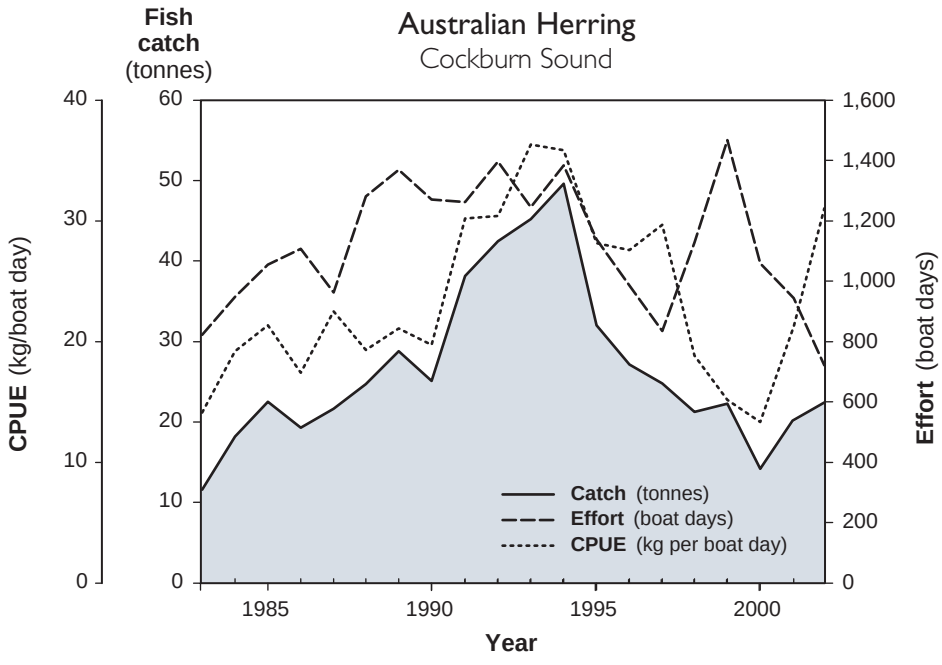
EXTERNAL FACTORS

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 1980–2002.



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 1980–2002.

West Coast Beach Bait Managed Fishery Status Report

Prepared by D. Gaughan and T. Leary

FISHERY DESCRIPTION

Boundaries and access

The West Coast Beach Bait Managed Fishery primarily targets whitebait (*Hyperlophus vittatus*). Because this species is also the primary target south of the managed fishery boundary, the catches of the as yet unmanaged south-west beach seiners have been included in this status report.

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, with access currently via managed fishery licence. A Government-funded Fishery Adjustment Scheme has reduced the fishery from 11 to 3 licences.

The south-west beach seine fishing activities, which also target whitebait, occur from Tim's Thicket south to Point D'Entrecasteaux, with activity typically concentrated in Geographe Bay (Cape Naturaliste to Preston Beach). While the management arrangements for this 'fishery' have 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.

Main fishing method

Beach seine net.

RETAINED SPECIES

Commercial production (season 2002):
All species 310 tonnes
Whitebait 183 tonnes

Landings

The main target species in this fishery is whitebait, of which 183 t were caught in the 2002 season. The catches of all other species landed in this fishery, which amounted to 107 t, were dominated by sea mullet, blue sprat, yellow-eye mullet, western sand whiting and buffalo bream (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 beach seine fishery'.

Metropolitan: The catch of whitebait for the metropolitan region during 2002 was 16 t, similar to catches in 2001 (11 t) and 1999 (11.1 t).

Mandurah: The whitebait catch at Mandurah was just over 2 t, an order of magnitude lower than catches for the previous two years (2001: 32.1 t, 2000: 33.6 t).

Bunbury: The Bunbury catch was similar to the past two years, with 165 t caught in 2002 compared with 197 t in 2001 and 175 t in 2000.

Fishing effort

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 is recorded on the monthly returns, the data provided by this fishery is not a reliable measure of effort applied to the whitebait stock.

Catch rate

See 'Fishing effort' above.

Recreational component: **Nil**

There is no recreational fishery for whitebait. Only a small number of the other retained species are caught recreationally (see p. 148).

Stock assessment completed: **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. On this basis, abundance in 2002 remained at moderately high levels which is consistent with the above-average Leeuwin Current in 2001.

The 2002 catch of 183 t falls within the acceptable range for total catch but 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, managed 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 cyclical nature of the fishery, whereby very good catches (usually related to a strong Leeuwin Current during the previous year) are often followed by one to two years of low catches, suggests that breeding stocks may become a limiting factor in years following environmentally driven low recruitment. Therefore this fishery needs to be carefully monitored.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

There is typically no 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.

Protected species interaction: **Low**

No protected species occur in the fishing area which could be caught by the beach seine gear.

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. Although the links between little penguins and whitebait are now clear, the impact of any such interaction 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 should continue. If, however, there is a move towards purse seining for whitebait this may change the relationship so potential food chain and direct impacts would need to be investigated.

Habitat effects: **Negligible**

All fishing occurs over sandy substrate and the impact of the relatively small amount of very light fishing gear would be negligible.

SOCIAL EFFECTS

Approximately 32 fishing units involving about 72 fishermen and crew worked in the whitebait industry in 2002.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2002): $476,000

The price for whitebait has risen slightly in recent years to a current average of $2.60/kg. Total catch value was about $476,000.

FISHERY GOVERNANCE

Acceptable catch range: **Whitebait 106–331 tonnes**

The range provided for whitebait reflects catches achieved since 1990 by the limited numbers of operators with access to these stocks. 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.

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, and is partway through the process of becoming fully managed to ensure that appropriate effort levels are maintained. 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 may have implications for 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

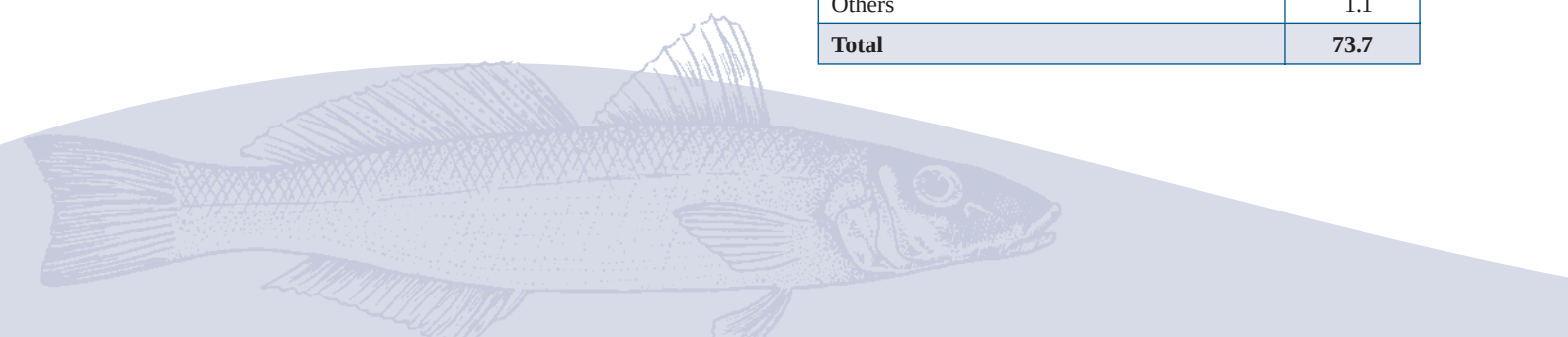
Catches in 2002 of retained species other than whitebait from the West Coast Beach Bait Managed Fishery. Numbers in brackets indicate that part of the catch taken from Cockburn Sound.

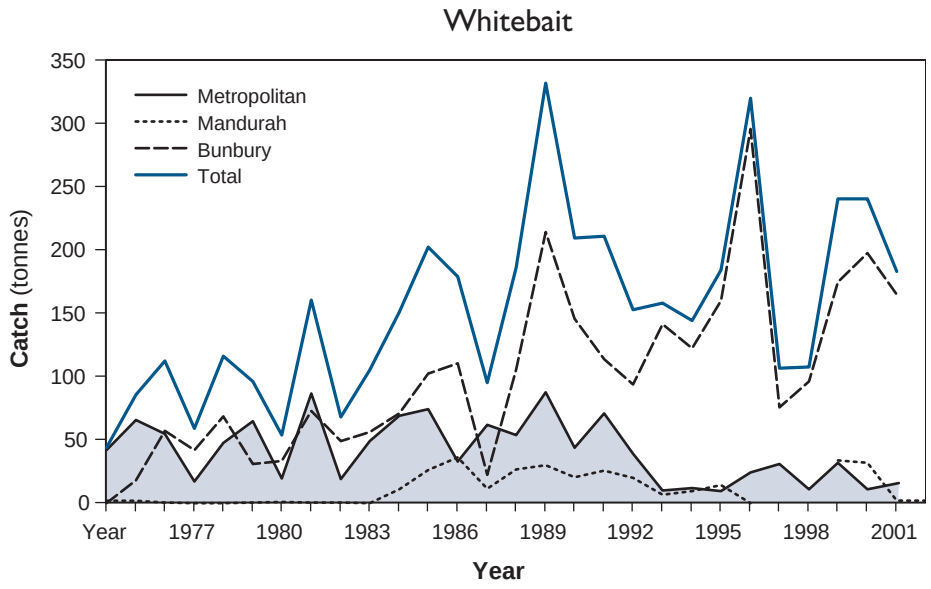
SPECIES		CATCH (tonnes)
Mullet, sea	*Mugil cephalus*	17.6 (2.2)
Sprat, blue	*Spratelloides robustus*	9.2 (9.2)
Whiting, western sand	*Sillago schomburgkii*	2.6 (0.3)
Mullet, yellow-eye	*Aldrichetta forsteri*	2.3 (0.2)
Mackerel, scaly	*Sardinella lemuru*	1.4 (1.2)
Others		0.7 (0.7)
Total		**33.8 (13.8)**

WEST COAST BEACH BAIT TABLE 2

Catches in 2002 of retained species other than whitebait from the south-west beach seining sector.

SPECIES		CATCH (tonnes)
Mullet, sea	*Mugil cephalus*	38.4
Whiting, western sand	*Sillago schomburgkii*	13.9
Sprat, blue	*Spratelloides robustus*	10.6
Bream, buffalo	*Kyphosus sp.*	4.8
Garfish, sea	*Hyporhamphus melanochir*	2.6
Mullet, yellow-eye	*Aldrichetta forsteri*	2.3
Others		1.1
Total		**73.7**





WEST COAST BEACH BAIT FIGURE 1

Total annual catch of whitebait for each sector from 1975 to 2002.

West Coast Purse Seine Managed Fishery

Management Summary

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*). The product has a variety of uses, being sold for human consumption, angling bait, commercial bait, tuna grow-out food and pet food. The tuna feed market is the main consumer of sardinella, and human consumption the major end user for pilchards.

As in the South Coast Purse Seine Managed Fishery, the spread of a *Herpesvirus* through the west coast in 1995 and again in 1998/99 had a serious impact on the pilchard stock. The possibility of a further outbreak represents a real threat to the fishery.

The fishery operates between 33° S latitude and 31° S latitude and there are also two purse seine development zones currently operating north and south of this area. The Southern Development Zone consists of three operators who operate purse seine nets in 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). While the managed fishery and the Southern Development Zone mainly target pilchards, the Northern Development Zone targets sardinella.

The fishing season runs from 1 April to 31 March of the following year. The pilchard catch allocation (cap) for the 2002/03 licensing period remained set at 720 t. For 2003/04, following recovery of the stock, the pilchard catch cap has been increased to 1,000 t, and there is also a limit of 1,500 t on the take of other small pelagic fish permitted to be taken by licensees. Ninety per cent of the allocation of the available catch has been apportioned to holders of a managed fishery licence, 3% is provided for supplementary access endorsement holders and 7% for operators in the Southern Development Zone. The Northern Development Zone continues to have an informal trigger catch cap of 2,700 t for sardinella.

The determination of a pilchard and other small pelagic fish catch cap and the process for allocation among licensees is considered to be a temporary measure until more formal output controls are implemented in the fishery. Management arrangements are currently based on limited entry, capacity setting and controls on gear and boat size; however, it has been accepted for some time that the fishery should be managed under an individually transferable quota (ITQ) arrangement.

The framework that would see the change to ITQ management has been developed in consultation with stakeholders and is close to being finalised. The new management plan proposes to include the Northern and Southern Development Zone operators.

Further to improving current management arrangements for purse seining off the west coast, the Department is also considering longer-term strategies that will lead to improved ecosystem-based management. The commercial take of small pelagic fish will be considered in relation to its effect on other species in the ecosystem that depend on them as a food source.

The catch-cap-setting process is coordinated through the Purse Seine Management Advisory Committee, an expertise-based committee established to advise the Minister on matters relating to the management of purse seine fishing in Western Australia.

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 (as required)

Research Summary

Research on this fishery continues to utilise CAES data, biological monitoring of catches and spawning biomass estimates from egg surveys. The most recent bi-annual survey of spawning biomass was undertaken in July–August of 2002. These data are compiled into the following status report and ultimately will be used to set and review total allowable catches (TACs) once the fishery moves to quota management.

The need to introduce a new management approach, following the post-mass-mortality period when the fishery was essentially closed in some regions, was originally presented to the Purse Seine MAC during 2001. This initiative was further developed during 2002 to focus on capping TACs at a level that would enable the fishery to endure severe downturns in recruitment. In addition, once the stock had recovered annual changes in TACs, whether up or down, would not be allowed to exceed 25%. 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. However, before this can be progressed, the co-dominance of pilchards and sardinella, a feature not relevant to the south coast purse seine fisheries, has been recognised as a significant issue that needs to be addressed.

West Coast Purse Seine Managed Fishery Status Report

Prepared by D. Gaughan and T. Leary

FISHERY DESCRIPTION

Boundaries and access

The boundaries of this fishery are *'all Western Australian waters between 31° south latitude (near Lancelin) and 33° south latitude (near Cape Bouvard) and on the landward side of the 200 nautical mile Australian Fishing Zone limit, but excluding those waters within the boundaries of the Marmion Marine Park Reserve No. 1'*. Access to the fishery is under a limited entry system with eight full licences and six supplementary access holders. No quota system is in place at present. As there is currently no evidence for separate adult assemblages along the lower west coast (in contrast with the situation on the south coast), catch data from the developmental purse seine fishing zone, which lies between Cape Bouvard and Augusta, is included in the total for the West Coast Purse Seine Managed Fishery.

Main fishing method

Purse seine net.

RETAINED SPECIES

Pilchard is typically the dominant species in the catch, with sardinella important in recent years. In addition, smaller quantities of maray are commonly caught, while small catches of anchovies and yellowtail scad also occur periodically.

Commercial production (2002): 1,365 tonnes

Landings

The combined catch of pilchards, sardinella and maray for the managed fishery area increased to 1,347 t in 2002; the southern developmental zone did not contribute any catch during this year. This level of harvest is still considerably less than the catches in the mid-1990s (West Coast Purse Seine Figure 1). Encouragingly, the contribution of pilchards to the combined catch increased from less than 148 t in 2001 to 512 t in 2002. The sardinella catch increased from 596 t in 2001 to 701 t in 2002. In addition, a substantial catch of 136 t of maray (traditionally a minor retained species) was landed for the year. A very small number of anchovy (0.4 t) were recorded in 2002, whilst 6 t of yellowtail scad were landed. Overall the catch reflects an increased availability or abundance of pilchards, and an increasing trend toward the utilisation of other species available to the fishery.

Fishing effort

A small number of vessels continued to participate in the fishery in 2002. Together they fished a total of 543 days, an effort decrease of 36% over 2001 (738 days). The recent significant changes in catches (i.e. fewer pilchards) and associated restructuring in the fishery (e.g. development of new markets for sardinella) have impacted on the effort being applied in the fishery. It is not possible to estimate effort

separately for the different species being targeted.

Catch rate

The estimated catch rate for all small pelagics was 2,514 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 completed: **Yes**

Stock assessment is completed for pilchards, which are fully exploited on the west coast. Although no stock assessment has been undertaken for sardinella in the Fremantle 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.

A spawning biomass survey conducted in 2002 provided evidence that the pilchard stock was recovering strongly after the 1998/99 mass mortality event. The average age of the west coast pilchard catches is 3 years, which is indicative of a healthy stock that has experienced recent good levels of recruitment. However, 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. The issue of stock availability continues to remain unresolved.

Exploitation status: **Fully exploited**

Pilchards and sardinella are fully exploited.

Breeding stock levels: **Increasing**

See 'Stock assessment' above.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

This fishery targets specific schools of small pelagic fish so bycatch is insignificant. Small pelagic fish which are sometimes caught but for which there are no stable markets for the quantities involved include yellowtail scad (*Trachurus novaezelandiae*), blue mackerel (*Scomber australasicus*) and *Decapterus macrosoma*, a tropical scad.

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. It should be noted, however, that in 'normal' circumstances (i.e. in the absence of disease events or extended periods of very poor recruitment) the quota for pilchards is set at 10–15% of the spawning biomass, thus leaving 85–90% available to natural predators.

The concept of managing ecosystems, rather than single species, has been presented to the Purse Seine MAC during 2001. Small pelagic fish represent a conceptually easy group for which to begin implementing ecosystem-based fisheries management. For example, various seabirds will predate on a variety of species of small pelagics 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. This issue represents a complex shift in the management philosophy for purse seine fisheries in Western Australia and continues to undergo further development. The completion of FRDC project 98/203 (Gaughan et al. 2003) and further work 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.

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 west coast purse seine industry has undergone a major restructure in recent years. Following the mass mortality event of 1998/99, some licence holders and crew had to obtain income from elsewhere; however, the industry is now growing again. Including vessel crews, the industry provided direct employment for 24 people during 2002.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2002): **$1.6 million**

During 2002, pilchards and maray were sold as individually quick frozen bait and blocks to commercial and recreational markets, whilst pilchards and sardinella were processed for human consumption. All three species were also utilised as tuna feed. The average price of sardinella was $800/t, whilst pilchard fetched $900/t.

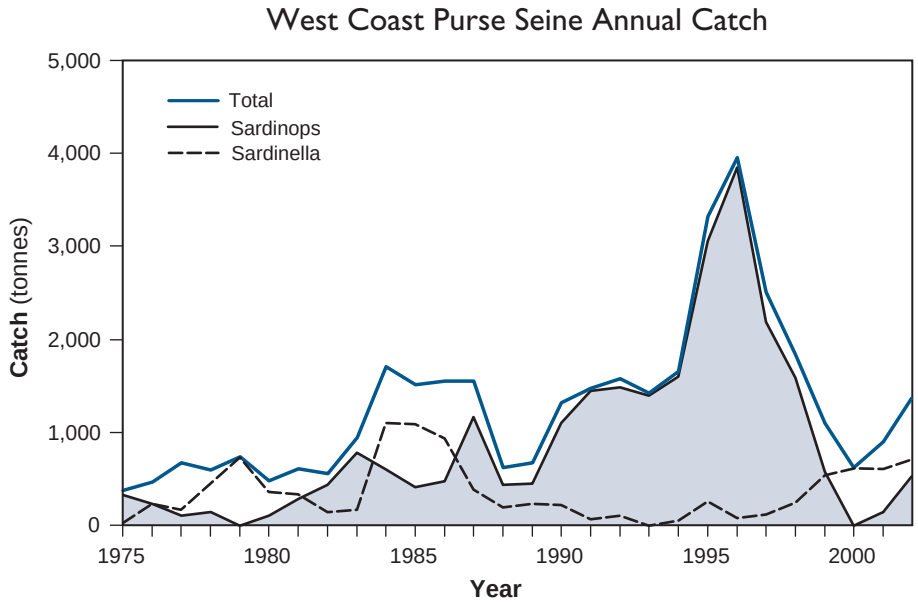
FISHERY GOVERNANCE

Acceptable catch (or effort) range: Not available

Management arrangements are currently based on limited entry with controls on gear and boat size; however, it has been accepted for some time that the fishery should be managed under a catch quota arrangement. The framework of arrangements that would see the change to quota management has been developed following consultation with stakeholders but has yet to be legislated. This situation remains unchanged from last year due to uncertainty about the recovery of the pilchard stocks. Until this issue is addressed, an acceptable catch range cannot be provided.

EXTERNAL FACTORS

The major factor influencing the pilchard stock has been the impact of the 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.



WEST COAST PURSE SEINE FIGURE 1

Annual catches of pilchards and sardinella along the lower west coast.

West Coast Demersal Scalefish Fishery

Management Summary

The 'west coast demersal scalefish fishery' describes the most important subset of the State's wetline fishery that has access to species or fishing methods not currently subject to a management plan. The wetline fleet comprises both 'wetline only' vessels and vessels with other managed fishery licences, and is only limited by the overall ceiling on fishing boat licences. Wetline fishing targets mainly demersal finfish using handlines and droplines. The major areas for wetline catches within the west coast bioregion are the Abrolhos Islands, mid-west coast, 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 takes baldchin groper (*Choerodon rubescens*) and a range of other species. These species are also caught in the demersal gillnet and longline fishery and by the recreational sector, including charter boats.

Widespread community concern over the unrestricted access of the wetline vessels to a wide range of species led to a study of the fishing activity of wetliners published as Fisheries Research Report no. 118 (Crowe et al. 1999). This document took a 'snapshot' of the fleet at 30 June 1998 and examined its seven-year fishing history (six years for the Abrolhos Islands). The report summarised catch data of dhufish, pink snapper and baldchin groper.

A review of the wetline fishery to develop more effective management arrangements was announced by the Minister for Fisheries in September 2002. Membership of panels to conduct the review was announced in March 2003, with the first meetings held in June. The review is essential before resource-sharing issues can be addressed under an allocation framework as proposed by the Integrated Fisheries Management review.

The Minister has appointed two panels to conduct the review for the west coast and Gascoyne bioregions:

- a Commercial Access Panel, appointed to devise a fair and equitable method of determining who will have access to the fishery and their level of allocation; and
- a Management Planning Panel, appointed to develop the specific management arrangements for the fishery.

This is the first time a two-panel system has been used in a review in Western Australia. This was done to separate the task of determining the management arrangements for the fishery (which requires extensive input from commercial fishing members) from access and allocation (which may benefit from a more independent analysis of fairness and equity issues).

Key issues that will need to be considered as part of the review include:

- the best methods/controls to manage the fishery;
- how to reduce the high level of latent effort within the fishery;
- how to determine the allocation of access to the fishery;
- consideration of the 3 November 1997 benchmark date announced by the previous Minister; and
- the cost of any management models.

This process will report to the Minister for Fisheries in 2004 and is expected to result in the development of a management plan for wetline fishing.

Governing Legislation/Fishing Authority
Fish Resources Management Regulations 1995
Fishing Boat Licence

Research Summary

Two research projects, both funded by FRDC, are focusing on demersal fishes in the west coast bioregion. The first project, on release mortality of demersal fishes, comprises two parts: a tagging study examining longer-term mortality of under-size demersal fish using three methods of release (venting, shotline and simple), and a short-term mortality experiment on snapper and dhufish that has been completed.

Results from the short-term (several days) release mortality experiments indicate that depth is the major factor affecting mortality in dhufish and snapper, with an average mortality of 52% in dhufish across all depths tested. Hook damage, causing severe bleeding from the gills, accounted for 5% and swallowed hooks accounted for another 8% of all deaths in released fish. The remaining mortality was attributed to barotraumas (akin to decompression sickness in divers) which increased with depth of capture from 21% at 0–14 m to 86% at 45–59 m (West Coast Demersal Scalefish Figure 1). The mortality rates of fish returned by recreational and commercial fishers could be higher than found here if some fish also die as a result of an inability to swim back to depth due to inflated swim bladders. Removing the expanded gas from the swim bladder by venting did not affect the mortality of caged fish and therefore may assist released fish to descend easily.

The second FRDC-funded research project, commencing in July 2003, will study the stock structure of dhufish and pink snapper populations along the west coast to determine the appropriate geographical scale for management. Regional variation in age structure and timing of reproduction will be examined in populations of dhufish and pink snapper and information on the biological parameters for lower west coast pink snapper will be collected. The research project includes funding for a PhD student (Murdoch University) studying reproductive biology, age and growth of pink snapper on the lower west coast.

The preliminary assessments of major demersal species in the west coast bioregion will 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.

A further FRDC-funded project has also undertaken work of relevance to this fishery. An alternative method of stock assessment for dhufish has been provided by a time-series model that makes forecasts of catches from one to up to five years in advance. The model incorporates lagged interactions of CAES catch rate data measured over a specific month (November) each year and annual Southern Oscillation Index (SOI) averages. A positive correlation was found between catches and the SOI component. The dhufish fishery is only weakly seasonal. However, November is typically the month before the peak catch period and November catch rates may signify the abundance of the mature fish prior to spawning. The SOI is thought to affect the abundance of juvenile settlement.

West Coast Demersal Scalefish Stocks Status Report

Prepared by J. St John

FISHERY DESCRIPTION

Boundaries and access

The west coast bioregion encompasses the waters of the Indian Ocean south of latitude 27° S and west of longitude 115°30′ E. During 2001/02 a total of 66 ‘wetline only’ vessels, and another 189 vessels that were licensed in other fisheries, operated within this bioregion using handline and dropline to target demersal species. Wetlining for west coast demersal scalefish is not yet subject to a specific management plan.

Main fishing method

Handline and dropline.

RETAINED SPECIES

Commercial production (season 2001/02): 1,094 tonnes

Landings

During 2001/02, 243 of the 255 boats in the west coast bioregion wetlined for demersal finfish, an additional 39 boats compared to last year. Of these, 227 boats reported catching West Australian dhufish, 214 boats caught pink snapper and 141 boats caught baldchin groper. Landings of pink snapper were highest at 250 t, followed by dhufish at 219 t. Among the other demersal species, baldchin groper was in the top four with 34 t. In the northern area of the west coast off Geraldton, major demersal 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), with 124 t caught by 86 boats. Also, 56 boats caught 14 t of coral trout (*Plectropomus maculatus*). These six major demersal species comprised almost 60% of the total catch of all species caught by handline and dropline in the fishery.

The remainder of the catch included around 75 other scalefish species, 17 species of sharks and rays and three invertebrate groups. Samson fish (*Seriola hippos*), redfish (correctly Bight redfish, *Centroberyx gerrardi*) and sharks (copper whaler, *Carcharinus brachyurus*, and wobbegong, Orectolobidae) ranked highly, with catches of 72, 40 and 74 t respectively (sharks combined).

In 2001/02 the catch of the entire fishery was 1,094 t, an increase of 198 t (22%) over the previous year.

Catches of demersal scalefish taken under other managed fishery licences are not included in the above catches. The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) landed 87 t of scalefish in 2001/02, including 16 t of dhufish and 14 t of pink snapper (see demersal gillnet and longline fisheries status report on pp. 132–136). The Cockburn Sound finfish fishery also lands small quantities of large mature pink snapper, which are likely to form part of an oceanic stock.

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 2). The wetline catch of 219 t during 2001/02 was the highest ever reported and continues the trend for escalating catch of this species. (By contrast, the catch of dhufish in the WCDGDLF for 2001/02 was 16 t, which was the same as the previous year.)

This year's reported catch is 41% above the 155 t of the 10-year mean up to 1999/2000. Moreover, for the second consecutive year, it is above the upper limit of the acceptable range of 125–179 t, this time by 22%. Highest monthly catches of over 20 t were recorded in both April and May 2002.

Pink snapper: The trend to increasing catches of pink snapper continues in 2001/02 with landings of 250 t, an increase of 46 t over the previous year. The catch this year was also above the 10-year average of 204 t, however it is well below the last peak catch of 309 t in 1995/96 (West Coast Demersal Scalefish Figure 3). The higher catch appears to fit a general cyclical pattern of snapper catches in this region reflecting large natural annual fluctuations in recruitment to the stock, particularly in the north of the bioregion. Thus, it is likely that pink snapper stocks were more abundant this year because the pink snapper catch in gillnets of the WCDGDLF rose from 7 t in 2000/01 to 14 t in 2001/02 without any significant increase in effort.

Similarly to last year, catches greater than 20 t occurred from January to June 2002, with the highest catch of nearly 36 t in April.

Baldchin groper: The catch of baldchin groper in 2001/02 was 34 t, which is close to the 10-year average of 31.8 t. Compared to dhufish and snapper, the catch of baldchin groper has remained relatively consistent over the last 10 years (West Coast Demersal Scalefish Figure 4). Monthly catches ranged from 1.7 t to a high 5.1 t in April, with catches greater than 3 t reported from March to June.

Fishing effort

Throughout 2001/02, 243 boats fished a total of 12,118 days in the west coast demersal scalefish fishery. Compared to the previous year, effort in this fishery increased 30% and the number of active boats increased by 18%. Throughout the bioregion, fishing effort for pink snapper and baldchin groper reached their highest levels yet at 9,635 and 5,999 days respectively, whereas fishing effort for dhufish was at its second highest for the decade. Even though these increases are substantial, they only represent the mobilisation of a small fraction of the latent effort possible in this fishery. These effort levels have also not been adjusted to reflect changes in efficiency.

Catch rate

To examine the catch rates of individual species caught throughout the bioregion, catch and fishing effort from boats that targeted these species were examined in two areas (Geraldton and Fremantle) which 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 system 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 boats, were calculated for dhufish and snapper in both regions and for baldchin groper in the Geraldton region only (West Coast Demersal Scalefish Figures 2, 3 and 4). Furthermore, the nominal effort of each boat used to calculate dhufish CPUE was 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.

Recreational component: > 30%

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 under way. Preliminary analyses indicate that the recreational catch of dhufish and snapper may be much greater than was found in the previous estimates 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 Fisheries Report 2000/2001* for more details). Consequently, the new information is likely to show that the recreational component is now significantly higher than the previously reported 30% of the total catch of demersal finfish in this region.

Stock assessment completed: Yes

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, yet the fishing efficiency of this fleet has increased with technological improvements over the last 10 years (see above) which affects this relationship. 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 dhufish catch rates are adjusted for fishing efficiency.

Research to generate the regional age structures of dhufish and pink snapper populations within the west coast bioregion has been initiated to enable more sophisticated stock assessment techniques to be used in the future.

Dhufish: Catch rates of dhufish in the Geraldton area may be a relatively reliable measure of stock abundance because fishers in this area target a suite of high-value species including coral trout, baldchin groper and lethrinid species. In Fremantle, dhufish is the most valuable species and highly targeted, with fishers attempting to maximise their catch rates of this species, potentially making them a less robust indicator.

The catch rates of dhufish around Fremantle have risen for the first time since the exceptionally high rates in 1997/98 (West Coast Demersal Scalefish Figure 2). At 42 kg/day, current catch rates are 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. Catch rates of dhufish in Geraldton have risen consistently throughout the decade to their current level of 44 kg/day, which is significantly higher than the 10-year average of 32 kg/day. The average catch rates in the two regions are very similar, with significant differences in two years only, 1996/97 and 1997/98.

The WCDGDLF uses gillnets, which are a passive form of fishing that does not target dhufish directly. Therefore, the gillnet catch rates (kg fish/ km of net/ day of standardised effort at 19 hours = 1 day) provide an alternative and arguably better index of abundance. The CPUE of dhufish caught by the WCDGDLF rose by 18% over the last three years, from 5.72 in 1999/2000 and 6.11 in 2000/01 to 6.76 in 2001/02.

Although these increasing catch rates should signify healthy dhufish stocks, there are a number of precautionary elements that need to be considered, as set out below, and close scrutiny of the fishery is required to ensure that it does not become over-exploited.

- The escalating commercial catch of dhufish in recent years, with the record catch in 2001/02, shows that this species is under increasing fishing pressure. Furthermore, the dhufish is an icon species that is targeted by recreational fishers in increasing numbers and is distributed across Western Australia's most populated area, Perth and surrounds.
- Whilst corrections have been used to account for the increases in fishing efficiency due to the introduction of global positioning systems (GPS), these are difficult to measure and the impact of increasing fisher knowledge remains unquantified.
- The increased fishing effort is only a small proportion of the potentially high level of latent effort available in this fishery.

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 snapper catch (West Coast Demersal Scalefish Figure 3). The two areas have very different patterns of average catch rates of pink snapper over the decade. Within areas, 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). In 2001/02, despite the increasing catch, the average catch rate at Geraldton was lower than the previous year, though still relatively high. 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.

The catch of pink snapper in 2001/02 by other fisheries in this region suggests that there was an increased abundance of pink snapper stocks. For example, pink snapper caught by the WCDGDLF rose from 7 t in 2000/01 to 14 t in 2001/02 and the CPUE increased from 2.67 to 6.06 (kg/ km net/ day). As already discussed, this apparent increase in abundance is likely to be a peak in the cyclical pattern. Therefore, if high levels of fishing effort on pink snapper by the wetline fishery continue, this may be of concern in the future.

Baldchin groper: Catch and catch rates of baldchin groper have been the least variable of the major species in the west coast demersal scalefish fishery. The average CPUE for

baldchin groper by the top 10 boats at Geraldton has remained steady around 15 kg/day over the last decade; however, in 2001/02 the CPUE (approximately 12 kg/day) has declined slightly to its 1992/93 level (West Coast Demersal Scalefish Figure 4). At the same time, total fishing effort for baldchin groper increased 16% to reach a record level (9,635 fishing days), but total catch only increased 2%. If this pattern of increasing fishing effort with decreasing catch rates continues, then the fishery may be showing signs of over-exploitation, particularly as these catches have not been adjusted for the inevitable increase in fishing efficiency over the past decade.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

The adjusted catch rates for the three main target species provide an indication of spawning biomass, which does not suggest that breeding stock levels are currently affecting subsequent recruitment. Direct measurements of current breeding stock levels against estimated virgin biomass would be needed to confirm this assessment. Fish species that aggregate to spawn are, however, more vulnerable to over-exploitation because these aggregations may be predictable in time and/or space. Of the main target species, pink snapper are known to form large spawning aggregations and dhufish are suspected of aggregating to spawn; however, very little is known about dhufish spawning behaviour.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Line fishing is a highly selective fishing method that targets demersal fishes using baited hooks. Bycatch therefore comprises only a small proportion of the overall catch, and includes small numbers of inedible species (e.g. silver toadfish) or small fishes (e.g. wrasses), which are discarded.

Protected species interaction: **Not applicable**

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 74% of the boats (189) in the wetline fleet are associated with other licensed fisheries. Only 66 boats in the wetline fleet hold no other licences and thus are 'wetline only'. On average, the entire wetline fleet fished 47 days each employing around 168 skippers and crew to take demersal finfish during 2001/02.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001/02): $5.3 million

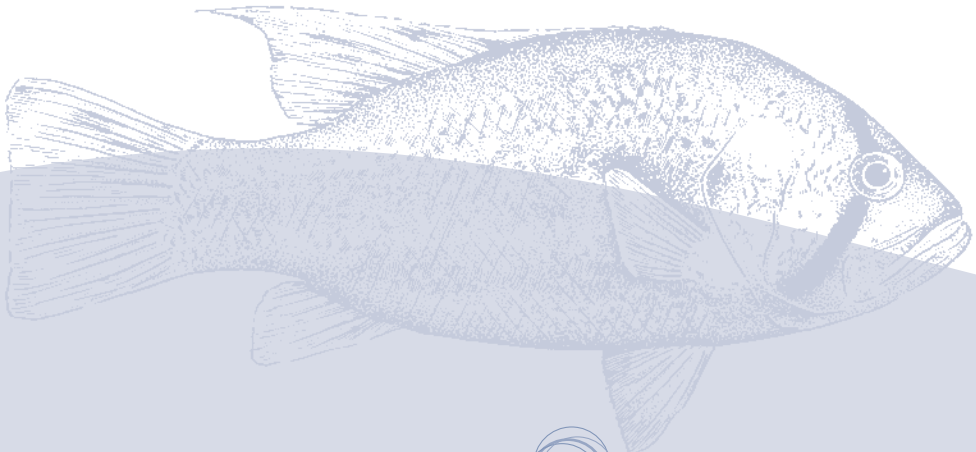
The estimated value of the fishery in 2001/02 includes all species caught by handlines and droplines on the west coast of Western Australia. More than 108 species or groups of seafood were recorded as catch and sold for an estimated $5.3 million. The highest-valued catch was dhufish at 37% of the total value, followed by pink snapper (22%), the lethrinids (11%), baldchin groper (4%) and coral trout (3%). Catch of all other species combined was 23% of the value of this fishery. Based on 2000/01 prices, dhufish, pink snapper and baldchin groper sold on average for $9.41/kg, $5.24/kg and $6.72/kg respectively and, at $10.54/kg, coral trout commanded the highest average price of all species in the fishery.

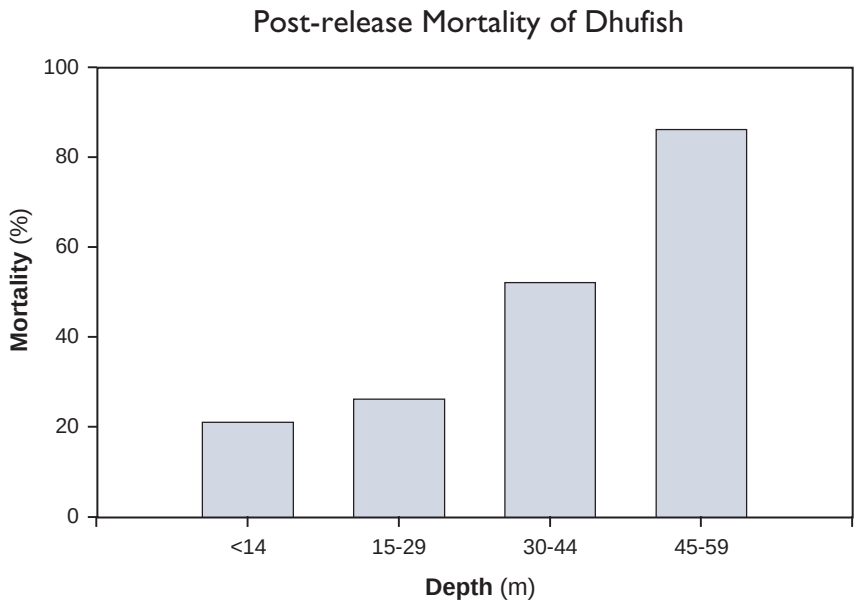
FISHERY GOVERNANCE

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

The 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 is 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.

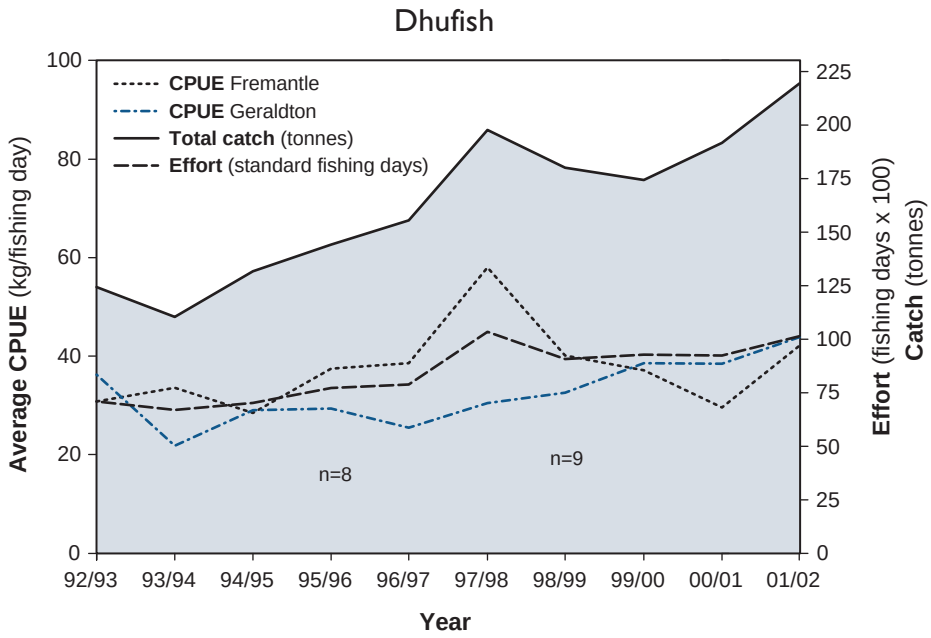
For the second consecutive year, the catch of the entire fishery at 1,094 t is well above the acceptable range. This range was exceeded by 12% in 2000/01 and 37% in 2001/02. Although catches of pink snapper and baldchin groper in 2001/02 were both within the acceptable range based on 1990s catches, the record catch of dhufish, at 219 t, was well above the acceptable range for the second consecutive year. 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. A review of the management arrangements for this fishery is currently under way as part of the 'wetline review'.





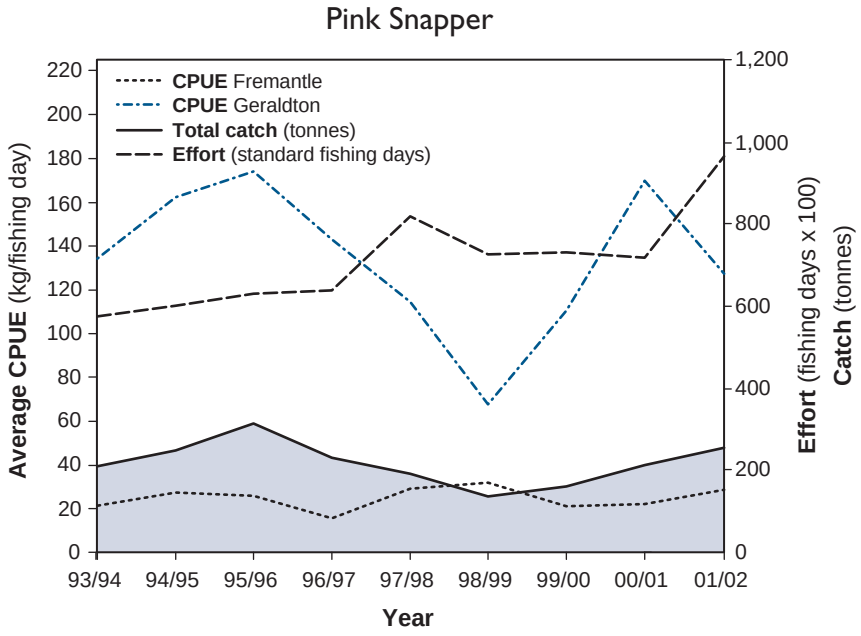
WEST COAST DEMERSAL SCALEFISH FIGURE 1

Post-release mortality of dhufish (Glaucosoma hebraicum) in experimental cages at four depths of capture: 0–14 m (n = 19), 15–29 m (n = 19), 30–44 m (n = 23) and 45–59 m (n = 23).



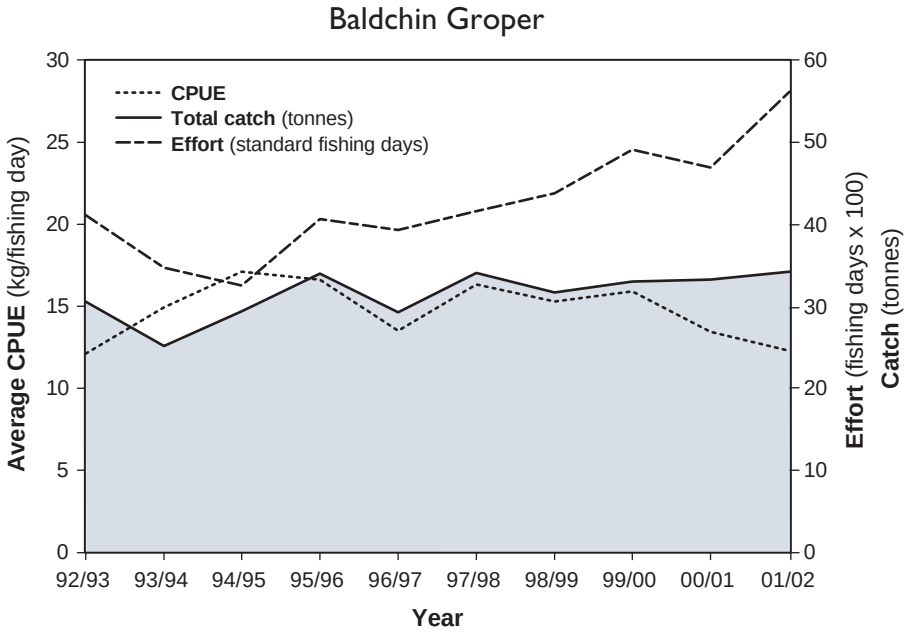
WEST COAST DEMERSAL SCALEFISH FIGURE 2

Annual catch and adjusted effort for dhufish in the west coast demersal scalefish fishery over the decade from 1992/93 to 2001/02. 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 3

Annual catch and effort for pink snapper in the west coast demersal scalefish fishery over the decade from 1992/93 to 2001/02. Catch per unit effort (CPUE, kg/standard 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 4

Annual catch and effort for baldchin groper in the west coast demersal scalefish fishery over the decade from 1992/93 to 2001/02. Catch per unit effort (CPUE, kg/standard fishing day) is shown for baldchin groper caught by the top 10 boats each year off Geraldton.

GASCOYNE COAST BIOREGION

REGIONAL MANAGEMENT OVERVIEW

The Gascoyne coast bioregion is home to the State's major trawl fisheries, with managed fisheries for prawns and scallops occurring in Shark Bay and Exmouth Gulf. In addition, the region supports the important Shark Bay Snapper and Shark Bay Beach Seine and Mesh Net Managed Fisheries, which respectively provide most of the pink snapper and whiting catch for the State. An experimental fishery for blue swimmer crabs, based primarily in Carnarvon but operating throughout the waters of Shark Bay, is also being developed.

Key Commercial Program activities in the Gascoyne bioregion over the past 12 months have included:

- continued implementation of bycatch reduction devices in the trawl fisheries, with full implementation of grids and trials of fish escapement devices;
- refinement of the operational process of the Memorandum of Understanding for the Exmouth Gulf Prawn Managed Fishery to improve its functionality;
- completion of the report addressing the principles of ecological sustainability (in line with the requirements of the *Environment Protection and Biodiversity Conservation Act 1999*) for the Shark Bay Snapper Managed Fishery; and
- development of responses to public comments on the ecological sustainability reports for the Exmouth Gulf Prawn, Shark Bay Prawn and Shark Bay Scallop Managed Fisheries, and addressing of requirements arising from the ecological sustainability accreditation of these fisheries.

The Gascoyne bioregion is also home to an active wetline fishery, operating in a number of areas and incorporating:

- demersal line fishing;
- mackerel fishing (primarily by trolling); and
- beach seining and some near-shore gillnetting.

The demersal line fishery takes a range of demersal fish species, including emperors, baldchin groper/tuskfish and, more recently, the deep-water-dwelling goldband snapper (jobfish) 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 the two managed finfish fisheries (Shark Bay Snapper and Shark Bay Beach Seine and Mesh Net Managed Fisheries). The management arrangements for the wetline fishery will be considered in the review of wetline fishing announced by the Minister in September 2002.

Mackerel (generally narrow-barred and broad-barred Spanish mackerel) are also taken by a number of wetliners who specifically target this high-value fish, as well as by the operators working in the two managed finfish fisheries.

A new interim management plan for this fishery is likely to be implemented at the beginning of 2004.

There is also a small take of fish by beach seining using hand-hauled nets north of the northern boundary of the Shark Bay Beach Seine and Mesh Net Managed Fishery.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Compliance activities relating to the commercial fisheries of the Gascoyne coast bioregion are conducted by Fisheries Officers from offices located in Exmouth, Carnarvon and Denham. Compliance activities in the region comprise a mix of at-sea inspections of commercial operations in relation to their authorisations, catch, fishing gear and time/area of operation, in addition to land-based inspections of authorisations, catch (type and amount), fish processing factories, retail outlets and catch consignment deliveries. The various trawl fisheries operating in the region are also monitored remotely through the Department's satellite-enabled Vessel Monitoring System and, in some cases, quota monitoring systems.

Major fisheries serviced in the region include the Shark Bay Prawn, Shark Bay Scallop, Exmouth Gulf Prawn, Shark Bay Snapper and Shark Bay Beach Seine and Mesh Net Managed Fisheries, the experimental Shark Bay inshore crab fishery, and various wetline operations. Officers utilise the 9.5 m patrol vessel *John Brockman*, the 8 m patrol vessel *Gnulli* and a variety of small dinghies to conduct regular inshore at-sea inspections. From time to time there is a need to utilise the Department's larger seagoing patrol vessels for more extensive at-sea operations.

Activities during 2001/02

During 2001/02, Regional Services personnel undertook 7,593 hours of compliance work in commercial fisheries in the Gascoyne coast bioregion (Gascoyne Commercial Compliance Table 1), excluding work conducted for the Australian Fisheries Management Authority in Commonwealth fisheries. The major percentage of these hours comprised duties performed in relation to trawl fishery compliance activities.

During 2001/02, Fisheries Officers recorded 508 field contacts with commercial fishing operations and 1,217 office contacts with commercial fishers. In the course of the year officers issued 8 infringement warnings and 21 infringement notices, while a further 18 cases were progressed as prosecution actions against commercial fishers.

GASCOYNE COMMERCIAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in commercial fisheries within the Gascoyne coast bioregion during the 2001/02 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	7,593
Fisher field contacts by Fisheries Officers	508
District Office contacts by Fisheries Officers	1,217
Fishwatch reports *	26
OFFENCES DETECTED	
Infringement warnings	8
Infringement notices	21
Prosecutions	18

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

The region's major fisheries continued to be the focus of the majority of investigations resulting in prosecution action during the year. In particular, the Shark Bay Prawn and Scallop Managed Fisheries generated a number of VMS-related offences requiring investigation and in some cases prosecution.

However, a number of other commercial fisheries, including the Exmouth Gulf Prawn and Shark Bay Snapper Managed Fisheries and the wetline fishery, also required varying levels of investigation. The wetline compliance problems were generally restricted to a small number of fishers using unlicensed personnel as crew and/or incorporating the catches of recreational fishers in their consignments. The Shark Bay Snapper Managed Fishery, following stricter and more comprehensive management arrangements introduced in late 2000, generated several offences relating mainly to non-compliance with quotas or failure to complete correct catch and disposal records. A number of fishers were also investigated for authorisation-related offences.

Initiatives in 2002/03

2002/03 saw the Gascoyne bioregion's management staff working together with participants in the Exmouth Gulf Prawn Managed Fishery to complete a series of risk assessment workshops and meetings. The meetings allowed those involved to work through issues associated with levels of compliance funding and servicing for the fishery and resulted in both the Department and industry gaining a better understanding of one another's priorities, obligations and expectations, with a view to ensuring effective formulation and delivery of appropriate compliance projects.

The introduction of VMS into the Exmouth Gulf Prawn Fishery management arrangements during the 2002 season necessitated extra training in VMS-related matters for staff working at the Exmouth District Office. This training was able to build on experience gained over the past three years since the Shark Bay prawn and scallop trawl fisheries began using VMS. Additionally, the Department has been working to review the most appropriate strategy to deal with VMS-related offences. This has included the development of new protocols and processes incorporating staff from the Gascoyne bioregion, the Perth-based VMS centre and the Prosecutions Section, and is already producing benefits for those handling these matters.

REGIONAL RESEARCH OVERVIEW OF WETLINE FISHING

The CAES database indicates that around 12% of the State's wetline catch was reported from the Gascoyne coast bioregion during 2001/02. The top ten species comprised goldband snapper (*Pristipomoides multidens*) 69 t, Spanish mackerel (*Scomberomorus commerson*) 49 t, pink snapper (*Pagrus auratus*) caught outside of the Shark Bay Snapper Managed Fishery 43 t, sea mullet (*Mugil cephalus*) 19 t, rosy jobfish (*Pristipomoides filamentosus*) 17 t, red emperor (*Lutjanus sebae*) 12 t, northern bluefin tuna (*Thunnus tonggol*) 10 t, grey mackerel (*Scomberomerus semifasciatus*) 6 t, nor-west snapper (Lethrinidae) 6 t and spangled emperor (*Lethrinus nebulosus*) 6 t.

An interim management plan for the troll fishery for mackerel, details of which are reported under the north coast bioregion (pp. 97–102), will commence 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. 64–67). The majority of the mullet catches were reported from the area between the northern boundary of the beach seine fishery and Carnarvon.

Shark Bay Prawn Managed Fishery

Management Summary

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%. The fleet also catches between 20% and 30% of the annual scallop catch in Shark Bay.

Most large king and tiger prawns are exported whole or headless to Asia (Japan) and Europe, while the Australian markets take most of the smaller king and coral prawns. The fishery has an annual value of around $25–30 million, although the value of the catch fluctuates according to catch levels, the prices of prawns on world markets, and exchange rates.

Management of the fishery is based on limited entry, crew limitations, gear controls, season and area openings and closures, moon phase closures and daily fishing time controls.

A Ministerial exemption was again granted to licensees prior to the start of the 2003 season, exempting operators from the 375 boat unit rule currently provided for under the Shark Bay

Prawn Management Plan 1993. Management responses to the longer-term removal of the 375 boat unit rule are being discussed with industry. An exemption was also granted to allow licensees to trial 'bison' otterboards (as opposed to standard flat wooden otterboards) during the 2003 season.

Bycatch reduction devices (specifically grids) continue to be fully implemented during the 2003 season. Vessels operating in the fishery are required by way of a condition on the managed fishery licence to fish with a grid in each net. Trials of secondary bycatch reduction devices or fish escapement devices (FEDs) (for example, square mesh panels) are also occurring during the 2003 season. It was necessary to provide an exemption to provide for such trials given that the meshes associated with the FEDs are greater than provided for in the legislation.

The 2003 fishing season commenced on 6 March and is scheduled to close on 1 November. The timing of the opening of the season allows the harvest of large residual prawns which were not caught in the previous year's season. Within the main fishing period, there are various subsidiary openings and closures which are aimed at catching prawns at appropriate sizes and protecting the stock from recruitment over-fishing.

Since the 1999 season, moon closures have been made more variable, changing from a standard three-day period to between three and seven days over the full moon. This change is aimed at increasing economic efficiency by shifting fishing effort away from the period where catch rates are reduced and a greater proportion of the catch is soft-shelled and therefore less marketable. Permanent nursery area closures within the fishery prevent the fishing of small prawns while two spatio-temporal closures serve to protect tiger prawn breeding stocks. The Vessel Monitoring System continues to be an integral part of the fishery's management strategy and provides the mechanism to give effect to the various closures in the fishery.

The Shark Bay Prawn Management Advisory Committee has been replaced by the Joint Trawl Management Advisory Committee (JTMAC), which covers the Shark Bay Prawn, Shark Bay Scallop, and Exmouth Gulf Prawn managed fisheries. Given the overlap between the three Gascoyne trawl fisheries it was considered more efficient to merge the previously separate MACs. The JTMAC, which provides high-level advice to the Minister on the management of these fisheries, held its inaugural meeting in February 2003. The JTMAC process provides for management arrangements to be better tailored to maintaining the sustainability of the fishery, ensuring cost-effective management and achieving the maximum economic return from the prawn resource. Detailed fishery management matters (e.g. opening/closing dates, spatial and temporal closures) are now dealt with directly between the Department and licensees.

Environment Australia has declared the fishery as being managed in an ecologically sustainable manner under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a variety of recommendations, this approval allows product from the fishery to be exported for a five-year period.

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

Research Summary

Research activities continued to focus on stock assessment and monitoring the status of the prawn stocks, particularly tiger prawns. All boats completed detailed research logbooks, which together with pre-season and spawning stock surveys, made up the database for monitoring the fishery.

A collaborative project with industry to review the impact of trawling on non-target species has been evaluating gear modifications to reduce bycatch and improve product quality. A further FRDC-funded project is examining the biodiversity of bycatch in trawled and untrawled areas of Shark Bay.

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

Shark Bay Prawn Managed Fishery Status Report

Prepared by E. Sporer and M. Kangas

FISHERY DESCRIPTION

Boundaries and access

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).

Twenty-seven boats are licensed to engage in prawn trawling in this fishery and all licences were active in the 2002 season, which opened on 6 March and closed on 21 October.

Recruitment surveys in March and April within the closed area south and east of the Carnarvon/Peron Line and the extended nursery area (ENA) were used to determine the extent of this area to be opened. The Carnarvon/Peron area was opened on 11 April. Owing to small prawn size the ENA remained closed to fishing until 6 May. The ENA closed to fishing on 1 August to protect juvenile king prawns.

Denham Sound opened on 6 March, with trawling restricted to the area north of the Torbay Line, and closed from 1 May. The Sound, including the Torbay Line, reopened on 1 August and remained open until the end of the season (21 October).

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002): 2,075 tonnes

Landings

The total landings of major penaeids for the 2002 season were 2,075 t, comprising 1,554 t of king prawns, 510 t of tiger prawns and 11 t of endeavour prawns. There were also 102 t of minor penaeids (coral prawns) landed.

The 2002 landings represent a substantial increase compared to 2001, with the catch of king, tiger and endeavour prawns within the acceptable catch range. King prawn landings for 2002 were close to the five-year average (1,516 t) (Shark Bay Prawn Figure 2) whilst the tiger prawn landings were slightly lower than the five-year average (561 t).

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.

Scallop landings by the prawn fleet in 2002 totalled 371 t whole weight. All Shark Bay Prawn Managed Fishery boats have Shark Bay Scallop Managed Fishery Class B licences.

By-product landings included 155 t of blue swimmer crab (*Portunus pelagicus*), 29 t of squid, 19 t of cuttlefish, 21 t of tuna (wetlining), 8 t of mulloway (*Argyrosomus hololepidotus*) and a small quantity of other miscellaneous finfish species.

Fishing effort

Effort recorded in the 2002 daily logbooks for the fleet showed nominal effort as 49,494 hours, which was a reduction of 4,818 hours when compared with the last five years' average effort (54,312 hours). Fishing effort is being monitored with the aim of reducing ineffective trawl hours whilst maintaining high catch rate levels, thus reducing overall effort to improve economic efficiency within the prawn trawl fleet. There were seven moon closure periods consisting of three, five and seven days providing a total of 192 nights' fishing. Following consultation with the Research Division and industry, the August and September moon closure periods were extended from seven to ten days, and together with the voluntary early closure, only a total of 182 nights were actually fished. Although the number of fishing days (and thus trawl hours) has been reduced during the 2002 season, effective effort is high. The catch and effort in this fishery requires vigilant monitoring of both king and tiger prawn stocks to maintain effective effort at current levels.

Catch rate

A catch rate of 31.4 kg/hr for king prawns was observed, which was the highest catch rate since 1964. This, in part, reflects the reduction in fishing during periods of low catch rate aimed at increasing economic efficiency.

The 2002 tiger prawn catch rate of 10.3 kg/hr was higher than the 2001 season (7.4 kg/hr) and comparable to that of the years 1991–2000 (mean 10.4 kg/hr). The 2002 season catch rates have also been affected by 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 completed: Yes

The king and tiger prawn stocks are fully exploited. 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). 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. We continue to examine catch trends to enhance our 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 1,500 and 500 t respectively.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

The multi-species nature of this fishery requires the levels of exploitation 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 the king prawn stock remains at a point where recruitment is not 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.

Two standardised research surveys (to confirm commercial catch rates derived from logbook information) were carried out on 4 and 18 June 2002 to obtain the catch rate of tiger prawns, which provided the basis for closure of the southern spawning area on 23 June. The average catch rate of tiger prawns for the surveys in 2002 was 15.5 kg/hr compared to 10.2 kg/hr in 2001. In 2001, because the TPSA was closed on 19 June, the threshold catch rate was maintained throughout July and August in the TPSA. In 2002, however, fishing was allowed in the TPSA during the period 18–23 June, and a subsequent survey on 30 July indicated the catch rate had declined to only 3.6 kg/hr in the TPSA (which is still above the SRR trigger level of 2 kg/hr). In future, therefore, the TPSA will close immediately after survey confirmation of the threshold catch rates (10 kg/hr) being reached. This regime of

surveys and closure will continue for a minimum of three years (2001–2003 inclusive) to allow an analysis of its usefulness in protection of spawning stock.

The northern spawning area, which is aligned with the northern portion of the original 1996 TPSA, was not closed during the 2002 season because a survey could not be completed in the area and it was anticipated that low fishing activity would occur there. The season average commercial catch rate (10.3 kg/hr) and the total catch for tiger prawns was within expectations. Furthermore, the fishing arrangements provided larger sizes and good quality prawns during the season.

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 rainfall 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.

NON-RETAINED SPECIES

Bycatch species impact: **Moderate**

Bycatch composition is dominated by dead wire weed, which breaks off the extensive shallow Wooramel seagrass bank annually over summer, and small fish species mostly not exploited 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 medium relative to other subtropical trawl fisheries at about 4–8 times the prawn catch. A study on the bycatch of trawled and untrawled areas of Shark Bay is under way and will further document bycatch abundance and composition during 2002/03. Trialling and implementation of fish escapement devices (square mesh panels in cod-ends) should further reduce the quantity of small fish retained in trawls.

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 generally 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.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Although the exploitation rates of the retained target species are high, such species have very high natural mortality rates and make up a relatively low 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 only 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 2002, the total area trawled within Shark Bay was approximately 885 square nautical miles which represents less than 20% 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, means that the typical impact of the trawls is minimal.

SOCIAL EFFECTS

The estimated employment for the year 2002 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 (2002): **$30 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 2001 except for tiger prawns, and average ex-boat prices were as follows:

King prawns	$13.10/kg
Tiger prawns	$18.25/kg
Endeavour prawns	$9.00/kg
Coral prawns	$2.00/kg

FISHERY GOVERNANCE

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

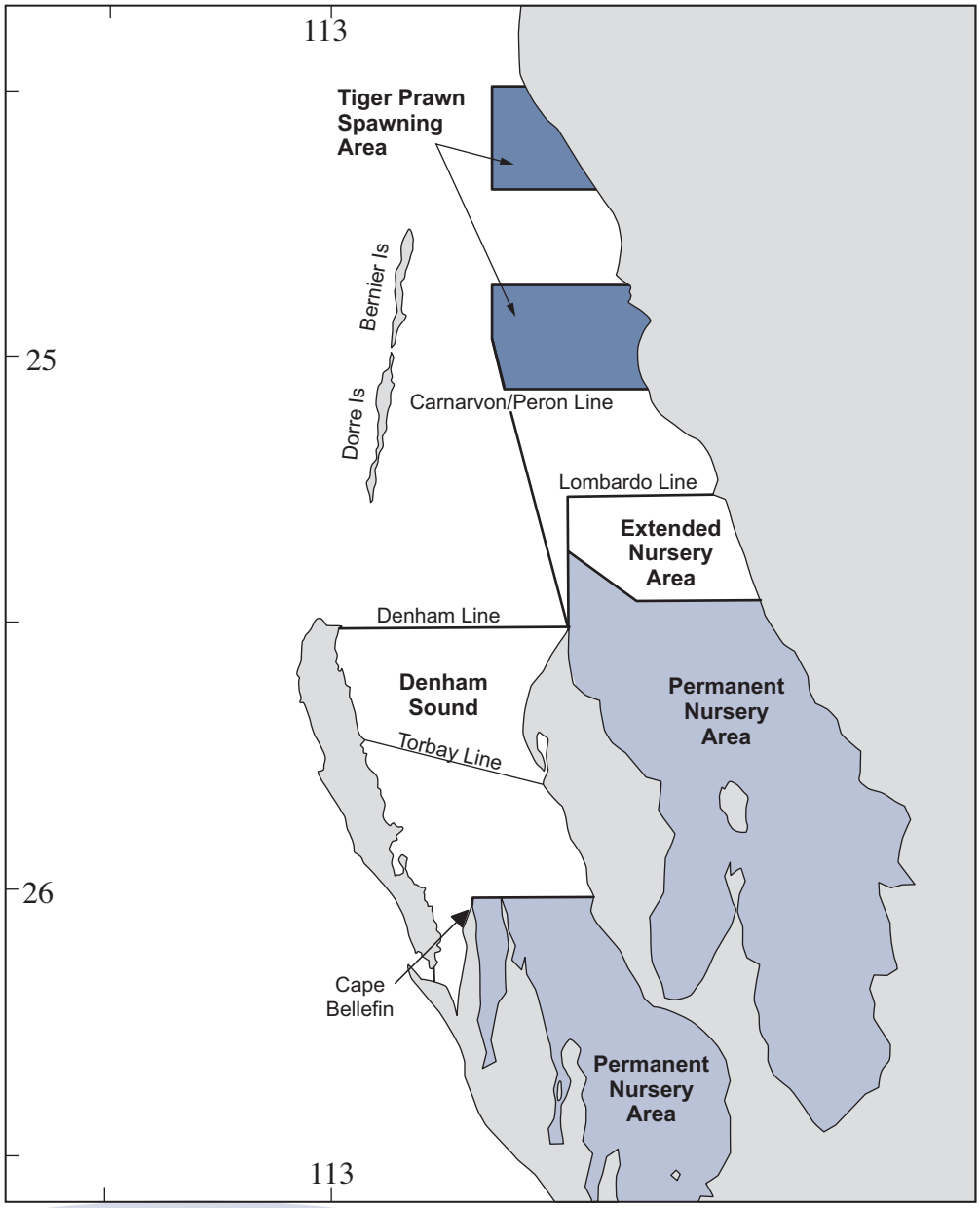
Under current effort levels and normal environmental conditions, and based on the 10-year range of catches following the restructuring of the fishery to 27 licences (1990), the acceptable catch range for major penaeids is 1,501–2,330 t. Acceptable catch ranges for individual species are king prawns 1,100–1,600 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 2002 were within the acceptable ranges set. Monitoring of the tiger prawn stock will still be regarded as a high priority in this fishery and the collaborative initiative with industry to refine the TPSA closure system will continue.

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.

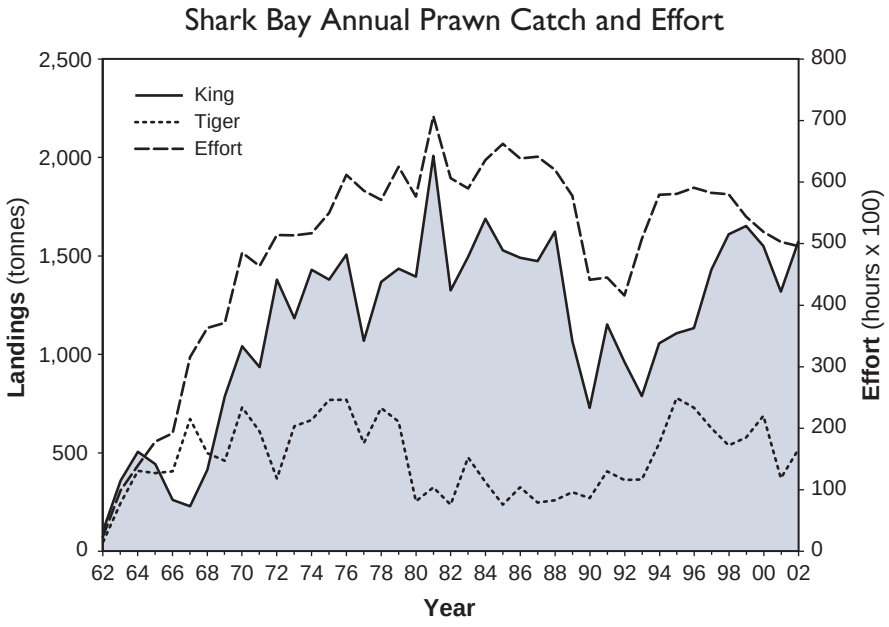
The Leeuwin Current also appears to affect scallop recruitment, which can cause a redirection in effort away from prawn areas and artificially lower prawn catches when scallops are very abundant.

Cyclone effects including high 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, 1962–2002.

Exmouth Gulf Prawn Managed Fishery

Management Summary

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*).

The 2003 fishing season commenced on 1 April and is scheduled to close on 15 November. The more flexible fishing arrangements trialled in the 2002 season are continuing during the 2003 season. This provides industry with the flexibility to maximise tiger prawn size (and hence market value) while maintaining the existing monitoring and tiger prawn breeding stocks catch threshold protocols. The Memorandum of Understanding between industry and the Department continues to ensure accountability.

Management controls also include limited entry and gear restrictions as well as controls on vessel size and power. Licensees in the fishery have again been granted an exemption to continue trialling quad gear (four smaller nets). It is likely that the Exmouth Gulf Prawn Management Plan 1989 will be amended during the 2003 season to allow for more flexible gear configurations (through unitisation without altering the total headrope in the fishery). The Vessel Monitoring System continues to be an integral part of the fishery's management strategy.

Bycatch reduction devices (specifically grids) continue to be fully implemented during the 2003 season by way of a condition on the managed fishery licence. It is expected that secondary bycatch reduction devices or fish escapement devices (for example, square mesh panels) will be trialled later in the 2003 season.

The Department, in association with industry, is also in the process of preparing an application to the Commonwealth's Department of Agriculture, Forestry and Fisheries Australia in order to gain certification from the US Department of State that the fishery is BRD-compliant in terms of potential turtle captures. This will allow licensees to export product to the US market. Industry has also installed additional 'hopper' sorting systems on vessels, which improves the survival of some bycatch species. There are now seven vessels which have hopper systems.

The Exmouth Gulf Prawn Management Advisory Committee has been replaced by the Joint Trawl Management Advisory Committee, which covers the Exmouth Gulf Prawn, Shark Bay Prawn and Shark Bay Scallop Managed Fisheries. Given the overlap between the three Gascoyne trawl fisheries it was considered more efficient to merge the previously separate MACs. The JTMAC, which provides high-level advice to the Minister on the management of these fisheries, held its inaugural meeting early in 2003. The JTMAC process provides for management arrangements to be better tailored to maintaining the sustainability of the fishery, ensuring cost-effective management and achieving the maximum economic return from the prawn resource. Detailed fishery management matters (e.g. opening/closing dates, spatial and temporal

closures) are now dealt with directly between the Department and licensees.

Environment Australia has declared the fishery as being managed in an ecologically sustainable manner under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a variety of recommendations, this approval allows product from the fishery to be exported for a five-year period.

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

Research Summary

Research activities continue to focus on stock assessment and surveys to monitor both annual recruitment of tiger prawns and residual spawning stock levels. All boats completed detailed research logbooks which, together with survey data and factory records, provide the database for managing the fishery. A pre-season survey of the king prawn stocks was also undertaken in collaboration with industry to assist with developing harvesting strategies.

Collaborative research has continued with industry on assessing devices to reduce unwanted bycatch. 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.

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

Exmouth Gulf Prawn Managed Fishery Status Report

Prepared by E. Sporer and M. Kangas

FISHERY DESCRIPTION

Boundaries and access

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).

There were 13 boats licensed to operate in the Exmouth Gulf Prawn Managed Fishery during the 2002 season. All boats towed 4.5 fathom quad gear (four nets).

The 2002 season arrangements allowed for a maximum of 200 fishing nights with a minimum of 28 non-fishing nights for moon closures around the full moon (four nights each moon closure period). The entire fleet, however, utilised only 183 nights for the season.

The scheduled season arrangements saw the season officially opened on 6 April 2002 and closed on 20 November 2002. The fishing patterns were flexible with voluntary closures following an assessment, through surveys, of king and tiger prawn size and abundance in different areas. Therefore, the fleet actually commenced fishing on 16 April, in Areas A and B. The fishing grounds were progressively opened using results from both research and industry-initiated surveys. These surveys also provided data leading to opening times and extent of the tiger prawn fishing grounds to be trawled within Areas B and C.

These consultative, survey-based fishing arrangements enable a rapid response to resource fluctuations, and in turn provide a conservative and sustainable approach to stock management. The arrangements still involved a mandatory closure of the tiger prawn spawning area when the tiger prawn catch rate reached 19 kg/hr (quad gear catch rate), or on August 1, whichever occurred first.

A total of 17 extra nights were not fished during the season. This included the first 10 nights after the official opening date (6–15 April), two extra nights from extended moon closure periods, one night because of a strong wind warning, and the voluntary ending of the season four days early on 16 November. In addition, Exmouth recorded heavy rainfall (304.6 mm) in the 24-hour period between 3 and 4 June which resulted in flooding that caused damage to a number of trawlers moored at the marina. Twelve boats did not fish during these two nights, and two boats were not able to fish until 12 June due to the severe damage inflicted by the flood.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002): 809 tonnes

Landings

The total prawn landings from Exmouth Gulf for the 2002 season were 809 t, an increase on last year's combined landings of 670 t, and comprised 244 t of king prawns, 395 t of tiger prawns and 170 t of endeavour prawns landed (Exmouth Gulf Prawn Figure 2). King prawn catches were still below the acceptable range. Surveys and monitoring of the king prawn stocks have been instigated to review whether the low catches are a result of changes in the fishing strategy over the past two years (targeting tiger prawns at the start of the season), or if a longer-term effect of Cyclone Vance is impacting catches. There was an increase in the catch of both tiger and endeavour prawns in 2002 compared to 2001 when catches were still

recovering from the negative affects of Cyclone Vance upon the juvenile prawn habitat. These improvements in tiger prawn catches in the past two years are considered to reflect the improvement in nursery habitats.

Recorded landings of by-product included 48 t of coral prawns, 12 t of blue swimmer crab (*Portunus pelagicus*), 8 t of squid, 5 t of cuttlefish, 4 t of bugs (*Thenus orientalis*), 1 t each of shark and octopus and an insignificant amount of mixed finfish species.

Fishing effort

Total nominal effort for the 2002 season was 26,358 hours. The equivalent effort in twin-gear terms, after adjusting for changes in configuration from twin to quad gear, was 32,440 hours, which was slightly lower than in 2001 (33,284 hours). Most of this reduced effort is attributed to the loss of boat time due to damage resulting from the flooding of the marina.

Catch rate

The catch rate in twin-gear terms for king prawns was 7.5 kg/hr, at the low end of the range for this species. The catch rates of 12.2 kg/hr for tiger prawns and 5.3 kg/hr for endeavour prawns were well above those in 2001.

Recreational component: **Nil**

Stock assessment complete: **Yes**

The king and tiger prawn stocks have been fully exploited each year, as regular surveys permit variations to the management arrangements to optimise the catch. For tiger prawns, this process is also supported by survey-based indices of recruitment and spawning stock with respect to the accepted SRR. 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 2002 was below the acceptable catch range (350–550 t) for the third year running, having fallen back to the levels seen in the 1970s and 1980s. The reasons for this are being investigated. A regular sampling regime is being developed, with a high level of collaboration from industry, to monitor the king prawn stocks during 2003 and assess whether the reduced catches are due to a change in fishing strategy (i.e. early targeting of tiger prawns).

The tiger prawn catch during 2002 was within the acceptable range, and appears to have recovered from the cyclone-induced low of 2000. The damaging impacts of Cyclone Vance on nursery seagrass habitats severely affected recruitment in 2000, but a high proportion of the structured habitats inshore have been regularly surveyed and shown to have recovered, resulting in much improved recruitment in 2002. Length-frequency distributions from recruitment surveys show a higher proportion of recruits than residual prawns, which is the normal pattern expected. The catch in 2002 was achieved while maintaining a significant biomass of spawning stock (approximately 100 t) during the spring period (August–October).

The effective effort on tiger prawns has increased in the last three years from a low of 15,200 hours in 2000 to 27,600 hours in 2001 and 31,100 hours in 2002, coinciding with increased stock levels. The effective effort in 2002 is similar to the mean effective effort observed between 1990 and 1997 (30,500 hours) even though the nominal hours have decreased by 10% on average. This implies increased efficiency to target tiger prawns in the current fleet, probably due to within-season surveys, flexible spatial openings and fleet manipulation.

The endeavour prawn stock was moderately fished in 2002 as a portion of the tiger prawn grounds in Area C was opened for a longer period, providing increased access to endeavour prawn stocks compared to 2001.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

King prawn breeding stock levels in the fishery are maintained at adequate levels through the controls on effort and the extended breeding period and low overall catchability of the species.

Tiger prawn breeding stock levels are maintained at adequate levels by within-season management action each year. This strategy, which maintains the biomass of tiger prawns for spawning above the historically determined biological reference point, utilises a cut-off threshold catch rate of 19 kg/hr quad gear (16 kg/hr standard twin gear). During 2002, tiger prawn catch rates were closely monitored from May to August and the tiger prawn grounds closed on 1 August. Subsequent standardised tiger prawn breeding stock surveys from August to October showed an October CPUE of 21.2 kg/hr in the main spawning grounds, i.e. well above the threshold level. After consultation with industry, the tiger prawn area was re-opened for ten nights' fishing (1–10 November inclusive). This was done to investigate the effect on recruitment in the following season from having a harvest strategy that maintained relatively high levels of prawns during spawning season (August–October) but allowed these to be fished to levels below the 19kg/hr threshold after the spawning season had finished.

Consequently, there was an agreement with industry to use a lower cut-off threshold of 14 kg/hr during this November period. A survey was completed in the tiger prawn spawning area to confirm that the catch rate was greater than 14 kg/hr after fishing had closed. The recruitment of tiger prawns for the 2003 season will be assessed in the light of this new strategy.

Endeavour prawn breeding stocks in the fishery are considered to be at adequate levels as their distribution largely overlaps that of the tiger prawns, with the result that the tiger prawn closure also protects a significant portion of the endeavour prawn breeding stock each year. Endeavour prawns are also considered to be resilient to fishing pressure due to their smaller size and low catchability similar to king prawns.

Projected catch next season (2003):
540–810 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 2003, the projected tiger prawn catch is 540–810 t, which should be close to the highest catch of tiger prawns in the last 25 years.

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 2002 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. Moreover, grids will be compulsory in 2003 which should eliminate 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 exploitation, the impact of the catch on local food chains is unlikely to be significant in view of the high natural mortality 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 2002, 38% of the licensed fishery area and only about 35% of the target species habitat 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 likely to be low.

SOCIAL EFFECTS

The estimated employment for the year 2002 was 52 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 2002:
$11.7 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	$14.30/kg
Tiger prawns	$16.70/kg
Endeavour prawns	$9.00/kg
Coral prawns	$2.00/kg

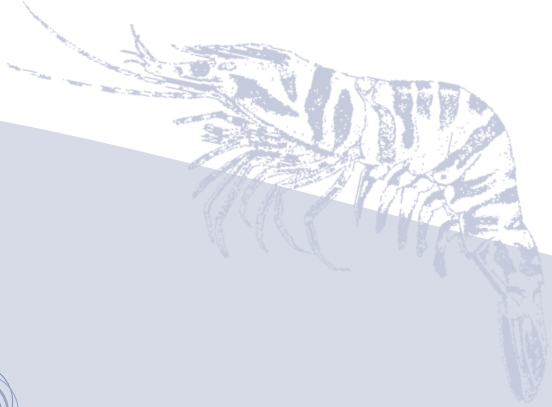
FISHERY GOVERNANCE

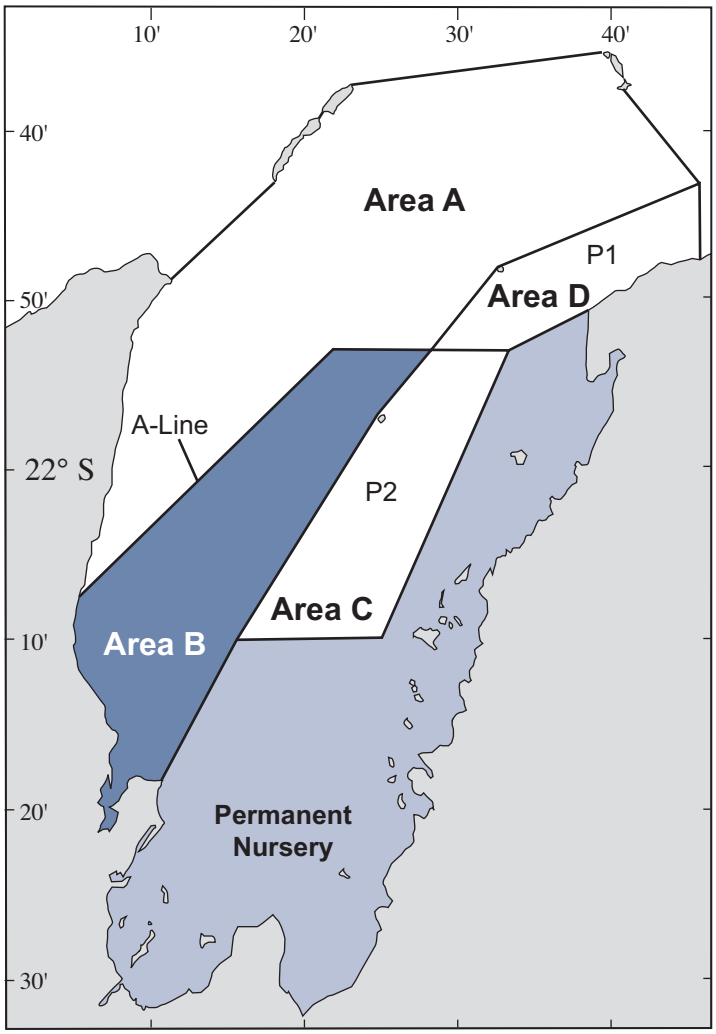
Acceptable catch range: **771–1,276 tonnes**

Under current fishing effort levels, the acceptable catch range for major penaeids is that of the late 1990s (771–1,276 t). 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.

EXTERNAL FACTORS

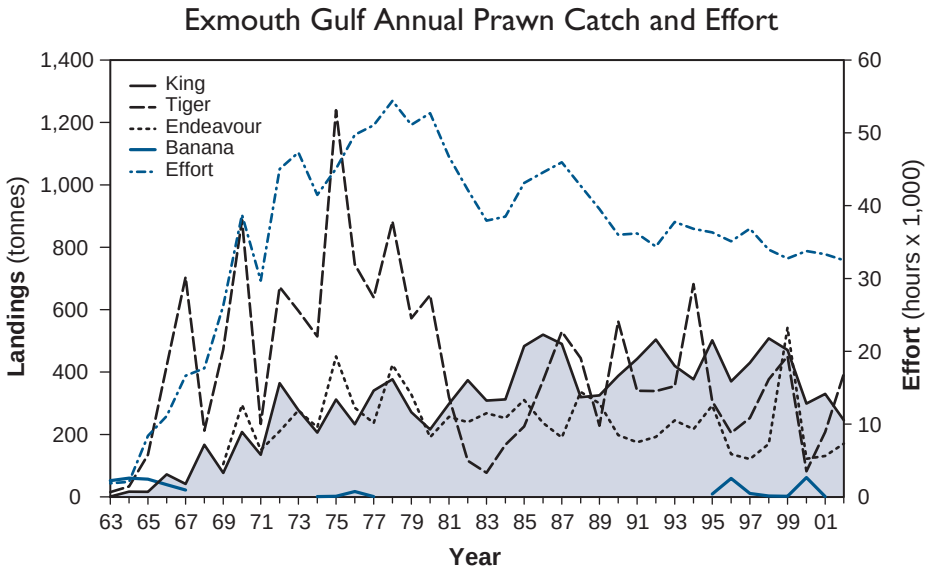
Changes to the nursery seagrass habitat in the eastern area of Exmouth Gulf following Cyclone Vance in 1999 appear to have had a significant effect on the productivity of the Gulf. Surveys of the juvenile tiger prawn habitat were undertaken in the spring of 1999, 2000 and 2001 by CSIRO and in early 2003 by the Department of Fisheries, all in conjunction with industry. The results of the CSIRO surveys indicated an increasing trend in seagrass biomass, from 1.2% in 1999 to 10.3% in 2000 and 40% in 2001, while over 60% cover was observed in many areas in 2003.





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, 1963–2002.

Shark Bay Scallop Managed Fishery

Management Summary

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 by vessels licensed to take only scallops (14 class A licences) and vessels which also fish for prawns in the Shark Bay Prawn Managed Fishery (27 class B licences).

Management of the fishery 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 fishing season commenced on 20 May and is scheduled to close on 1 November (the same day as the Shark Bay Prawn Managed Fishery), although it is likely that the dedicated class A vessels will cease fishing around June or July when catch rates become uneconomic. Primary management measures include limited entry, area closures, gear controls and crew limits. The Vessel Monitoring System continues to be 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).

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).

The Shark Bay Scallop Management Advisory Committee has been replaced by the Joint Trawl Management Advisory Committee, which covers the Shark Bay Scallop, Shark Bay Prawn and Exmouth Gulf Prawn Managed Fisheries. Given the overlap between the three Gascoyne trawl fisheries it was considered more efficient to merge the previously separate MACs. The JTMAC, which provides high-level advice to the Minister on the management of these fisheries, held its inaugural meeting early in 2003. Detailed fishery management matters (e.g. opening/closing dates, spatial and temporal closures) are now dealt with directly between the Department and licensees.

Environment Australia has declared the fishery as being managed in an ecologically sustainable manner under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. While subject to a variety of recommendations, this approval allows product from the fishery to be exported for a five-year period.

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

Research Summary

Research for monitoring the status of the scallop stock in Shark Bay is based on detailed research logbook 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 project with industry to review the impact of trawling on non-target species has been evaluating gear modifications to reduce bycatch and improve product quality. A further FRDC-funded project is examining the biodiversity of bycatch in trawled and untrawled areas of Shark Bay.

The following status report summarises these research findings.

Shark Bay Scallop Managed Fishery Status Report

Prepared by M. Kangas and E. Sporer

FISHERY DESCRIPTION

Boundaries and access

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.

Fourteen boats with Class A licences (scallop only) and 27 boats with Class B licences (prawn and scallop) are endorsed to fish the waters of Shark Bay and Denham Sound. 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).

The 2002 scallop season commenced on 6 May in Denham Sound, and remained open for 10 days for scallop fishing only. Owing to the fishing arrangements for the opening of the extended nursery area for prawns, no Class B scallop boat fished the Denham area in May. Fishing for scallops commenced on the main fishing grounds in Shark Bay on 16 May. Trawling for scallops by Class A boats had ceased by the end of June because of low catch rates. Denham Sound was re-opened on 1 August but with only one Class A scallop boat fishing, and for one night only. The Shark Bay scallop season officially closed on 21 October.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002): 1,770 tonnes whole weight

Landings

The total scallop landings for this fishery, for both A and B Class scallop boats, were 1,770 t whole weight, of which 1,300 t were taken from the Red Cliff and North West Peron grounds and the remaining 470 t from Denham Sound during the 10 days of fishing in May. This overall catch was within the acceptable range set and also within the projected range based on the pre-season survey. It represents an increase of 700 t compared to the catch in 2001.

The Class A fleet (all 14 boats fished in 2002) caught 1,399 t or 79% of the total catch, with the Class B fleet taking 371 t (Shark Bay Scallop Figure 1). Low quantities of by-product (8.5 t of blue swimmer crabs, *Portunus pelagicus*, 3.1 t of cuttlefish and 2.7 t of bugs, *Thenus orientalis*) were also recorded for the Class A fleet during 2002.

Fishing effort

The total effort recorded by the Class A boats in 2002 was 11,284 hours, a 30% increase on the very low effort in 2001.

Catch rate

A mean catch per unit effort of 124 kg/hr (whole weight) was recorded for the Class A fleet in 2002 compared to 81 kg/hr in 2001. This efficient catch rate was maintained as a result of the decision to cease fishing by the end of June.

Recreational component: Nil

Stock 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 was at the low end of the range, as measured using the data from the November 2001 scallop survey. This low recruitment, apparently due to environmental conditions, resulted in a 2002 catch that was within the range projected. This follows a strong Leeuwin Current in 1999–2001, a feature which has previously been correlated with low recruitment and is therefore not considered to reflect the impact of fishing. 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. This allows 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 low in 2002 as a result of the low recruitment, it is considered adequate to provide recruitment in the normal range for 2003.

Projected catch next season (2003): 1,200–1,900 tonnes whole weight

The catch projection for the 2003 season is based on the November 2002 survey. On the main fishing ground in Shark Bay, observed recruitment was similar to last year, providing a catch range forecast for this area of approximately 1,000–1,500 t whole weight. Higher recruitment was observed in the Denham Sound area, giving a predicted catch range of 200–400 t whole weight. The catch projection for the fishery as a whole is therefore in the range 1200–1,900 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 2002, grids were installed into one net to minimise the capture of large animals on Class A scallop boats, and full implementation is planned to take place in 2003. Once this occurs the risk to these species will be negligible.

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 2002, 14% 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 2002 was 190 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 2002: $5.8 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 price for scallops was $3.30/kg whole weight or $16.50/kg meat weight. Meat weight is 20% of whole weight.

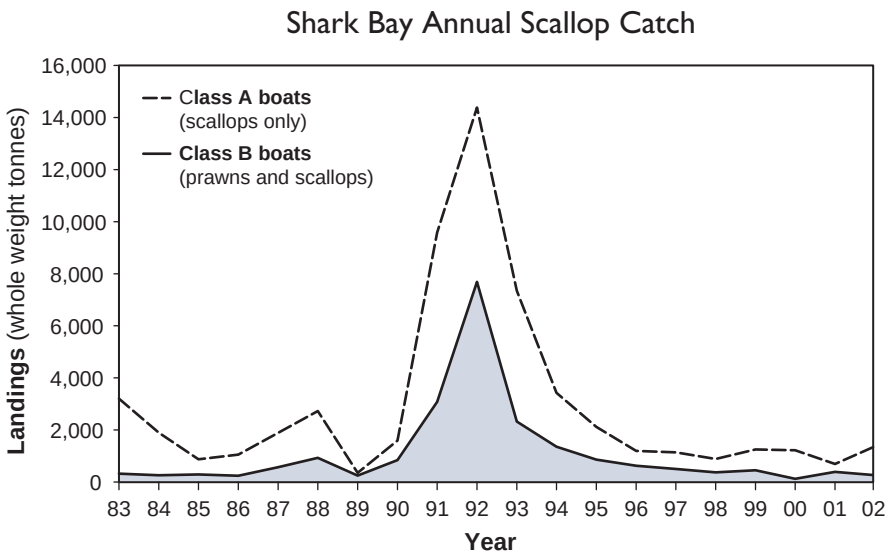
FISHERY GOVERNANCE

Acceptable catch range: 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 to lower end of this acceptable catch range.

EXTERNAL FACTORS

A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay. Generally, high sea levels (corresponding to strong Leeuwin Current) correlate with poor recruitment. The 1999–2002 recruitment was low due to poor environmental conditions. There is a need to examine the mechanisms that control recruitment success in greater detail in future projects 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, 1983–2002.

Shark Bay Beach Seine and Mesh Net Managed Fishery

Management Summary

The Shark Bay Beach Seine and Mesh Net Managed Fishery operates in the waters of Shark Bay and takes a mixed catch of whiting (*Sillago schomburgkii* and *S. analis*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and yellowfin bream (*Acanthopagrus latus*). Entry into the fishery is limited, with 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. 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.

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 meeting

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 decade with the main target species being fished at sustainable levels. The fishery, although relatively small-scale, makes a significant contribution to the Denham economy and community. A comprehensive ESD report on this fishery has been completed as the basis of an application to meet the requirements of the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*. This process determined performance indicators based on catch and catch rates for each of the four main species in the fishery (whiting, tailor, sea mullet and yellowfin bream). The following status report summarises the research findings for this fishery.

Shark Bay Beach Seine and Mesh Net Managed Fishery Status Report

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

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'.*

At May 2002, 11 fishing-unit licence holders were registered in the beach seine and mesh net fishery and were based at Denham. The fishery is also subject to net length and mesh size controls. The legislation indicates 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.*

Main fishing method

Beach seine and haul net.

RETAINED SPECIES

Commercial production (season 2002):
All finfish 300 tonnes
Key target species 280 tonnes

Landings

The 2002 total catch for the Shark Bay beach seine and haul net fishery of 300 t represents an increase of 41 t compared to the 2001 reported catch (Shark Bay Beach Seine Figure 1). There is no long-term trend in the pattern of total landings from this fishery over the past 12 years with catches averaging 280 t per year (Shark Bay Beach Seine Figure 1). The total landings during 2002 included 99.7 t of whiting, together with a substantial catch of sea mullet (135.8 t), 26.9 t of tailor and 17.4 t of yellowfin bream. The remaining reported landings of 20.5 t comprised over 20 different species of finfish.

Whiting, which is the main target species in Shark Bay, comprises nearly one-third of the total catch and includes both *Sillago schomburgkii* and *S. analis*. Assessments of the fishery have previously been based only on the total whiting catch and effort data (Shark Bay Beach Seine Figure 2) but this has now expanded to include analyses of three additional target species – sea mullet, tailor and yellowfin bream (Shark Bay Beach Seine Table 1).

Fishing effort

During 2002, there was an average of seven boats fishing per month, expending a total of 1,253 days of fishing effort for the year (Shark Bay Beach Seine Figure 2). The overall trend in fishing effort in the Shark Bay beach seine and haul net fishery has been a decline to a low point in 1995, followed by a slight increase from 1995 to 2002.

Catch rate

The CPUE (based on nominal effort) for the overall Shark Bay beach seine and haul net fishery increased steadily between

1990 and 1995. Following the 1995 peak there has been a slight downward trend in the CPUE values. The 2002 season catch rate was 239.7 kg/boat day (all species) (Shark Bay Beach Seine Figure 1).

The CPUE for the whiting fishery showed a rising trend during the 1990s to levels greater than 110 kg/day, but has declined since 2000 to its current level of 79.5 kg/boat day (Shark Bay Beach Seine Figure 2). The catch rates for the other three species have also been assessed and are all within acceptable levels (Shark Bay Beach Seine Table 1).

Recreational component: **< 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. When the boat-based recreational catch of those species that are targeted by the commercial fishery (whiting, tailor, sea mullet, yellowfin bream) is compared with the commercial catch of those same species from the closest calendar year (2000), it is seen to make up approximately 0.6% of the combined commercial and recreational landings.

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

Stock assessment completed: **Yes**

The current level of whiting exploitation by the fishery (100 t at 79 kg/day) is within the acceptable catch range and above the catch rate threshold of 70 kg/day, both of which are based on 50 years of data.

The catch levels (27 t) and the catch rate (20.4 kg/day) of tailor by the fishery in 2002 were both within the long-term acceptable catch range (25–40 t) and above the catch rate trigger point (18 kg/day). Whilst the catch and catch rate were relatively low compared with the past few years, they were still high compared with historical levels.

The 2002 catch of 136 t of sea mullet is within the acceptable catch range (85–155 t) and the current catch rate of 79 kg/day is well above the trigger level (50 kg/day). The continuation of the stable catch levels and catch rates in recent years indicates that the level of sea mullet exploitation by the fishery is sustainable.

Catches of western yellowfin bream have been relatively stable since 1968 at an average of 8.7 t per year. Over the last 15 years, from 1988 to 2002, catch has ranged from 5.6 t (in 1995) to 17.4 t (in 2002) with an overall stable trend. Such stability over a relatively long period suggests that this catch range is sustainable.

In summary, the catches and catch rates in 2002 for the four main species have each remained within their acceptable range. It is therefore concluded that this fishery is currently harvesting these species in a sustainable fashion.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

As the legal minimum length for 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 the 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

During 2002, the average number of fishers in the Shark Bay Beach Seine and Mesh Net Managed Fishery was 20. Fishing and associated local fish processing is one of the major sources of employment for the Denham community.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2002):
All finfish $817,000
Whiting $353,000

FISHERY GOVERNANCE

Acceptable catch ranges:
Key target species 210–353 tonnes

Under the current management regime, the acceptable catch range for the key target species in this fishery is 210–353 t. Acceptable catch ranges for individual species are whiting 95–140 t, tailor 25–40 t, sea mullet 85–155 t and yellowfin bream 5–18 t. These ranges were derived by double exponential smoothed forecasting of past annual catches to 1998 and the variation of observations around the predictions. The confidence intervals are set at 80%. If annual catches fall outside these ranges an investigation into the cause will be triggered which, if required, may lead to changes in the management arrangements.

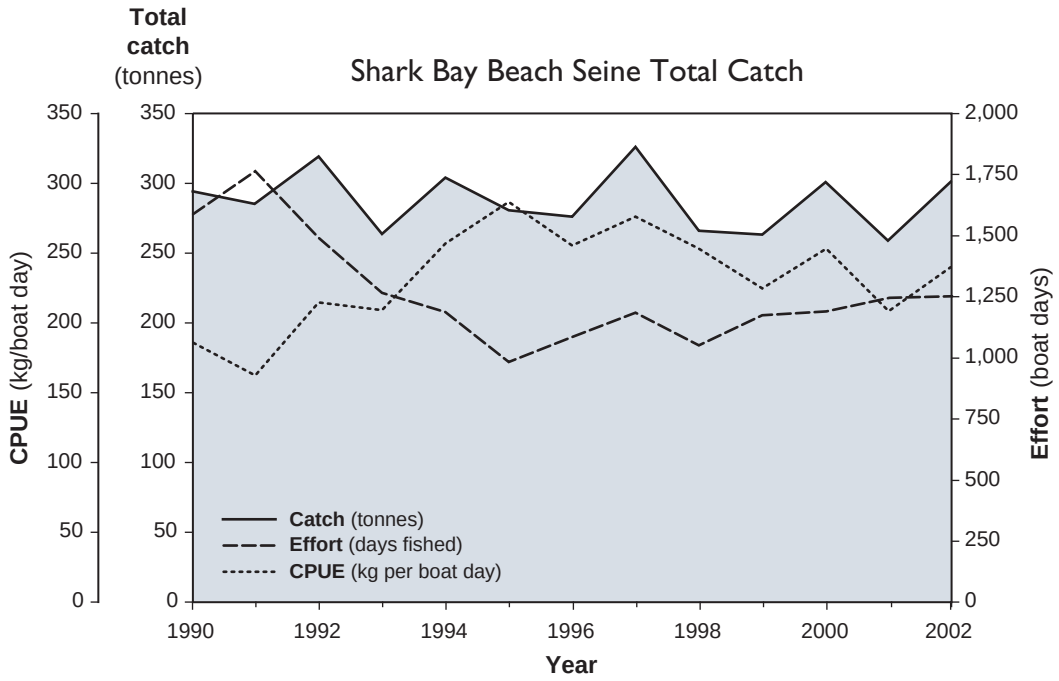
EXTERNAL FACTORS

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

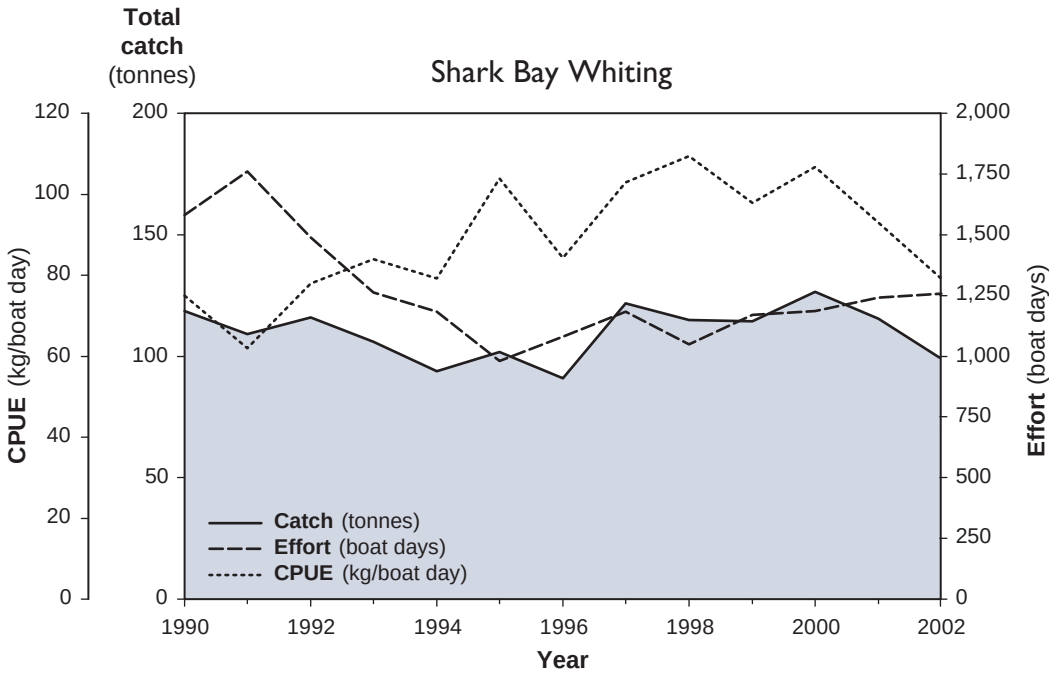
The annual catch per unit effort (CPUE, kg/boat day) and the trigger level for key species from Shark Bay over the period 1998–2002.

SPECIES	*TRIGGER LEVEL (kg/day)*	*1998*	*1999*	*2000*	*2001*	*2002*
Whiting	70	109	97	106	92	79
Tailor	18	33	32	32	21	21
Mullet	50	109	98	107	93	80
Bream	5	7.6	5.9	7.3	6.2	13



SHARK BAY BEACH SEINE FIGURE 1

The annual catch (t), effort (boat days) and catch per unit effort (CPUE, kg/boat day) for the total finfish fishery of Shark Bay over the period 1990–2002.



SHARK BAY BEACH SEINE FIGURE 2

The annual catch (t), effort (boat days) and catch per unit effort (CPUE, kg/boat day) for whiting from Shark Bay over the period 1990–2002.

Shark Bay Snapper Managed Fishery

Management Summary

The Shark Bay Snapper Managed Fishery has been in operation since the late 1980s and has been managed using a mix of input and output controls. The annual (1 September to 31 August) total allowable catch of pink snapper (*Pagrus auratus*) is currently set at 563,750 kg, which equates to 110 kg for each of the 5,125 units. The ongoing sustainability of the fishery is currently under review and a reduction in TAC is expected in the coming year.

A final application has been submitted to Environment Australia for the fishery as part of EA's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A public comment period was conducted during early 2003 and a formal assessment is currently being undertaken by EA.

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 meeting

Research Summary

Detailed research on the offshore snapper fishery was undertaken during the 1980s and provides the scientific knowledge base for management. An FRDC-funded project which commenced in July 2000 has utilised the age data collected since the 1980s to assess the potential for increased yields from this oceanic snapper stock. The preliminary results from this research are now available.

Catch and effort monitoring data, the ESD report and the preliminary results from the FRDC project have been used to compile this status report.

Shark Bay Snapper Managed Fishery Status Report

Prepared by M. Moran

FISHERY DESCRIPTION

Boundaries and access

The Shark Bay Snapper Managed Fishery 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. 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. Since 2001, the whole year s catch has been subject to a single TAC and

individually transferable quotas. The snapper quota for 2002 was set at 563.7 t.

Main fishing method

Mechanised handline.

RETAINED SPECIES

Commercial production (season 2002): Snapper 487 tonnes
Other species 158 tonnes

Landings

The Shark Bay Snapper Managed Fishery operates on the ocean stock of snapper, which is distinct from the inner Shark Bay stocks. Commercial catches of snapper from the ocean stock in 2002 were slightly higher than the previous year, at 487 t compared with 467 t in 2001. The snapper fishery also took 158 t of other finfish species compared with 105 t in 2001. Moreover, the composition of this catch differed from 2001 by having a high component of outer-shelf species such as goldband snapper (*Pristipomoides* spp.). The outer-shelf fishery has grown rapidly since it began in 2000. The catch of these other species is detailed in Shark Bay Snapper Table 1.

Fishing effort

The effectiveness of fishing effort varies markedly on a seasonal basis, peaking in June and July. Fishing effort in the managed snapper fishery, calculated as the total catch for the year divided by the May–August CPUE, was 1,320 standard May–August boat days in 2002, compared with 894 days in 2001. This level of effort to take the catch of 487 t falls outside the acceptable range of 820–950 days used to take the average 500 t catches of the 1990s.

This high effort to take the smaller than average catch is an indicator of low abundance of snapper and was a trigger for the review of the fishery which is currently in progress.

Catch rate

An improved method of calculation has been used in this year's report to more accurately reflect fishing effort targeted mainly at snapper. This was considered necessary because fishers' monthly catch returns report total line-fishing effort, without distinguishing between effort targeted at snapper and that targeted at other demersal scalefish. In the new calculation, only catch and effort figures for boats which caught 4 t or more of snapper in the two-month peak period were used. Consequently, historic catch rate levels will not reflect those reported previously.

The average catch per boat day for licensed vessels during the peak months (June–July) was 555 kg in 2002. This is approximately 21% lower than the average catch rate observed during the 1990s of 700 kg/boat day (Shark Bay Snapper Figure 1).

Recreational component: 7.5%

The Gascoyne Recreational Fishing Survey, conducted between April 1998 and March 1999 (Sumner et al. 2002), estimated that the boat-based recreational catch of snapper from the oceanic stock was 14 t, approximately 2.5% of the commercial catch. In addition, there is a recreational catch of oceanic pink snapper taken on charter boats. This was reported to be 24 t (5% of the commercial catch) in 2002.

For the genetically distinct inner bay stocks of snapper (not covered by this status report), most of the catch is taken by recreational fishers and is now subject to separate management arrangements. Research to assist the management of these stocks is reported in the recreational fisheries section on pp. 161–164.

Stock assessment completed: Yes

The oceanic pink snapper stock is now considered to be over-exploited. A stock production model assessment of this stock completed in the mid-1980s estimated the maximum sustainable annual yield to be around 600 t. The average commercial catch during the past 15 years has, however, only been approximately 500 t. One of the main objectives of the FRDC-funded project which commenced in July 2000 was to use more advanced age-structured modelling techniques to assess the potential for increased yields from this stock. The preliminary results from this project indicate, however, that the 600 t value was probably an over-estimate of the sustainable yield. Thus, the stock appears to have been declining slowly since the early 1990s, despite commercial landings of only 500 t. Consequently, the total allowable catch will be revised downwards based on the final results of this project.

One clear result is that, as for other snapper stocks in Australia and New Zealand, the levels of annual recruitment can be highly variable. There was a peak in recruitment during the early 1990s, following which recruitment levels declined to reach relatively low levels by the late 1990s. These low levels of recruitment came at a time when there were still adequate breeding stock levels (i.e. > 40% unfished level, see below) and are therefore most likely attributable to environmental effects on the survival rate of eggs, larvae and early juveniles. Additional fishery data from 2001, 2002 and 2003 will be used to update the stock assessment and provide advice for ongoing management prior to the peak fishing season in 2004.

An additional threat to the fishery's sustainability may be posed by the rapidly expanding activity of the wetline fleet, which is not licensed to land pink snapper taken within the boundaries of the fishery, and therefore releases them at sea. At the depths fished, most returned snapper die, with a consequent increase in the total fishing mortality.

Exploitation status: Over-exploited

Breeding stock levels: Inadequate

Snapper breeding stock level for the oceanic stock has been estimated as part of the current FRDC project to be currently 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. Appropriate management actions to initiate restoration of the stock to this level will be taken in 2004 based on the final results of this project.

Given the very rapid increases in catch of the outer-shelf component of the wetline fishery in this area (Shark Bay Snapper Figure 2), the sustainability of some deep-water scalefish species may also be of concern. Although there are insufficient data to assess the status of these species at present, the issue requires immediate management attention and careful monitoring in the future.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

There is very little discarding of unwanted bycatch in the managed snapper fishery, as virtually all the catch consists of demersal fish with a medium to high market value. However, pink snapper itself may now have become the discarded bycatch of the wetline boats, with potential negative effects for sustainability of the stock (see 'External Factors').

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 stock is currently going through a low period, corrective management action will be taken to restore the adult stock to above 40% of its unfished level. Juvenile and sub-adult stocks have not been affected by the snapper fishery as the catch of under-size fish is minimal.

Habitat effects: **Negligible**

The nature of the fishery, targeting aggregations of adult snapper using hooks and lines, means that the fishery has no impact on the habitat.

SOCIAL EFFECTS

Nine boats fished both peak and off-peak seasons (about nine months) with an average crew of 3. This rose during the peak season (four months) to a total of 25 boats (including 9 trawlers) with an average crew of 5.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2002): **$3 million**

The value of the pink snapper taken in the fishery was $2.25 million, while other finfish species added a further $750,000.

FISHERY GOVERNANCE

Acceptable effort range: **709–930 days**

Based on catch per unit effort levels during the period 1990–2000, the acceptable effort range to take the 2003 total allowable commercial catch of 563.7 t would be 709–930 standard June–July boat days. This range has been estimated using an improved set of catch rates developed in 2002. However, the range may be revised following the current review of the fishery.

EXTERNAL FACTORS

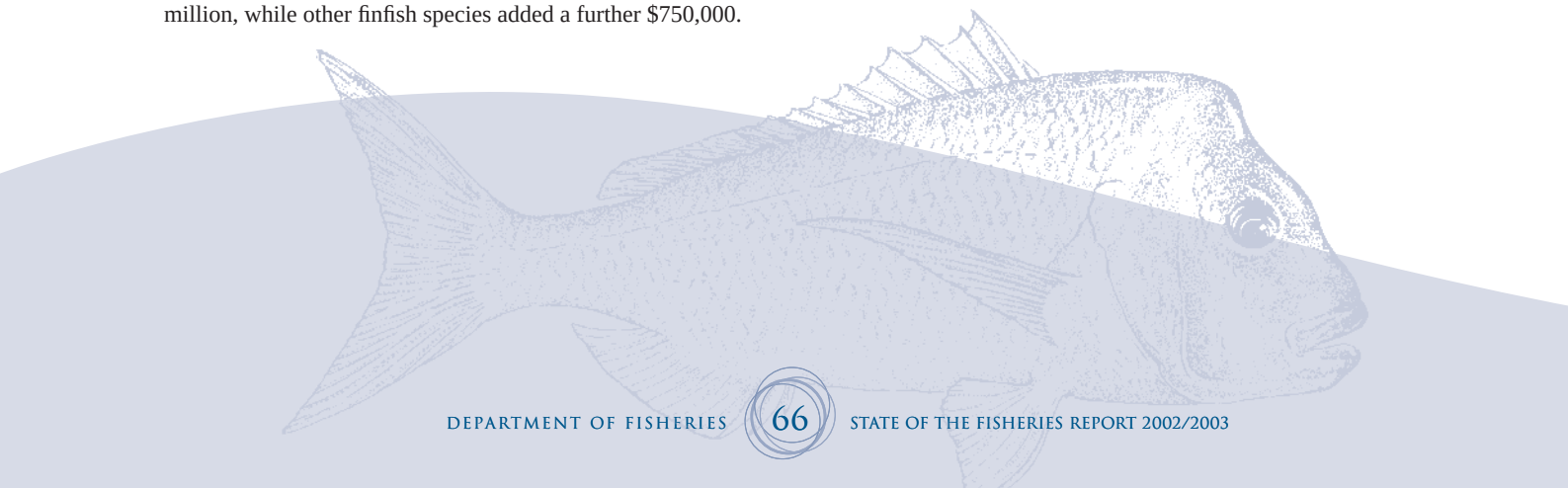
Wetline boats operating in the region (i.e. commercial line-fishing boats without a Shark Bay Snapper Managed Fishery licence) have been taking increasing catches of scalefish species other than snapper in recent years. A considerable, but unknown, quantity of snapper are therefore caught and returned to the sea by these fishers, many of which will not survive. This increased mortality on the stocks is likely to be an additional threat to the sustainability of the snapper fishery.

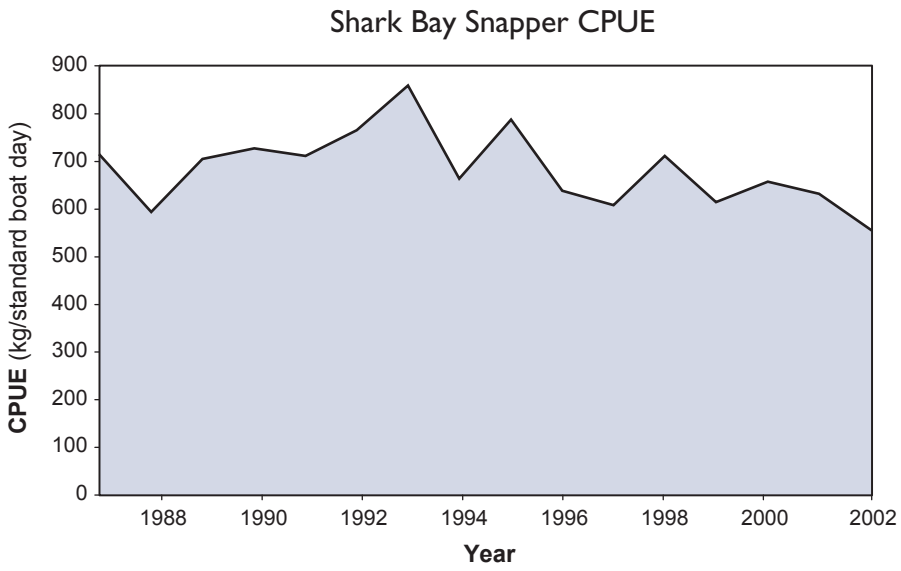
Under the Offshore Constitutional Settlement, Commonwealth-licensed trawlers may operate in the region outside the 200 metre isobath. A trawler has been operating consistently in the region of the managed snapper fishery in recent years and also catches an unknown quantity of snapper.

SHARK BAY SNAPPER TABLE 1

Catches in the years 2001 and 2002 by Shark Bay Snapper Fishery licensed boats, in the area between 23° S and 26° S, of species other than pink snapper (excluding mackerels which are reported on pp. 97–102).

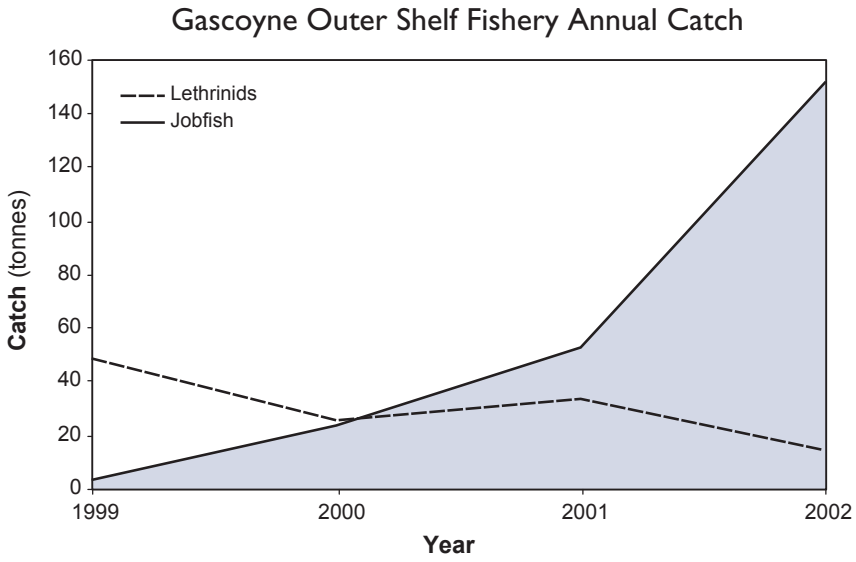
SPECIES		*TONNES 2001*	*TONNES 2002*
Emperors	Lethrinidae	31.1	27.0
Mulloway	Sciaenidae	15.9	21.4
Cods	Serranidae	11.3	19.8
Red emperor	*Lutjanus sebae*	9.1	9.5
Trevallies	Carangidae	8.1	9.3
Jobfish	*Pristipomoides* spp.	5.1	42.1
Other		24.4	28.7
Total		**105.0**	**158.0**





SHARK BAY SNAPPER FIGURE 1

Catch per unit effort by year from 1987 to 2002 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

The increasing catches in the area between 23° S and 26° S, by non-holders of Shark Bay Snapper Managed Fishery licences, of deep-water snappers (= jobfish, goldband snapper) and decreasing catches of inner-shelf emperors (lethrinids), illustrating the expansion of the wetline fishery in the region and the shift of focus from the inner to the outer shelf.

NORTH COAST BIOREGION

REGIONAL MANAGEMENT OVERVIEW

Commercial fisheries in this bioregion are focused on the tropical and deep-water snappers in offshore waters and on barramundi, threadfin salmon and shark in coastal areas. Most of the State's smaller prawn trawl fisheries are also based in this region.

The Pilbara Fish Trawl (Interim) Managed Fishery continued to be the State's largest demersal finfish fishery. Other important providers of demersal finfish operating in the area are the Northern Demersal Scalefish and the Pilbara Trap Managed Fisheries. All three fisheries operate under individually transferable effort (ITE) management arrangements, monitored by the Vessel Monitoring System.

Following the expansion of the VMS to include the Kimberley and Nickol Bay Prawn Managed Fisheries in 2001, the Onslow Prawn Managed Fishery also came under VMS in 2002. In these fisheries the VMS is used primarily for the management of closed waters (nursery areas).

In the Kimberley Prawn Managed Fishery, use of the VMS has also been extended to deal with the significant levels of latent effort in the fishery. Following an extensive review during the second half of 2002 aimed at identifying the most appropriate solution to the potential for latent effort to be activated, an effort pool system was implemented for the 2003 season. This system provided for the maximum number of boat days in the fishery to be capped at levels reflecting acceptable effort inputs.

The wetline fishery in the north coast bioregion operates in a number of areas:

- mackerel fishing (primarily by trolling);
- beach seining and near-shore gillnetting; and
- demersal line fishing (Pilbara line fishery).

Following recommendations to the Minister from an independent review panel which examined the mackerel fishery, the Department is working towards the implementation of an interim management plan for this fishery by January 2004.

There is also a take of fish throughout the region by beach seining and near-shore gillnetting using hand-hauled nets, which is not currently subject to any dedicated management plan. Demersal finfish are also taken by line in the Pilbara by holders of fishing boat licences. The activities of the wetline fishery will be reviewed as part of Pilbara Wetline Review, expected to occur in 2005. This review will also be a key element in preparing the fishery for Integrated Fisheries Management.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Commercial fishery compliance inspections in the north coast bioregion are conducted by Fisheries Officers working out of offices located in Broome and Karratha. These officers undertake a variety of activities in the region, including sea-based inspections of licences, catch and fishing gear, and land-based inspections of catch, fish processing factories, retail outlets and catch consignment deliveries. Some management arrangements require vessels to operate with a Vessel Monitoring System on board, and this requires officers to monitor vessel locations and the time each vessel spends within specific areas of fisheries.

The 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. Officers utilise two 6.5–7 m patrol vessels located at Karratha and Broome to conduct inshore at-sea inspections, while a dedicated large patrol vessel (> 20 m) is deployed from other regions to carry out offshore work, particularly during the dry season.

Activities during 2001/02

During 2001/02, Department of Fisheries Regional Services personnel undertook 2,711 hours of compliance work in commercial fisheries in the north coast bioregion (North Coast Commercial Compliance Table 1), excluding work conducted for the Australian Fisheries Management Authority in Commonwealth fisheries. Although there was a wide range of compliance activities conducted within the region's commercial fisheries, many related to vessels operating outside the conditions of the relevant management plans for the major fisheries, in particular the Pilbara Fish Trawl and Northern Demersal Scalefish Managed Fisheries.

During 2001/02, Fisheries Officers recorded 54 field contacts with commercial fishing operations (excluding pearling compliance activities) and 946 office contacts with commercial fishers. During the year, one infringement notice was issued, and a further 10 cases resulted in prosecution action against commercial fishers.

Overall, the main areas of concern within the bioregion relate to continued infringements detected through the VMS, and inherent complexities within the management arrangements that lead to inadvertent breaches of the legislation.

Initiatives in 2002/03

Funding of the compliance program for those commercial fisheries in the north coast bioregion not covered by cost recovery has proved a management issue as available funds

have declined. Discussions continue with the commercial sector to assist in developing more efficient and cost-effective management strategies that in turn will lead to more effective compliance outcomes. Outcomes to date include the substitution of the Northern Demersal Scalefish Fishery's Ministerial Advisory Committee with direct consultation with licensees and other stakeholders.

NORTH COAST COMMERCIAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in commercial fisheries within the north coast bioregion during the 2001/02 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	2,711
Fisher field contacts by Fisheries Officers *	54
District Office contacts by Fisheries Officers	946
Fishwatch reports **	44
OFFENCES DETECTED	
Infringement warnings	0
Infringement notices	1
Prosecutions	10

* Excludes compliance activities conducted in the Pearl Oyster Fishery.

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

REGIONAL RESEARCH OVERVIEW OF WETLINE FISHING

This assessment, which utilised the CAES database, indicates that around a quarter (24%) of the State's wetline catch during 2001/02 was reported from this bioregion, which includes waters off both the Kimberley and Pilbara coasts. The top ten species comprised Spanish mackerel (*Scomberomorus commerson*) 330 t, giant threadfin (*Eleutheroyema tetradactylum*) 106 t, goldband snapper (*Pristipomoides multidens*) 24 t, unspecified shark 19 t, unspecified mackerel 17 t, grey mackerel (*Scomberomorus semifasciatus*) 9 t, trevally (Carangidae) 9 t, unspecified tuna (Scombridae) 8 t, unspecified threadfin (Polynemidae) 7 t. The next most numerous species group in the catch were the shovelnose/fiddler rays (Rhinobatidae/Rhinchobatidae, 6 t) that are being increasingly targeted for their fins.

An interim management plan for the troll fishery for mackerel, details of which are reported on pp. 97–102, will commence 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.

Onslow Prawn Managed Fishery

Management Summary

The Onslow Prawn Managed Fishery targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*).

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. The 2003 fishing season commenced on 1 March and will end on 15 November, which generally aligns with season dates for the adjacent Exmouth Gulf Prawn Managed Fishery. However, different areas within the fishery have different season dates, which allows access to the various target species, primarily tiger and banana prawns, at appropriate times.

Bycatch reduction devices (grids) were fully implemented into the fishery in the 2003 season, with vessels required to have BRDs fitted to both nets. In addition, the Vessel Monitoring System has been implemented within the fishery since 2002.

A final application has been submitted to Environment Australia for the Onslow prawn fishery as part of EA's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. Following the public comment period, formal assessment by EA will be undertaken.

Governing Legislation/Fishing Authority
Onslow Prawn Fishery Management Plan 1991
Onslow Prawn Managed Fishery Licence

Consultation Process
Department–industry meetings

Research Summary

Research for managing this small fishery involves stock monitoring and assessment utilising the CAES monthly return data provided by industry, as well as information from voluntary logbooks 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 comprehensive ESD report was completed for this fishery as the basis of the application to meet the requirements of the Commonwealth's Environment Protection and Biodiversity Conservation (EPBC) legislation. This process determined performance indicators based on catch for each of the four main prawn species taken by the fishery.

The following status report summarises these research findings.

Onslow Prawn Managed Fishery Status Report

Prepared by M. Kangas and E. Sporer

FISHERY DESCRIPTION

Boundaries and access

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 then 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.

During the 2002 season the areas were open during the following periods:

Area 1	2 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 May–30 September

Different licence classes apply to this fishery allowing boats to trawl in specific zones. These classes are listed below (figures in brackets indicate 2002 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)

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002): 135 tonnes

Landings

The total landings of major penaeids for the 2002 season were 135 t, including 42 t of king prawns, 77 t of tiger prawns, 14 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 total landings ranging from approximately 60 t to 130 t. The season catch of 135 t is the highest since 1988 and is slightly above the acceptable catch range for this fishery. Recorded landings of by-product species included 25 t of coral prawns, 9 t of bugs (*Thenus orientalis*), 3 t of squid, 2 t of blue swimmer crabs (*Portunus pelagicus*) and less than 1 t each of black tiger prawns (*Penaeus monodon*), cuttlefish and mixed finfish species.

Fishing effort

During 2002, 1,010 fishing days were recorded by boats licensed to fish in the Onslow prawn fishery. This was approximately 60% up on the average number of fishing days recorded in the previous two years.

Catch rate

Not assessed.

Recreational component: Nil

Stock assessment complete: Yes

The catches during 2002 were above average for king, tiger and endeavour prawns. Tiger prawn landings were above the acceptable catch range and may reflect favourable environmental conditions for this species (i.e. an absence of destructive cyclonic activity). As a result of improved stock abundance the overall fishing effort increased from 643 boat days in 2001 to 1,010 in 2002. Banana prawn catches were low, again reflecting the low summer rainfall (25 mm) in the area. The rainfall during summer 2002/03 was a total of 12.6 mm and therefore it is expected that banana prawn catches will remain low 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. 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. The introduction of bycatch reduction devices (grids) in the fishery during 2002 should eliminate 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 2002 was 12–15 skippers and crew, with up to 10 people involved in local processing.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002: $1.7 million

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices received by vessels fishing along the Pilbara coast in 2002 were as follows:

King prawns	$12.50/kg
Tiger prawns	$13.00/kg
Endeavour prawns	$7.50/kg
Banana prawns	$12.00/kg
Coral prawns	$3.00/kg

FISHERY GOVERNANCE

Acceptable catch range: 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:

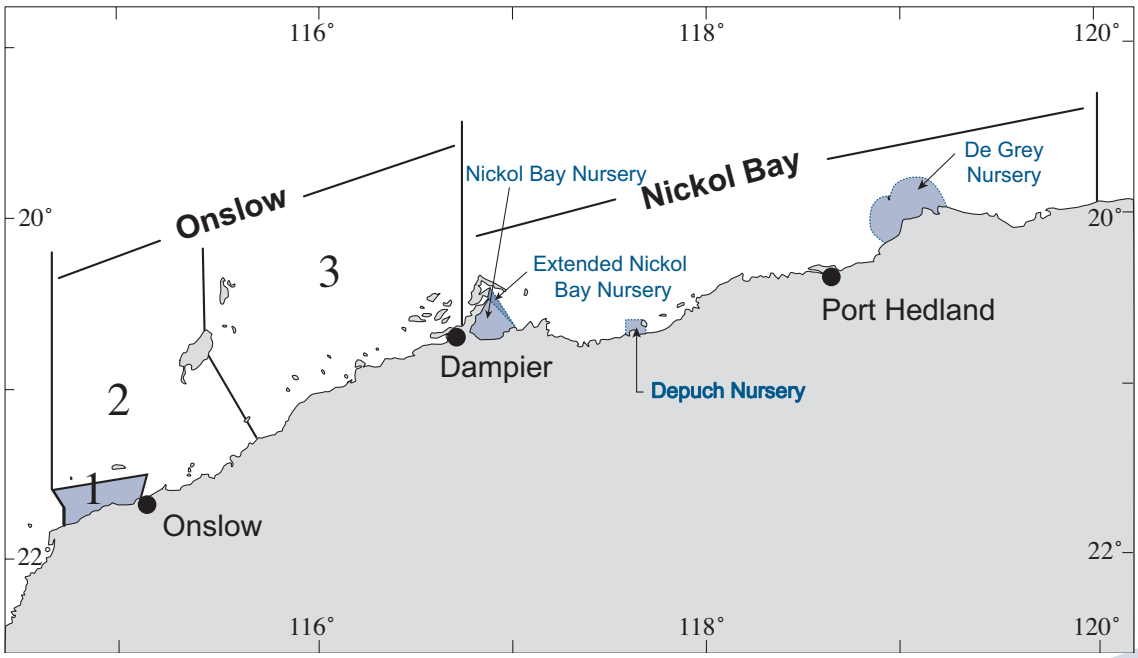
King prawns	10–55 t
Tiger prawns	5–40 t
Endeavour prawns	5–20 t
Banana prawns	2–90 t

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.

EXTERNAL FACTORS

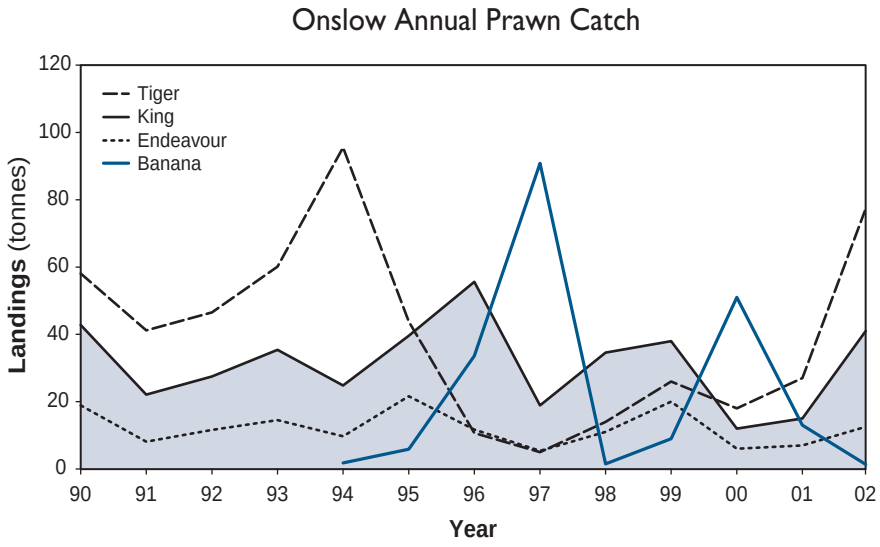
The catches taken are from a number of separate nursery areas and are highly variable from year to year. This is particularly the case for the rainfall-dependent banana prawn.

Catches of tiger prawns from this fishery are also quite variable. 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 of the Onslow and Nickol Bay Prawn Managed Fisheries.



ONSLOW PRAWN FIGURE 2

Annual landings for the Onslow Prawn Managed Fishery, 1990–2002.

Nickol Bay Prawn Managed Fishery

Management Summary

The Nickol Bay Prawn Managed Fishery (NBPF) targets banana prawns (*Penaeus merguiensis*), western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*) and endeavour prawns (*Metapenaeus* spp.).

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. The main fishing ground for the 2003 fishing season opened on 1 May and will close on 15 November. Having a number of fishing areas with varying season dates allows access to target species, usually tiger and banana prawns, at appropriate times.

Bycatch reduction devices (grids) were fully implemented into the fishery in the 2003 season, with vessels required to have BRDs fitted to both nets. In addition, the Vessel Monitoring System has been implemented within the fishery since 2002.

A final application has been submitted to Environment Australia for the Onslow prawn fishery as part of EA's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. Following the public comment period, formal assessment by EA will be undertaken.

Governing Legislation/Fishing Authority
Nickol Bay Prawn Fishery Management Plan 1991
Nickol Bay Prawn Managed Fishery Licence

Consultation Process
Department–industry meetings

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.

A comprehensive ESD report has recently been completed for this fishery which was used as the basis of an application to meet the requirements of the Commonwealth's EPBC legislation. This process determined performance indicators based on catch for each of four main types of prawns taken by this fishery.

The following status report summarises these research findings.

Nickol Bay Prawn Managed Fishery Status Report

Prepared by M. Kangas and E. Sporer

FISHERY DESCRIPTION

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).

During the 2002 season the major fishing areas were open during the following periods:

Nickol Bay Nursery	1 May–31 August
Extended Nickol Bay Nursery	1 May–15 November
Depuch Nursery	1 May–31 August
De Grey Nursery	1 May–15 November

There were 14 boats licensed to trawl for prawns in Nickol Bay during 2002, with only 11 boats fishing.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002): 100 tonnes

Landings

The total landings of major penaeids for the 2002 season were 100 t, comprising 22 t of banana prawns, 67 t of king prawns, 8 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 catches of banana prawns during the last two years are the lowest recorded in 35 years and are, therefore, lower than the acceptable range which was based on catches of the 1990s. Nonetheless, the 2002 catch was within the projected catch range (1–40 t) forecast on the basis of very low rainfall over the period December–March. As a result of the low catch of banana prawns, the overall catch for the fishery was in the low end of the acceptable catch range.

Recorded by-product species for 2002 were 10 t of coral prawns, 9 t of bugs (*Thenus orientalis*), 2 t of blue swimmer crabs (*Portunus pelagious*) and less than 1 t each of black tiger prawns (*Penaeus monodon*), squid, shark and mixed finfish species.

Fishing effort

During 2002, 647 days of fishing was recorded by boats licensed to fish in the Nickol Bay prawn fishery. This was approximately 15% down on the average number of fishing days recorded in the five years 1996–2000.

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). The low catch in 2002 was in the expected range according to the relationship as a result of low summer rainfall in 2001/02, which was the second lowest recorded in 35 years. King, tiger and endeavour prawn catches were all within the acceptable ranges for these species.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Projected catch next season (2003):
Banana prawns 40–80 tonnes

The catch projection for banana prawns, based on the 89 mm of rain during the 2002/03 summer period, is between 40 t and 80 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 2002, only 6% 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 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. The introduction of bycatch reduction devices (grids) in the fishery during 2002 should eliminate 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 6% 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 2002 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 2002:
$1.3 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 2002 were as follows:

Banana prawns	$12.00/kg
King prawns	$12.50/kg
Tiger prawns	$13.00/kg
Endeavour prawns	$7.50/kg
Coral prawns	$3.00/kg

FISHERY GOVERNANCE

Acceptable catch range: 90–300 tonnes

Under current effort levels and previous environmental conditions, the acceptable ranges of prawn catches, based on the catches of the 1990s, are as follows:

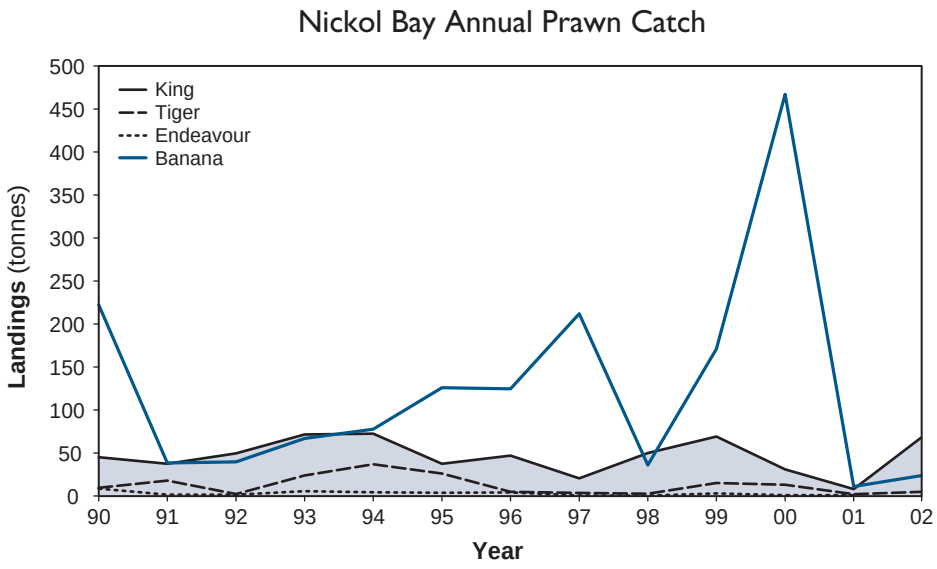
Banana prawns	40–220 t
King prawns	20–70 t
Tiger prawns	2–40 t
Endeavour prawns	1–10 t

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.

EXTERNAL FACTORS

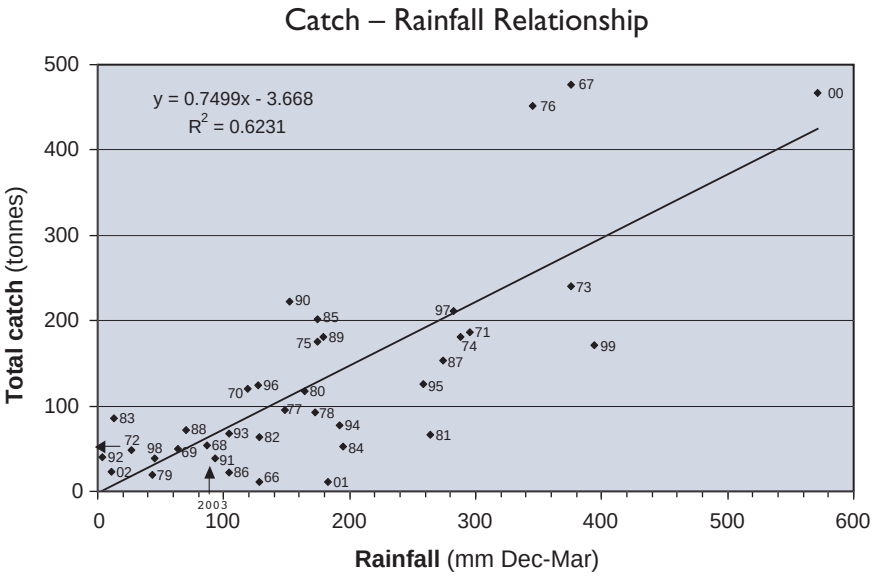
Banana prawns usually dominate the catch from Nickol Bay. The catch of this species is positively correlated with rainfall in the months December–March. With 89 mm of rainfall recorded for this period during 2002/03 and the low catches observed in 2002, relatively low landings (40–80 t) of banana prawns are forecast for 2003. The king prawn catches were within their acceptable range, indicating a return to normal environmental conditions for this species.

The majority of boats in the prawn fleet of Nickol Bay are also licensed to fish 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. In recent years, however, 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. These vessels, however, are not economically viable in the NBPF in low banana prawn years such as 2001 and 2002 and leave the fishery early, leading to highly variable effort in the fishery.



NICKOL BAY PRAWN FIGURE 2

Annual landings for the Nickol Bay Prawn Managed Fishery, 1990–2002.



NICKOL BAY PRAWN FIGURE 3

Relationship between banana prawn landings and rainfall between December and March for the years 1966–2002.

Broome Prawn Managed Fishery

Management Summary

The Broome Prawn Managed Fishery targets western king prawns (*Penaeus esculentus*) and coral prawns (a combined category of small penaeid species). The fishery operates in a designated trawl zone off Broome and generally coincides with the seasonal closures for the Commonwealth Northern Prawn Fishery (NPF) and the Kimberley Prawn Managed Fishery.

The 2003 fishing season commenced on 24 May and is scheduled to close on 12 August, taking advantage of the new moon phases in an attempt to maximise catches of king prawns. Management controls also include limited entry and gear restrictions.

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).

A draft application has been submitted for the fishery as part of Environment Australia's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

Governing Legislation/Fishing Authority
Broome Prawn Managed Fishery Management Plan 1999
Broome Prawn Managed Fishery Managed Fishery Licence

Consultation Process
Department–industry meeting

Research Summary

Research data for managing this small seasonal fishery is provided by detailed research logbooks completed by all boats. This data is 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. A comprehensive ESD report has been generated for this fishery which formed the basis for the application to meet the requirements of the Commonwealth's EPBC legislation.

The following status report summarises these research findings.

Broome Prawn Managed Fishery Status Report

Prepared by M. Kangas and E. Sporer

FISHERY DESCRIPTION

Boundaries and access

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'.

The permitted fishing area was opened for the 2002 fishing season on 1 June and closed on 15 August, allowing for a total of 75 nights' fishing, all of which were fished. The longer Northern Prawn Fishery mid-season closure has allowed for a longer fishing period in 2002 compared to earlier years.

Five WA-based NPF (Gulf of Carpentaria) boats are licensed to operate in this fishery.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002): 209 tonnes

Landings

The total landings for the 2002 season were 209 t, including 121 t of king prawns and 88 t of coral prawns (Broome Prawn Figure 1). King prawn landings for 2002 were 47% higher than the five-year average (83 t), whereas the catch of coral prawns has been consistent at around 80 t over the last three years, with last year's catch being the highest since 1996 when landings of coral prawns were first recorded.

Fishing effort

Nominal effort recorded in the daily research logbooks for the fleet was 4,022 hours, the highest on record since 1997 (when detailed recording of hours began). The increased effort reflects the additional days allocated for fishing in 2002 over the appropriate moon phases, and the fact that catch rates were maintained over the extended fishing period.

Catch rate

Average catch rates of 30.2 kg/hr for king prawns and 21.9 kg/hr for coral prawns were recorded. The catch rate for king prawns remained relatively stable for the duration of the fishery, declining from an average of 34 kg/hr in June to 25 kg/hr in August, and was higher than in the previous three seasons. In 2002 the season incorporated three new moon periods, providing optimal conditions for fishing.

Recreational component: Nil

Stock assessment complete: Yes

A Delury depletion analysis incorporating lunar effects was carried out on the 2002 logbook data to quantify the standing stock of king prawns in the Broome fishery. From this analysis, a standing stock of approximately 320 t was estimated. This indicates that for the 2002 season approximately 40% of the stock was taken by fishing, utilising the 4,022 hours of fishing recorded in this fishery. 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. When sufficient years of data have been assembled, it will be possible to relate the proportion of the king prawn stock not fished at the end of each fishing season (a measure of residual spawning stock) and the recruitment of king prawns in the subsequent year.

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

Breeding stock levels: Adequate

Depletion analysis indicated that approximately 60% of the king prawn stock was left when fishing ceased in the 2002 season. This stock would contribute to the spawning stock for 2003 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 2002, 54% 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 introduction of bycatch reduction devices (grids) in the fishery during 2002 should eliminate 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 2002 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 2002: $1.9 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 2002 were as follows:

King prawns	$13.85/kg
Coral prawns	$3.00/kg

FISHERY GOVERNANCE

Acceptable catch range: 55–260 tonnes

Under current effort levels and previous environmental conditions, the acceptable ranges of prawn catches are as follows:

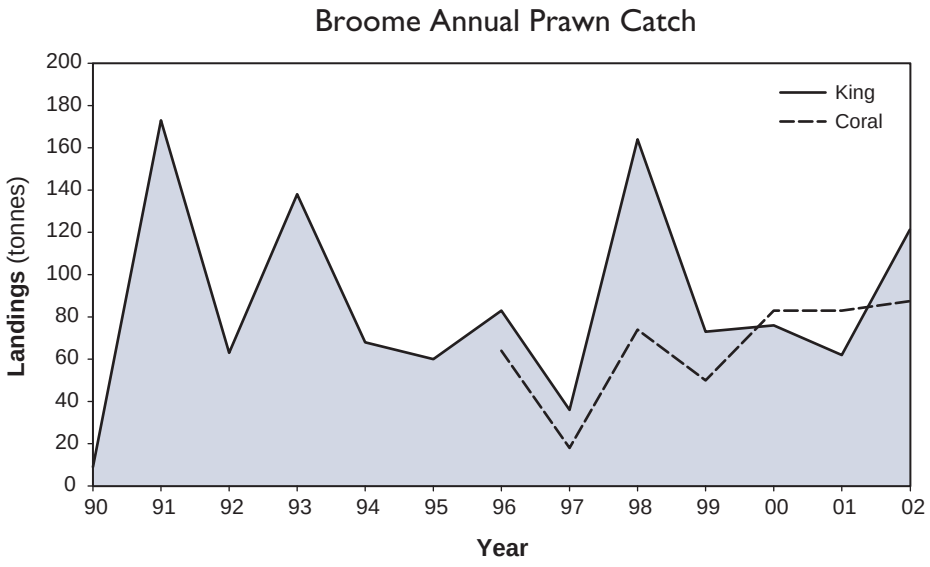
King prawns	35–170 t
Coral prawns	20–90 t

For king prawns the acceptable range is based on the catches of the 1990s, while for coral prawns it is based on the seven-year range since catches were first recorded. Therefore, the 121 t of king prawns taken in 2002 is in the middle of the acceptable range for this species. The catch of 88 t of coral prawns is at the upper levels of their range.

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. Historically, the timing of this fishery has been set to coincide with the NPF mid-season closure rather than the appropriate lunar periods. Consequently, the timing of the fishing period has not always been optimal for maximising the catch from the king prawn stock. This was most evident in 2001 when a low exploitation rate occurred.

This fishery is valuable, despite its short season, because it allows up to nine 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, 1990–2002.

Kimberley Prawn Managed Fishery

Management Summary

The Kimberley Prawn Managed Fishery (KPMF) operates off the north of the State between Koolan Island and Cape Londonderry and abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF). The KPMF predominately targets banana prawns (*Penaeus merguiensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*). A significant number of vessels hold authorisations to operate in both the KPMF and the NPF, and opening and closing dates are aligned to prevent large shifts of fishing effort into the Kimberley fishery.

The management controls for the Kimberley Prawn Managed Fishery are based on limited entry, seasonal closures, gear controls and restrictions on boat replacements. In 2003 a total effort cap system was introduced that restricts the number of fishing days available within the fishing season to explicitly deal with the latent effort arising from the large number of vessels authorised to operate in the fishery. For the 2003 season, effort levels were notionally set at 600 and 900 boat days for the first and second parts of the season respectively.

The Vessel Monitoring System was introduced into the fishery during 2001. From the second half of the 2003 season, bycatch reduction devices (specifically grids) were also required in all gear, except try nets.

A draft application has been submitted for the fishery as part of Environment Australia's ecological sustainability reporting process under *the Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

Governing Legislation/Fishing Authority
Kimberley Prawn Fishery Management Plan 1993
Kimberley Prawn Fishery Managed Fishery Licence

Consultation Process
Department–industry meeting

Research Summary

Research data for monitoring this fishery are provided by Western Australian fishers' monthly returns, and by research logbooks 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.

A comprehensive ESD report was completed for this fishery which formed the basis of the application to meet the requirements of the Commonwealth's EPBC legislation.

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

Kimberley Prawn Managed Fishery Status Report

Prepared by M. Kangas and E. Sporer

FISHERY DESCRIPTION

Boundaries and access

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'*.

Seasonal dates for the Kimberley Prawn Managed Fishery are aligned with those of the adjacent Northern Prawn Fishery. Consequently, the 2002 season opened on 1 April and closed for the mid-season closure on 27 May. The fishery re-opened on 4 August and ran until the final season closure on 9 November.

Although a total of 135 boats had access to the Kimberley Prawn Managed Fishery under various licensing arrangements, only 30 boats operated in the fishery during the 2002 season.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2002): 378 tonnes

Landings

The total landings for the 2002 season were 378 t, comprising 239 t of banana prawns, 80 t of tiger prawns, 58 t of endeavour prawns and 1 t of king prawns (Kimberley Prawn Figure 1).

The banana prawn catch was within the projected catch range (200–380 t) using the preliminary relationship between summer rainfall and catches. The endeavour prawn catch was also in the acceptable catch range (7–80 t). The tiger prawn catch was the highest on record and slightly higher than the acceptable catch range for this species (15–60 t) as a result of improved recruitment (rather than targeting). Recorded by-products were 19 t of squid, 6 t of bugs and 3 t of coral prawns.

Fishing effort

During the 2002 season, 30 vessels operated in the fishery for a total of 1,135 fishing days.

Catch rate

Not assessed.

Recreational component: Nil

Stock assessment complete: Yes

Although there has been no formal stock assessment based on catches and fishing effort for the Kimberley prawn stocks, nevertheless the relationship recognised from other fisheries between rainfall and catches of banana prawns (the dominant species taken in this area) may provide a degree of forecasting.

Investigations have shown a promising relationship between early season rainfall (January and February) and the subsequent catch of banana prawns. Rainfall during the period January–February 2003 was 645 mm at Derby and 610 mm at Kalumburu, which indicates that banana prawn catches for 2003 should be in the range of 240–370 t. Investigations on refining rainfall–catch relationships are continuing.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Projected catch next season (2003):
Banana prawns 240–370 tonnes

The projected catch for 2003 based on the rainfall–catch relationship is 240–370 t for banana prawns.

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. In the Kimberley, however, banana prawns may be dispersed due to local tidal conditions, with the result that more general 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**

Turtle exclusion devices are used by the NPF boats that operate in this fishery. Trials of bycatch reduction devices (grids) commenced in the Kimberley Prawn Managed Fishery during 2002. Once implemented, these measures should eliminate 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 less than 5% of the licensed area. Owing to the unusual nature of the environment, characterised by extreme (10 m) tidal ranges, heavy mud substrates and high turbidity, the fishing is judged to have minimal impact on the habitat.

SOCIAL EFFECTS

Estimated employment for the year 2002 was 120 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2002:
$4.9 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 2002 were as follows:

Banana prawns	$12.00/kg
Tiger prawns	$18.71/kg
Endeavour prawns	$9.00/kg

FISHERY GOVERNANCE

Acceptable catch range: **240–500 tonnes**

Under current effort levels and previous environmental conditions, the acceptable ranges of prawn catches, based on the catches of the 1990s, are as follows:

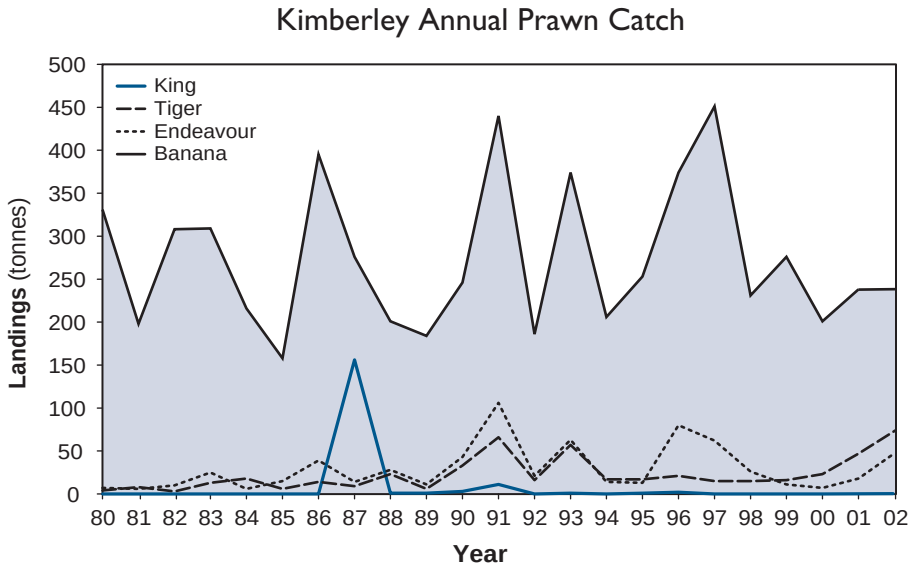
Banana prawns	200–450 t
Tiger prawns	15–60 t
Endeavour prawns	7–80 t

Note the overall acceptable range for all species combined is different from the aggregate of the individual species ranges shown, as the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species in the same year.

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 is done to prevent the small Kimberley fishery from attracting too much fishing effort from its much larger neighbour. However, it must be noted that the level of latent effort in this fishery is high and this issue is currently being addressed by management.



KIMBERLEY PRAWN FIGURE 1

Annual landings for the Kimberley Prawn Managed Fishery, 1980–2002

Kimberley Gillnet and Barramundi Managed Fishery

Management Summary

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) extends from the WA/NT border to the top of Eighty Mile Beach, south of Broome (latitude 19° S). It encompasses the taking of any fish by means of gillnet and the taking of barramundi by any means.

The species taken are predominantly barramundi (*Lates calcarifer*) and threadfin salmon (*Polydactylus macrochir* and *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.

Following the development in 2000 of the 'Barramundi Accord', management arrangements have now been 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.

Governing Legislation/Fishing Authority

Kimberley Gillnet and Barramundi Managed Fishery Management Plan 1989

Kimberley Gillnet and Barramundi Managed Fishery Licence

Consultation Process

Department–industry meeting

Research Summary

A collaborative three-year FRDC-funded research project between Murdoch University and Department of Fisheries began in July 2002 to study the biology of both the threadfin salmon species along with estuary cod (*Epinephelus coioides*), Malabar grouper (*E. malabaricus*) and mangrove jack (*Lutjanus argentimaculatus*). A detailed stock assessment of the threadfin salmons in the KGBF will be undertaken at the completion of this project.

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. The following status report is compiled annually and provided to industry and regional management.

In previous years, the data for this fishery has been reported on a financial year basis, but from this year it is presented on a calendar year basis to better reflect the actual fishing season and summer closure.

Kimberley Gillnet and Barramundi Managed Fishery Status Report

Prepared by S. Newman

FISHERY DESCRIPTION

Boundaries and access

The boundaries of this limited entry fishery 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°21'38" 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.

Access to the KGBF is currently limited to seven licences, with all seven vessels fishing during 2002. Currently there are two exemption holders authorised to operate along the Eighty Mile Beach in the Pilbara Coast fishing area.

Main fishing method

Gillnet.

RETAINED SPECIES

Commercial production (season 2002):
All species 124.4 tonnes
Barramundi 39.5 tonnes
Threadfin salmon 76.4 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 bluenose 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 northern (Pilbara/Kimberley) bioregion: Cambridge Gulf (including Ord River), Kimberley Coast (six river systems), King Sound (including Fitzroy River), Broome Coast, 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 fishing area lying outside the managed fishery area below latitude 19° S. Each of these principal fishing areas is considered separately because of their differing histories of development, effort application, recreational 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 2002 (previously reported on a financial year basis) was 124.4 t (Kimberley Gillnet Figure 1). 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 39.5 t for 2002 (Kimberley Gillnet Figure 2), approximately the same as in 2001.

The 2002 landings of threadfin salmon in the KGBF were 76.4 t, almost double those of barramundi (Kimberley Gillnet Figure 3). It should also be noted that the total KGBF catch of threadfin salmon was exceeded by the reported catch of 86.1 t of threadfin salmon in the Pilbara Coast fishing sector. Catches of threadfin salmon from the KGBF can be seen to vary substantially from year to year, with the 2002 catch up from last year but close to the five-year average.

These two main species groups (barramundi and threadfin salmon) comprise 93% 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 2002 are summarised in Kimberley Gillnet Table 3. The 2002 reported landings in the KGBF also comprised a total of 18 other species categories, including 3.2 t of sharks and rays (all species).

Fishing effort

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 2002, the total effort across the four prescribed fishing areas was 1,568 units. This total level of effort is the highest in the fishery since 1998 (Kimberley Gillnet Figure 1) but considerably lower than during the early 1990s.

Catch rate

The catch and effort for barramundi peaked in the late 1980s and since then total catch and effort have fallen, with an accompanying increase in catch per unit of effort. The catch of barramundi in the fishery has been steady over the last decade with decreases in effort resulting in an increase in CPUE. The CPUE in 2002 was down on that reported in 2001, whereas effort increased (Kimberley Gillnet Figure 2).

The trends for catch and CPUE for threadfin salmon are very similar: both peaked during 1999 and declined from 1999 to 2001 before increasing in 2002 (Kimberley Gillnet Figure 3). The reduced catch and CPUE from 1999 to 2001 may have resulted from a switch in targeting practices from threadfin to barramundi during this time. The current system does not allow us to determine the targeted effort applied to each of these species.

Recreational component: **Not assessed**

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. The total recreational scalefish catch was estimated to be 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. The proportion of the recreational catch from the West Kimberley region will be available during 2003. In addition, data has been collected from a recent National Recreational Fishing Survey and it is hoped that this data will become available on a regional basis in the near future.

Recreational fishing records from charter boats were not included in the Pilbara and West Kimberley survey data. In late 2001, 85 fishing tour licences and 5 ecotour licences were issued for the north coast bioregion (Pilbara and Kimberley coasts). At the same time, a logbook system was instigated to collect catch and fishing effort information from tour operators. These data are being analysed and will be available in 2003.

Stock assessment completed: **Yes**

The last detailed stock assessment, reported in the *State of the Fisheries Report 2000/2001*, 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. This increase in catch and effort will be monitored closely in future years. The catch levels in Cambridge Gulf in 2001 and 2002 are slightly lower than that recorded in 2000. Since 1994 the level of catch has reflected the level of effort in this sector of the fishery. Overall effort in this sector has declined to an historical low. There is on average an increasing trend in CPUE in the Cambridge Gulf sector. Similarly 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 tends to fluctuate at low levels.

The reported catch of threadfin salmon, the other key target species, declined from 1999 to 2001 before increasing to some extent in 2002. This decline may have been a function of declining abundance of threadfin or specific targeting of barramundi. The catch of threadfin salmon will be closely monitored in future years.

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 but there are currently no indications of any problems.

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. 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 changes.

SOCIAL EFFECTS

During 2002, 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 (2002): **$713,000**

The KGBF landed a total of 124.4 t of fish in 2002, for a catch value of over $713,000. This estimate is based on the landed weight of each species recorded in the CAES system and the 2001 average price per kilogram of whole weight of each species as supplied by fish processors.

The Pilbara Coast sector landed a total of 118.3 t of fish in 2002 for a catch value of $453,000. 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 $1.17 million.

FISHERY GOVERNANCE

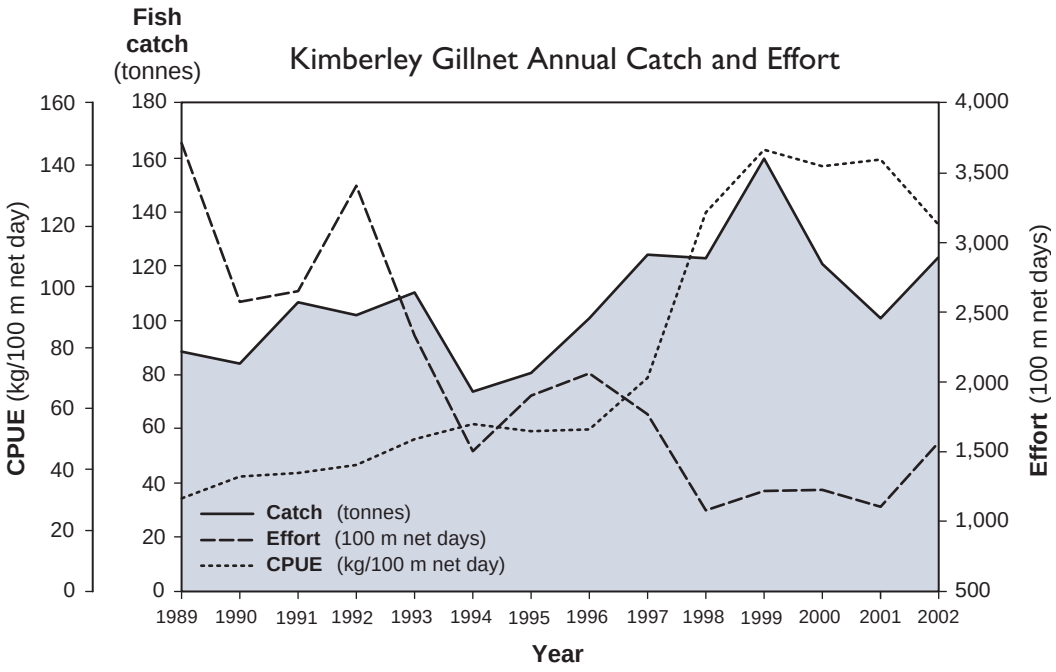
Acceptable catch range: **Barramundi 25–40 tonnes**

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 due to an increasing abundance of the target species flowing from substantial decreases in effort over the past decade.

EXTERNAL FACTORS

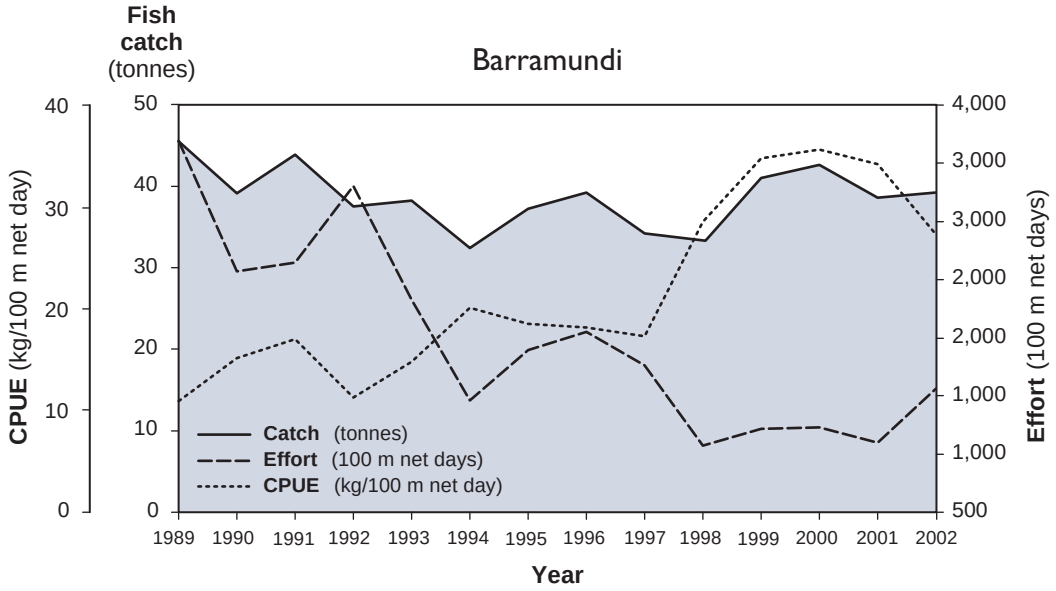
The barramundi stocks utilising the large, productive Kimberley river systems as nursery areas are expected to be reasonably resilient to fishing pressure. However, the smaller, isolated stocks along the arid Pilbara coastline are likely to experience more variable recruitment. These stocks are subject to relatively uncontrolled fishing under general wetline licence arrangements, as well as from recreational fishers, and are likely to need more specific management arrangements in the future.

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 are not considered to pose a threat to the viability of the resource. Given the present levels of commercial fishing effort across the KGBF, it is unlikely that the abundance of barramundi is being significantly impacted.



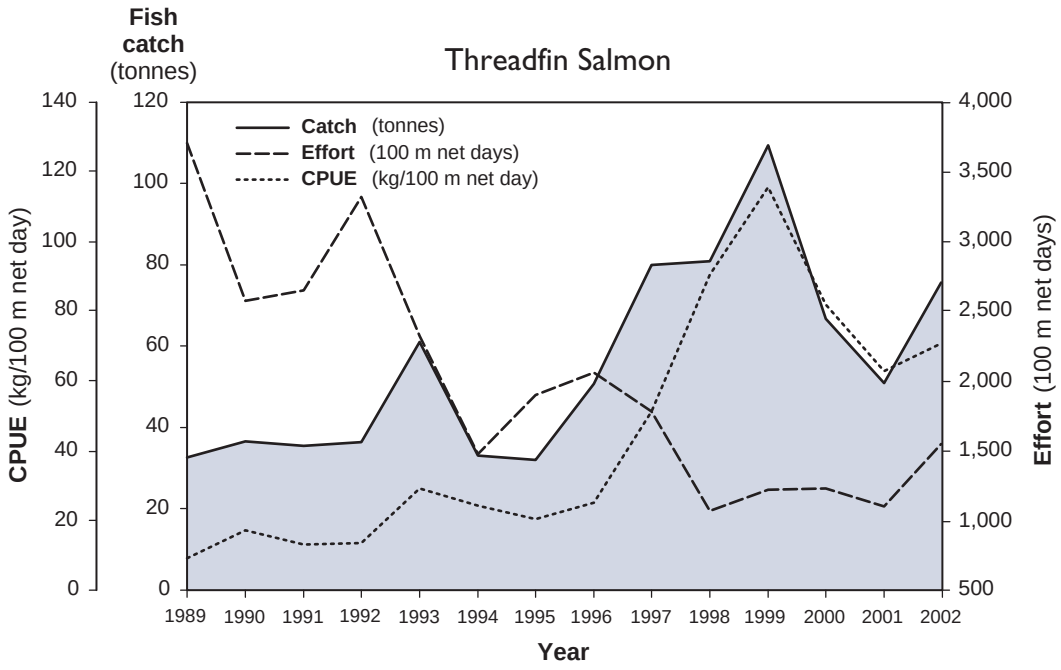
KIMBERLEY GILLNET FIGURE 1

The annual total catch, effort and catch per unit effort (CPUE, kg/100 m net day) from the KGBF over the period 1989 to 2002.



KIMBERLEY GILLNET FIGURE 2

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 2002.



KIMBERLEY GILLNET FIGURE 3

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 2002.

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 2002.

CATCH CATEGORY	*PRINCIPAL FISHING AREA*				
	Cambridge Gulf	**Kimberley Coast**	**King Sound**	**Broome Coast**	**Pilbara Coast**
Barramundi	8.1	12.1	6.5	12.8	<1.0
Threadfin salmon	1.9	4.1	1.9	68.5	86.1
Total	**11.3**	**17.3**	**9.8**	**86.1**	**118.3**

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**
Barramundi	37.8	39.4	34.3	33.5	41.2	42.9	38.8	39.5
Threadfin salmon	32.5	51.0	80.2	81.3	109.8	66.7	50.9	76.4
Total	**81.2**	**101.0**	**124.6**	**123.2**	**160.4**	**120.7**	**100.5**	**124.4**

KIMBERLEY GILLNET TABLE 3

Summary of the reported catch (t) and percentage composition of each of the major species taken in the KGBF in 2002.

SPECIES	*CATCH (tonnes)*	*COMPOSITION %*
Threadfin salmon	76.4	61.42
Barramundi	39.5	31.71
Sharks and rays	3.2	2.56
Black jewfish	1.7	1.37
Tripletail	1.0	0.76
Other fish	2.6	2.18
Total	**124.4**	**100**

Northern Demersal Scalefish Managed Fishery

Management Summary

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).

The fishery is managed by input controls, including individually transferable effort allocations, gear restrictions and area closures. The total effort allocation, based on a nominal total sustainable catch (TSC), is allocated on an annual basis. In 2002, the nominal TSC was 800 t of demersal scalefish and the total effort allocation was 1,760 days.

A draft application has been submitted for the northern demersal fishery as part of Environment Australia's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

The Northern Demersal Scalefish Management Advisory Committee recommended the introduction of trigger points for catches of red emperor and goldband snapper at its 2002 meeting.

Governing Legislation/Fishing Authority

Northern Demersal Scalefish Managed Fishery Management Plan 2000

Northern Demersal Scalefish Managed Fishery Managed Fishery Licence

Consultation Process

Northern Demersal Scalefish Management Advisory Committee

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. A number of cod species which occur in the NDSF are Indian Ocean endemics about which little is known. 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.

The following status report provides a synthesis of the current data from the fishery.

Northern Demersal Scalefish Fishery Status Report

Prepared by S. Newman

FISHERY DESCRIPTION

Boundaries and access

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 zones, an inshore zone (Area 1) and an offshore zone (Area 2) (see Northern Demersal Scalefish Figure 1). The demersal scalefish resources of the deeper waters of the offshore zone (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.

Access to the offshore zone (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 2002, 5 vessels (trap fishing only) collectively held and operated the effort individually assigned to the 11 licences.

Main fishing method

Principally fish traps, and to a lesser extent line fishing methods such as handline and/or dropline.

RETAINED SPECIES

Commercial production (season 2002): 434 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). However, since 1996 catch levels have decreased. In the five 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 in this five-year period of approximately 508 t. The catch of demersal scalefish in the NDSF in 2002 was lower than that reported in the previous year as the result of a reduced trap catch and no line catch (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 2001. There was a slight increase in the landed catch of red emperor, up from 95 t to 101 t, whereas the catch of goldband snapper was down from 209 t to 152 t.

Fishing effort

Annual fishing effort quotas are allocated to Area 2 (trap or line fishing) permit holders with the NDSF. Vessels may use their allocated quota anywhere within the boundary of Zone 2. The five fish trap vessels that fished in the NDSF in 2002 reported using between 20 and 40 fish traps per day. No line fishing was undertaken in the NDSF in 2002. The effort allocated in 2002 was 160 fishing boat days per licence, or a total of 1,760 standard fishing days. A standard fishing day is defined as using up to 20 traps or 5 lines per day; if more are used, the number of days declines proportionally.

The number of days fished that is recorded in the VMS database is converted to standard fishing days and adjusted to take into account an allocation of travel days for travelling across sectors within the NDSF. The number of standard fishing days (SFDs) reported using VMS data was 900, indicating that 860 SFDs remained unutilised in the fishery at the end of the 2002 fishing season.

The fish trap effort in 2002 was marginally lower than that recorded in 2001 (Northern Demersal Scalefish Table 2). Since the introduction of management controls, fish trap effort has varied from 890 to 992 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 2002 was 478.1 kg per standard trap fishing day (20 traps x 23.91 kg/trap/day). The annual average trap CPUE in the fishery has ranged from 400 kg/day to 545 kg/day in the period from 1990 to 2002.

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. Since 1998, however, the CPUE for trap vessels has stabilised in the range 457–504 kg/day, which is similar to the range prior to the introduction of direct management control through the effort quota system. No trend 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 2002. 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 the 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 recreational fishing catch is expected to be small relative to the total commercial catch.

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. The total recreational scalefish catch was estimated to be about 300 t. Recreational fishers in the survey area reported an estimated total catch of around 12 t of spangled emperor and 6 t of red emperor, whereas the estimated total catch of scarlet perch was less than 1 t. Boat- and shore-based recreational fishers do not catch significant quantities of the other species that are targeted by the NDSF. The proportion of the recreational catch from the West Kimberley region will be available during 2003. In addition, data has been collected from a recent National Recreational Fishing Survey and it is hoped that this data will become available on a regional basis in the near future.

Recreational fishing records from charter boats were not included in the Pilbara and West Kimberley survey data. In late 2001, 85 fishing tour licences and 5 ecotour licences were issued for the north coast bioregion (Pilbara and Kimberley coasts). At the same time, a logbook system was instigated to collect catch and fishing effort information from tour operators. These data are being analysed and will be available in 2003.

Stock assessment completed: 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 TSC 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 a catch level of approximately 800 t 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 TSC to be achieved within each year. The outcome

from this effort determination process for the 2003 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 five 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. The assessment models also indicated that the spawning biomass of both species was above the recommended limit of 40% of the virgin spawning biomass (54% for red emperor and 41% for goldband snapper). 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 length and age at maturity for goldband snapper and red emperor were reported in the *State of the Fisheries Report 2000/2001*. 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 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 2002 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 (2002): **$2.41 million**

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery landed a total of 434 t of demersal scalefish in 2002, for a catch value of over $2.41 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 2001). This value is lower than that reported in 2001 owing to the lower catch levels in the fishery.

FISHERY GOVERNANCE

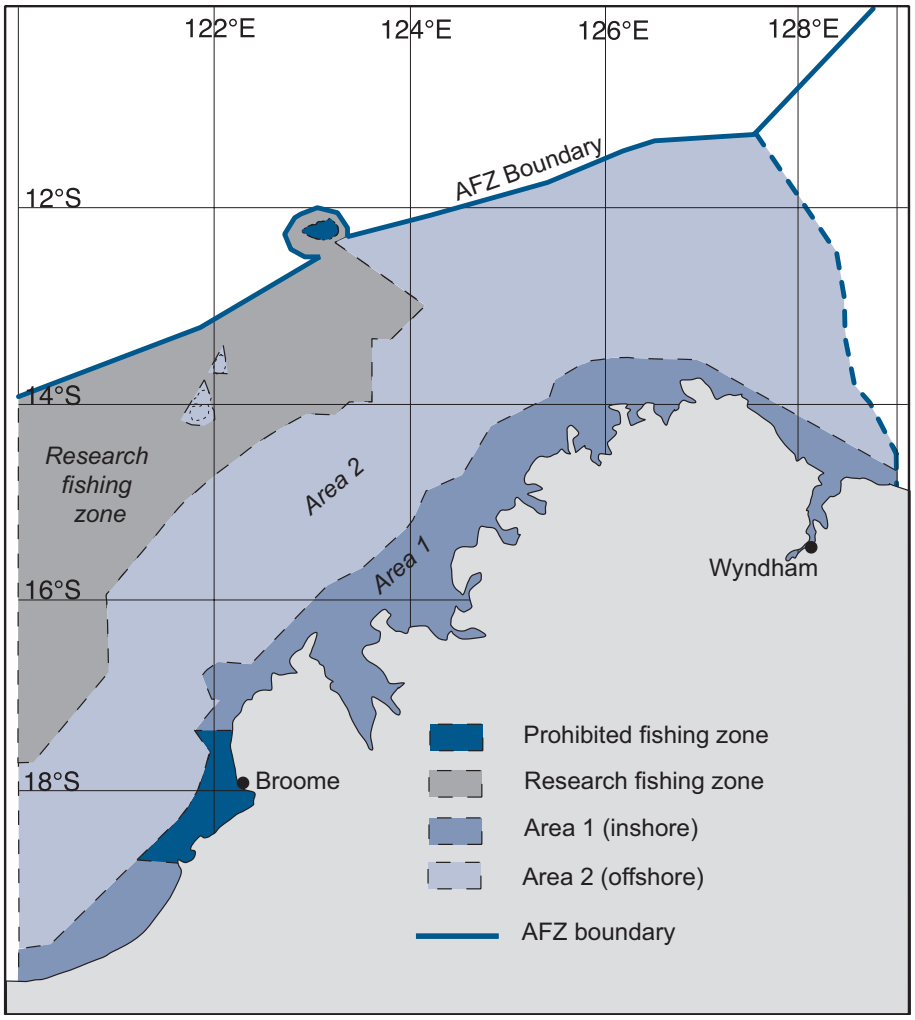
Acceptable catch range: **600–1,000 tonnes**

For the calendar year 2003, the total allowable effort was 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 five years since the introduction of management controls (1998–2002), the fleet has been unable to achieve the 800 t TSC. 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 with the spawning biomass of each species 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 re-assessed and discussed with industry.

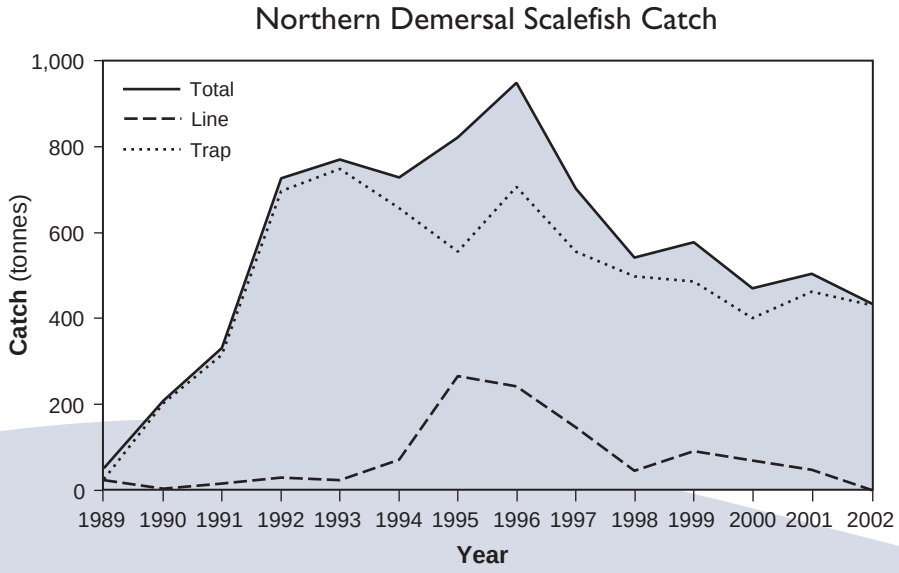
EXTERNAL FACTORS

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 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

Catches of demersal finfish in the NDSF by line and trap, 1989–2002.

NORTHERN DEMERSAL SCALEFISH TABLE 1

Recent annual catches of major target and by-product species or species groups by the NDSF. Note Tables 1 and 2 give updated figures that may differ slightly from those reported in previous years.

SPECIES	NDSF ANNUAL CATCH (tonnes) 1998	1999	2000	2001	2002
Goldband snapper (*Pristipomoides* spp.)	233	292	189	209	152
Red emperor (*Lutjanus sebae*)	109	101	90	95	101
Scarlet perch (*Lutjanus malabaricus*)	17	18	23	39	61
Spangled emperor (*Lethrinus nebulosus*)	26	27	32	36	35
Cod/grouper (Serranidae)	96	76	75	84	49
Other species	61	63	67	45	36
Total Demersal Scalefish Catch	**542**	**577**	**476**	**509**	**434**

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**

Pilbara Demersal Finfish Fisheries

Management Summary

The majority of demersal finfish produced from the North West Shelf are taken by fish trawling activities, with a lesser quantity taken by fish traps and line. Both the Pilbara Fish Trawl (Interim) Managed Fishery and the Pilbara Trap Managed Fishery are controlled through a combination of area closures, gear restrictions, and total and area effort limitations. The individually transferable effort regimes are monitored by the satellite-based Vessel Monitoring System.

Since the trawl fishery came into a formal management framework in 1998, effort has been reduced and redistributed to achieve the best yield from the fishery while keeping exploitation rates of key indicator species (red emperor, *Lutjanus sebae* and Rankin cod, *Epinephelus multinotatus*) at sustainable levels. 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 red emperor may require species limits in the future.

The trawl fishery underwent significant restructuring during 2002/03. To reflect the fact that the peak fishing period is over the months of December and January, the operational year has been changed from a calendar year to a financial year, to take effect on 1 July 2003. Implementation of this shift required a six-month fishery season, with half the normal effort allocation, in the period 1 January to 30 June 2003. Additionally, following a research stock assessment, 10% of the allocated effort was removed from Areas 1 and 5 of the trawl fishery, equal to a total effort reduction of 7%. The trap fishery also underwent a 7% reduction in total effort.

The management plan for the trap fishery was amended during 2002/03 to allow for more flexible nominations of trap. In addition, the trap vessels may now also utilise the Port of Broome.

Some demersal scalefish are also taken by 'wetline only' vessels that do not have access to specific managed fisheries.

A draft application has been submitted for the fishery as part of Environment Australia's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

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

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.

In addition, research surveys of both the deeper and the inshore areas adjacent to the existing trawl grounds have been completed under separate FRDC-funded projects. A draft report on bycatch from the Pilbara trawl fishery, funded by the Natural Heritage Trust (NHT) and the Department of Fisheries, was released in 2002. Further work is planned to develop gear modifications to reduce impact on protected species.

The following status report, which provides a synthesis of the data from the fishery, utilises the results of the earlier research together with ongoing catch and effort data provided through the research logbook system, CAES and VMS.

Pilbara Demersal Finfish Fisheries Status Report

Prepared by P. Stephenson and J. King

FISHERY DESCRIPTION

Boundaries and access

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. In 2000, effort quota was introduced, with transferable trap units being allocated and their utilisation being monitored by VMS.

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 is a general diagram showing the management areas within this fishery. The exact latitudes and longitudes delineating the areas are listed in the Pilbara Fish Trawl Fishery (Interim) Management Plan 1997.

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. There are 11 licence units with varying time allocations throughout Areas 1 to 6, with Areas 3 and 6 having zero time allocation. The allocated effort quota is transferable and monitored by VMS.

In addition, some wetline fishing occurs within the boundaries of the trawl and trap fisheries. Planning for consolidation of the general wetline catch in the Pilbara is continuing.

Main fishing method

Trawling is the dominant fishing method, with trapping and line fishing being relatively minor components.

RETAINED SPECIES

Commercial production (season 2002):
Trawl 2,310 tonnes
Trap 306 tonnes
Line 90 tonnes

Landings

Catches of the major species for 2002 are shown in Pilbara Table 1. The catches by different fishing methods for the years 1985 to 2002 are shown in Pilbara Table 2 and illustrated in Pilbara Figure 2.

Demersal scalefish catch by trawl, trap and line was 2,310 t, 306 t, and 90 t respectively.

The 2002 trawl fishery demersal scalefish catch had a similar species composition to that in 2001 apart from an increase in the 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). The major target species landed in 2002 (2001 catch in brackets) were threadfin bream (Nemipteridae) 363 t (228 t), blue spot emperor (*Lethrinus hutchinsi*) 353 t (318 t), red snapper (*Lutjanus erythropterus*) 278 t (365 t), flagfish (*Lutjanus vitta*) 211 t (171 t), goldband snapper (*Pristipomoides multidens*) 99 t (122 t), scarlet perch (*Lutjanus malabaricus*) 82 t (88 t), red emperor (*Lutjanus sebae*) 79 t (74 t), spangled emperor (*Lethrinus nebulosus*) 19 t (24 t), and Rankin cod (*Epinephelus multinotatus*) 17 t (19 t). Retained by-product totalled 180 t, including shark 68 t (73 t), bugs 5 t (7 t), and cuttlefish 104 t (67 t). There is the potential to increase catches of smaller species such as flagfish and threadfin bream, but there has been little interest by industry due to increased levels of handling and low prices.

The trap fishery catch increased to 306 t in 2002 (266 t in 2001). Major species taken by the trap fishery in 2002 (2001 figures in brackets) were red emperor 36 t (30 t), blue spot emperor 57 t (43 t), goldband snapper 38 t (26 t), Rankin cod 20 t (21 t), and red snapper 41 t (35 t). There is no by-product in this fishery.

Demersal scalefish catches by line fishing were lower in 2002 at 90 t (99 t in 2001). The catches in 2002 (2001 figures in brackets) were mainly goldband snapper 27 t (38 t), spangled emperor 11 t (8 t), red emperor 6 t (4 t) and Rankin cod 3 t (4 t). In addition, line vessels recorded catches of 193 t (117 t) of sharks and rays (which includes part of the North Coast Shark Fishery catch) and 119 t (103 t) of mackerel in the Pilbara.

The Pilbara shark catch is reported in more detail in the Northern Shark Fisheries Status Report (pp. 104–107), and the mackerel catch in the Spanish Mackerel Stock Status Report (pp. 98–102).

Fishing effort

The fishing effort in the trap, line and trawl sectors of the commercial fishery is shown in Pilbara Table 3. The effort in days is from monthly catch and effort returns, however for the trawl fishery, the effort from 1991 to 2002 is also recorded as the net bottom time (hours) taken from skippers' logbook 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 in 1998 to 2002 are shown in Pilbara Table 4.

The management plan allows for some flexibility in the effort distribution between areas, which resulted in an effort over-run in 2002 of 1% in Area 2 and 3% in Area 4 (compared with 8% and 3% in 2001). This decrease was due to management changes reducing the allowable over-run. There was no trawling in Area 3 or Area 6 in 2002.

Two trap boats were allocated 5,867 trap units in 2002 (days multiplied by number of traps) and the number of units used, calculated from VMS, was 5,828. This number of units equates to 382 days fished with an average of 15.2 traps per day, an increase from the average of 13.7 traps used per day in 2001. The number of days allocated, the number of days used and the percentage of the allocation used in 2000–2002 are shown in Pilbara Table 5.

In 2002, line fishers reported operating for 660 days, compared with 401 days in 2001. This effort does not include trolling, which is reported in the Spanish Mackerel Stock Status Report (pp. 98–102), nor the dropline and longline effort in the Northern Shark Fisheries (pp. 104–107). Plans for future management of line fishing in the Pilbara will be considered during the statewide wetline fishing review.

Catch rate

The trawl catch rates (based on nominal VMS effort) for red emperor are now relatively stable. In the recently developed Areas 4 and 5 the catch rates, which were 4.6 and 5 kg/hour respectively in 1998, were 5.2 and 3.4 kg/hour in 2002. Similarly, in Area 1 the catch rate has stabilised at a low level of 2 kg/hour and in Area 2 it has been between 4.5 and 6.3 kg/hour for the last four years.

Blue spot emperor catch rates have steadily decreased in Area 1 from 44.8 kg/hour in 1996 to 18.7 kg/hour in 2001, with a slight increase to 21.3 kg/hour in 2002. In Area 5, catch rates have decreased steadily from 13 kg/hour in 1996 to 7.9 kg/hour in 2002. In Area 2 and Area 4, blue spot emperor catch rates have been stable at approximately 19 and 11 kg/hour respectively from 1996 to 2002.

Rankin cod catch rates have decreased in Area 1 and Area 5, from 0.8 and 1.9 kg/hour respectively in 1998 to 0.4 and 1.1 kg/hour in 2002, but appear to be stable in Area 2 and Area 4 at approximately 1.2 and 1.5 kg/hour respectively in recent years.

Despite the declines in some of the indicator species, the overall trawl catch rate has increased during the past three years. In 2002, the catch rate for all retained species was 112.4 kg/hour, which was up significantly from 96.6 kg/hour in 2001. There has probably been little efficiency increase on individual vessels in the last 12 months, but the consolidation of the fleet has resulted in the effort allocation being used by the more efficient vessels. There is likely to be some efficiency increase in the future that will bias the observed catch rates upwards in future years.

Catch rates for the trap fishery (based on the reported number of days fished) have increased considerably in the last two years. This can be attributed to efficiency gains flowing from the consolidation of the fleet. The line catch rate in 2002 was considerably lower than in 2001.

Recreational component: Not assessed

There is a major recreational fishery in the Pilbara and the charter sector in this area is an increasing user of the resource. 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.

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. The total recreational scalefish catch was estimated to be about 300 t. Recreational fishers in the survey area reported an estimated total catch of around 12 t of spangled emperor and 6 t of red emperor, whereas the estimated total catch of scarlet perch was less than 1 t. 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.

Stock assessment completed: Yes

Red emperor and Rankin cod were used as indicators of long-lived species and blue spot emperor was used as an indicator of short-lived species.

Trawl and trap fishery: In 2002 the stock assessment model was updated with catch and catch rate data for the three indicator species. Red emperor age composition data for 1982, 1983, 1995, and 2002 were also incorporated into the model. The assessment indicated upward trends in spawning biomass of red emperor in all areas except Area 4, with satisfactory and increasing spawning stock over the whole fishery (Pilbara Figure 3). Rankin cod appeared to be depleted in Area 5 and in the area west of the trawl fishery, although overall spawning stock level was adequate (Pilbara Figure 4). The blue spot emperor stock in Area 1 appears to be depleted, although there is an increase in the catch rate in 2002. Overall, however, the stock of this species appears to be adequate. A 10% trawl effort reduction in Areas 1 and 5 of the trawl fishery, and an equivalent effort reduction in the trap fishery, was mandated for 2003.

Anticipated increases in efficiency, especially as a result of consolidation in the trap and trawl fleets, may make further effort adjustment necessary in the future.

Line fishing: The line catch was lower in 2002, although the recorded number of days fished increased. These fluctuations in catch and effort are due to dedicated and skilled operators moving in and out of the fishery.

While goldband snapper is not an indicator species, the high catch in 2001 was cause for concern. In addition, this deeper-water species matures at a relatively large size and is long-lived and thus more vulnerable to over-exploitation. Recent stable isotope ratio studies indicate there is little mixing of recruited goldband snapper between the Pilbara and Kimberley fisheries. However, there may be exchange of eggs and larvae. This has management implications, as stock depletion in one fishery may reduce recruitment in adjacent fisheries. The goldband snapper catch decreased in the line and trawl fishery in 2002 but increased considerably in the trap fishery.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Breeding stocks of the short-lived species (e.g. flagfish, threadfin bream) have been assessed as adequate overall. Catch rates of blue spot emperor show a declining trend in Areas 1 and 5 of the trawl fishery, but it is likely that an adequate breeding stock exists over the whole fishery.

The spawning biomass of red emperor and Rankin cod was estimated to be satisfactory over the whole fishery, although there appears to be local depletion in Area 1 of the trawl fishery, in the portion of the trap fishery off Onslow, and in Area 5 of the trawl fishery.

The effort reduction in 2003 should ensure breeding stock levels of the indicator species are maintained at satisfactory levels in the short to medium term.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The NHT-funded project on bycatch in the trawl fishery conducted in 2002/03 indicated that the bycatch of under-size and unmarketable scalefish varied considerably between vessels and was approximately 1,000 t in 2002. The landed catch of sharks was 68 t in 2002, which is approximately 40% of the weight of shark caught. The scalefish returned to the water are expected to have poor survivorship.

The trap and line fisheries have minimal bycatch.

Protected species interaction: **Moderate**

During the trawl bycatch survey, the capture of protected species was recorded for 100 days at sea (approximately 7.7% of the effort in 2002). Dolphins were attracted to the trawl and swam freely in and out of the trawl net. In the survey period, four dead bottlenose dolphins were found in the cod-end of the trawl net, but the significance of these accidental captures, relative to the population size and natural mortality of the North West Shelf dolphin population, is unknown. Mechanisms to reduce this interaction are being investigated.

Sea snakes and turtles are occasionally captured in the fish trawl nets. Of the seven turtles captured in the bycatch survey conducted in 2002, five were released alive. All sea snakes were released alive. Pipefish and seahorses are captured in the trawl fishery, and 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 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: **Moderate**

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. At the now permitted levels of trawl and trap exploitation, it is expected that the stocks will stabilise, albeit at a low level for some species in some areas. Overall, the effect of the fishery on the food chain of the North West Shelf is considered to be an acceptable impact.

Habitat effects: **Moderate**

Impacts to the habitat are restricted to those of the trawl fishery, which in turn 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, 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 5 vessels were directly employed during 2002 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 (2002): **$9 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 2002 was $7.2 million, with a retained by-product valued at $400,000. 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 $1.3 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. 104–107) and the Spanish Mackerel Stock Status Report (pp. 98–102) respectively.

The catches from the Pilbara fisheries dominate the Western Australian metropolitan markets and support the local fish processing sector. There is also an increasingly important export of scalefish to Europe and Asia.

FISHERY GOVERNANCE

Acceptable catch range: **Trawl 1,900–2,200 tonnes**
Trap 150–300 tonnes
Line 50–115 tonnes

In the trap and line fisheries, the catch range is based on the catch variation of the target species over the period 1993 to 2001. In the trawl fishery, due to reduction in the allocated effort, there were decreases in catch from 1996 to 2000. The acceptable catch range has been determined from the catch rate and the allocated effort. The trawl catch in 2001 was slightly above the upper limit of the defined range, due to fleet consolidation which has seen the more efficient vessels forming a larger proportion of the fleet. In 2002, there were 2,546 hours of unused trawl effort, but the catch was higher than the previous year due to increased catch rates and the fact that more scalefish were retained on some vessels. Consequently, the 2002 catch of 2,310 t exceeded the acceptable range.

For 2003, the effort allocation in the trap and trawl fishery has been decreased by 7%, but the increased catch rate is likely to result in further increases in the trawl and trap catch. Consequently, in 2004, either the catch range should be increased or further adjustments be made to the trap and trawl effort allocation.

Following the consolidation of the trap and trawl fisheries into a smaller number of dedicated operators in recent years, it would be beneficial to set an effort level which could be left unadjusted for several years. If this were to occur, there might need to be appropriate adjustment to the allocated effort in the trawl and trap sectors. The increased line catch of goldband snapper and the increasing charter catch are also cause for concern, as these sectors do not have effort or catch limits at present.

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 adversely 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 2002.

		FISH TRAWL CATCH		TRAP CATCH		LINE CATCH		TOTAL CATCH
		tonnes	%	tonnes	%	tonnes	%	tonnes
Blue spot emperor	*Lethrinus hutchinsi*	353	86%	57	14%	1	0%	411
Threadfin bream	*Nemipteridae*	363	100%	-	-	-	-	363
Red snapper	*Lutjanus erythropterus*	278	87%	41	13%	-	-	319
Flagfish	*Lutjanus vitta*	211	94%	13	6%	-	-	224
Goldband snapper	*Pristipomoides multidens*	99	60%	38	23%	27	17%	164
Red emperor	*Lutjanus sebae*	79	65%	36	30%	6	5%	121
Scarlet perch	*Lutjanus malabaricus*	82	82%	12	12%	6	6%	100
Spangled emperor	*Lethrinus nebulosus*	19	28%	37	55%	11	12%	67
Frypan snapper	*Argyrops spinifer*	42	98%	1	2%	-	-	43
Rankin cod	*Epinephelus multinotatus*	17	42%	20	50%	3	8%	40
Other demersal scalefish		767	90%	51	6%	36	4%	854
All demersal scalefish		**2,310**	**85%**	**306**	**11%**	**90**	**4%**	**2,706**
Shark and ray		68	26%	0		193*	74%	261
Other by-product		112	100%	0		0		112

* 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**

* 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' logbook data.

YEAR	LINE (days)	TRAP (days)	TRAWL (days)	TRAWL (hours)
1985	809	709	-	-
1986	655	548	19	-
1987	614	507	17	-
1988	985	804	32	-
1989	863	1,198	310	-
1990	1,332	1,321	698	-
1991	740	472	1,132	8,660
1992	514	681	983	10,030
1993	876	696	832	10,725
1994	732	545	1,484	22,087
1995	852	608	1,571	21,529
1996	814	513	1,550	25,246
1997	809	483	1,389	19,810
1998	692	503	1,291	20,555
1999	453	842	1,139	15,963
2000	500	518	957	14,084
2001	401	446	1,162	15,330
2002	**660**	**418**	**1,035**	**17,329**

PILBARA TABLE 4

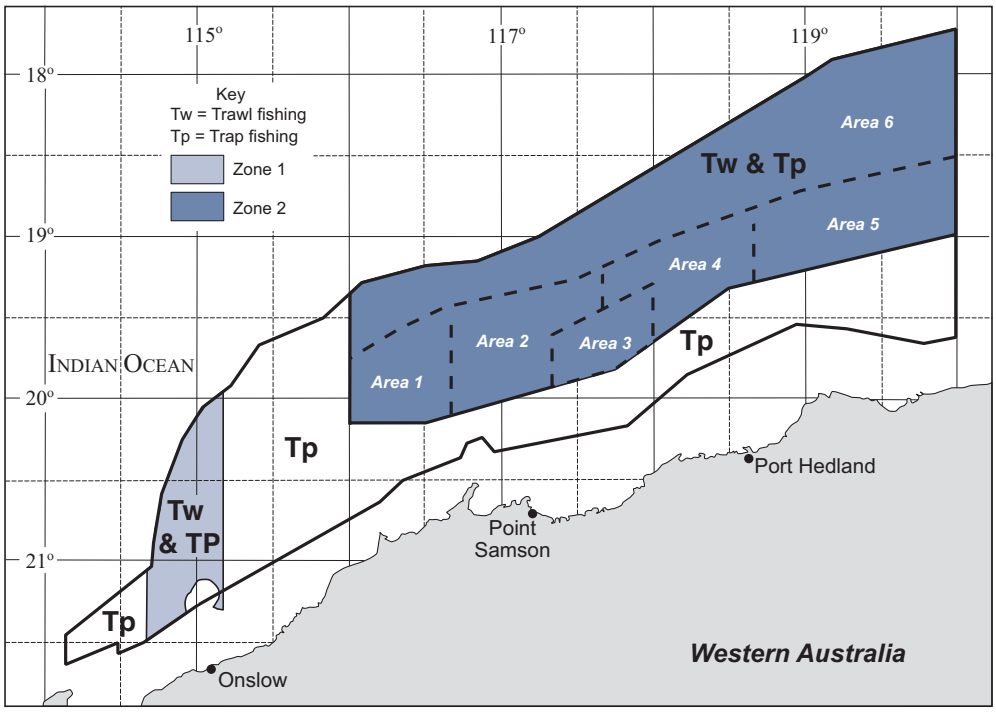
The number of hours allocated, the number of hours used and the percentage of the allocation used in each area of the Pilbara trawl fishery.

		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%**

PILBARA TABLE 5

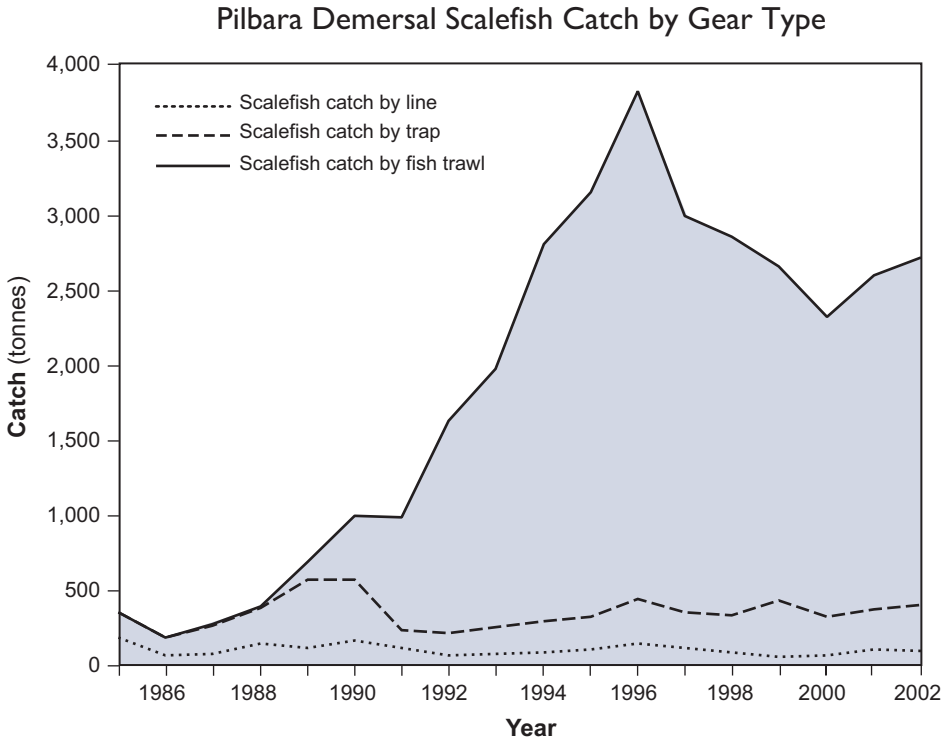
The number of days allocated, the number of days used and the percentage of the allocation used in the Pilbara trap fishery.

2000	time allocation	524	2001	time allocation	420	**2002**	**time allocation**	**385**
TRAP	time used	507	TRAP	time used	414	**TRAP**	**time used**	**382**
	% of time used	97%		% of time used	99%		**% of time used**	**99%**



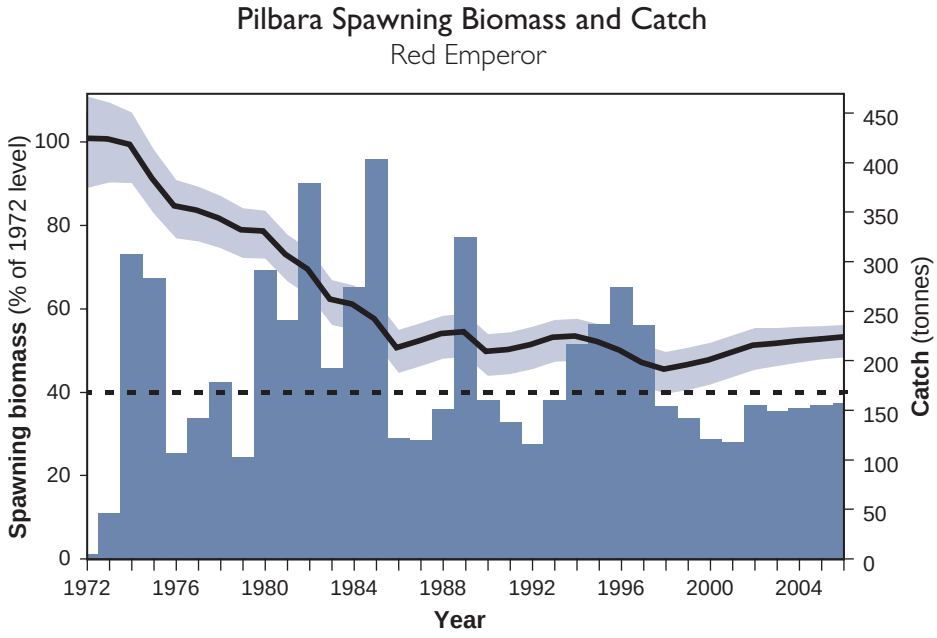
PILBARA FIGURE 1

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.



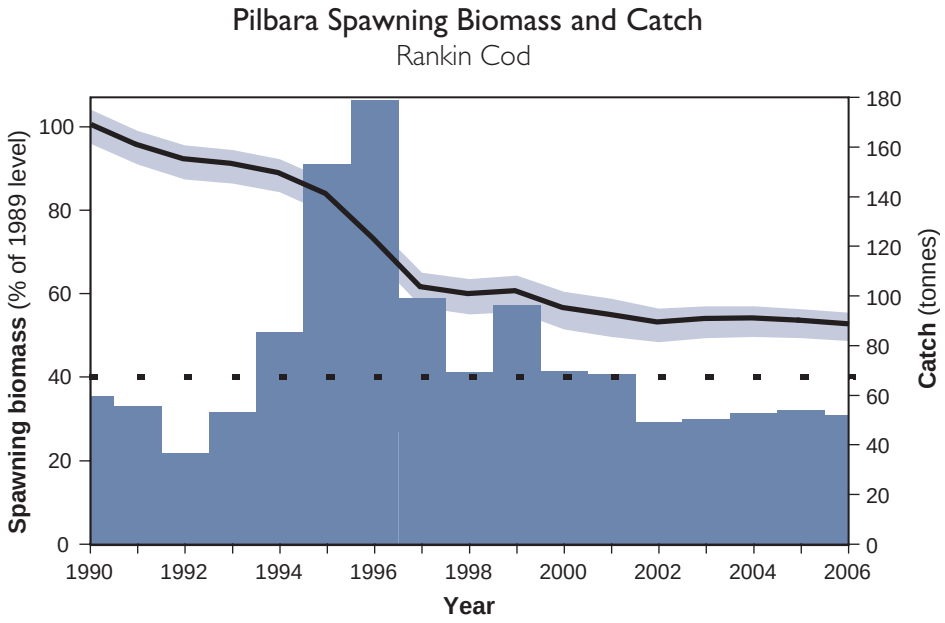
PILBARA FIGURE 2

Demersal scalefish catches by trawl, trap, and line from 1985 to 2002.



PILBARA FIGURE 3

Spawning biomass (with 95% confidence intervals) as a percentage of the 1972 level (black line); the biological reference point (40% of the 1972 level – dashed line); and the catch from all fishing sectors (columns) for red emperor in the Pilbara fishery. Data from 2003 onwards is projected from the model.



PILBARA FIGURE 4

Spawning biomass (with 95% confidence intervals) as a percentage of the 1990 level (black line); the biological reference point (40% of the 1990 level – dashed line); and the catch from all fishing sectors (columns) for Rankin cod in the Pilbara fishery. Data from 2003 onwards is projected from the model.

Mackerel Fishery

Management Summary

Fishing for mackerel species, which is currently available to all Western Australian licensed commercial fishing boats, was reported by 78 boats during 2002. Although most of these catches were made opportunistically by boats operating within other fisheries, there are about 10 boats which specifically target mackerel.

Owing to concerns over increased catches and evidence to suggest that the species may be in danger of over-fishing, the Mackerel Independent Advisory Panel was appointed in 2001 to make recommendations to the Executive Director on criteria for access to, and management arrangements for, the mackerel fishery. Following extensive consultation, recommendations from the advisory panel and advice from the Department of Fisheries, the Minister for Fisheries has approved the drafting of the Mackerel Fishery (Interim) Management Plan, to commence in 2004.

The mackerel fishery (including all mackerel of the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium*) will be managed under an output (quota) management system. The fishery will be divided into in three zones (Gascoyne/West Coast, Pilbara and Kimberley) with specified points of landing for mackerel catch. All zones will be managed through the use of VMS, the reporting of catch prior to landing and an option for the Executive Director to vary the mackerel fishing season.

The total allowable catch for each zone of the fishery will be set by the Executive Director, after taking the best scientific and operational advice available to him to ensure sustainability of the mackerel fishery.

Access to the fishery will be based on catch history in a specified criteria period, with the level of access entitlement being determined by catch levels during the criteria period.

A draft application has been submitted for the mackerel fishery as part of Environment Australia's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

Governing Legislation/Fishing Authority
Fish Resources Management Regulations 1995
Fishing Boat Licence

Consultation Process
Department–industry meetings

Research Summary

Two mackerel-related FRDC funded research projects were completed in 2002. Both projects focused on the narrow-barred Spanish mackerel, *Scomberomorus commerson*, which is the main target species in the Western Australian mackerel fishery. Firstly, a joint WA/NT/Qld project was conducted to determine the stock structure of Spanish mackerel in northern

Australia and, secondly, a stock assessment of Spanish mackerel in Western Australia was conducted to gather biological information and analyse catch and effort data for the commercial fishery. With the aid of fisheries models, the results of these projects are now being used to determine the status of mackerel stocks in Western Australian waters and will provide a basis for management arrangements to control the future catches from the fishery.

The following status report summarises the research findings for this fishery presented in the ESD application, which are based primarily on data for Spanish mackerel.

Spanish Mackerel Stock Status Report

Prepared by M. Mackie and K. Smith

FISHERY DESCRIPTION

Boundaries and access

Spanish mackerel are widespread throughout the Indo-West Pacific. In Western Australia, they are fished commercially from Geraldton northwards to the Northern Territory border. Mackerel are reported as far south as Albany on rare occasions. Spanish mackerel are usually captured at or near the surface in coastal areas around reefs, headlands and shoals. Anecdotal evidence suggests that many also spend time dispersed in deeper offshore waters, particularly during summer when the coastal fishery is generally not viable. Results of the recent stock structure project suggest that the extent of along-shore movement by Spanish mackerel in northern Australia is limited (typically < 100 km). Therefore, the stock in Western Australia probably consists of spatially discrete subpopulations of adults.

Most of the commercial catch is taken from May through to October, with minor catches made during summer in the Pilbara and Kimberley regions when weather conditions permit. Under the interim management plan (IMP), the fishing season will be restricted to a period of six months in each sector. Access to the mackerel fishery will also be restricted to fishers who meet certain criteria.

Catches in the mackerel fishery are reported in four sectors, described below. However, at the commencement of the IMP in 2004, the West Coast and Gascoyne sectors will be combined.

Kimberley sector: The use of dories (5–6.5 m dinghies) is restricted to this sector, which extends east of longitude 121° E (previously 120° E) to the Northern Territory border. Dories troll two to three lines and work to a mother boat that is about 20 m in length. Fishing gear used in this sector 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 sector are usually filleted, boxed and frozen for distribution throughout Australia.

Pilbara sector: This sector extends from longitude 114° E to 121° E and north of 23° S. Vessels used in this area are between 9 and 15 m in length (no dories), with one to two crew using 180 kg mono line and wire trace. In recent years the main catches from this sector have come from the Port Hedland area. Fishing trips usually last less than a week, and the product is trunked, brined, and sold locally or sent fresh to Perth markets.

Gascoyne sector: This sector extends from 27° S to 23° S. Vessels used in this area are between 7 and 15 m in length and are crewed by one to two persons for trips lasting one to five days. 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.

West coast sector: This sector extends south of 27° S. Fishing gear and methods are the same as those used in the Gascoyne sector, with most catches obtained from the Geraldton and Abrolhos areas. Few commercial mackerel catches are made south of Geraldton. Note that for analyses of catch rates the Gascoyne and west coast sectors are combined.

Main fishing method

Trolling.

RETAINED SPECIES

Commercial production (season 2002):
Spanish mackerel 467.9 tonnes
Other mackerel 56.2 tonnes

Landings

Spanish mackerel (*Scomberomorus commerson*) is the main target species and may comprise more than 90% of the catch. Grey or broad-barred mackerel (*S. semifasciatus*) is the dominant by-product, particularly in the Gascoyne and west coast sectors where it is sometimes captured in large numbers. However, fishing methods need to be modified in order to catch this species in quantity. 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. Bait collection by mackerel fishers is currently being reviewed and may be restricted under the IMP.

The reported catch of 467.9 t of Spanish mackerel in 2002 comprised 245.8 t from the Kimberley sector, 136.8 t from the Pilbara sector, 53.5 t from the Gascoyne sector and 31.9 t from the west coast sector (Spanish Mackerel Figure 1 and Table 1).

Historic trends in catches were described in the *State of the Fisheries Report 2000/2001*. Yearly variations and the overall trends in total catch of Spanish mackerel are mainly influenced by catches in the Kimberley sector, which is the largest of all the sectors. Discussion with fishers indicated that the relatively low 2000 catch in the Kimberley region was mainly due to environmental effects on the seasonal abundance of mackerel.

However, the catch level recovered in 2001 and has continued to increase in 2002. Reported catches in the west coast sector are usually minor, although relatively high catches of 33 t and 32 t were recorded in 2001 and 2002 respectively. This significant increase was apparently due to an increase in mackerel availability in this sector following an unusually high recruitment year in 1999/2000 (as noted during the stock assessment project). The 2002 catch was also the highest recorded for the Pilbara sector, but at 136.8 t it does not represent a significant increase on the previous average. Nevertheless, with relatively high catches in most sectors, the total catch of Spanish mackerel in 2002 was the highest yet recorded.

The annual catches of the other species of mackerel, including grey, spotted, shark and school mackerel, caught by this fishery are shown in Spanish Mackerel Table 1. The large fluctuations in catches of these 'other mackerel', including peaks in total catch in 1992 and 1997, mainly reflect periods of high abundance of grey mackerel in each sector. 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 sector. It has also been increasingly targeted in the Pilbara sector in recent years. However, little is currently known about the distribution and abundance of grey mackerel in the north of the State. Grey mackerel are captured in large numbers in some years although they are usually present in the fishery for only one or two months each year.

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 sector. Historically, catches of 'other mackerel' have shown significant year-to-year variability, mainly due to fluctuations in the Kimberley and Pilbara sectors. The catch of 'other mackerel' in all sectors during 2001 and 2002 was relatively low and stable at about 56 t, with individual catches in each sector ranging from 8.7 t (Pilbara) to 16.8 t (Kimberley).

Fishing effort

The commercial fishing effort for Spanish mackerel recorded in the CAES database for the 2002 season, by sector, was as follows:

Kimberley sector	8 boats	639 days
Pilbara sector	18 boats	721 days
Gascoyne sector	26 boats	1,051 days
West coast sector	40 boats	978 days

The annual number of boats recording catches of Spanish mackerel has varied substantially since 1980, from 4 to 20 boats in the Kimberley sector, 17 to 53 boats in the Pilbara sector, 13 to 56 boats in the Gascoyne sector, and 10 to 40 boats in the west coast sector. Note some of these boats may fish in more than one sector.

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. Initiation of a fishery-specific logbook 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 sectors. This peak occurs earliest in southern waters: during May in the west coast sector, in July in the Gascoyne sector and in August in the Kimberley and Pilbara sectors. The Pilbara sector 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 155 kg/day), with an increasing trend since 1996. Catch rates in the Pilbara sector have fluctuated significantly, reaching a low in 1988 of 43 kg/day, but since 1990 they have continued to rise, particularly after 1996, with 234 kg/day recorded in 2002 (Spanish Mackerel Figure 2). Catch rates in the combined west coast/Gascoyne sector are lower than in the two northern sectors and exhibit a 6- to 7-year cyclic pattern. During the past 20 years, they have had peaks of 95 kg/day 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 was 50 kg/day.

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 2001/2002*. No subsequent surveys of recreational fishing have been conducted.

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 will be available in 2003/04.

Reported catches of Spanish mackerel by recreational charter vessels are relatively minor. In 2002, approximately 18 t of Spanish mackerel were reported by charter vessels. Catches were mainly taken in the Kimberley and Pilbara sectors (75%) or Gascoyne sector (20%).

Stock assessment completed: **Yes**

An initial assessment of Spanish mackerel stocks was completed in 2002, using biomass dynamics and yield-per-recruit modelling. Details were reported in the *State of the Fisheries Report 2001/2002*. 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 2002 and will be incorporated into future models.

A new time-series model was also devised to forecast Spanish mackerel catches using lagged fishery-dependent monthly catch rates and environmental interactions. The model found that an interaction between October commercial catch rates and the annual average series of the Southern Oscillation Index (SOI), both lagged two to three years, reliably predicted the aggregate commercial Spanish mackerel catch for the State. In the model, October catch rates are assumed to signify abundance of spawning stock, while the SOI is hypothesised to affect the survival of juvenile recruitment stock. The positive correlation between Spanish mackerel catches and the SOI component therefore suggests that the high catches in 2002 may be partly attributable to the high positive SOI in 1999 and 2000.

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 expert 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 preliminary 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: **Low**

Fishing for Spanish mackerel uses specialised troll lines to target the schooling fish and involves limited discarding. Species occasionally caught and generally discarded include sailfish, billfish, pike, barracuda, shark, mackerel tuna, queenfish and trevally.

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 68 people were employed catching Spanish mackerel during the 2002 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.

Estimated annual value (to fishers) for year (2002):
Spanish mackerel $2.7 million
Other mackerel $310,000

Overall ex-vessel prices for Spanish mackerel ($5–6/kg) and other mackerel ($4–6.50/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: **275–417 tonnes**

Acceptable catch ranges for the individual sectors were previously based on historic catch ranges, but were revised in late 2002 to be more consistent with new management arrangements to be introduced under the IMP. Revised catch ranges in each sector, except the Gascoyne, were based on

the minimum and maximum catches occurring within the criteria period of 1991–1997. Therefore, revised acceptable catch ranges are Kimberley: 150–198 t, Pilbara: 69–134 t and west coast: 6–15 t. In the Gascoyne, catches ranged from 9 to 78 t during the criteria period. However, unusually low catches occurred from 1989 to 1995, possibly as a result of over-fishing from 1981 to 1987. Therefore, an acceptable catch range of 50–70 t, based on historic catches rather than the criteria period, has been retained in the Gascoyne.

These acceptable catch ranges may be further revised when the IMP is introduced or when the processes controlling recruitment variability in Spanish mackerel are better understood.

In 2002, reported catches were within the acceptable catch range in the Gascoyne sector. However, reported catches were above the acceptable catch range in the Kimberley and west coast sectors, and were at the maximum acceptable level in the Pilbara sector. These relatively high catches reflect very strong recent recruitment to the fishery and are not considered to be a threat to the sustainability of the resource. Catches are expected to fall back within acceptable ranges in the next one to three years, partly as a result of natural fluctuations in abundance. Also, future catches will be constrained by catch quotas and other management measures implemented under the IMP.

EXTERNAL FACTORS

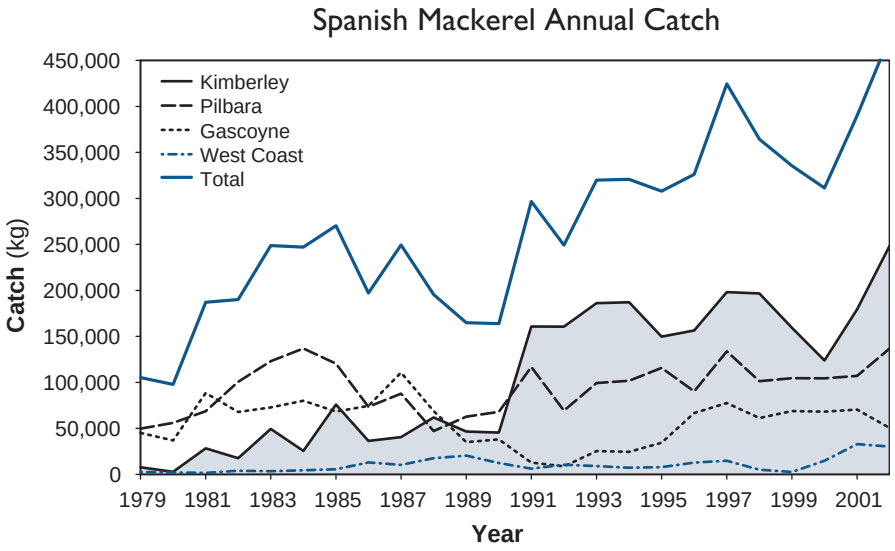
Spanish mackerel and the other mackerel species caught by this fishery are all are relatively short-lived, fast-growing species. Consequently, there are likely to be relatively large changes in the abundance of these species in the different sectors through time that are not the result of fishing but from variations in recruitment strength caused by environmental fluctuations.

SPANISH 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.

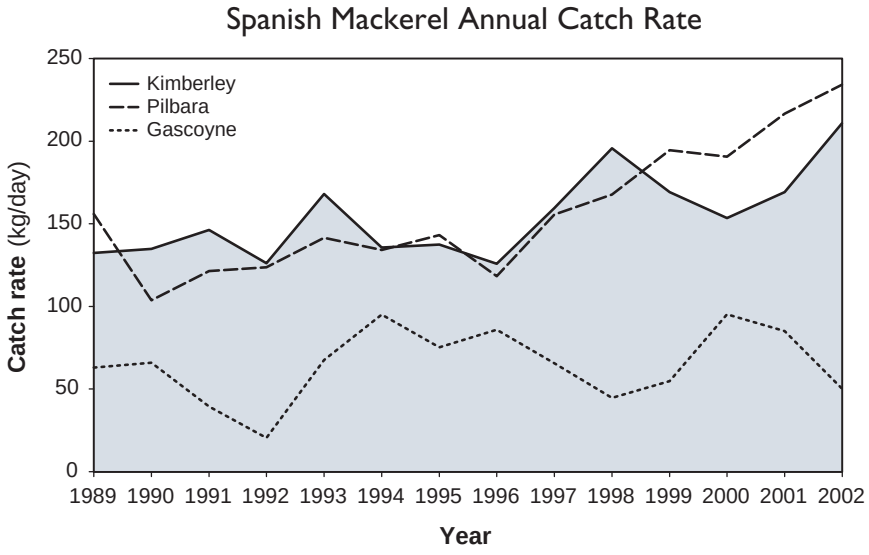
YEAR	SPANISH MACKEREL (tonnes)					OTHER MACKEREL (tonnes)				
	KIMBERLEY*	PILBARA	GASCOYNE	WC	TOTAL	KIMBERLEY	PILBARA	GASCOYNE	WC	TOTAL
1980	2.8	56.0	36.9	2.2	97.9	0.0	8.6	2.1	0.0	10.8
1981	28.3	68.7	88.5	1.7	187.2	1.9	0.4	0.1	0.1	2.5
1982	17.6	100.7	67.8	4.0	190.1	3.3	3.6	11.8	1.2	19.9
1983	49.5	123.0	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**

* Catches by Taiwanese gillnet fishers of approximately 5–90 t per year (mean approx. 50 t) between 1980 and 1986 (Stevens and Davenport 1991) are not included in these estimates. These gillnet catches include data east to longitude 131° E and therefore are not directly comparable with Kimberley catches.



SPANISH MACKEREL FIGURE 1

Annual catch of Spanish mackerel in Western Australia.



SPANISH MACKEREL FIGURE 2

Estimated catch per unit effort (kg/day) for vessels specialising in catching Spanish mackerel. Effort data was based on only those vessels known to target the species.

Northern Shark Fisheries

Management Summary

The 'northern shark fisheries' comprise the State-managed WA North Coast Shark Fishery (Pilbara/western Kimberley) and the Joint Authority Northern Shark Fishery (eastern Kimberley). Operators in both fisheries mostly operate demersal longlines to target sharks.

Joint Authority Northern Shark Fishery (*JANSF*)*:* The commercial take of shark in Western Australian waters east of 123°45′ E longitude (Koolan Island) is controlled by a joint authority arrangement between the Commonwealth 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 Commonwealth Ministers for Fisheries.

The *Offshore Constitutional Settlement 1995* specifies that the use of pelagic gillnets, demersal gillnets and demersal longlines to commercially take sharks and rays (class Chondrichthyes) and bony fish (class Osteichthyes) is to be managed by the Joint Authority under Western Australian law.

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. The Section 43 order is considered to be an interim management arrangement, and will give the WAFJA an opportunity to consider the longer-term management of the JANSF.

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 limits and restrictions on lengths of pelagic gillnet will also be introduced. The take of mackerel by JANSF operators will also be prohibited unless JANSF operators hold a licence to operate in the proposed mackerel fishery.

WA North Coast Shark Fishery (*WANCSF*)*:* The Western Australian-controlled sector of the northern shark fisheries is managed by way of an order made under section 43 of the *Fish Resources Management Act 1994*. The order was gazetted in May 1993 and applies to all Western Australian waters off the north coast, from longitude 114°06′ E (North West Cape) to 123°45′ E (Koolan Island). The order prohibits the use of shark longlines, shark droplines, pelagic gillnets and powered hauling devices.

There are eight operators entitled to fish in the WANCSF with shark gear by way of a fishing boat licence condition which permits the use of gear (primarily longline gear) fitted with metal traces. The Department intends to review and update the management arrangements for the WANCSF similar to the arrangements implemented in the JANSF and may also consider widening the gear prohibition to apply to any type of longline.

The WA Demersal Net and Hook Fisheries Management Advisory Committee includes a representative from the northern shark fisheries. The MAC met on 8 and 21 August 2002 to specifically discuss the National Plan of Action for the Conservation and Management of Sharks, which was adopted by State, Territory and Commonwealth representatives on the Shark Assessment Group in late 2002.

The Department of Fisheries is involved in a cooperative approach to shark research by agencies across northern Australia, including CSIRO and the Northern Territory and Queensland fisheries agencies. Given the level of national and international concerns about shark conservation and the overlap of stocks with over exploited Indonesian stocks, it is likely there will be continuing pressure to review and further constrain the exploration of sharks and related species in these fisheries.

A draft application has been submitted for the northern shark fisheries as part of Environment Australia's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

Governing Legislation/Fishing Authority
Fisheries Notice no. 476 (Section 43 order)
Fisheries Notice no. 602 (Section 43 order)
Condition 127 on a Fishing Boat Licence

Consultation Process
WA Demersal Net and Hook Fisheries Management Advisory Committee
Department–industry meetings as required

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 began in July 2000 and will provide an improved understanding of these fisheries and of northern shark stocks generally. An EA/FRDC-funded research project examining the sustainability of Australia's tropical sharks and rays, which began in 1999, 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 researchers from CSIRO, the Department of Fisheries' shark research section, the Northern Territory Department of Business, Industry and Resource Development and the Queensland Department of Primary Industries. Phase 2 of this project, which aims to fill some of the information gaps identified during Phase 1, began in July 2002 and is scheduled for completion in June 2005.

The following status report is a summary of the material that was generated for the application submitted to meet the requirements of the Commonwealth's EPBC legislation. This was largely prepared based on CAES data provided by industry and a knowledge of tropical shark stocks from preliminary research data and the scientific literature.

Northern Shark Fisheries Status Report

Prepared by R. McAuley and D. Gaughan

FISHERY DESCRIPTION

Boundaries and access

Western Australia manages fishing for shark by longline or dropline from longitude 114°06′ E to 123°45′ E (the WANCSF). Longline and gillnet fishing for shark from longitude 123°45′ E to the WA/NT border is managed by Joint Authority between Western Australia and the Commonwealth (the JANSF). Gillnet fishing is not permitted west of longitude 123°45′ E or within 12 nautical miles of the coast east of longitude 123°45′ E. A total of 13 fishers have licensed access to one or more of these zones.

Owing to the small number of operators in the JANSF, confidentiality arrangements do not permit the publication of catch and effort data from this fishery on their own. Therefore, 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 northern shark fishery for assessment purposes.

Main fishing methods

Primarily shark dropline and shark longline. During 2001/02, two vessels reported using gillnets in the JANSF.

RETAINED SPECIES

Commercial production (season 2001/02): 456 tonnes

Landings

The total shark catch by the two fisheries of 456 t during 2001/02 represents a 67% increase from the previous season. This total included 185 t of 'blacktip' (a name used to describe several species of the family Carcharhinidae) and 72 t of sandbar sharks. The dramatic increase (293%) in the catch of 'blacktip' shark species is a result of additional effort in the Kimberley region, where the Australian blacktip (*Carcharhinus tilstoni*) and spot-tail shark (*Carcharhinus sorrah*) are more common. In 2001/02, the northern shark fisheries retained only 3 t of scalefish species. For a more detailed breakdown of catch species composition, see Northern Shark Table 1. Annual catches since 1994/95 are shown in Northern Shark Figure 1.

In addition to the catch by the two dedicated fisheries, sharks are also caught by other commercial sectors. During 2001/02, vessels licensed in other managed fisheries operating in the area between North West Cape and the WA/NT border reported catches of shark and ray totaling 87 t. A further wetline/longline catch of 83 t of shark and ray was taken by vessels without access to managed fisheries. The combined 'external' catch of 170 t is 86% higher than the previous season and is greater than one-third of the landings from the dedicated shark fisheries, making the total catch of sharks in this region 626 t.

Fishing effort

Because longlining is the primary fishing method in the northern shark fisheries, effort is standardised in terms of hook days. The standardised effort measure used is the number of longline or dropline hooks multiplied by the number of fishing days. In previous years, gillnet effort data in the JANSF were converted using a fixed conversion rate based on the net-to-hook ratio used in the management of the temperate demersal gillnet and longline fisheries, which is 3 m of net to 1 hook. However, because comparative longline and gillnet catch and effort data are available for 2001/02, the longline CPUE of sharks has been used to convert gillnet effort into the longline equivalent effort from the gillnet catch for this and previous years.

In 2001/02, the total fishing effort was 501,489 hook days expended by 9 vessels, which represents an increase of 91% over the previous year (Northern Shark Figure 2). Unlike previous years, effort was evenly distributed between the two fisheries. 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

There is no clear trend in the catch rate data (Northern Shark Figure 2). This is probably due to the large number of species caught and the lack of consistent fishing practices used over time in these fisheries.

Recreational component: Not assessed

Stock assessment completed: Preliminary

A preliminary stock assessment of the fisheries' main target species, the sandbar shark (*Carcharhinus plumbeus*), has been conducted using a demographic model that incorporates empirically measured age-specific exploitation rates and biological data to determine the likely response of the stock to current levels of fishing mortality. Whilst there is currently some uncertainty regarding the biological parameters used in this analysis (particularly the reproductive periodicity), the model indicates that at current levels of exploitation, the rate of population growth (r) is positive and the stock should continue to replace itself. Even under the most pessimistic scenario (that the species has a three-year reproductive cycle and that exploitation rates are underestimated by 35%), exploitation appears to be sustainable, although the rate of population growth under these circumstances is low ($r = 0.006\ yr^{-1}$). The model also indicates that if the current age structure of the catch remains the same, the stock can most likely withstand a 61% increase in catch before the population will begin to decline. Updated biological parameters and exploitation rates will be available at the conclusion of the current FRDC-funded research project in June 2004.

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 risk assessment 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 elasmobranchs and other 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 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.

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 direct employment in the northern shark fleet during 2001/02 was approximately 30 fishers.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001/02): $1.3 million

The combined value of the catch from the two managed sectors was approximately $1.3 million (including the estimated value of shark fins). As fishers do not specify the value 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 2001/02 season, shark fins maintained their value of between $25 and $120/kg depending on fin size and species, however the lower fin value than has been used in previous years reflects a higher catch of smaller, lower-value sharks. Categories of shark which do not have saleable fins were excluded from fin valuation.

FISHERY GOVERNANCE

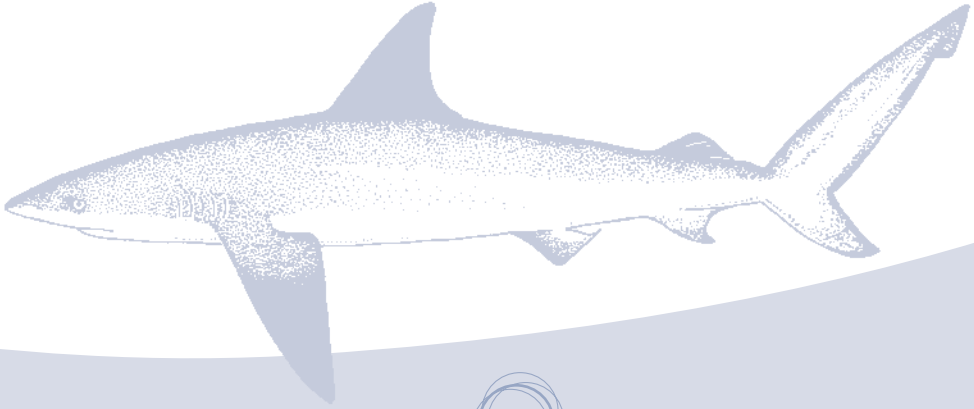
Acceptable catch range: **Sandbar sharks < 117 tonnes**

Owing to the large number of elasmobranch species caught in these fisheries, it is not feasible to formally assess every one. 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 proxy for monitoring the catch of secondary species.

The maximum acceptable annual sandbar shark catch in the northern shark fisheries of 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%.

EXTERNAL FACTORS

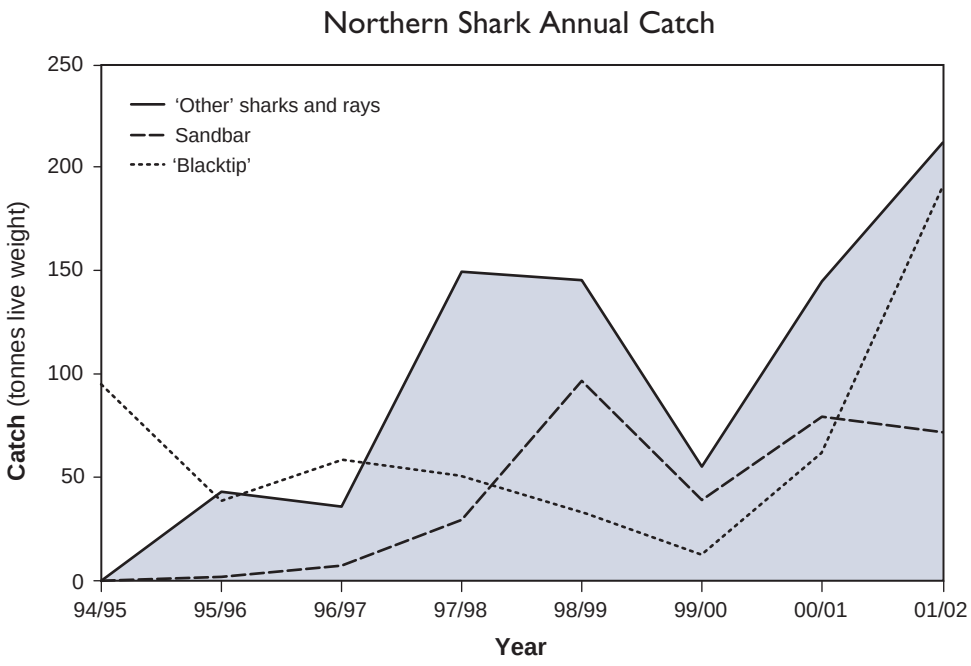
A significant quantity of sharks are caught in the State's northern bioregion as by-product by vessels licensed to fish for other target species. This factor, in addition to the multi-species nature of the tropical shark fisheries, will make formal stock assessment of the minor species caught in these fisheries particularly difficult.



NORTHERN SHARK TABLE 1

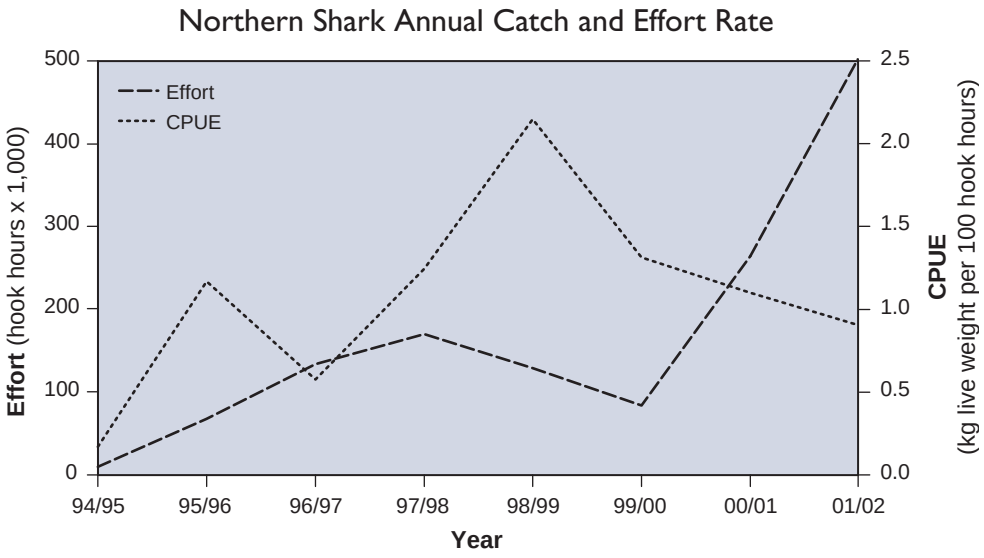
Catch species composition for the northern shark fisheries (WANCSF and JANSF), 2001/02.

SPECIES		CATCH (tonnes)
Elasmobranchs		
Blacktip shark	*Carcharinhus* spp.	185
Sandbar (thickskin) shark	*Carcharinhus plumbeus*	72
Hammerhead shark	Sphyrnidae	43
Tiger shark	*Galeocerdo cuvier*	37
Lemon shark	*Negaprion acutidens*	26
Pigeye shark	*Carcharinhus amboinensis*	25
Shovelnose rays		11
Bronze whaler shark	*Carcharinhus obscurus*	6
Grey reef shark	*Carcharinhus amblyrhynchos*	6
Skates and rays		< 1
Other sharks		45
Total shark		**456**
Scalefish		3



NORTHERN SHARK FIGURE 1

Annual landings for the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2001/02.



NORTHERN SHARK FIGURE 2

Annual effort and catch rates of all sharks and rays for the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2001/02.

SOUTH COAST BIOREGION

REGIONAL MANAGEMENT OVERVIEW

The major fisheries of the south coast bioregion are the Abalone, Demersal Gillnet and Longline and South Coast Purse Seine Managed Fisheries. The first two of these also extend to the west coast, but are reported under the region where their main activity is focused. Other fisheries include the beach net fishery for salmon and a crustacean trap fishery which primarily targets southern rock lobsters but also catches various species of deep-water crab, as well as western rock lobsters in the Augusta area. There is also a commercial fishery operating in a number of estuaries on the south coast. A trawl fishery for scallops has been more active in recent years following a very high scallop catch in 2000.

A key management step in 2002/03 was the implementation of new management arrangements for the South Coast Estuarine Fishery. The South Coast Estuarine Fishery (Interim) Management Plan 2001 was gazetted in January 2002 and came into force on 1 July 2002. Implementation involved a familiarisation meeting with industry, and regularly responding to industry queries about the details of the arrangements. Further development of management arrangements for the demersal gillnet and longline (shark) fisheries has been another key focus. The shark fisheries (both the south and west coast components) have been engaged in a strict process of effort reduction and exploitation rate control over the last five years to rebuild the biomass of the major shark stocks. However, the threat of over-exploitation and the potential for activation of latent effort remain important issues in both the western and southern demersal gillnet and longline fisheries. Growing national and international concerns about shark conservation are also likely to maintain pressure for further measures to protect sharks and restrict catches.

There was a substantial increase in vessels 'gearing up' to target deep-sea crabs (particularly snow crabs) on the south coast in 2002. As a result, the Minister for Fisheries prohibited the take of snow crabs in this area while research on the species is completed, and management arrangements for a comprehensive south coast crustacean fishery, including all rock lobster and crab fisheries, are further developed.

The wetline fishery in the south coast bioregion is the smallest of the regional wetline fisheries and fishing activity is focused around Albany, Bremer Bay and Esperance.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Commercial fishery compliance inspections on the south coast are conducted by Fisheries Officers working out of offices

located in Esperance and Albany. These officers undertake a variety of activities in the region, including sea-based inspections of authorisations, catch and fishing gear, and land-based inspections of catch, fish processing factories, retail outlets and fish consignments. Major fisheries serviced include abalone, rock lobster, deep-sea crab, demersal gillnet and longline targeting shark, and estuarine and beach seine fisheries targeting salmon, herring, cobbler, leatherjackets, crabs, bream and whiting. Officers utilise one 6 m patrol vessel to conduct inshore at-sea inspections, while a dedicated large patrol vessel (< 25 m) is deployed from other regions to carry out offshore work on an occasional basis. In addition to work conducted by District-based staff, the Serious Offences Unit conducts investigations into serious fishery offences on a needs basis.

Activities during 2001/02

During 2001/02, Regional Services personnel undertook 7,171 hours of compliance work in commercial fisheries in the south coast bioregion (South Coast Commercial Compliance Table 1), excluding work conducted for the Australian Fisheries Management Authority in Commonwealth fisheries. The major compliance effort was directed to the commercial abalone fishery, with the remainder worked in the wide range of minor commercial fisheries operating in the bioregion. Minor fisheries of particular focus included the salmon, shark and estuarine fisheries.

Fisheries Officers recorded 457 field contacts with commercial fishing operations and 480 office contacts with commercial fishers. Some of these contacts arose as a result of information supplied through the 24-hour toll-free Fishwatch hotline, a telephone service that allows members of the public to report incidences of suspected illegal activity. During the year, 4 infringement warnings and 5 infringement notices were issued, and a further 25 cases resulted in prosecution of commercial fishers.

SOUTH COAST COMMERCIAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in commercial fisheries within the south coast bioregion during the 2001/02 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	7,171
Fisher field contacts by Fisheries Officers	457
District Office contacts by Fisheries Officers	480
Fishwatch reports *	14
OFFENCES DETECTED	
Infringement warnings	4
Infringement notices	5
Prosecutions	25

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

The abalone fishery on the south coast was again provided a high level of compliance oversight, with 40% of the time spent by Fisheries Officers on commercial fisheries concentrated on abalone activities. Illegal (unlicensed) commercial 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 licensed fishery.

Recreational/commercial conflict in relation to access to designated fishing zones was the only real compliance concern with the salmon fishery this season. Compliance activities for salmon and herring included beach inspections for block nets and the checking of commercial licences. There were no prosecution reports submitted for the fishery in the southern bioregion.

Compliance monitoring activities undertaken in the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery included monitoring the use of time/gear units and net lengths. A program involving on-board inspections of fishing equipment was conducted in 2001/02. All of the commercial vessels inspected were found to be compliant with the fishery regulations.

In the South Coast Purse Seine Managed Fishery, the closures and associated regional effects resulting from the pilchard mortality events continued to impact on the fishery in 2001/02. A small research quota was introduced in June 2001 in an effort to gauge stock recovery in the fishery. Slightly increased quotas were introduced in January 2002, which required compliance overview.

The illegal sale of fish by unlicensed individuals or organised groups, primarily in the abalone fishery, continued to be of concern within the bioregion. There were reports of activity relating to the illegal take of shark within both the managed and wetline fisheries. Reports of interference with fishing gear in the southern rock lobster and deep-sea crab fisheries have also been received.

Initiatives in 2002/03

Following the introduction of the South Coast Estuarine Fishery (Interim) Management Plan on 1 July 2002, Fisheries Officers have been conducting a compliance program to raise awareness of the changes introduced within the plan. The main focus is on the maximum lengths of nets, restrictions on permitted gear, and weekend fishing closures.

Priority is also being placed on compliance checks within the shark fishery aimed at preventing breaches of the finning regulations, and on at-sea inspections in the deep-sea crab and rock lobster fisheries.

REGIONAL RESEARCH OVERVIEW OF WETLINE FISHING

The CAES database indicates that a small proportion (7%) of the wetline catch in 2001/02 was reported from the south coast bioregion. The top ten species comprised redfish (*Centroberyx*

affinis) 25 t, pink snapper (*Pagrus auratus*) 21 t, hapuku (*Polyprion oxygeneios*) 20 t, samson fish (*Seriola hippos*) 14 t, trevalla (*Hyperglyphe antarctica*) 12 t, cod (Serranidae) 8 t, West Australian dhufish (*Glaucosoma hebraicum*) 7 t, wobbegong (*Orectolobus* spp.) 6 t, queen snapper (*Nemadactylus valenciennesi*) 5 t and Australian herring (*Arripis georgianus*) 5 t. Fisheries along the south coast are concentrated around Albany, Bremer Bay and Esperance. Hapuku and redfish are targeted in deeper waters at the edge of the continental shelf.

South Coast Rock Lobster Fisheries

Management Summary

Esperance Rock Lobster Managed Fishery: This fishery operates between longitudes 120° and 125° E, catching the southern rock lobster, *Jasus edwardsii*, and a small quantity of various deep-sea crab species. Favourable rock lobster habitat supports a small but significant and relatively secure rock lobster fishery.

Windy Harbour/Augusta Rock Lobster Managed Fishery: Catch data cannot be released in this fishery as there are only two licensees and the public disclosure of this information would breach the confidentiality requirements of the *Fish Resources Management Act 1994*. Both western and southern rock lobsters, together with small quantities of deep-sea crabs, are taken from this fishery, and the catch data are included in the totals for the adjacent West Coast Rock Lobster Managed Fishery.

Other south coast rock lobster fishing endorsements: In addition to the two managed rock lobster fisheries on the south coast, significant catches are also taken by vessels authorised to fish outside of these areas. These vessels operate in two zones, one between the two managed fisheries and the other east of the Esperance fishery. They catch predominantly southern rock lobster, although small catches of western rock lobster, *Panulirus cygnus*, are also taken in the western zone.

These zones do not lend themselves to full-time specialist rock lobster fishing. Instead, rock lobster fishing operations in these areas are generally part of more diversified fishing activities, with the level of operation and catch varying from year to year according to changes in recruitment and relative abundance.

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'.

A draft application has been submitted for the south coast crustacean fisheries as part of Environment Australia's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

Governing Legislation/Fishing Authority

Esperance
Esperance Rock Lobster Management Plan 1987
Esperance Rock Lobster Managed Fishery Licence

Windy Harbour/Augusta
Windy Harbour/Augusta Rock Lobster Management Plan 1987
Windy Harbour/Augusta Rock Lobster Managed Fishery Licence

Other south coast endorsements
Fish Resources Management Regulations 1995
Regulation Licence granted under Regulations 125 and 126
Fishing Boat licence condition 105

Consultation Process
Department–industry meetings

Research Summary

Research in this sector involves assessing the current status of the stocks in the area based on commercial catch returns and information from south coast rock lobster fishermen. This information is reflected in the following status report.

South Coast Rock Lobster Fishery Status Report

Prepared by R. Melville-Smith

FISHERY DESCRIPTION

Boundaries and access

The boundaries of the Esperance Rock Lobster Managed Fishery (ERLF) are between longitudes 120° E (near Hopetoun) and 125° E (near Point Culver) seawards to the 200 nautical mile Australian Fishing Zone outer limit. In 2001/02, 11 vessels were licensed to fish in the area.

Boundaries for the neighbouring southern rock lobster fishery zones are defined as:

Great Australian Bight (*GAB*) *zone:* being the Australian Fishing Zone adjacent to the south coast of Western Australia, from longitude 125° E to longitude 129° E to the 200 m depth contour.

Albany zone: being the waters of the Australian Fishing Zone adjacent to the south coast of Western Australia, from longitude 116° E to longitude 120° E to the 200 m depth contour.

In 2001/02, 31 vessels were endorsed to fish in the GAB and Albany zones. Endorsements have been frozen since October 1994 and fishermen without ongoing catch history can be asked to show cause why their pot entitlements should not be cancelled. It is recognised that the Albany/GAB zones will never be a significant rock lobster fishery and are best managed as an adjunct to fishers' other diverse operations.

Main fishing method

Rock lobster pots.

RETAINED SPECIES

Commercial production (season 2001/02): 66 tonnes

Landings

A catch of 34 t of southern rock lobsters was taken in the ERLF in 2001/02, a decrease of 15% on the catch taken in the 2000/01 season (40 t). The combined catch for the GAB and Albany southern rock lobster fishery zones in 2001/02 was 32 t, a decrease of 18% on the 2000/01 figure (39 t). Catches decreased from 7 to 4 t in the Albany zone and from 32 to 28 t in the GAB zone. As a by-product of the rock lobster fishery, 10 t of giant crabs (*Pseudocarcinus gigas*) (an increase of 100%) and 13 t of champagne crabs (*Hypothalassia acerba*) (a decrease of 7%) were landed in the Albany zone, while 2 t of giant crabs (a decrease of 60% over the 2000/01 figure) were landed in the ERLF.

Fishing effort

The nominal fishing effort levels in the ERLF remained unchanged in 2001/02 compared to 2000/01, at 67,000 pot lifts. Total effort for the Albany and GAB zones in the 2001/02 season was 103,000 pot lifts, a decrease of 12,000 pot lifts (10%) on the previous season's 115,000 pot lifts. Fishing effort decreased in the Albany zone from 45,000 pot lifts in 2000/01 to 24,000 pot lifts in 2001/02, and increased in the GAB zone from 70,000 pot lifts in 2000/01 to 79,000 pot lifts in 2001/02. Effort figures are confounded in the Albany zone, because an unknown proportion of the effort recorded there may have targeted deep-water crabs rather than lobsters.

Catch rate

Catch per unit of fishing effort for southern rock lobster in the 2001/02 season in the ERLF decreased by 17%, from 0.6 kg/pot lift in 2000/01 to 0.5 kg/pot lift in 2001/02. The combined catch per unit of fishing effort for southern rock lobster in the GAB and Albany zones in the 2001/02 season was 0.31 kg/pot lift, a decrease of 9% compared to the 2000/01 season. Catch rates in the Albany zone remained similar at 0.15 kg/pot lift in the 2001/02 and 2000/01 seasons, but decreased in the GAB zone by 20%, from 0.45 to 0.36 kg/pot lift.

Recreational component: < 13%

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 completed: Yes

Model outputs show that the ERLF fishery is stable at current annual catch levels of around 40 t, as achieved since 1998/99, but not at the 60 t levels that were experienced in the early to late 1990s (South Coast Rock Lobster Figure 1). There has been a substantial increase in effort in the recent seasons, for little or no increase in catch. One explanation for this may be that there is localised depletion occurring. However, an alternative explanation may be that in the 2000/01 season, the maximum number of pots permitted per boat was increased from 60 to 90. Experienced fishers in this fishery had warned that it was not possible to effectively deploy more than 60 pots per day and this may be the reason for the decrease in catch per unit effort in the fishery. Future trends in catch rate are being closely monitored.

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 lobster in the Albany fishery has shown an overall downward trend in recent years, despite a general increase in effort (South Coast Rock Lobster Figure 1). 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 Rock Lobster Figure 1).

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. Puerulus settlement to this region is probably derived from the bulk of the stock in South Australian, Tasmanian and Victorian waters and, as such, the broodstock in WA waters probably makes an insignificant contribution to the southern rock lobster larval pool. Available evidence would suggest that recruitment may be sporadic and driven by large-scale environmental factors rather than localised breeding stock levels.

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 to protect 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 has remained at acceptable levels.

NON-RETAINED SPECIES

Bycatch species impact: Low

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

Protected species interaction: Negligible

Rock lobster pots and ropes 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, and any impact of fishing on the general food chain is expected to be minimal.

Habitat effects: Low

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 (2001/02): $2.5 million

The beach value of the southern rock lobster fishery was about $2.1 million in 2001/02, based on a beach price of $31/kg. Giant crabs ($25/kg) and champagne crabs ($9.50/kg) added an additional $400,000 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.

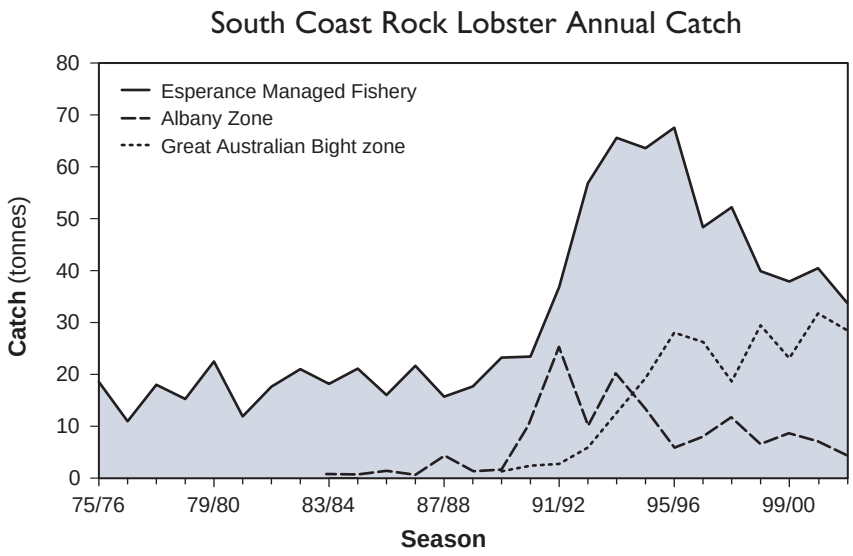
FISHERY GOVERNANCE

Acceptable catch range: 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.

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.



SOUTH COAST ROCK LOBSTER FIGURE 1

Seasonal catches of southern rock lobster by management area, 1975/76 to 2001/02.

Abalone Managed Fishery

Management Summary

The Abalone Managed Fishery targets three abalone species: greenlip abalone (*Haliotis laevigata*), brownlip abalone (*Haliotis conicopora*) and Roe's abalone (*Haliotis roei*). In Western Australia the large 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.

The fishery is divided into eight management areas, with separate total allowable catches (TACs) being set for each species taken in each area on an annual basis. The quota year and licensing period runs from 1 April to 31 March of the following year. However, TACs may be adjusted during the year under certain circumstances.

In terms of allocation of quota to individual operators, each Abalone Managed Fishery Licence has associated with it transferable units of entitlement. Each unit is ascribed a value by dividing the TAC for a given area and species by the total number of units allocated for that area and species.

A minimum unit holding applies to licences in the fishery, though there are some licences which are permitted to operate below this minimum in recognition of historical fishing practices.

Abalone divers are required to provide daily catch information in the form of a catch and disposal record. Details including the weight of abalone collected, the number of abalone (for greenlip/brownlip only), the date and location of collection and the name of the diver are all recorded and used to assist in research, compliance and management matters.

A final application has been submitted to Environment Australia for the abalone fishery as part of EA's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A public comment period was conducted during early 2003 and a formal assessment is currently being undertaken by EA.

Governing Legislation/Fishing Authority
Abalone Management Plan 1992
Ministerial Policy Guideline no. 10
Abalone Managed Fishery Licence

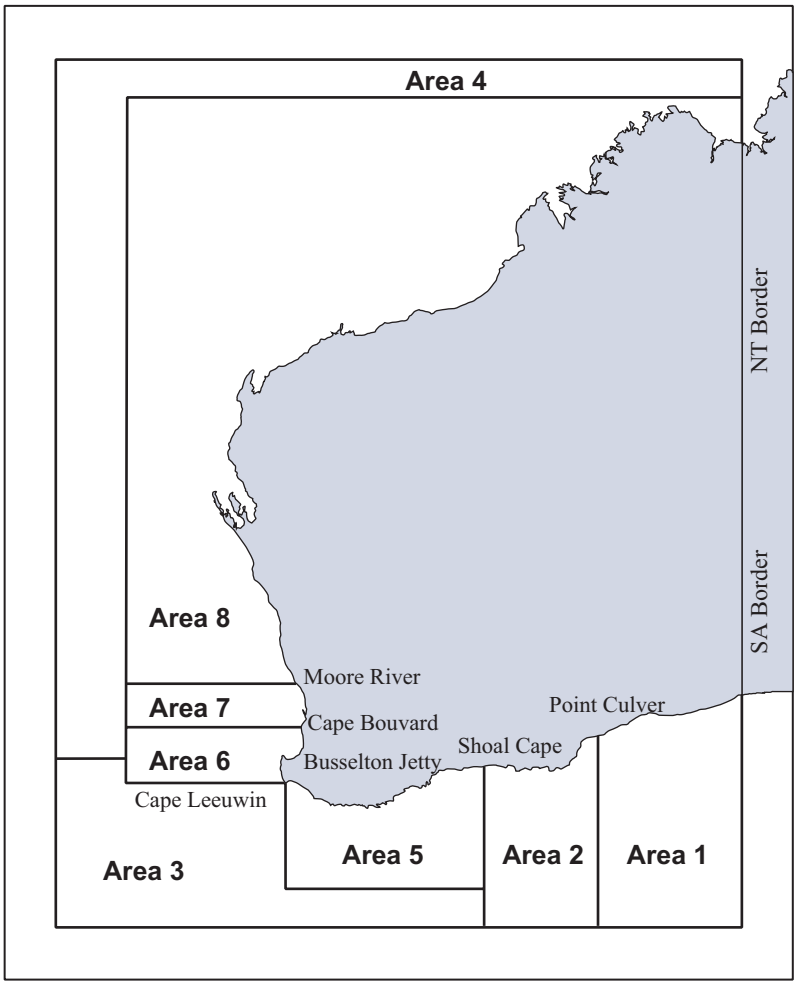
Consultation Process
Abalone Management Advisory Committee
Department–industry meetings

Research Summary

The 2002 quota period (1 April 2002 to 31 March 2003) represents the fourth full season of abalone fishing under current management arrangements. Prior to 1999 the Abalone Managed Fishery was divided into three zones. Since then, fishing has been separated by species into a greenlip abalone fishery, brownlip abalone fishery and Roe's abalone fishery, with transferable units of quota allocated over eight areas throughout the State (Abalone Figure 1).

Basic research monitoring for the eight abalone catch areas is undertaken annually utilising industry data from daily catch records, information from processors, fishers' monthly returns and data collected during specific research projects. In each of the eight areas, the fishing days required to achieve the catch are monitored annually to ensure that the stock levels are being maintained. For the greenlip and brownlip fishery, examining the number of abalone caught for each consignment enables estimation of the mean size of abalone taken. For the Roe's abalone fishery, where divers do not record the number of individual abalone, a similar measure is being developed using information from the abalone processors.

In addition to monitoring the principal stocks, the Department is preparing a draft report on research into the harvesting of stunted greenlip populations (those that rarely reach legal minimum length), with a view to recommending harvesting regimes for these populations. A second research initiative using research and industry divers to test the efficacy of underwater video for monitoring density and size structure of abalone stocks has also commenced, using funding from the FRDC. In the coming season (2003/04), investigations into the use of targets, triggers and decision rules for managing TAC will also be undertaken.



ABALONE FIGURE 1

General map showing management areas used to set quotas for the commercial abalone fisheries of Western Australia.

Greenlip and Brownlip Abalone Status Report

Prepared by A. Hart and F. Fabris

FISHERY DESCRIPTION

Boundaries and access

The greenlip/brownlip abalone fisheries include Areas 1, 2 and 3, which extend from the SA/WA border to Busselton Jetty.

For historical reasons, greenlip and brownlip abalone quotas in Western Australia are managed in meat weight, whereas the remainder of Australia's abalone fisheries operate on whole weight. For comparative purposes, therefore, this status report notes both whole and meat weights. Standard conversion factors for meat weight to whole weight are currently 2.667 for greenlip abalone and 2.5 for brownlip abalone.

The quota period for all areas was 1 April 2002 to 31 March 2003.

Main fishing method

Diving. Abalone divers operate from small fishing vessels (generally < 9 m).

RETAINED SPECIES

Commercial production (season 2002):

Greenlip 166.72 tonnes whole weight
Brownlip 27.45 tonnes whole weight

Landings

Catches are controlled by quotas, which were initially set at 194.7 t whole weight (73 t meat weight) for greenlip and 34.9 t whole weight (14 t meat weight) for brownlip for the 2002 season. However, a revised determination mid-season by the Executive Director raised the TAC by 4% to 202.5 t whole weight (75.9 t meat weight) for greenlip abalone and 35.89 t whole weight (14.35 t meat weight) for brownlip abalone. This does not represent an increase in real terms, but was raised in accordance with changes in estimates of weight due to time of measurement.

The greenlip catch was estimated to be 166.7 t whole weight (62.5 t meat weight) for the 2002 season (Abalone Table 1). This was 11% lower than in 2001 and 18% below quota. Historically, the full quota is never taken in Area 1 (the Nullarbor fishery) as fishing conditions are quite difficult. In Area 2, low catch rates (induced by a high target meat weight as a result of an industry–Government agreement) and a conservative approach to fishing by industry resulted in a voluntary reduction in total greenlip catch to 19.7 t (from 24 t) meat weight in the main stocks and 4.6 t from stunted stocks. In Area 3, only 91% of the greenlip quota was taken.

The brownlip catch was 27.5 t whole weight (11 t meat weight) for the 2002 season (Abalone Table 1). This was 12% lower than in 2001 and 24% below quota. In Area 2, an industry decision to conserve stock capped the brownlip take at 63% of the quota, while in Area 3, 97% of the original 6 t quota (prior to the mid-season review) was taken.

Fishing effort

This year, effort was divided into the main and stunted stocks, as fishing of stunted stocks is becoming a significant proportion of the quota, and needs to be treated separately (see Stock Assessment section). Total effort for the main stocks in 2002 was 1,035 days fished for greenlip and brownlip abalone. This was greater than the effort in 2001 (992 days) but similar to the effort of 2000 (1,028 days).

For the 2002 catch of 164.2 t (from the main stocks), the effort of 1,035 diver days was lower than the acceptable effort range. However, the catch from the main stocks was 74.2 t (31%) less than the TAC (238.4 t), and is the reason why effort is lower than the acceptable range.

Catch rate

In 2002, the catch rate for the main greenlip stocks was 132 kg whole weight (50 kg meat weight) per diver day. This was an overall 20% reduction from 167 kg whole weight (62 kg meat weight) per diver day in 2001 and is caused by a 22% reduction in Area 2 (60 to 47 kg meat weight per diver day), and a 20% reduction in Area 3 (64 to 51 kg meat weight per diver day). It is the lowest catch rate in eight years, since the targeting of larger-sized animals in both Area 2 and Area 3. There has been a three-year declining trend in catch rates from 1999 to 2002 in both Area 2 and Area 3, and catch rates are at the lower end of the historically acceptable range. These declines are only partially related to stock abundance; they are also correlated with effective increases in minimum length fished in both areas, and thus represent a lower exploitation rate. However, special note needs to be made of the Hopetoun region in Area 3, where catch rates have dropped from 87 kg meat weight per day in 1999 to 40 kg meat weight per day in 2002.

Recreational component (2002): **20% approx. (under review)**

Based on telephone surveys of recreational licence holders, preliminary estimates have been made that approximately 15% and 25% respectively of the total greenlip and brownlip abalone catches may be taken recreationally. These estimates, particularly for the cryptic, low-catchability brownlip species, have very wide confidence limits and require additional validation. Noting that these estimates may change with further review, they should not be quoted or used as precise measures of catch.

Stock assessment completed: **Yes**

Greenlip and brownlip abalone stocks are assessed by analysing industry data from daily catch records, information from processors, and data collected during specific research projects.

In recent years industry has collaborated with the Department of Fisheries to develop strategies for the sustainable harvesting of 'stunted' populations of abalone. This has resulted in significant catches of greenlip abalone in recent years (30 t whole weight in 2002; Abalone Table 1). In 2002, 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). A report summarising the findings and recommendations of this research will be published in 2003. It will recommend harvest protocols in terms of spatial extent of target populations, catch, catch rate and size targets for assessment, and rotational harvesting periodicity.

In Area 2, average meat weight for greenlip stocks in 2002 (198 g) was the highest recorded in 10 years. The Area 2 greenlip catch rate was 46 kg meat weight per day in 2002, a decrease from 60 kg meat weight per day in 2001. The increasing meat weight and decreasing catch rate arise from a decision to set a high meat weight target as a stock conservation measure. This measure will be removed in the 2003 season, and research effort directed towards establishing the best combination of stock conservation targets (i.e. catch, catch rate and meat weight considered together).

The average meat weight of brownlip abalone in Area 2 increased from 249 g in 2001 to 285 g in 2002. Again, this was the result of a high meat weight target, rather than reflecting the state of the stock.

In Area 3, the average meat weight of greenlip abalone taken in 2002 was 223 g, similar to the 2001 average (226 g). The high weights are being maintained by a more conservative fishing regime (increased minimum sizes). The quota for brownlip abalone in Area 3 was increased by 5 t whole weight (2 t meat weight) prior to the 2000 season to allow divers to target new areas for brownlip abalone. This increase was retained for the 2001 and 2002 seasons, and average meat weights have been maintained (274 g in 2000 and 2001; 279 g in 2002).

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Research has shown that greenlip abalone mature at between 80 and 100 mm shell length, and brownlip abalone mature at between 90 and 130 mm shell length, which are both well below the legal minimum size limits set across the fishery (140 mm shell length in Area 1 and 2; 145 mm in Area 3). 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 (2002):
$10.4 million

The estimated average price received by fishers was $146/kg meat weight for greenlip and $119/kg meat weight for brownlip abalone. On the basis of the average prices, the greenlip and brownlip abalone fishery was valued at approximately $10.4 million. These prices were the same as 2001, but significantly lower than the 2000 values of $163/kg meat weight for greenlip and $132.50/kg meat weight for brownlip abalone.

FISHERY GOVERNANCE

Acceptable effort range: **1,095–1,511 diver days for 238.4 tonnes whole weight**

For fishing to remain at a historically sustainable level, the effort to take the 2003 quota from the main stocks should fall within the five-year (1994–1998) effort range (1,095–1,511 diver days) that reflects the acceptable variation in the main stocks.

The Area 2 greenlip quota will remain at 80 t whole weight (30 t meat weight) in 2003. However, fishing of stunted stocks has resulted in only one year (2000) since 1997 in which the TAC has been taken entirely from the main stocks. In light of this, the Department (in consultation with stakeholders) will be developing formal indicators of stock status against which the stock can be evaluated during next season's review.

The Area 2 brownlip quota was voluntarily reduced in 2002 from 19.8 to 18 t whole weight (7.92 to 7.2 t meat weight) in response to the recent downward trends in meat weights. Fishing in Area 2 during the season (including the western sector) operated under a Memorandum of Understanding between the Department of Fisheries and industry. The MOU provided in-season evaluations of sector performance in terms of average meat weight against pre-determined historical means. This resulted in elevated meat weights and reduced catch rates as industry divers targeted larger animals to stay above the target size. Hence for the 2002 season, CPUE and meat weight in Area 2 were more indicative of fishing behaviour than stock status. The MOU will not be continued for the 2003 season.

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 increased, and the effect on catch rates of technology changes such as the introduction of GPS and motorised underwater scooters and shark protection cages is yet to be quantified. The anecdotal observation is that divers are able to cover much larger distances in a day if they choose to do so, hence the area searched becomes larger and impacts on the calculation of fishing effort. All these effects, as well as the impact of illegal fishing in some areas, 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)[3]	GREENLIP kg whole (meat) wt[4] 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	178 (67)
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	167 (63)
1999	189,750	180,620	8,024	28,000[5]	27,673	208,293	920	182 (68)
2000	194,669	189,846	4,307	34,875	33,531	223,377	1,028	178 (67)
2001	194,669	187,459	21,243	34,875	31,089	218,548	992	167 (62)
2002	**202,521[6]**	**166,721**	**29,931**	**35,893**	**27,451**	**194,172**	**1,035**	**132 (50)**

Notes

1. Data source: quota returns.
2. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.
3. Effort (diver days): this year, database improvements allowed a better estimate for the main stocks, and they 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 TAC fixed for the first year in 1999.
6. 2002 Greenlip/brownlip TAC raised by 4% mid-season in accordance with changes in weight processing, but does not represent an increase in actual allowed catch.

Roe's Abalone Status Report

Prepared by A. Hart and F. Fabris

FISHERY DESCRIPTION

Boundaries and access

The Roe's abalone fishery includes Areas 1, 2, 5, 6, 7 and 8 and extends from Steep Point (Shark Bay) in the north to the SA/WA border.

Main fishing method

Diving. Roe's abalone divers operate from small fishing vessels (generally < 9 m), although on occasion they can approach stocks from the shore.

RETAINED SPECIES

Commercial production (season 2002):
97.7 tonnes whole weight

Landings

Quotas control catches, with the TAC for the 2002 quota year being 107.9 t whole weight for Roe's abalone. The catch of 97.7 t whole weight for the 2002 season (Abalone Table 2) was 2% lower than 2001 and lower than the TAC, as some stock in remote locations (primarily Area 1) remained unfished.

Fishing effort

Total effort for dedicated Roe's abalone divers in 2002 was 655 diver days, which was lower than the acceptable range. However, the lower effort is a reflection of a good catch rate and the fact that the entire quota was not taken.

Catch rate

The Roe's abalone catch rate for dedicated divers in 2002 was 131 kg/day, which was the second highest catch rate recorded since 1994.

Recreational component: **40–45% (approx.)**

The recreational catch estimates for 2002 were in the range 40–45% of the total Roe's abalone catch. See Recreational Abalone Fishery Status Report, pp. 151–156.

Stock assessment completed: **Yes**

Stocks of Roe's abalone are assessed by analysing industry data from the daily catch and effort records across the 10 x 10 mile grid reporting system, information from processors, and data collected during specific research projects.

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 catch rates. In particular, Area 2 and Area 5 have shown increasing catch rates, and the Department recommended a 10% TAC increase for Area 2 in the 2003 season. Industry, however, sought to take a conservative approach for the time being, and the recommended increase in Area 2 was not implemented for the 2003 season.

An increase in the legal minimum size limit for Area 1 from 60 mm to 75 mm shell length has addressed the threat of over-fishing in the 10 nautical miles of coast adjacent to the access point at Twilight Cove (Nullarbor cliffs). Although the abundance of Roe's abalone is not of concern at other locations on the south coast, a portion of the quota consistently remains unfished due to the remoteness of the fishing locations and the unpredictable nature of the weather.

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. 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) and inappropriate distribution of fishing effort by less experienced fishers. The quota reductions in this area have worked and catch rates recovered from a low of 109 kg per diver day in 2000 to 132 kg per diver day in 2002. Subsequently, the TAC in Area 8 has been increased from 12 t in 2002 to 15 t for the coming season (2003).

Annual stock surveys of the metropolitan stocks are reported in the Recreational Abalone Fishery Status Report, pp. 151–156.

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. As a consequence of the relatively low exploitation rates which leave a significant biomass of abalone on the reef at all times, it is unlikely that the fishery has any significant effect on the food chain in the habitat.

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 (2002): **$4 million**

The estimated average price was about $41/kg whole weight for Roe's abalone. On the basis of the average price the fishery was worth approximately $4 million. The price of Roe's abalone in 2002 was the same as last year (2001), but significantly lower than in 2000 ($55/kg whole weight).

FISHERY GOVERNANCE

Acceptable effort range: **679–914 diver days for 107.9 tonnes whole weight**

To be fished at a historically sustainable level, the 2003 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.

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**

Notes

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

South Coast Estuarine (Interim) Managed Fishery

Management Summary

The South Coast Estuarine Fishery (Interim) Management Plan 2001 was approved by the Minister and published in the Government Gazette on 22 January 2002. The new management arrangements came into force on 1 July 2002 and expire on 30 June 2005.

The new arrangements have better defined permitted fishing methods and times. They have also provided for transferability of authorisations when the number of units in the fishery has been reduced to the optimum level of 15.

Governing Legislation/Fishing Authority

South Coast Estuarine Fishery (Interim) Management Plan 2001

South Coast Estuarine (Interim) Managed Fishery Permit

Consultation Process

Department–industry meetings

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 during the 1970s and 1980s. This database from commercial fishermen also provides a valuable and consistent source of information for monitoring recreationally important stocks where they are harvested by both groups.

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

South Coast Estuarine (Interim) Managed Fishery Status Report

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

The following estuaries and inlets located between Cape Beaufort and the WA/SA border are reported under the South Coast Estuarine (Interim) Managed Fishery (SCEF): Broke Inlet, Irwin Inlet, Parry Inlet, Wilson Inlet, Princess Royal Harbour, Oyster Harbour, Waychinicup Inlet, Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Culham Inlet, Jerdacuttup Lakes, Oldfield Inlet, Torradup Inlet and Stokes Inlet. The level of access stood at 25 fishing units in July 2002, a reduction from the previous year as a result of the Voluntary Fisheries Adjustment Scheme. South coast licensees have access to each of these individual south coast estuaries, except Beaufort Inlet where only three licensees a year are granted entry.

Under new management arrangements introduced in July 2002, Parry Inlet and Torradup Inlet were closed to commercial fishing. The SCEF is a multi-species fishery targeting many finfish species. 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*).

Main fishing method

Gillnet/haul net.

RETAINED SPECIES

Commercial production (season 2002): 259.5 tonnes

Landings

The total reported landings of 259.5 t from the south coast estuaries in 2002 incorporate molluscs and crustaceans as well as finfish, and are composed of the following species:

Cobbler	*Cnidoglanis macrocephalus*	92.1 t
Black bream	*Acanthopagrus butcheri*	36.9 t
Sea mullet	*Mugil cephalus*	25.7 t
Australian herring	*Arripis georgianus*	14.9 t
Blue swimmer crabs	*Portunus pelagicus*	12.9 t
Leatherjacket	Monocanthidae	12.0 t
King George whiting	*Sillaginodes punctata*	11.3 t
Flathead	Platycephalidae	11.3 t
Yellow eye mullet	*Aldrichetta forsteri*	10.0 t
Silver bream	*Rhabdosargus sarba*	8.5 t
Pink snapper	*Pagrus auratus*	2.1 t
Other species		21.8 t

The reported total commercial catch from south coast estuaries shows a decline from the peak catch in 1992. The reported 2002 catch figure has decreased from the 2001 levels by 14 t (South Coast Estuarine Figure 1). Catches in Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Irwin Inlet, Jerdacuttup Lakes, Oldfield River, Stokes Inlet and Wilson Inlet were each more than 1 t greater than in 2001. Broke Inlet, Oyster Harbour and Princess Royal Harbour each had 2002 catches reduced by more than 1 t compared to the 2001 catches. Culham Inlet and Parry Inlet showed only minor changes in catches from last year. There were no reported catches in 2002 from Torradup Inlet which, along with Parry Inlet, was closed to commercial fishing in July 2002.

While over 40 species of finfish, sharks, rays and invertebrates are represented in the annual catch from south coast estuaries, the predominant finfish species are usually cobbler, King George whiting, sea mullet, Australian herring and black bream.

Black bream: In 2002, the reported catches of black bream in south coast estuaries increased by 9 t from 2001 levels, continuing a general trend towards an increased catch in the last four years (South Coast Estuarine Figure 2). Catches from Beaufort and Stokes Inlets accounted for this increased catch.

Cobbler: During 2002, the catch was concentrated in four south coast embayments/estuaries, namely Wilson Inlet, Oyster Harbour, Princess Royal 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 2002 catches in Wilson Inlet have increased by 19 t from the 2001 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 2002, the majority of catches were reported from Wilson Inlet. The King George whiting catch from Wilson Inlet for 2002 was an increase over 2001 levels 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

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 1992, the overall fishing effort in the SCEF has declined, and in 2002 this trend continued due to the removal through the VFAS of several fishing units (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 whilst fishing effort has decreased.

Recreational component: Not assessed

Stock assessment completed: Yes

Black bream: Black bream populations are genetically unique 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 for the Wellstead Estuary population from research by Sarre (1999), the results of which were 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.

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. However, the current level of catch (which is at an historical high), and average catch per vessel operating, indicate that this valuable stock is trending to higher abundance over the past decade.

King George whiting: Approximately 84% of the south coast catch of King George whiting is fished from 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 Stock Status Report, pp. 125–127.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Black bream: A preliminary eggs-per-recruit model was developed for the black bream stock in the Wellstead Estuary using biological data for the Wellstead Estuary population from research by Sarre (1999), the results of which were presented in the *State of the Fisheries Report 1999/2000*. 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 stock.

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 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. However, over recent years, fishing operations targeting finfish have been compromised by the presence of increasing quantities of blue swimmer crabs.

Protected species interaction: **Negligible**

No protected species are threatened by these fisheries, however sea lions do impact negatively on fishing operations on a very limited basis.

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 35 fishers during the 2002 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 (2002): **$914,000**

FISHERY GOVERNANCE

Acceptable catch range: **200–500 tonnes**

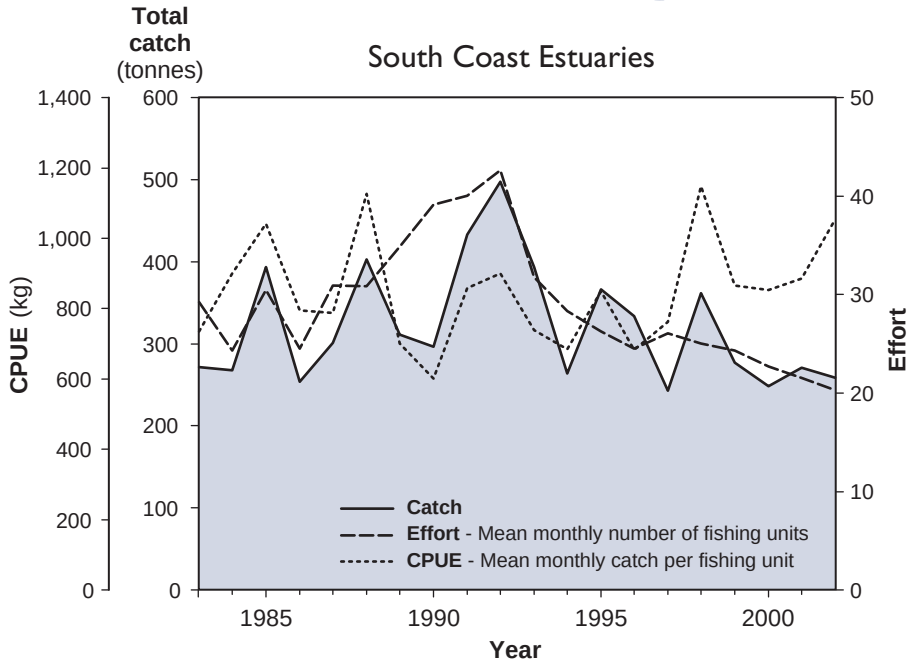
The acceptable catch range under current management arrangements is 200–500 t (rounded to the nearest 50 t) and the catch of 260 t in 2002 was within this acceptable range.

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 FAS funded buy-backs, the acceptable catch range may need to be recalculated.

EXTERNAL FACTORS

Variation in fish abundance in these south coast estuarine stocks is largely driven by environmental influences on recruitment. In the SCEF this is further complicated by the natural closure of some estuaries and the need for human intervention to breach estuarine bars, mostly for a range of

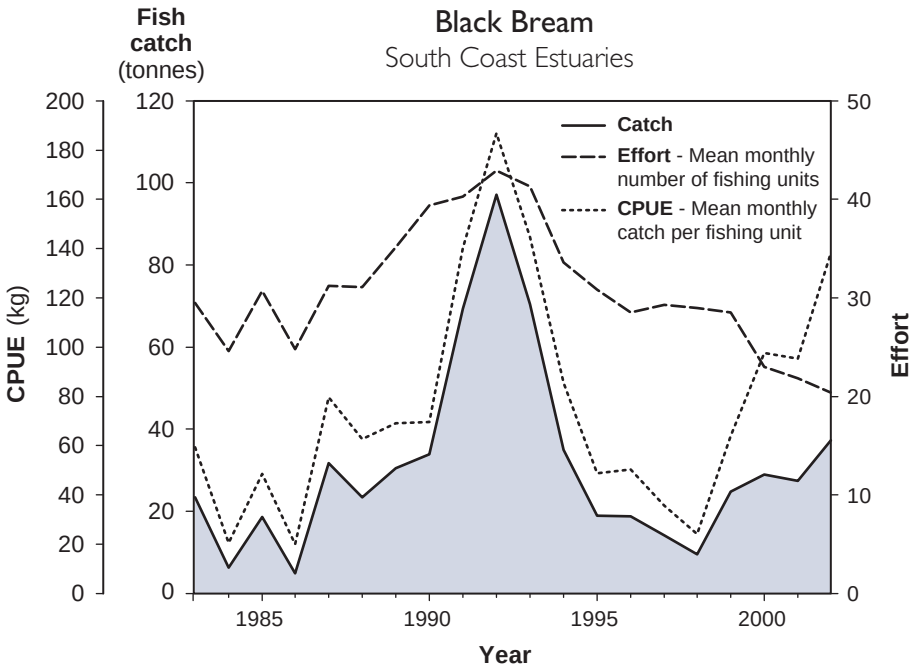
reasons related to estuarine amenity coupled with ecosystem 'health'. These factors, which are outside the control of the Department of Fisheries, often have a dominant influence on the reported commercial catch and effort from year to year.



SOUTH COAST ESTUARINE FIGURE 1

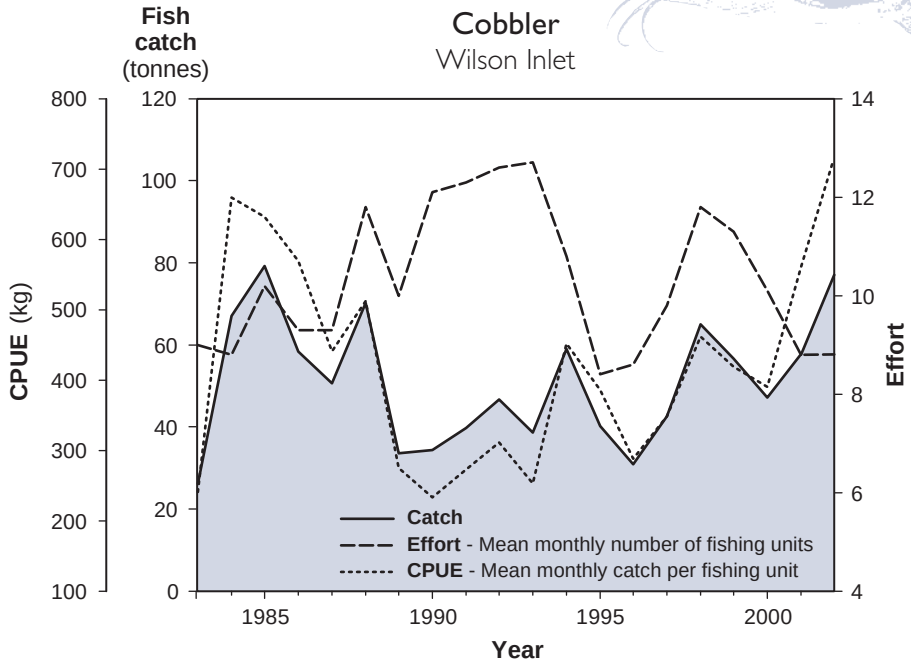
The annual catch, effort and catch per unit effort (CPUE) for the South Coast Estuarine Fishery over the period 1983–2002.

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.



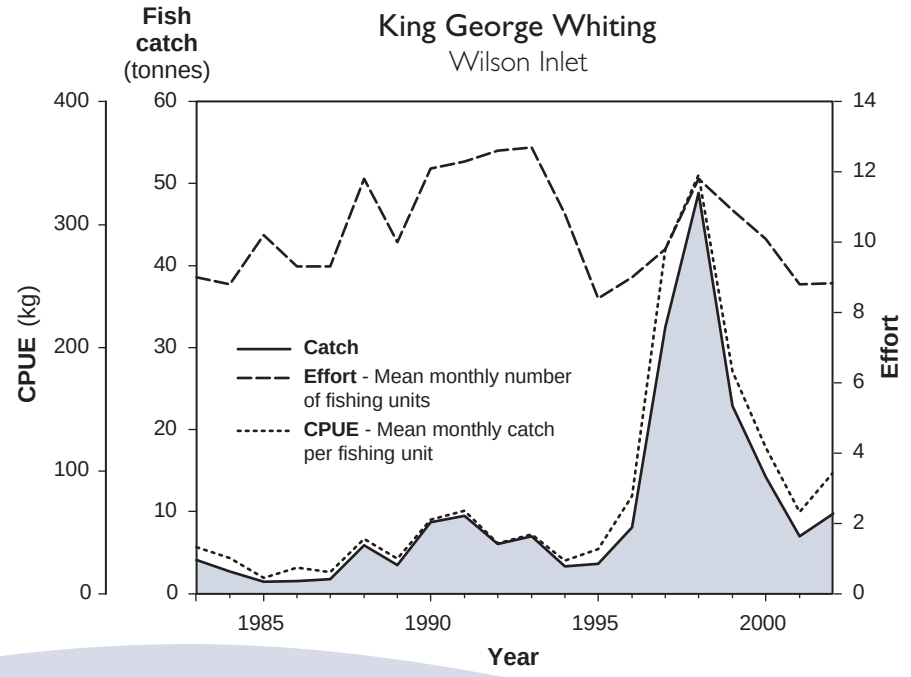
SOUTH COAST ESTUARINE FIGURE 2

The annual catch, effort and catch per unit effort (CPUE) for the black bream *(Acanthopagrus butcheri)* fishery in south coast estuaries over the period 1983–2002.



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 1983–2002.



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 1983–2002.

Western Australian Salmon Fisheries

Management Summary

The western Australian salmon (*Arripis truttaceus*) is taken primarily during its annual east-to-west migration, usually between February and May each year. Fishing operations are conducted by teams of fishers setting beach seine nets using small jet-powered boats.

There are two managed salmon fisheries:

- The South Coast Salmon Managed Fishery permits authorisation holders to operate from assigned beaches between Shoal Cape and Cape Beaufort.
- The South West Coast Salmon Managed Fishery operates north of Cape Beaufort. Fishermen can operate from any beach in this zone, and share the use of beaches under priority of netting rules specified in the Regulations.

Industry members are being encouraged to investigate ways of improving fish handling and value-adding techniques to improve their profit margin. As salmon is considered a prime recreational species, resource-sharing issues are likely to be a major consideration in future management of these fisheries.

A draft application has been submitted for the fishery as part of Environment Australia's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

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

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

Consultation Process
Australian Salmon and Herring Industry Advisory Committee
Department–industry meetings

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.

Presently, a juvenile index of recruitment for Australian salmon in Western Australian waters is being developed as part of an FRDC-funded project. This index of recruitment and the potential link to subsequent levels of catch will be completed by late 2003. Time-series analysis of the historic Australian salmon commercial catches to predict future commercial catches is also being investigated through a separate FDRC-funded project also due to be completed by the end of 2003. These two projects will be using different methods to assist in predicting future commercial Australian salmon catches.

A comprehensive ESD report has been completed for these fisheries which formed the basis for the application to meet the requirements of the Commonwealth's EPBC legislation.

Western Australian Salmon Fisheries Status Report

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

As at May 2002, each of 18 licensed teams had access to a nominated beach in the South Coast Salmon Managed Fishery, the boundaries of which 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'*. There are no legislated net length or mesh size restrictions for the south coast fishers. A further 12 licensees collectively had access to beaches in the South West Coast Salmon Managed Fishery, the boundaries of which 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'*. An additional three licensees have access to the west coast sector north of Busselton Jetty to Tim's Thicket, via a condition on their fishing boat licence. These licensed fishers are the only ones with authority to land and sell Australian salmon in Western Australia.

Main fishing method

Beach seine.

RETAINED SPECIES

Commercial production (season 2002): 2,623 tonnes

Landings

The total State catch for the 2002 season was 2,623 t, which was about 200 t more than the previous year (Salmon Figure 1).

The 2002 south coast commercial catch of Australian salmon was 1,995 t, very similar to 2001. Once again, almost the entire catch 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 (1,211 t or 61%) was taken from the western sector of the fishery (west of Albany to Windy Harbour), with 580 t (29%) from the central region (east of Albany to Cape Riche). The smallest proportion (205 t or 10%) was again taken from the eastern sector of the fishery (from Cape Riche eastwards).

The south-west and west coast catch for 2002 totalled 627.5 t, nearly twice the low catch reported in 2001.

Fishing effort

There are 18 south coast and 15 south-west and west coast fishing teams (three with access only from north of Busselton Jetty to Tim's Thicket). This is the same number that operated last year. Their methods of operation preclude a more precise calculation of effective fishing effort.

Catch rate

During 2002, the average catch per fishing team was 110.9 t for the south coast (down from 114.8 in 2001) and 41.8 t for the west coast (up from 21.7 in 2001).

Recreational component: **6% (approx.)**

The most recent surveys, conducted in 1994 and 1995 (Ayvazian et al. 1997), indicated that the recreational catch share was about 6% of the total south coast catch and 8–16% of the west coast catch. Given the slightly increased commercial catch in 2002, it is likely that there would have also been an improved recreational catch for the year.

Stock assessment completed: **Yes**

The results from preliminary yield-per-recruit and egg-per-recruit analyses were presented in the *State of the Fisheries Report 1999/2000*. Noting that the commercial fishing effort in the major part of the fishery on the south coast is fixed, the higher levels of catch since the mid-1990s indicate that the overall abundance of the stock is being maintained. The movement of more spawning-run fish from the south coast to the west coast indicates the influence of the environment rather than a higher stock level.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Current commercial catches indicate that the breeding stock is currently at an acceptable level. However, egg-per-recruit analysis indicates that the current exploitation level on the western Australian salmon population is high, owing to the 'gauntlet' nature of the fishery, which catches migrating schools of salmon as they pass each of the fishing beaches in turn. Any substantial increase in the catch from either commercial or recreational fishers, or significant reduction in recruitment due to unusual environmental effects, could take the stock below a limit 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.

Protected species interaction: **Negligible**

Seals or sea lions are occasionally surrounded by a beach seine, but are released immediately by the fishers. This is possible because the seine netting operation is an active method of fishing involving fishers setting the net and immediately retrieving it. If any protected species are enclosed, they will be seen and the fishers are able to release them from the seine net soon after capture without injury.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

As salmon are only one of a number of predatory species in the marine food chain of the lower west and south coasts, the fishery has minimal potential to reduce the mortality on prey species. Moreover, given the naturally occurring variability in Australian salmon biomass, any fishery effect is likely to be similar in magnitude to other factors contributing to the natural variation on prey species. Overall, the ecological impact of the fishery is assessed as low.

Habitat effects: **Negligible**

No habitat impacts occur as the fishery operates seine nets only on sandy surf beaches.

SOCIAL EFFECTS

The south coast fishery involved an average of 82 fishers and the south-west and west coast fishery involved an average of 38 fishers during the 2002 fishing season.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2002): **$1.1 million**

The south coast catch in 2002 was received by five processors: Albany Bait Producers, Austral Fisheries, Bevans Fish Supplies, Bremer Fish Processors and Polar Group.

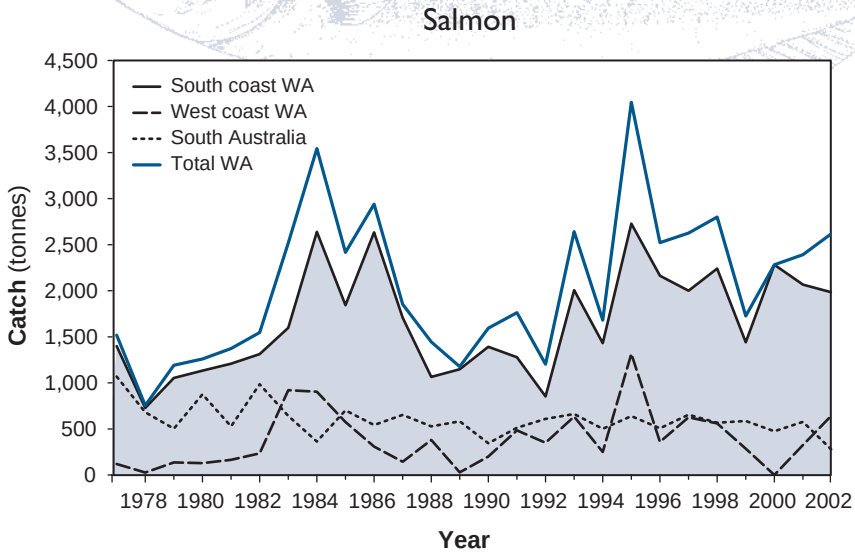
FISHERY GOVERNANCE

Acceptable catch range: **1,300–3,600 tonnes**

The expected catch range under the current management regime is 1,300–3,600 t (rounded to the nearest 50 t) of salmon. This projection is derived by double exponential smoothed forecasting of the 35 years of annual catches to 1998 and the variation of observations around the predictions. The confidence intervals have been set at 85%. Future annual catch values that fall outside of this range will be investigated. Where consecutive values occur outside of the range, changes to the management arrangements to protect the stock may need to be considered. The 2002 catch of 2,623 t fell well within the catch range.

EXTERNAL FACTORS

The higher catches of Australian salmon along the west coast during 2002, compared to earlier years, 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 2002. 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 1977 to 2002.

Australian Herring Fishery

Management Summary

The majority of the commercial catch of Australian herring (*Arripis georgianus*) is taken using herring trap nets (also known as 'G' trap nets) from south coast beaches. Many commercial participants within the herring fishery are also involved in the salmon fishery.

South coast herring trap fishers are individually assigned to particular 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.

Governing Legislation/Fishing Authority
Fisheries Notice no. 478 (Section 43 order)
Condition 42 on a Fishing Boat Licence

Consultation Process
Department–industry meetings

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.

Currently an Australian herring stock assessment model has been developed using all available research data and CAES information from Western Australia and South Australia and is in the final stage of preparation. Additionally there are two FRDC projects which are nearing completion. The first is focused on the development of a juvenile index of recruitment for Australian herring, while the second is using time-series analysis of historic commercial catches. Both are due for completion by the end of 2003 and will assist in the accurate prediction of herring catches.

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

Australian Herring Stock Status Report

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

During 2002 there were 10 licensees (most of whom are also Australian salmon fishers) permitted to take herring using 'G' trap nets set on nine nominated south coast beaches. On the west coast, the Cockburn Sound (Fish Net) Managed Fishery specifically fishes for Australian herring. In addition, small

quantities of Australian herring are also taken by wetline vessels, and by some coastal and estuarine licensed fishers on both the south and west coasts. For completeness, these small catches have been included in this status report.

Main fishing method

Trap ('G') net, beach seine and gill net.

RETAINED SPECIES

Commercial production (season 2002): State 600 tonnes
South coast 508 tonnes

Landings

The total catch of Australian herring for the State in 2002 was 600 t, a decrease of approximately 159 t from the 2001 catch (Herring Figure 1). The south coast catch was 508 t, which comprised 85% of the total State catch. The south coast landings included 489 t from the ocean (471 t from trap nets and 18 t from other gear) and 18 t from estuaries and embayments. The south coast catch to the end of May 2002 (traditionally the end of the trap net fishing season) was 493.6 t, or 97% of the annual south coast catch. The west coast catch was 92.4 t and included 27.8 t from the ocean, 3.7 t from estuaries and 60.9 t from embayments (Geographe Bay and Cockburn Sound).

Fishing effort

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 2002 was 47.1 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.

Recreational component: **Approx. 10% (south coast)**

Recreational catch and effort figures are not available for 2002. However, data collected in 1994 and 1995 (Ayvazian et al. 1997) indicated that the recreational catch shares at that time for the south and west coasts were around 10% and 60% respectively.

Stock assessment completed: **Yes**

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 model suggest that the proportion of the stock on the west coast of WA is smaller than that on the southern coast of Australia. Increasingly, evidence suggests that the influence of factors other than fishing may be largely responsible for fluctuations in the catch and hence the breeding stock levels (see 'External Factors').

For the south coast portion of the stock, examination of the relationship between catch and trap net effort indicates that the reduction in effort from the mid-1990s has generated the expected improvement in commercial catch rates, from about 35 t per trap net team with 19 teams to above 45 t per trap net team with 10 teams. The corresponding relationship between total catch and effort further suggests that the lower current effort levels may have reduced the average catch by at least 100 t in a typical year, thus leaving more stock to grow to a larger size and/or increase the availability of Australian herring to other fishers. However, annual fluctuations in the trap net catch may also result from effects other than fishing, as previously discussed.

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 appear to be at satisfactory levels, and above a conservative biological limit reference point of 40% of the total virgin biomass.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The main south coast fishery operates primarily through fixed trap nets on nine 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**

Whilst there is occasionally some interaction with protected species such as fur seals and sea lions these do 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 48 fishers during 2002. Additional employment is created in the processing and distribution networks and retail fish sales sectors.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2002): $192,500

This estimate is for the south coast trap net fishery only.

FISHERY GOVERNANCE

Acceptable catch range: South coast 450–1,200 tonnes

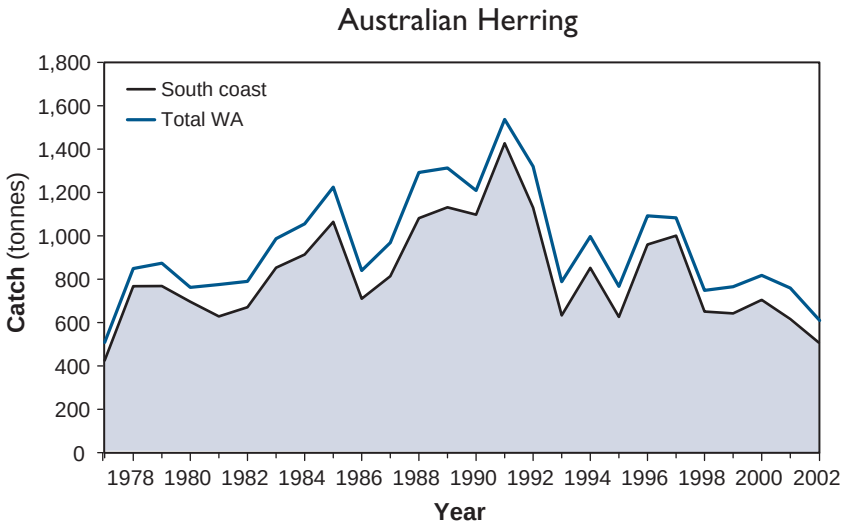
The acceptable catch range for the south coast Australian herring trap net fishery under the current management regime is 450–1,200 t (rounded to the nearest 50 t). This projection is derived by double exponential smoothed forecasting of the past annual catches to 1998 and the variation of observations 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, management changes to protect the stock may need to be considered.

Using the above methods, the commercial west coast herring catch is expected to be between 60 t and 125 t. The 2002 annual commercial west coast catch was 92 t, within the range of acceptable catch limits.

The current catch of 508 t for the south coast fishery is within the range set, but catches in recent years have been towards the lower end of the range, partly as a result of the reduction in the number of teams fishing. Therefore, the likely catches in relation to environmental influences may need to be recalculated as part of the implementation of the new stock assessment techniques.

EXTERNAL FACTORS

Until 1991, the catch trend was increasing. As is the case for Australian salmon, a proportion of the herring resource is recruited from South Australian nursery areas. In most years, however, '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 the main nursery areas and source of recruitment. Thus, historical catch records between 1976 and 1998 indicate that the size of the west coast catch is unrelated to the size of the south coast catch (correlation coefficient = 0.38; non-significant).



HERRING FIGURE 1

Catches of Australian herring from the south coast and the total Western Australian catch for the period 1977 to 2002.

South Coast Purse Seine Managed Fishery

Management Summary

This fishery is based on the capture of pilchards (*Sardinops sagax*) and other small pelagic fish by purse seine nets in the waters off the south coast of Western Australia between Cape Leeuwin and the WA/SA border under the provisions of the South Coast Purse Seine Management Plan 1994. Pilchards have a variety of uses, being sold for human consumption, angling bait, commercial bait, tuna grow-out food and pet food. The recreational angling bait market is currently the main focus.

The spread of a *Herpesvirus* throughout the pilchard population in 1995 and again in 1998/99 has had a serious impact on the stock. Understanding of the pathogen has increased significantly since the first outbreak, but there are still important knowledge gaps, such as the source of the virus, and the possibility of a further outbreak represents a real threat to the industry.

Purse seine fishing on the south coast is controlled by the setting of a total allowable catch (TAC) for small pelagic fish including pilchards, scaly mackerel (*Sardinella lemuru*), yellowtail scad (*Trachurus novaezelandiae*), anchovies (*Engraulis australis*), sandy and blue sprat (*Hyperlophus vittatus* and *Spratelloides robustus*) and maray (*Etrumeus teres*). Each zone in the fishery is allocated a set amount of transferable quota units whose values change depending on stock assessment data. There is a total of 890 quota units currently allocated across each of the five zones in the fishery.

The fishing season for the South Coast Purse Seine Managed Fishery runs from 1 July to 30 June each year. Research data indicates that the fishery is recovering well from the pilchard mass mortality events, and it was on this basis that an increase in the small pelagic fish TAC from the previous season was approved. The TAC for Zones 1 and 2 (Albany) was set at 909 t for the 2002/03 fishing season, with 402 t available from July to December 2002 and 507 t available from January to June 2003. The TAC for Zone 3 (Bremer Bay) was set at 1,230 t and for Zone 4 (Esperance) at 1,500 t for the season.

The TAC-setting process is coordinated through the Purse Seine Management Advisory Committee, an expertise-based committee established to advise the Minister on matters relating to the management of purse seine fishing in Western Australia.

Governing Legislation/Fishing Authority
South Coast Purse Seine Management Plan 1994
South 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

Consultative Process
Purse Seine Management Advisory Committee
Agency–industry meetings
Department–industry meetings (as required)

Research Summary

Data for setting quotas is derived from fishery-independent spawning biomass surveys, quota returns and biological monitoring of the commercial catch composition.

Research in 2003 will continue to focus on fishery-independent spawning biomass surveys, part of a five-year FRDC-funded project examining the regrowth of the pilchard stocks in Western Australia. Monitoring of the commercial catches has recommenced with the re-opening of the fishery. Biomass surveys and analysis of catches together allow the annual review of stocks in each major zone and compilation of the following status report.

The need to introduce a new management approach, following the post-mass-mortality period when the fishery was essentially closed in some regions, that was originally presented to the MAC during 2001 was further developed during 2002. This initiative would focus on capping TACs at a level 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%. 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.

The previous two *State of the Fisheries Reports* anticipated a change in the reporting period for this fishery from calendar to quota years, but this was delayed because of the instability in the fishery following the mass mortality event of 1999. The change has been implemented in the current report, resulting in a six-month overlap with the previous report. Thus the South Coast Purse Seine Managed Fishery Status Report in the *State of the Fisheries Report 2001/2002* was for the period January–December 2001, while the current report is for the period July 2001 – June 2002.

South Coast Purse Seine Managed Fishery Status Report

Prepared by D. Gaughan and T. Leary

FISHERY DESCRIPTION

Boundaries and access

The South Coast Purse Seine Managed Fishery consists of three primary management zones, with separate quota units for each zone. 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 Cape D'Entrecasteaux but has not been significantly fished to date.

The access to the fishery is under a limited entry system with each vessel having individually transferable quota.

Main fishing method

Purse seine net.

RETAINED SPECIES

Commercial production (season 2001-02): 1,169 tonnes

Landings

TACs for Albany and Bremer Bay were set at 300 and 500 t respectively. In the Esperance zone a TAC of 1,130 t was set for the quota year.

The catch of pilchards (*Sardinops sagax*) achieved in Albany, Bremer Bay and Esperance in 2001/02 was 279, 490 and 401 t respectively (South Coast Purse Seine Figure 1).

The annual catches were quite close to the TACs for both Albany and Bremer Bay, thus providing an indication that the recommendations were appropriate during this phase of recovery for the fishery. However, the annual catch for Esperance was only 25% of the recommended TAC. Rather than reflecting a mismatch between stock levels and expectations for the fishery, this low catch is attributed to the very large numbers of juvenile pilchards that have essentially swamped the traditional fishing grounds of the Esperance fleet. These juveniles have predominantly been below a marketable size, resulting in fishers avoiding them. However, besides consisting of individuals too small for traditional markets, the schools of juvenile pilchards have also made detection of large fish difficult. Thus, the low catch is due to low availability and/or catchability in the fishing grounds, with the pilchard biomass survey for Esperance (see below) having shown a widespread distribution of mature age fish offshore from the inshore fishing grounds.

Catches of other small pelagic species in the 2001/02 quota period were insignificant (< 2 t).

Fishing effort

Albany zone: The recorded number of CAES days in 2001/02 was 314.

Bremer Bay zone: The recorded number of CAES days in 2001/02 was 431.

Esperance zone: The recorded number of CAES days in 2001/02 was 320.

Catch rate

Albany zone: The 2001/02 catch rate for the Albany zone was 886 kg/day.

Bremer Bay zone: The 2001/02 catch rate for the Bremer Bay zone was 1,138 kg/day.

Esperance zone: The 2001/02 catch rate for the Esperance zone was 1,253 kg/day.

Recreational component: **Nil**

Stock assessment completed: **Yes**

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. During 2001/02, there was strong recruitment across the south coast. This was particularly evident at Esperance where fish less than three years old dominated the traditional fishing grounds.

The strong recovery in pilchard biomass at Albany and Bremer Bay as revealed using the daily egg production method (DEPM) has now been supported by the age-structure data when fed into the simulation model. At the end of 2002 the model has indicated spawning biomasses of 11,363–24,225 t for Albany and 7,691–21,393 t for Bremer Bay. A DEPM survey was completed for Esperance in January 2002 and confirmed that the pilchard spawning stock in this region appears to not have recovered as quickly as has been the case in Albany and Bremer Bay. Thus, while the spawning biomass at Albany and Bremer Bay is high by historical standards, the estimated 11,651–29,409 t for Esperance is about half of the historical level.

The high abundance of juvenile pilchards in Esperance was again accompanied by low availability of older fish. The reasons for this remain unclear. As mentioned in the last report, there is a possibility that in contrast to the documented spatial dynamics of the 1990s, the low numbers of adult pilchards near Esperance could be related to the strong influx of pilchards into Albany in 2001. Movement of adult pilchards from Esperance towards Albany and Bremer Bay could still be happening consistently but at a level that the current catch-sampling and stock assessment cannot detect.

Exploitation status:
Albany and Bremer Bay zones under-exploited
Esperance zone fully exploited

Breeding stock levels: **Adequate**

Estimates of vulnerable biomass (which closely reflects spawning biomass) at the end of 2002 have been updated from the previous report using additional catch-at-age data and DEPM estimates of spawning biomass. These are provided above for the individual south coast regions.
The total estimated spawning biomass across the south coast was 52,900 t (30,705–75,027 t), which represents 69% of the virgin biomass. This is less than the previous estimate of 87% of virgin spawning biomass. The prime cause for this reduction is the reduced estimate from Esperance. However, the change from the previous estimate is within normal levels of variability for estimates of breeding stock of pilchards.
In terms of the management of the fishery, 69% of virgin biomass is still considered healthy for stocks, such as pilchards, which undergo large fluctuations in recruitment, and need to be maintained well above the average acceptable level (in the order of 40%).

NON-RETAINED SPECIES

Bycatch species impact: **Low**

This fishery targets specific schools of small pelagic fish, particularly pilchards, so bycatch is insignificant. Other species of small pelagic fish sometimes caught in small quantities, which are occasionally retained as by-product but mostly released from the net or later discarded, include yellowtail scad (*Trachurus novaezelandiae*), maray (*Etrumeus teres*) and blue mackerel (*Scomber australasicus*).

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 or 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. The quota for pilchards is generally set at 5–10% of the spawning biomass, thus leaving 90–95% available to natural predators.

The concept of managing ecosystems, rather than single species, has been presented to the Purse Seine MAC during 2001 and again during 2002. Small pelagic fish represent a conceptually easy group for which to begin implementing ecosystem-based fisheries management. For example, various seabirds will predate on a variety of species of small pelagics 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 conditions). This issue represents a complex shift in the management philosophy for purse seine fisheries in Western Australia and continues to undergo further development.

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 reopening of the pilchard fishery in Albany and Bremer Bay in July 2001 following the 1998/99 mass mortality has seen an upturn in the number of people employed in this industry. This includes those directly employed on boats and those in the processing and transport sectors. Currently there are 6 vessels fishing in Albany, providing income for about 15 people. Local factories employ about 15 casual and full-time staff to process and package pilchards. There have been 3 vessels fishing in the Bremer Bay zone for the season, employing 9–10 crew. The processors in Bremer Bay provide work for between 15 and 18 casual and full-time workers. The number of people employed in the Albany and Bremer Bay pilchard fisheries is expected to increase further following the recommendations for quota increases in 2002/03. In Esperance, where an economically significant TAC has remained, there was an aggregate of 3 vessels working in the 2001/02 season, employing approximately 10–11 staff (skippers and crew). The catch from these was directed through two factories, which in turn employed approximately 15–20 casual staff as well as 4 full-time staff, including the owners.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001): $1.17 million

The higher-value angling blocks/trays and individually quick frozen (IQF) fish continue to represent almost the entire catch processed. The different product types for each zone are shown in South Coast Purse Seine Table 1. At an average price of $1000/t, the total catch value for 2001/02 was $1.17 million, significantly more than last year's $870,000.

FISHERY GOVERNANCE

Acceptable catch (or effort) range: **Effort not available**

The south coast purse seine fishery is still being managed conservatively to ensure the regrowth of the pilchard stock following the 1998/99 virus epidemic. Quotas and stock modelling based on biomass estimates from surveys conducted in each zone currently provide the only means to forecast catch. Given the significant changes to the fleet that have occurred recently, historical figures may no longer be valid for comparisons, therefore the expected effort range to land the TAC in each region is not yet available.

EXTERNAL FACTORS

Following the loss of stock due to the mass mortality event of 1998/99, serious concerns were raised about the survival of pilchard stocks in Western Australia, but stocks are now showing positive signs of a recovery. Because there are still significant gaps in our knowledge of the pilchard *Herpesvirus*, it is not known if or when there may be another outbreak of the disease. The rebuilding process of the industry and the future viability of the fleet appear encouraging. The gap left in the angling bait market following the closing of the pilchard fishery in Albany and Bremer Bay led to an increased volume of *Sardinops sagax* being imported from overseas, which presented a degree of risk to the local pilchard stocks. While the volume of pilchards imported for angling bait has now dwindled, the Western Australian industry is being threatened by the growth of the South Australian pilchard fishery. The South Australian fishery has undergone a period of very strong growth and has been said to be providing competitively priced

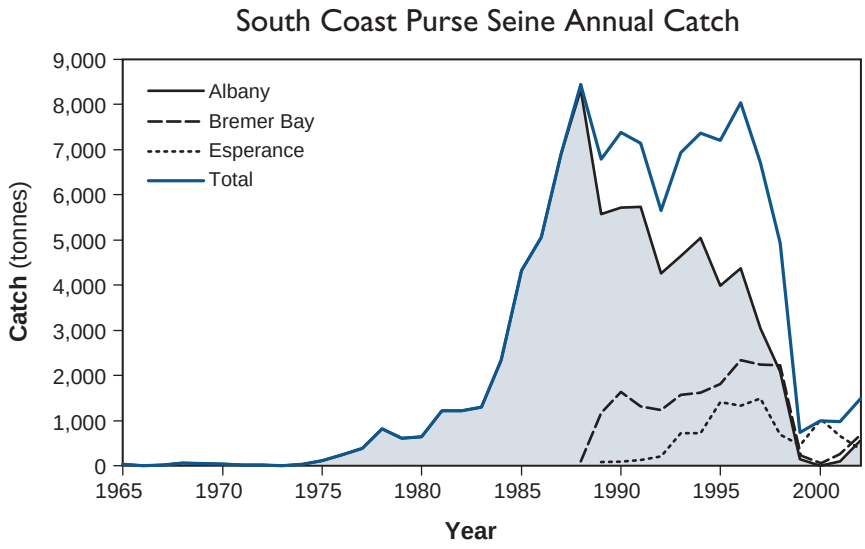
pilchards in Western Australia's traditional east-coast bait markets. This is viewed by some industry members as the biggest current threat to the south coast purse seine industry.

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. 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 (t) from Albany, Bremer Bay and Esperance for 2001/02.

PRODUCT	ALBANY	BREMER BAY	ESPERANCE	TOTAL SOUTH COAST
Trays	229.3	367.9	355.1	952.3 (81.4%)
IQF	48.7	116.7	29.8	195.2 (16.7%)
Pet food/ Other	0.2	5.8	15.8	21.8 (1.9%)
Total	**278.2**	**490.4**	**400.7**	**1,169.3**



SOUTH COAST PURSE SEINE FIGURE 1

Annual catches of pilchards along the south coast, by fishing zone.

Demersal Gillnet and Demersal Longline Fisheries

Management Summary

The take of finfish, including shark, by demersal gillnet and demersal longline is controlled on the south coast and the west coast (south of Shark Bay) through two similar management plans. Both fisheries are managed using effort controls in the form of limited entry and an individually transferable effort system that regulates both time and gear use into tradeable units of entitlement. One unit permits the use of one net of a particular length, or a demersal longline with a particular number of hooks, for one month.

Management has historically been focused on ensuring the sustainable exploitation of three main species, whiskery shark (*Furgaleus macki*), dusky whaler shark (*Carcharhinus obscurus*) and gummy shark (*Mustelus antarcticus*). On the west coast, the sandbar or thickskin shark (*Carcharinhus plumbeus*) is also emerging as an important commercial species.

Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (*JASDGDLF*)*:* The joint authority arrangement for the JASDGDLF covers the take of sharks, rays and bony fish by 'demersal gillnets and all other lines' (demersal longlines) from 33° S latitude to the WA/SA border and out to the limit of the Australian Fishing Zone.

West Coast Demersal Gillnet and Demersal Longline (*Interim*) *Managed Fishery* (*WCDGDLF*)*:* Extensive research carried out on the commercially important shark species off the Western Australian coast indicates that this fishery shares a series of unit stocks with the JASDGDLF. Because of the commonality of these key stocks, the WCDGDLF is reported under the south coast bioregion. The biomass targets for the three major species in the south coast fishery also apply to the west coast fishery.

The west coast fishery extends from 33° S latitude to 26° S latitude and out to the limit of the Australian Fishing Zone. An order prohibiting the use of longlines and droplines with metal traces, demersal gillnets and powered hauling devices applies to Western Australian waters between 26°30′ S latitude (Steep Point) and 114°06′ E longitude (North West Cape), and has been in place since April 1993. The primary purpose of the order is to protect breeding stocks of dusky whalers.

The west coast fishery is currently managed under an interim management plan, which is due to expire on 31 May 2004. The Minister for Fisheries has recently authorised the Department to undertake consultation on a new management plan for the fishery, which is intended to be in place by the expiry of the interim plan.

Following the conclusion in 2000/01 of the five-year gear reduction strategy in the JASDGDLF, the Department is currently reassessing the status of the three key target species and will initiate a management response on the basis of these results. In addition, the Department is currently considering ways to address key shark management issues including the removal of latent effort, limiting increases in fishing efficiency to cap effort at its current level, and reducing fishing mortality on sharks in other fisheries. Growing international and national concern about the need to conserve sharks means that there will be continuing pressures to implement further measures to restrict shark catches and bolster breeding stocks.

The ability of fishers outside the managed shark fisheries to take sharks by other methods continues to be a matter of concern. The *Fish Resources Management Regulations 1995* were amended in November 2002 to prohibit both commercial and recreational fishermen from attaching hooks to rock lobster pots, pot lines, mooring lines and anchor ropes. This prohibition was implemented to reduce the catch of large sharks, particularly dusky whalers, which are targeted for their fins.

The WA Demersal Net and Hook Fisheries Management Advisory Committee met on 8 and 21 August 2002 specifically to discuss the National Plan of Action for the Conservation and Management of Sharks, which was adopted by State, Territory and Commonwealth representatives on the Shark Assessment Group in late 2002.

A draft application has been submitted for both the WCDGDLF and the JASDGDLF as part of Environment Australia's ecological sustainability reporting process under the *Environment Protection and Biodiversity Conservation Act 1999*. A final application is being developed which will be submitted to EA in 2004.

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 1997

West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery Permit

Fisheries Notice no. 601 (Section 43 order)

Consultation Process

WA Demersal Net and Hook Fisheries Management Advisory Committee

Department–industry meetings (as required)

Research Summary

A major FRDC-funded study 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 commenced in July 2000 focusing on the sandbar (thickskin) shark component of the fishery.

Research monitoring of the fishery involves analysis of CAES data and biological sampling of commercial catches. During 2002/03, a major revision of the catch and effort database for these fisheries was undertaken using improved validation protocols, and reported to the WA Demersal Net and Hook Fisheries Management Advisory Committee.

These research data are used to provide the following status report on the fishery.

Demersal Gillnet and Demersal Longline Fisheries Status Report

Prepared by R. McAuley and D. Gaughan

FISHERY DESCRIPTION

Boundaries and access

Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery: The JASDGDLF was declared a limited entry fishery in 1988, managed under a Joint Authority with the Commonwealth Government. It 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 fishery is currently managed using 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 2000/2001*). 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. In the 2001/02 season there were 57 JASDGDLF licences.

West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery: An interim management plan for the demersal gillnet and demersal longline fishery between latitude 33° S and a line drawn north of North West Cape (114°06′ E) was introduced in 1997/98. However, shark fishing has been prohibited between Steep Point (26°30′ S) and North West Cape since 1993. 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. Access to the WCDGDLF during 2001/02 was limited to 26 licences.

Main fishing method

Demersal gillnet.

RETAINED SPECIES

Commercial production (season 2001/02):
All sharks 1,152 tonnes
Key species 766 tonnes

Landings

Historical catches have been revised this year according to improved catch and effort data validation procedures and will therefore not necessarily match those reported previously.

The total shark catch of 1,152 t from these fisheries in 2001/02 comprised 842 t from the JASDGDLF and 310 t from the WCDGDLF, made up as follows:

JASDGDLF:	
Dusky whaler*	176 t
Gummy shark*	343 t
Whiskery shark*	141 t
Sandbar shark**	30 t
Other shark	152 t
Total shark	**842 t**

WCDGDLF:	
Sandbar shark**	130 t
Dusky whaler*	60 t
Whiskery shark*	30 t
Gummy shark*	15 t
Other shark	75 t
Total shark	**310 t**

* Original key target species subject to stock assessment.

** Sandbar (known locally as thickskin) shark was not previously reported separately, but is emerging as an important commercial species on the west coast and is the subject of a research project commenced in July 2000.

In addition to these shark landings, approximately 10–20% of the overall demersal gillnet and longline catch is now composed of finfish species which are retained for sale. In 2001/02, scalefish landings totalled 160 t in the JASDGDLF and 87 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 user groups and these catches are reported here because of their importance to an understanding of the true exploitation rates. During 2001/02, 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 shark and ray totalling 11 t. An additional 166 t catch of shark and ray was taken by wetline vessels without access to managed fisheries.

Fishing effort

Historical effort levels have been revised this year according to improved catch and effort data validation procedures. The revised data indicate that effort had previously been over-estimated for these fisheries, particularly in the years leading up to the implementation of the JASDGDLF management plan in 1988.

JASDGDLF: 151,232 kilometre gillnet hours (Zone 1: 36,658; Zone 2: 114,574)

WCDGDLF: 52,981 kilometre gillnet hours

Effort is expressed as standardised kilometre gillnet hours and takes into account the small amount of longline effort still employed in the fisheries (Demersal Gillnet and Longline Figure 2). Effort in the JASDGDLF decreased by 6% in 2001/02, while that in the WCDGDLF decreased by 1%. The numbers of vessels fishing in each fishery in 2001/02 increased by one from the previous year, to 30 in the JASDGDLF and 14 in the WCDGDLF.

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.

Stock assessment completed: Yes (key species)

Stock assessment is carried out for the three main shark species caught by the fishery and the results presented to the MAC. A summary of the results is as follows.

Whiskery shark: Total whiskery shark landings decreased by approximately 3% in 2001/02 to 171 t, which was again at the lower limit of the acceptable catch range. There was an overall 5% increase in the whiskery shark catch in the JASDGDLF, despite the marginal decrease in effort. However, this analysis masks the contrast between zones, where there was an 11% decrease in Zone 1 but a 28% increase in

Zone 2. The WCDGDLF catch of whiskery shark decreased by 26%, despite a stable level of effort. Since the substantial declines in the overall catch rates of whiskery sharks during the late 1970s and early 1980s, catch rates now appear to have stabilised, albeit at a reduced level. This was again the case in 2001/02 when, despite the marked decline experienced in the WCDGDLF, there was a 2% increase in overall catch rate. The high catch rate in Zone 2 is probably a result of an increased level of effort targeted at gummy sharks, which have a similar ecological distribution to the whiskery shark, in the western portion of this region.

The stock assessment model shows that the biomass of whiskery shark declined from 1975 until recently, but has now stabilised, again at a low level . Biomass is currently between 29.6 and 33.9% of virgin biomass, and at current effort levels this biomass has a 41.9% chance of increasing.

Dusky whaler: At 236 t, the total catch of dusky whalers in 2001/02 was 21% less than that of the previous year. Dusky shark catches decreased by 26% and 21% respectively in Zones 1 and 2 of the JASDGDLF, and by 14% in the WCDGDLF. Catch rates were calculated to have decreased by 14% in Zone 1, 18% in Zone 2 and 12% in the WCDGDLF. The declining catch rates throughout all of south-western Australia strongly suggest that the size of the breeding population has been depleted and recruitment has declined. There is therefore 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, as well as ongoing 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.

Gummy shark: The total catch of gummy sharks in 2001/02 was 358 t, 40% higher than in the previous year and at the upper end of the acceptable catch range. This appears to be in response to increased abundance of this species, as well as increased targeting of effort to take advantage of this increased abundance. The 47% increase in overall catch rate and the results of previous stock assessments indicate that the stock abundance is likely to be above the target level. However, given the imminent conclusion of the five-year management cycle, a new stock assessment should be conducted as soon as possible.

Exploitation status: **Gummy sharks fully exploited**
Dusky whaler and whiskery sharks over-exploited

Current effort levels in this multi-species fishery are considered to be fully exploiting the gummy shark stocks and causing some over-exploitation of the dusky whaler and whiskery shark stock.

Breeding stock levels: **Declining**

Following concerns regarding the procedures used to validate catch and effort data used in stock assessment of the target shark species and questions regarding the reliability of the whiskery shark model, a review of these programs was undertaken in early 2003. The resulting stock assessment for whiskery sharks estimated that their current biomass is approximately 32% of its unexploited level and declining.

Recent catch rates of neonate dusky whaler sharks suggest that the breeding stock of this species is declining, possibly due to influences outside of the control of the fishery. Breeding stock of gummy sharks appears to be adequate.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

There is some discarded bycatch of unsaleable species of sharks, rays and scalefish. Following preliminary ESD assessment of these fisheries, all bycatch species impacts are considered to be low.

Protected species interaction: **Low–negligible**

The fishery has limited ability to interact with protected species as a result of its area of operation and the gear types used.

Sharks and rays: 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 these stocks is remote.

Turtles: Captures are rare as the fisheries largely operate well south of the normal range of most Western Australian turtle species.

Cetaceans: Dolphin captures are rare and unlikely to cause an impact on the population.

Pinnipeds: Fishers largely avoid seal and sea lion colonies and the number caught is likely to be extremely 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 2001/02 in the JASDGDLF was 50 skippers and crew, and in the WCDGDLF 20.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001/02): $5.5 million

JASDGDLF: $3.2 million (shark and scalefish)
JASDGDLF: $850,000 (shark fins)*
WCDGDLF: $1.1 million (shark and scalefish)
WCDGDLF: $300,000 (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.

The value of the fisheries was similar to last year. A declining trend in shark catches in recent years has been offset by increases in the value of shark fins to between $25 and $120/kg, depending on fin size and species.

FISHERY GOVERNANCE

Acceptable catch range: Key species 725–975 tonnes

Acceptable catch ranges for the key species, based on 10-year averages, are as follows:

Whiskery shark	175–225 t
Dusky whaler	300–400 t
Gummy shark	250–350 t
Sandbar shark	< 250 t

Catches of whiskery and dusky sharks are now at or below the target levels which were set before the last phase of net length reductions in the southern fishery was introduced. Given these effort reductions are now complete, these ranges will be readjusted before next year's report.

EXTERNAL FACTORS

Continued observed and anecdotal evidence suggests that significant numbers of large dusky whaler sharks have been taken over the previous 5–10 years by fishers operating outside the target fisheries. Unpublished catch data from Commonwealth-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

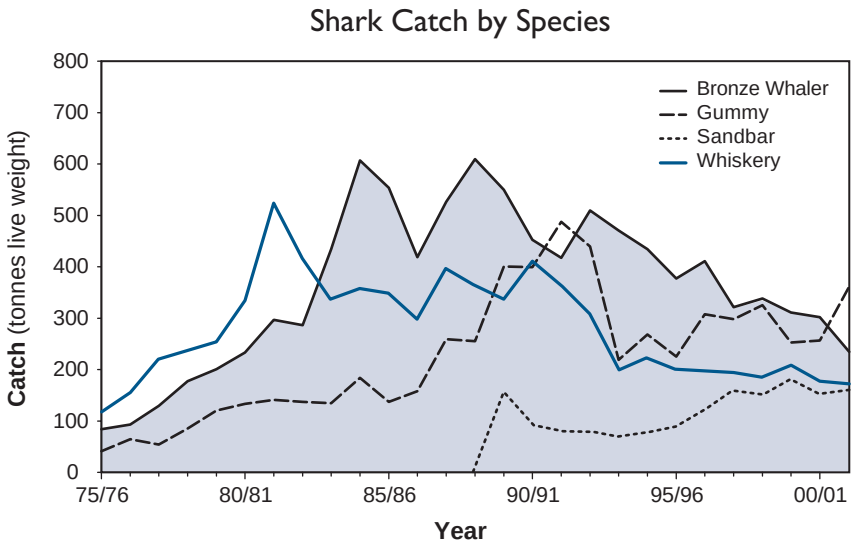
Shark catch species composition for the demersal gillnet and demersal longline fisheries (JASDGDLF and WCDGDLF), 2001/02.

		CATCH (tonnes)				
		JASDGDLF			WCDGDLF	STATE TOTAL
SPECIES		Zone 1	Zone 2	Total		
Gummy	*Mustelus antarcticus*	19	324	343	15	358
Dusky	*Carcharinhus obscurus*	105	71	176	60	236
Whiskery	*Furgaleus macki*	74	67	141	30	171
Sandbar (thickskin)	*Carcharinhus plumbeus*	30	0	30	130	160
Hammerhead	Sphyrnidae	7	31	38	22	60
Wobbegong	Orectolobidae	11	7	18	21	39
Blacktip	*Carcharinhus* spp.	1	< 1	1	21	22
School	*Galeorhinus galeus*	0	15	15	0	15
Skates and rays		0	6	6	1	8
Copper	*Carcharinhus brachyurus*	0	1	1	5	6
Shovelnose rays	Rhinobatidae, Rhyncobatidae	0	0	0	5	5
Pencil	*Hypogaleus hyugaensis*	< 1	2	2	1	3
Other sharks		55	17	72	0	72

DEMERSAL GILLNET AND LONGLINE TABLE 2

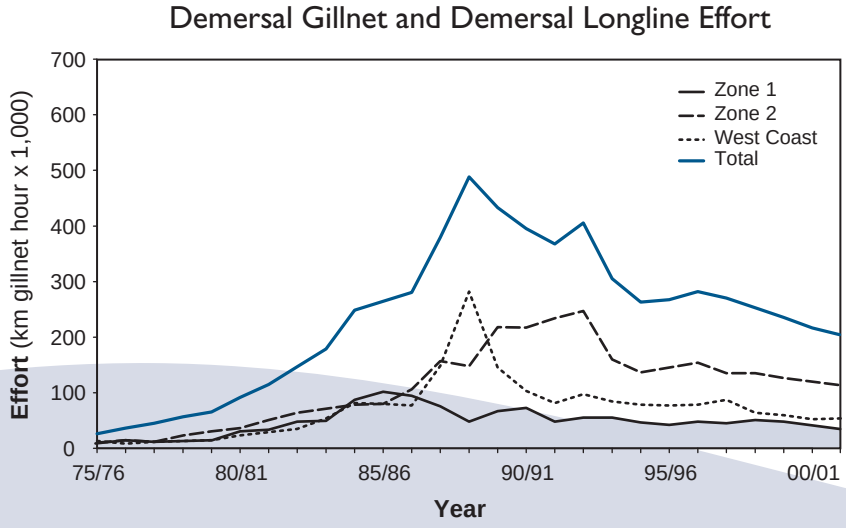
Scalefish catch species composition for the demersal gillnet and demersal longline fisheries (JASDGDLF and WCDGDLF), 2001/02.

		CATCH (tonnes)				
		JASDGDLF			WCDGDLF	STATE TOTAL
SPECIES		Zone 1	Zone 2	Total		
Queen snapper	*Nemadactylus valenciennesi*	9	22	30	7	68
Blue groper	*Achoerodus gouldii*	9	11	20	4	44
Pink snapper	*Pagrus auratus*	2	7	8	14	31
Dhufish	*Glaucosoma hebraicum*	6	1	8	16	31
Samson fish	*Seriola hippos*	5	2	7	12	27
Salmon	*Arripis truttaceus*	6	0	6	<1	12
Redfish	*Centroberyx affinis*	<1	4	4	<1	9
Boarfish	Pentacerotidae	<1	3	3	<1	6
Leatherjacket	Monacanthidae	<1	3	3	<1	6
Other scalefish		44	13	57	33	147



DEMERSAL GILLNET AND LONGLINE FIGURE 1

Annual catches of target shark species in the demersal gillnet and demersal longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2001/02.



DEMERSAL GILLNET AND LONGLINE FIGURE 2

Effort in the demersal gillnet and demersal longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2001/02.

NORTHERN INLAND BIOREGION

REGIONAL MANAGEMENT OVERVIEW

The only commercial fishery in the northern inland bioregion is the Lake Argyle Freshwater Catfish Fishery (LAFCF). Future management arrangements for this fishery are currently under examination.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

There is limited compliance monitoring in the LAFCF, with seven commercial contacts made during 2001/02. There were no compliance problems encountered, and monitoring continues to be a low priority. However, since 2002, gear identification requirements have been implemented in this fishery, and this will require some additional level of activity by Fisheries Officers.

Lake Argyle Freshwater Catfish Fishery

Management Summary

The only commercial freshwater fishery in Western Australia is in Lake Argyle in the Kimberley. This fishery, currently utilising gillnets, specifically targets the catfish or silver cobbler (*Arius midgleyi*) and is managed through a set of licensing conditions. There is a two-month closure during the wet season breeding period of November and December.

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, as well as outlining contingency procedures for circumstances when fishing gear has been lost or abandoned.

Future management measures for this fishery will include a review of the possible impact of latent effort within the fishery and a shift in the seasonal closures to better accommodate the wet season breeding period.

Governing Legislation/Fishing Authority
Fisheries Notice no. 665 (Section 43 order)
Condition 55 on a Fishing Boat Licence

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 on an annual basis.

This information is subsequently 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 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. Anecdotal evidence from sectors of the Lake Argyle catfish fishing industry has indicated a decline in fish size during recent years, supporting the view that exploitation rates were too high.

In previous years, the data for this fishery has been reported on a financial year basis, but from this year it is presented on a calendar year basis to better reflect the actual fishing season and summer closure.

The following status report provides a synthesis of the current data from the fishery.

Lake Argyle Freshwater Catfish Fishery Status Report

Prepared by S. Newman

FISHERY DESCRIPTION

Boundaries and access

The Lake Argyle Freshwater Catfish Fishery is contained in the impounded waters of the Ord River at Lake Argyle and on part of Lake Kununurra. During 2002 there were six licensees who had access to the fishery. There is a net length restriction of 1,500 m. While there is no mesh size restriction, the fishers have adopted a code of practice that states that nets should be no less than 6 inch (150 mm) mesh and 30 meshes deep. 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*).

Main fishing method

Gillnet.

RETAINED SPECIES

Commercial production (season 2002): **114 tonnes**

Landings

The primary target species in the fishery is the shovel-nosed catfish or silver cobbler (*Arius midgleyi*). 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), following which they increased to a peak catch of 231 t in 2000. Owing to voluntary reductions in effort, catches have declined in both 2001 and 2002. The 2002 catch, at 114 t, is back to the levels taken during the early 1990s and is now within the acceptable catch range for this fishery (Lake Argyle Catfish Figure 1).

Fishing effort

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 2002 was 4,698 units (100 m net days), which is lower than the 2001 fishing effort of 5,570 units and considerably lower than the effort expended in the fishery from 1998 to 2000 (Lake Argyle Catfish Figure 1). This suggests that the voluntary reduction in effort agreed by the fishers is working.

Catch rate

The catch rates achieved in the fishery from 2000 to 2002 have been similar to those achieved in 1993 and 1994. These catch rates are higher than those reported in the intervening five-year period (Lake Argyle Catfish Figure 1).

Recreational component: **Not assessed**

No data are currently available. It is possible that some data on recreational catches in Lake Argyle were collected during the recent National Recreational Fishing Survey, in which case these will be reported next year.

Stock assessment completed: **Yes**

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 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 during the past two years, and particularly in 2002, have been at more appropriate levels, with the 2002 catch now back within the acceptable catch ranges for this fishery.

In addition, the catch rate in the fishery from 2000 to 2002 has been higher than that recorded in the preceding five-year period.

Exploitation status: **Over-exploited**

Breeding stock levels: **Increasing**

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 have occurred during the past two years are assisting the recovery of the breeding stock, which should now be increasing towards adequate levels.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Minimal fish by-catch occurs in this fishery as a result of the large mesh size used relative to the species present in the lake.

Protected species interaction: **Low**

There is an incidental capture of freshwater or Johnston's crocodiles (*Crocodylus johnstoni*) by the freshwater catfish fishery in Lake Argyle. On the basis of the fishers' anecdotal information, the incidental capture of crocodiles is considered to be of minimal ecological significance.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The nets have minimal impact on the habitat.

SOCIAL EFFECTS

During 2002, six vessels fished in the LAFCF with an average crew level of 2 people per vessel, indicating that 12 people were directly employed in the fishery. Additional employment occurs in local fish processing plants and the distribution networks.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2002): **$302,000**

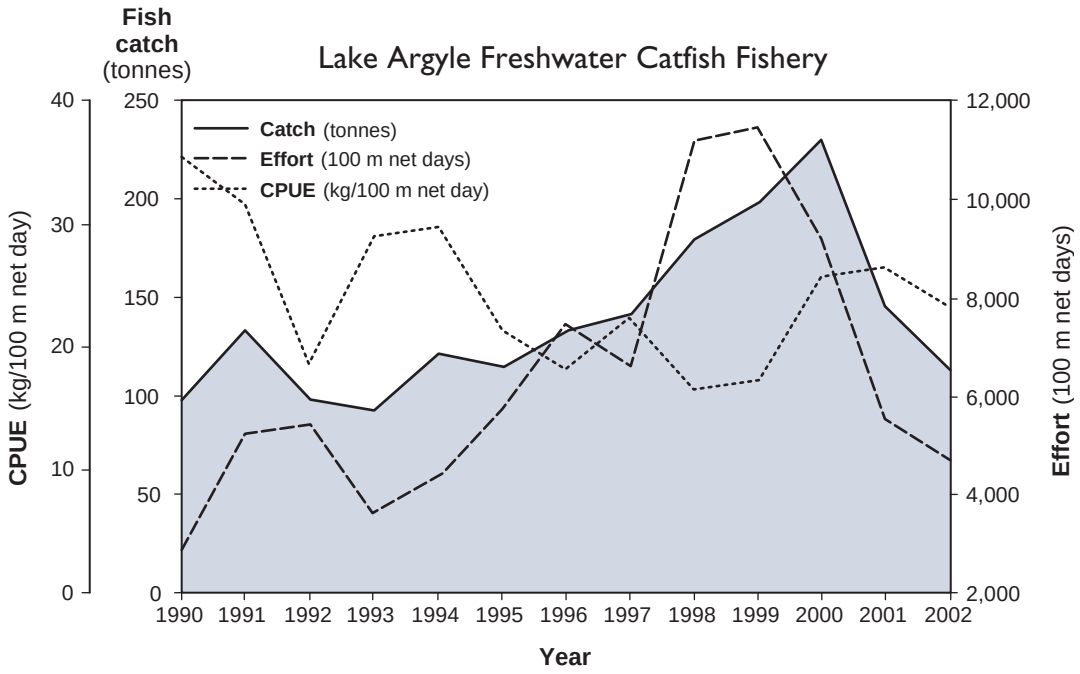
FISHERY GOVERNANCE

Acceptable catch range: **100–140 tonnes**

The acceptable catch range under the current management regime is considered to be in the range of 100–140 t of Lake Argyle catfish. This estimate is based on the 80% confidence limits around the average of the observed catches for the 10 years up to 1998. The catches from 1997 to 2001 exceeded this range (Lake Argyle Catfish Figure 1) and were driven by the utilisation of latent effort. The 2002 catch is now within the acceptable catch range as a result of voluntary decreases in effort in this 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.



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 1990 to 2002.

STATEWIDE FISHERIES

There are a small number of fisheries which operate across all bioregions of the State. Information on these minor fisheries is reported under this 'statewide' category.

Marine Aquarium Managed Fishery

Management Summary

The Marine Aquarium Managed Fishery comprises 13 licensees who operate throughout Western Australian waters under the Marine Aquarium Fishery Management Plan 1995.

The fishery targets in excess of 250 different species of fish for the marine aquarium industry, but catches are relatively low in volume because of the special handling requirements of live fish. Fish caught in the fishery may not be used for food purposes. Operators cannot take juvenile specimens of the commercially exploited species where there are specific size limits, and are not permitted to take species for which there are specific management arrangements or management plans.

The fishery s management plan establishes the legislative controls on the number of licences and operators, boat replacement size and the permitted means of capture. Other legislation imposes constraints on the areas in which commercial collecting of marine aquarium species can be undertaken.

The fishery currently meets the reporting requirements of Environment Australia in relation specifically to the commercial harvest of syngnathids in order to maintain its approved Wildlife Trade Operation status (which allows these species to be exported). An ecological sustainability report addressing the entire fishery is to be prepared and submitted to EA, applying to have the fishery's products approved for export in future under the *Environment Protection and Biodiversity Conservation Act 1999*. It is expected that this report will be prepared in the second half of 2003.

A proposal to provide for all licensees in the fishery to take limited quantities of live rock , live sand , coral and selected invertebrates is under development.

Early in 2003, the Department undertook a compliance risk assessment workshop for the fishery to identify ways of updating the legislation in terms of both management and compliance.

Industry is also in the process of establishing a formal industry association through the WA Fishing Industry Council.

Governing Legislation/Fishing Authority
Marine Aquarium Fishery Management Plan 1995
Marine Aquarium Managed Fishery Licence

Consultation Process
Department industry meeting

Specimen Shell Managed Fishery

Management Summary

The Specimen Shell Managed Fishery has 34 licensees who operate under the Specimen Shell Management Plan 1995. The fishery targets a range of specimen shell species along the entire Western Australian coastline, except where there are specific closures, for example within some marine parks and aquatic reserves.

The management plan establishes the legislative controls for the number of licences issued, number of crew , boat replacement size and permitted fishing methods.

The fishery currently meets the reporting requirements of Environment Australia in relation to the commercial harvest of specimen shells in order to maintain its approved Wildlife Trade Operation status (which allows these species to be exported). An ecological sustainability report addressing the fishery is to be prepared and submitted to EA, applying to have the fishery's products approved for export in future under the *Environment Protection and Biodiversity Conservation Act 1999*. It is expected that this report will be completed in the second half of 2003.

Ongoing management will focus on the level of exploitation of several nominated species and an assessment of the risk of stock depletion associated with levels of catch at both a regional and local scale.

Early in 2003, the Department undertook a compliance risk assessment workshop for the fishery to identify ways of updating the legislation in terms of both management and compliance.

Industry is also in the process of establishing a formal industry association through the WA Fishing Industry Council.

Governing Legislation/Fishing Authority
Specimen Shell Management Plan 1995
Specimen Shell Managed Fishery Licence

Consultation Process
Department–industry meeting

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RECREATIONAL FISHERIES

RECREATIONAL FISHERIES

General Overview

The Recreational Fisheries Program is responsible for the management of the recreational components of Western Australia's fisheries and the delivery of program outcomes identified through strategic, business and operational planning.

The program's key strategic objective is to maintain or improve the quality, diversity and value of recreational fishing and ecotourism based on fish and fish habitats in Western Australia through partnerships with the community.

Other major program objectives include:

- the conservation of fish stocks and their habitats of importance to recreational users;
- improved individual responsibility and community support for sustainable recreational fishing; and
- improved quality and diversity of opportunities for recreational fishing and activities associated with fish and the aquatic environment.

Community advice on planning and operational priorities is provided through the Recreational Fishing Advisory Committee and a network of 12 Regional Recreational Fishing Advisory Committees.

Additional advice on specific management issues is provided through community-based working groups and public submissions collated during planning processes.

Recreational fishers in specific fisheries contribute directly to the general cost of managing their fishery through the payment of licence fees for four species-based fisheries and one fishing activity. Licence fees were increased from 1 July 2002 following a review conducted during 2001/02. Revenue raised from licence fees is credited directly to the Recreational Fishing Fund to support recreational fisheries management, research and community education activities.

Anglers in marine finfish fisheries do not contribute to the cost of management, however funds raised through licensed fisheries are used to support compliance and research in the marine finfish fisheries.

The Recreational Fisheries Program was allocated a budget of $11.2 million including accruals in 2002/03. About $2.2 million was contributed directly by resource users through recreational fishing and fishing tour licence fees, with the remainder contributed by the State Government via the Consolidated Fund.

In the State's licensed recreational fisheries a total of 63,087 licences were issued in 2002/03. Recreational Fisheries Table 1 gives the breakdown of recreational licences issued over the past four years.

RECREATIONAL FISHERIES TABLE 1

Recreational fishing licences 1999/2000 to 2002/03.

	2002/03	*2001/02*	*2000/01*	*1999/00*
Rock lobster	26,989	23,343	25,566	25,714
Marron	5,101	9,507	11,206	11,966
Abalone	8,700	9,171	7,459	7.097
Netting	5,950	4,792	6,043	4,973
South-west freshwater angling	3,569	3,740	4,541	3,470
All categories (umbrella)	12,778	11,552	11,254	9,793
Total licences	**63,087**	**62,105**	**66,069**	**63,013**

Note that, because recreational fishing licences are valid for 12 months from the date of issue, totals may fluctuate during the course of a year. Licence numbers quoted in individual fishery status reports are extracted at a time of year relevant to the peak fishing season and may differ from the annual sales data.

Western Australia's Recreational Fisheries

Western Australia's 12,000 km coastline, 200 nautical mile fishing zone and inland regions support nine major recreational fisheries.

These are distributed between the State's four broad marine and two inland biogeographic regions (north, Gascoyne, west and south coasts, northern inland and southern inland).

From a biological perspective the boundaries of these regions are largely consistent with (or represent sub-sections of) the major oceanographic and climatic zones of Western Australia, and consequently the distribution of fish species and stocks.

In addition, these regions also coincide with discrete tourism regions of the State, and visitor fishing activity tends to focus within these areas during identifiable seasons.

The major recreational fisheries comprise four marine and estuarine multi-species finfish fisheries, a temperate and a tropical freshwater finfish fishery, and licensed single-species fisheries for western rock lobster (*Panurilus cygnus*), abalone (*Haliotis* spp.) and marron (*Cherax tenuimanus*).

Recreational fishing activity occurs in four main zones: creeks and estuaries, shore-based fishing, inshore marine fishing in waters generally within the inshore reef system or three nautical miles of the coast, and an offshore fishery which targets demersal fish and pelagics such as billfish and tunas.

Recreational catch and target species in each region vary significantly, as does the fishing pressure.

Threats and Opportunities

Western Australia's recreational fisheries are a major community asset, and contribute in excess of $570 million a year to the State's economy.

Since 1987 participation in recreational fishing of all kinds has more than doubled from 284,000 people to about 600,000 people a year, or from 27% to 35% of the State's population over 4 years old (Baharthah and Sumner 2003). The National Recreational and Indigenous Fishing Survey estimated that the mean fishing effort by recreational fishers was 7 days per year, with the total recreational fishing effort for the State estimated at 3.4 million fishing days (Henry and Lyle 2003).

Recreational fishing contributes to the quality of life of thousands of Western Australians and provides the basis for an important domestic market for the fishing tackle, bait, boating and vehicle manufacturing industries.

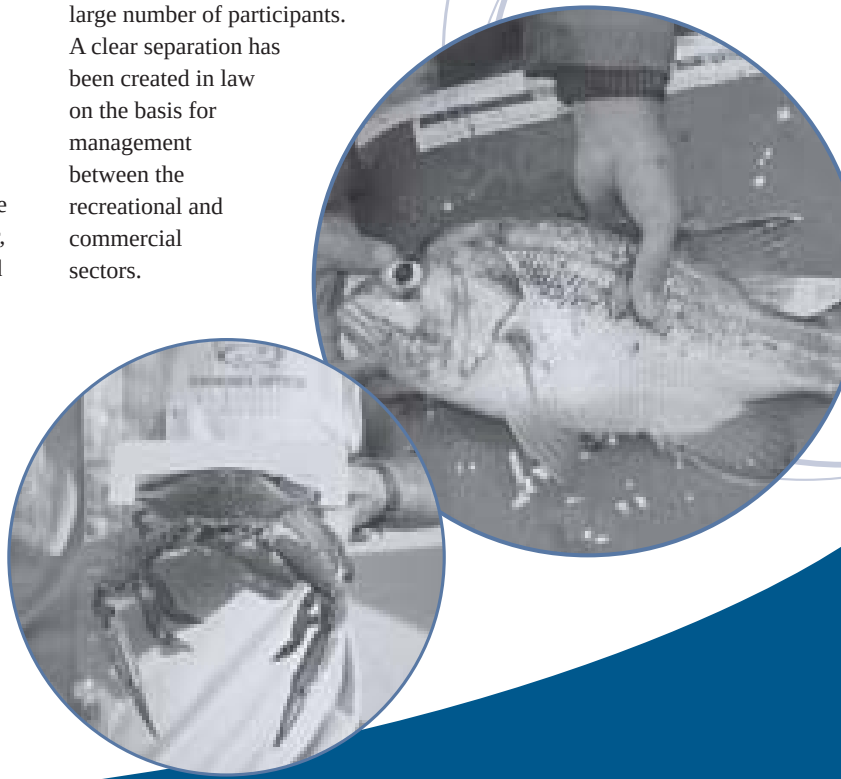
Major threats to the sustainability of Western Australia's recreationally fished stocks come from population growth, coastal development, improved fishing and fish storage technology, a low participation cost, and the opening of access to areas previously protected from significant levels of recreational exploitation by their remoteness. These factors are placing unprecedented pressure on many fish stocks at all stages in their life cycle, compounded in some instances by the eutrophication of rivers and estuaries.

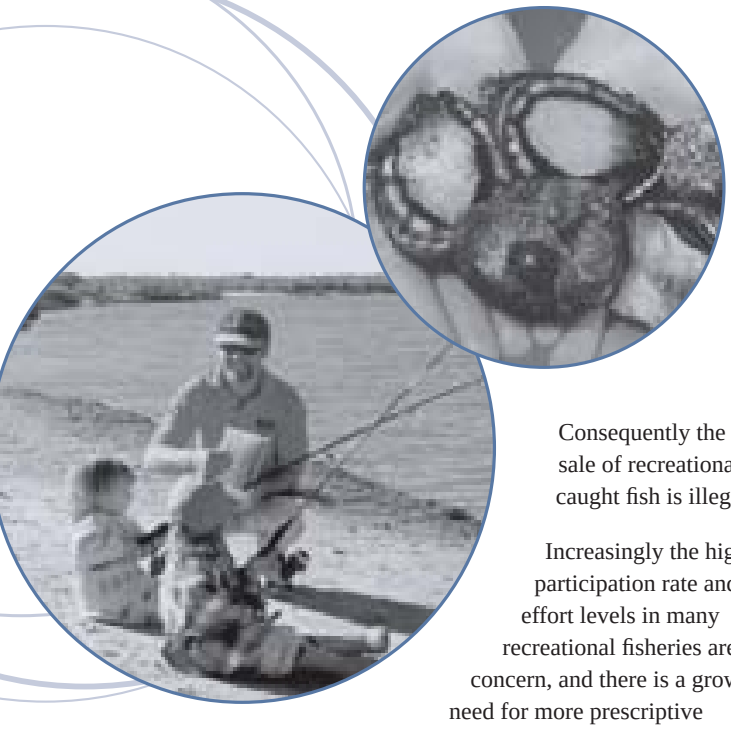
Opportunities for maintaining and developing recreational fishing as an important community activity and regional tourism drawcard occur through growing community support for fishing as a quality experience, rather than focusing on taking large quantities of fish.

Other opportunities are provided by the multi-species, regional nature of recreational fishing activities, a demand by fishers to be involved in all aspects of resource management, and limited fishery enhancement opportunities provided through the developing aquaculture industry, particularly for freshwater impoundments.

Recreational Fisheries Management

Most of Western Australia's recreational fisheries are managed through a mix of broad input controls (closures and size limits) and output controls (individual and boat catch limits) which provide some protection for juvenile and breeding fish, and help share the available catch between the large number of participants. A clear separation has been created in law on the basis for management between the recreational and commercial sectors.





Consequently the sale of recreationally caught fish is illegal.

Increasingly the high participation rate and effort levels in many recreational fisheries are of concern, and there is a growing need for more prescriptive regulations which can directly manage the total recreational catch or the recreational share of the total catch, rather than simply relying on socially acceptable bag limits for individual fishers.

A key outcome of the strategic planning process jointly carried out by the Department's Recreational Fisheries Program and the Recreational Fishing Advisory Committee is the development of four marine regional recreational fisheries management strategies, based on the State's major biogeographic regions (Recreational Fisheries Figure 1).

These five-year strategies aim to ensure that the quality of recreational fishing available in Western Australia is maintained or enhanced in the face of growing population pressures, and will complement management already in place for the licensed recreational fisheries and commercial fisheries.

The regional management framework also provides a relevant spatial and biogeographical basis for recreational fisheries management arrangements that can be readily incorporated into the proposed Integrated Fisheries Management arrangements along with the commercial and fishing tour sectors.

Key elements in each strategy include the clear identification of those fish species, stocks and areas of most importance for recreational fishing, those that are considered most at risk of over-exploitation, and the development of biological and 'fishing quality' outcome indicators against which each plan can be reviewed.

The Gascoyne and west coast regional strategies have been completed and are due to be implemented in 2003/04.

Fishing and Aquatic Tour Management

An important element in managing the recreational sector, and establishing the basis for integrated management and future resource allocation, has been the introduction of management for the previously open-access aquatic tour (charter and fishing tour) industry.

Fishing tour operators are not permitted to sell their catch, and are therefore not considered as commercial fishers. However, the industry provides an important and growing service to the State's recreational fishing and tourism industries.

In the latter half of 2001 legislation was passed enabling the grant of fishing tour operators' licences and aquatic ecotour licences across the State's four marine bioregions. By 2003, a total of 252 tour operators' licences and 32 ecotour licences had been issued. Of these, 46 fishing tour licences operate in two regions or more.

The aquatic tour industry is closely related to the recreational sector in species targeted, gear used and motivation for fishing. As a consequence the industry is managed under the current suite of recreational fishing regulations, although there is discrete legislation which imposes certain responsibilities and conditions on charter licence holders.

One of those conditions requires all operators to submit catch and effort returns for each trip, on a monthly basis. There is now a moratorium on the issue of any further fishing tour licences in fully exploited fisheries until there is sufficient data for an assessment of the sector's relative impact on the State's fish stocks.

It is envisaged that the bioregional management of the industry will provide the spatial framework for integrating the management of fishing tours and ecotourism with recreational fisheries, commercial fisheries and other uses such as conservation.

Recreational Fisheries Research Survey Program

Data for the estimation of recreational catch and effort is collected through a strategic program of surveys.

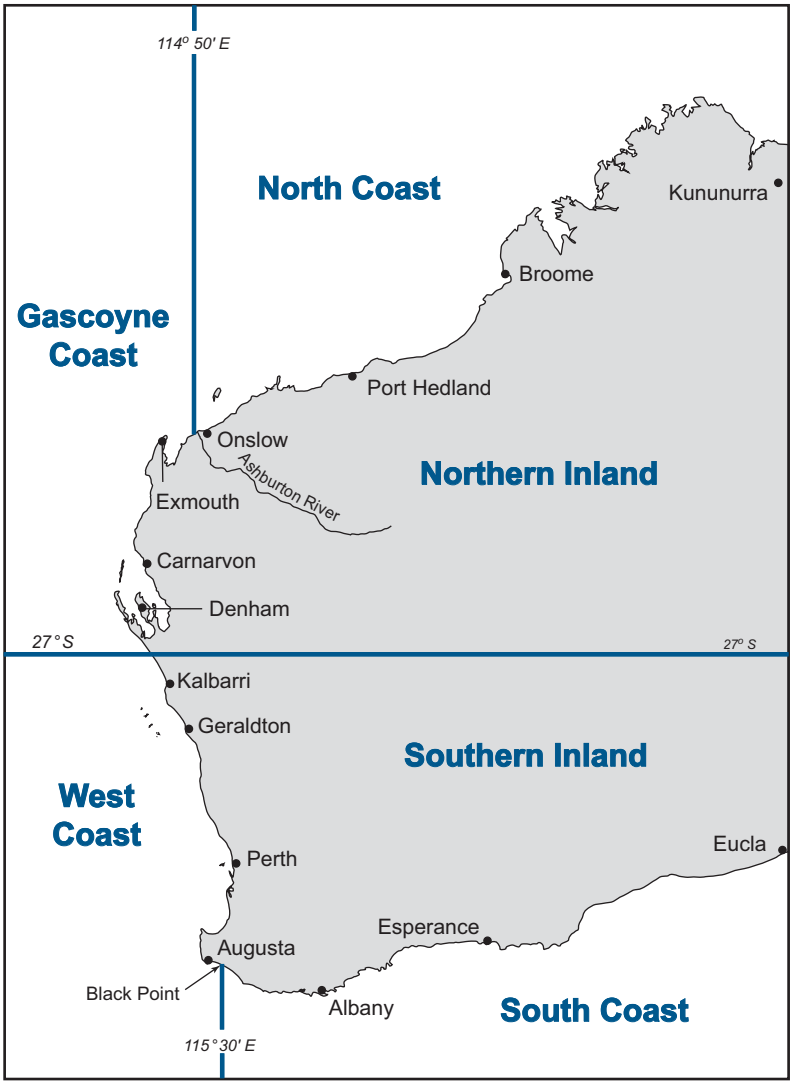
An annual community phone survey conducted by the Department of Fisheries provides broad information on trends in participation and fishing effort.

This community survey provides an overall estimate of the number of people participating in recreational fishing for the State and each bioregion within the State, as well as the number of days of fishing effort for the past 12 months. The estimate of participation is considered to be reasonably accurate; however, the estimate of fishing effort may suffer from bias due to problems of recall by respondents.

For specifically licensed species fisheries, an annual telephone or mail survey of licence holders is also undertaken to directly estimate catches for management purposes.

In addition to these mainly telephone-based annual surveys, detailed field (or 'creel') surveys are also carried out on each of the State's marine bioregions in turn. These surveys, involving interviews with anglers at boat ramps and fishing venues, each take place over a 12-month period, with the four marine bioregions being covered in rotation over a planned six-year cycle. During 2002/03 a reduced-scale survey of the south coast estuaries is being undertaken, owing to the high cost of surveys in this extensive region. It is hoped that the results from this survey can be combined in due course with a subset of the data from the previously conducted National Recreational Fishing Survey to provide useful estimates of the south coast catch.

In addition, a series of full creel surveys has been undertaken in the Shark Bay region to meet the more urgent management needs of the inner bay snapper stocks.



RECREATIONAL FISHERIES FIGURE 1

Map showing Western Australia's major biogeographical regions.

WEST COAST BIOREGION

REGIONAL MANAGEMENT OVERVIEW

The west coast, between Kalbarri and Augusta, attracts the highest level of recreational fishing activity in the State, with around 470,000 anglers fishing an estimated 2.4 million fishing days a year. Within this region the metropolitan coastal waters between Yanchep and Mandurah attract about 290,000 fishers, generating an estimated 1.3 million fishing days a year (Baharthah and Sumner 2003). (It should be noted that these estimates of fishing effort are approximate, owing to the limitations in the survey methods discussed previously.) The total effort from Kalbarri to Augusta for the boating sector alone was estimated at 453,000 angler fishing days in 1996/97 (Sumner and Williamson 1999).

Charter activity, although not covered in the 1996/97 survey, is also significant, with 130 fishing tour licences and 16 ecotour licences valid for the west coast bioregion in 2003.

Major species in the shore and inshore boat catch include Australian herring (*Arripis georgianus*), whiting (several species including King George whiting, *Sillaginodes punctata*), skipjack trevally (*Pseudocaranx dentex*), blue swimmer (manna) crabs (*Portunus pelagicus*), tailor (*Pomatomus saltatrix*), garfish (*Hyporhamphus melanochir*) and squid, while dhufish (*Glaucosoma hebraicum*), pink snapper (*Pagrus auratus*) and baldchin groper (*Choerodon rubescens*) dominate boat fishers' target list.

Estuaries including the Swan/Canning, Peel/Harvey, Leschenault and Hardy Inlet are highly popular recreational fishing areas and produce catches of black bream (*Acanthopagrus butcheri*), cobbler (*Cnidoglanis macrocephalus*), tailor, mulloway (*Argyrosomus hololepidotus*), flathead (Platycephalidae), flounder (Bothidae) and a suite of marine species. Western king prawns (*Penaeus latisulcatus*) and river prawns (*Metapenaeus dalli*) also provide a highly seasonal and variable fishery in the Swan/Canning and Peel/Harvey Estuaries.

Blue swimmer crabs are the target of Western Australia's largest recreational fishery, with over 80,000 participants. Major fishing areas include the Peel/Harvey Estuary, Leschenault Inlet, Cockburn Sound, Geographe Bay and Swan River. Catch surveys for these areas indicate that the total recreational catch is likely to be between 400 and 500 t per year (two million crabs), with over half of this coming from the Peel/Harvey Estuary.

Key issues facing Western Australia's west coast recreational fisheries revolve around the growth in recreational fishing pressure (particularly on demersal fish and the inshore reef system), coastal development and environmental degradation in estuaries and near-shore waters, and competition for the available resource with the commercial wetline and demersal gillnet fleet, commercial crab fleet and commercial estuarine fishery.

A review of recreational fisheries management arrangements for the west coast has been completed and new management arrangements will be implemented in 2003/04.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Fisheries Officers working out of District Offices located at Geraldton, Dongara, Jurien, Lancelin, Hillarys, Fremantle, Mandurah, Bunbury and Busselton deal with a number of recreational fisheries within the region. These include abalone, rock lobster, marine boat- and shore-based angling, and estuarine netting fisheries. Officers patrol near-shore waters using 8 m patrol vessels together with a number of smaller craft, and a 12 m vessel is used at the Abrolhos Islands. The Department's large patrol vessels PV *McLaughlin* and PV *Hamelin* (delivered March 2002) are also used to a limited extent.

Work in the recreational fisheries principally involves checking that fishers are adhering to size and bag limits. Areas of highest risk of non-compliance with management arrangements are considered to be abalone, rock lobster, crab, marine shell collection, marine finfish and estuarine netting.

Activities during 2001/02

A total of 20,672 hours of activity by Fisheries Officers were applied to coastal boating and land-based fishing and to overseeing netting by recreational fishers (West Coast Recreational Compliance Table 1). Approximately 45% of these hours were applied in the greater metropolitan area between Mandurah and Lancelin. Of the remaining hours, most were delivered in the south-west of the bioregion (Bunbury to Augusta), with approximately 25% of the total hours being applied in the mid-west (Jurien to Kalbarri).

The Fishwatch Service received 568 reports of illegal fishing activity for the 2001/02 year. Of all calls received around the state, over 75% related to incidents occurring in the metropolitan area. The main types of illegal activity reported there related to finfish (28%), abalone (10%), rock lobster (10%), crabs (10%), and marron (8%).

As a result of compliance activities, 388 warnings and 177 infringement notices were issued and 129 prosecutions were initiated in the west coast bioregion. Around 90% of all prosecutions concerned offences in the recreational rock lobster and abalone fisheries, with the majority relating to the take of under-size rock lobster and catches of abalone in excess of bag limits.

Compliance with the six-week closure to fishing for pink snapper in Cockburn Sound was again well supported by the recreational fishing community, with little evidence of fishers targeting snapper during the closed season.

The Voluntary Fisheries Liaison Officer (VFLO) program supplements fisher education activities conducted by Fisheries Officers. VFLOs are fishing enthusiasts who donate their time to educate other recreational fishers about fishing regulations, fish handling, catch care and conservation. The VFLO program involved 70 volunteers in the Perth area, 37 in Mandurah, 27 in Geraldton and the mid-west and 29 in Bunbury and Busselton. VFLOs reported a total of 13,351 recreational fisher contacts during 2001/02.

VFLOs throughout the bioregion attended various agricultural shows and community festivals, gave presentations to school and community groups and conducted fishing clinics for children, adults and seniors. Beachfront patrols and education programs continued to focus on correct fishing techniques, ethics and bag and size limits.

Metropolitan VFLOs also participated in 'Clean Up Australia Day' in March 2002 at Fremantle's North Mole. VFLOs looked at the impacts of recreational fishing on our marine environment, and encouraged community involvement at the site.

The successful 'Fishers with Disabilities' program run over the last couple of years by the metropolitan VFLO program and coordinated by Neville Thomas was a finalist in the 7th Annual Community Service Industry Awards 2001 in the category of Industry Support and Development. Due to the program's popularity, it toured the south-west of Western Australia, conducting fishing workshops for people with disabilities in Bunbury, Busselton, Augusta and Albany.

Mandurah VFLOs Pat McAuliffe, Andy Spurr, Alf Jones and Carol Lutey were awarded the Premier's Australia Day Active Citizenship Award for their 'Learning Circles for Fishers' program covering fishing knots, crabbing, fishing regulations, fishing tools and catch care. The Mandurah team has delivered the program to schools in the south-west and metropolitan areas up to three times a month in peak periods, with eight VFLOs and two Fisheries Officers involved in each presentation, and also took it to Newdegate, Corrigin, Wickepin and Yealering as part of the 'Year of the Outback'. Busselton VFLOs were also successful in securing sponsorship from the Rotary Club of Geographe Bay and the South West Regional Recreational Fishing Advisory Committee to establish 'Learning Circles for Fishers' in their area.

The Department's metropolitan Community Education Officer developed a new class presentation called 'Aquatic Invaders' which was offered to all metropolitan schools. This presentation explores the impacts of pollution, habitat destruction and introduced species on our aquatic ecosystems.

WEST COAST RECREATIONAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in recreational fisheries within the west coast bioregion during the 2001/02 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	*NUMBER*
Hours delivered in bioregion	20,672
Fisher field contacts by Fisheries Officer	40,190
District Office contacts by Fisheries Officers	21,347
Fisher field contacts by VFLOs	13,351
Fishwatch reports *	568
OFFENCES DETECTED	
Infringement warnings	388
Infringement notices	177
Prosecutions	129

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

Initiatives for 2002/03

Education of recreational fishers in respect to the fishing rules and the 'Fish for the Future' initiative remains a priority. However, the Department's move into the delivery of marine safety services within the community will broaden the role of both Fisheries Officers and VFLOs in this area. With this in mind, during 2002/03 the Regional Services Branch extended its use of risk assessment processes to determine priority areas of concern in both recreational fishing and marine safety.

The completion of the West Coast Recreational Fishing Review remains a future point of interest for recreational fishers within the bioregion. The implementation of the review has been moved back to 1 October 2003, enabling the Department to enact the complex legislative changes before the southern summer recreational fishing season starts.

The increase in recreational fishing licence fees from July 2002 will be used to support additional Fisheries Officers. Two mobile patrol units dedicated to education and compliance in recreational fisheries will patrol seasonally within the west coast bioregion, moving with the peak recreational fishing activity. The Department recognised the need for these units to increase compliance in the recreational sector and create an effective deterrent against illegal fishing.

REGIONAL RESEARCH OVERVIEW

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 (Lenanton and Hall 1976) 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.

Recreational Rock Lobster Fishery

Management summary

The recreational component of the western rock lobster (*Panulirus cygnus*) fishery is managed under a mix of fisheries regulations including a specific recreational licence. The licence arrangements are designed to complement the management plan for the commercial fishery and constrain to some extent the proportional impact of the recreational fishery.

Recreational management controls are not absolute, and allow variations in the total recreational catch against the total available catch to ensure the quality of the fishing experience is maintained, and the fishery continues to provide an appropriate proportion of social benefits through recreational fishing.

Current controls effectively limit fishing efficiency in the recreational sector, protect juvenile and breeding lobsters, and constrain the temporal spread of fishing effort.

These controls include an open season from 15 November to 30 June each year; a shorter season from 15 March to 30 June applies at the Abrolhos Islands. Night-time fishing for lobster by either diving or potting is prohibited.

Fishers are restricted to two pots per licence holder. 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.

A minimum size limit of 77 mm carapace length applies from 15 November to 31 January and 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 21º44′ and 30º S and those larger than 115 mm between 30º and 34º24′ S, excluding waters east of 115º 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.

In the last decade, as well as the seasonal 77 mm minimum size limit and the ban on taking female lobsters in breeding condition, a requirement has been introduced that lobsters be tail-clipped in order to stop recreationally caught 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.

It is not anticipated that there will be any change to the recreational rock lobster season opening in November 2003.

Research Summary

General research for managing the rock lobster stock is undertaken through the Commercial Fisheries Program and is reported under that section.

For the recreational component of this fishery, an annual survey of participants is used to estimate the recreational catch and to produce the following status report.

Licensed Recreational Rock Lobster Fishery Status Report

Prepared by R. Melville-Smith and A. Thomson

FISHERY DESCRIPTION

Boundaries and access

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. The Perth metropolitan region and Geraldton experience the greatest fishing activity. A recreational rock lobster licence is required to take any lobster, and for the 2001/02 season 39,623 licences were sold. The 2001/02 season operated between 15 November and 30 June inclusive, except at the Abrolhos Islands where the waters were closed to diving for rock lobsters, but open for potting, between 15 March and 30 June.

Main fishing method

Pots and diving.

RETAINED SPECIES

Recreational catch (season 2001/02):
545 tonnes (estimate)

The recreational catch of western rock lobster for 2001/02 was estimated at 545 t, with 383 t by potting and 162 t by diving. Comparative catch estimates for 2000/01 were 421 t by potting and 143 t by diving. The catch achieved was within the range of 450–550 t predicted in the *State of the Fisheries Report 2001/2002*.

Fishing effort

A total of 39,623 licences that permitted fishing for lobsters in the course of the season (rock lobster licences plus umbrella licences) were purchased, but only an estimated 27,300 (69%) were utilised for lobster fishing. This is a similar figure for licence usage to the 28,453 recorded in 2000/01, but in that season there was a higher proportion of users (76%). The average rates of usage by pot and diving fishers (excluding all those who held a licence but failed to use it) were 33 and 10 days respectively during the 2001/02 fishing season. These rates are similar to those found for the 2000/01 fishing season.

Catch rate

The average pot and diving catches were 1.3 and 2.7 lobsters per person per fishing day in the 2001/02 fishing season. These compare closely to the 2000/01 fishing season where potters and divers caught 1.3 and 2.5 lobsters per person per fishing day respectively.

Commercial share: **94% (approx.)**

The commercial fishery accounted for around 94% of the overall catch of western rock lobster over the past season.

Stock assessment completed: **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 6%), the full assessment information is provided in the commercial fishery status report (pp. 9–15).

Exploitation status: **Fully exploited**

See the commercial fishery status report.

Breeding stock levels: **Adequate**

See the commercial fishery status report.

Projected catch next season (season 2002/03):
700–800 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) over the period surveyed and this has had a highly significant impact on catch over time. The average annual rate of increase has been 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.

Puerulus settlement indices at Alkimos, which have been shown to be a reliable predictor of future recruitment in the southern region of the commercial fishery, have been used to predict the recreational rock lobster catch. 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 750 t in 2002/03 (Recreational Rock Lobster Figure 1) which would be a record recreational catch. Even higher catches are expected in 2003/04 and 2004/05.

Licence sales and usage are also expected to increase over the next few years; the prediction is that sales will increase to approximately 40,000 and usage to 31,000 in 2002/03. However, the costs of buying a lobster licence increased in 2002 from $25 to $30 per year and it is not known what effect this might have on licence sales or usage patterns.

NON-RETAINED SPECIES

See commercial fishery status report.

ECOSYSTEM EFFECTS

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

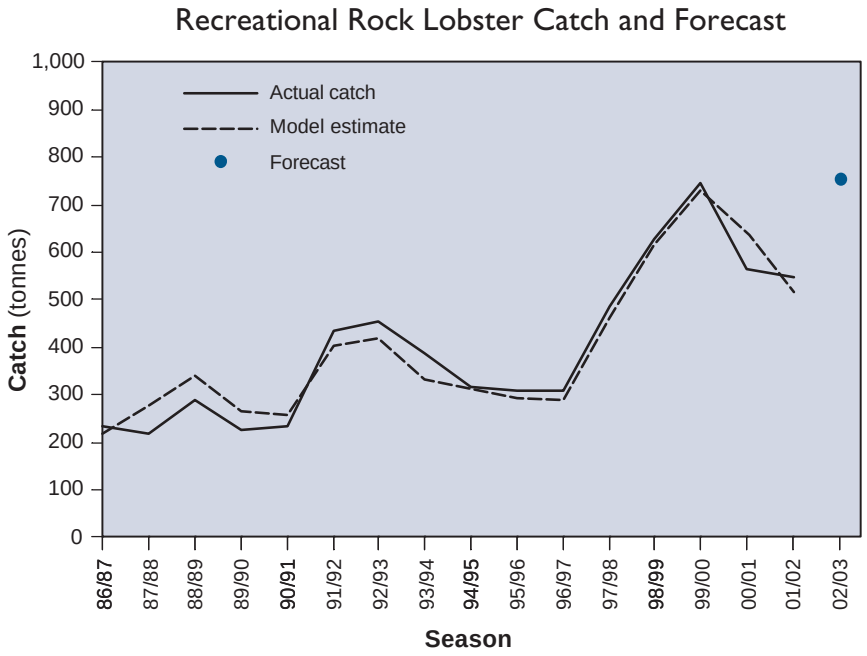
The direct value of the recreational catch in the 2001/02 season was about $18 million, however this represents only a minor proportion of the economic activity generated by this sector through the use of boats, fishing gear etc.

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.

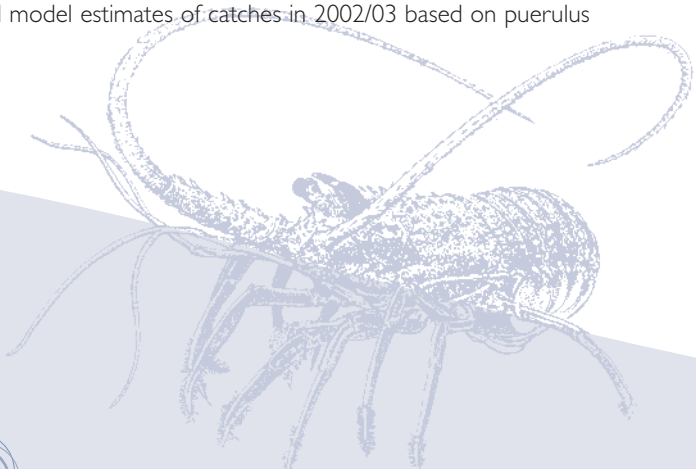
EXTERNAL FACTORS

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



RECREATIONAL ROCK LOBSTER FIGURE 1

Estimates of the recreational rock lobster catch since 1986/87 and model estimates of catches in 2002/03 based on puerulus settlement three to four years earlier and expected licence usage.



Recreational Abalone Fishery

Management Summary

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 takes place mainly on the inshore reef platforms between Geraldton and Augusta, with a concentration of fishing activity around the Perth metropolitan area and Geraldton. South of Cape Naturaliste the larger greenlip and brownlip abalone are also taken in deeper water.

Recreational fishers are required to take out either 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 with a daily bag limit of 20 per fisher. The minimum legal size for greenlip/brownlip abalone is 140 mm with a combined daily bag limit of 10.

A closed season applies to the Perth metropolitan area (Cape Bouvard to Wedge Island) and the Greenough area (Greenough River to Flat Rocks car park). Fishing is permitted in these areas for a total of nine hours over six consecutive Sundays, commencing on the first Sunday in November between the hours of 7.00 a.m. and 8.30 a.m. only. Elsewhere in the State abalone can be taken at any time of the year.

Following a review of the fishery a number of management arrangements will be introduced prior to November 2003. These changes include:

- The fishery will be 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).
- Separate seasonal fishing times will apply to the West Coast Zone and the combined Northern and Southern Zones. The open season for the West Coast Zone will continue to operate for a total of nine hours over six consecutive Sundays, commencing on the first Sunday in November between the hours of 7.00 a.m. and 8.30 a.m. only.
- Abalone fishing will be permitted in the Northern and Southern Zones all day and the season will remain open until 15 May 2004. In future years the fishing season in these zones will only be permitted between 1 October and 15 May.
- The daily bag/possession limit for Roe's abalone species will remain at 20 per fisher while the maximum number of this species that may be stored at a person's permanent place of residence will be 80.
- The daily bag limit for greenlip and brownlip abalone combined will be amended to 5 per fisher. The possession limit for this species will remain at 10 while the maximum number of this species that that may be stored at a person's permanent place of residence will be 20.

The management controls for the recreational abalone fishery constitute the most restrictive input management regime for a recreational fishery in Australia. Arrangements are designed to complement the management plan for the commercial fishery by constraining and cost-effectively managing the proportional impact of the recreational fishery on abalone, and also protecting other molluscs and reef species such echinoderms.

Research Summary

For research purposes, the recreational fishery for abalone has recently been reported in three main sectors: the Perth fishery (corresponding to the greatest concentration of fishing activity), and the west (excluding Perth) and south coast fisheries (corresponding to bioregional boundaries).

Catch and effort figures presented in this report are derived from two independent surveys: telephone surveys covering all of the State, and field surveys for the Perth fishery only. 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. The field survey estimates the catch and effort from each distinct Roe's abalone stock within the Perth fishery. Field survey results are based on effort estimates from head counts conducted from land and from aerial surveys. Catch rates and catch weight measures are obtained from interviews of recreational abalone fishers.

In addition to measuring the recreational catch, the Department's Mollusc Research section conducts a fishery-independent assessment of stocks in the Perth fishery. This is done by measuring size and density of abalone across the near-shore habitat at six indicator sites between Burns Beach and Penguin Island, the area which provides the majority of the recreational catch.

Licensed Recreational Abalone Fishery Status Report

Prepared by B. Hancock, T. Baharthah and N. Sumner

FISHERY DESCRIPTION

Boundaries and access

The Perth fishery extends from Cape Bouvard to Wedge Island. Access by recreational fishers to the Perth fishery is controlled by allowable fishing times (7.00 a.m. to 8.30 a.m.) and a limited season (six Sundays). There is also a small section of reef in the Greenough area of the west coast fishery (between the Flat Rocks car park and the mouth of the Greenough River) which operates under the same season and time restrictions as the Perth fishery. The Perth and Greenough season ran for six consecutive Sunday mornings from 3 November to 8 December during 2002.

The west coast recreational fishery sector includes all

other areas of the west coast down to and including Black Point (close to Cape Beaufort). This delineation reflects the bioregion boundaries of the west coast. The south coast recreational fishery sector extends east from Black Point to the South Australian border. Both the west and south coast sectors are currently open for recreational fishing throughout the year.

For all three fishery sectors a daily bag limit of 20 Roe's abalone and a combined limit of 10 greenlip and brownlip abalone is enforced throughout the State. There is a daily boat limit of twice the legal bag limit if more than one licence holder is fishing. The minimum legal size for recreational fishing of Roe's abalone is 60 mm, and for greenlip and brownlip abalone 140 mm.

Main fishing method

Roe's abalone can be collected while wading or free diving, whereas greenlip and brownlip abalone are usually taken while free diving or diving on compressed air.

RETAINED SPECIES

Recreational catch (2002): Roe's Perth fishery 38 tonnes
Roe's rest of State 27 tonnes
Greenlip 30 tonnes
Brownlip 9 tonnes

All catches are shown in whole weight.

Calculating the recreational catch in tonnes requires estimates of the total numbers of each species of abalone caught and an estimate of the mean weight for each species in each recreational catch region (see Recreational Abalone Tables 1 and 2 and Figure 1). Direct estimates of the mean weight for recreationally caught abalone are available only for the Perth Roe's abalone recreational fishery, and then only for the 1999–2002 seasons. The weights used within the other regions and for the other species are based on the commercial catch weights and recreational minimum legal sizes (Recreational Abalone Tables 1 and 2).

As in previous years, the majority of Roe's abalone were taken in the Perth fishery. Catch estimates for the Perth fishery during 2002, derived from telephone and field surveys, were 39.3 t and 36.0 t respectively. Based on these estimates, the catch for the Perth fishery has decreased by about 18% from 2001. This was driven by a decrease in effort and catch rate, as the mean weight of abalone was similar in 2001 and 2002 (91.7 g and 89.7 g respectively).

The catch of Roe's abalone in the other areas of the fishery was estimated using telephone surveys stratified by recreational abalone and umbrella licence holders and residential location (Recreational Abalone Table 2). The estimated catch from the west coast has remained fairly steady (22.5 t, an increase of 4%) while the catch from the south coast (4.9 t) declined by 20%, driven by a decrease in effort.

The estimated recreational catch of greenlip abalone on the west coast (18.4 t) decreased by 22% over the 2001 levels, which is the first decrease since estimates commenced in 1999. The west coast brownlip catch estimate (4.6 t) decreased by 58% to the same level as 2000. The catch of greenlip abalone from the south coast decreased by 50% from 2001 to 11.4 t. This is the lowest catch recorded from this area (Recreational Abalone Table 2), with a 30% decrease in both catch rate and effort. The catch estimate for brownlip abalone from the south coast also decreased by 29% to 4.7 t, with a similar decrease in effort.

These catch estimates for the west coast and south coast are less precise than that for the Perth abalone fishery and have wide confidence limits. This is due to the smaller sample size and the reduced ability of fishers to recall past fishing trips over a period of 12 months, rather than six weeks in the case of the Perth abalone fishery. There may also be some incorrect identification amongst the three species. For these reasons, these estimates should only be regarded as preliminary indications of recreational fishing impact.

Fishing effort

The total recreational fishing effort during the 2002 Perth fishery was estimated at 26,300 fisher days from the telephone survey and 22,500 fisher days from the field survey. These figures represent decreases of 11% and 12% respectively over the 2001 estimates from the corresponding survey technique, but are still higher than effort in the years prior to 2001. These increases are consistent with the increase in the number of licences purchased to participate in the recreational abalone fishery, which rose to over 21,000 during the 2002 Perth season (including umbrella licences covering all licensed recreational fisheries), with 8,680 specific abalone licences (Recreational Abalone Figure 2). The telephone survey estimated that 6,900 of these licence holders participated in the Perth fishery, a slight decrease (6%) from 2001. Participation in 2002 was 33% of the total number of all valid licences (abalone and umbrella).

Fishing effort for the south coast and west coast fisheries has not been separated by species since it is possible to fish all species on the same day. Estimated effort in 2002 was 6,900 fisher days on the south coast and 17,500 fisher days on the west coast. This represents a decrease in effort for the south coast of 28% from the effort estimated for 2001, and a decrease of 5% for the west coast. Effort estimates for the south coast continue to decline, while the effort for the west coast is still substantially higher than in 1999 or 2000 (Recreational Abalone Table 2). The telephone survey estimated that 3,600 licence holders fished the west coast and 1,400 fished the south coast during 2002.

Catch rate

The catch rate during the 2002 Perth season was estimated at 16.7 and 17.9 abalone per fisher day by the telephone and field surveys respectively, a decrease of 5% over the 2001 figures for both techniques. The Roe's abalone catch rates on the south and west coasts were estimated at 7.9 and 14.3 abalone/day respectively, which were increases of 11% and 9% over 2001. The catch rates for greenlip were 3.5 and 1.6 abalone/day on the south and west coasts respectively, decreases of 31% and 18%. Brownlip catch rates were 1.1 abalone/day on the south

coast, which was similar to those for 2001, and 0.4 abalone/day on the west coast, which was lower than the 2001 rate of 0.9.

Commercial share: **Roe's 55–60% approx. Greenlip/brownlip 80% approx. (under review)**

The commercial fishers in the Perth Roe's abalone fishery have caught their quota of 36 t in recent years. This was about 49% of the combined recreational and commercial catch in 2002, similar to the four-year average of 48% (1999–2002). For the State as a whole, the commercial Roe's abalone catch share was estimated at 55–60%.

For greenlip and brownlip abalone the commercial catches were 166.7 t and 27.5 t respectively. These catches represent about 85% and 75% of the estimated total take of these two species statewide.

Stock assessment completed: **Yes**

For the Perth fishery, size distributions and densities were measured from six indicator reefs, Burns Beach, Beaumaris, Waterman's Reserve, Mettams Pool, Bailey Street and Penguin Island. Surveys were conducted using quadrats placed at repeated positions along fixed transects oriented perpendicular to the shore, across the reef platform and sub-tidal areas of abalone habitat. All abalone within a quadrat were counted and measured. These surveys were conducted in January and February each year from 1996 to 2003 (post-season) to assess the effects of fishing and to get an indication of the stock levels available for subsequent seasons (Recreational Abalone Table 3). The abundance measures from January and February reflect the abalone stocks following the recreational fishery in November and December of the previous year.

Mean densities after the recreational season have remained fairly stable since 1996. There have been slight decreases in total abundance on the Bailey Street and Mettams Pool platforms that are mainly due to declines in the density of sub-legal-sized abalone. There has been no appreciable increase in the sub-tidal stocks at Bailey Street or at Mettams Pool, which has had a low abundance since 1997. Platform abundances at Penguin Island in 2003 were lower than previously recorded, possibly a response to the re-opening of Penguin Island to fishing in 2000 (reflected in the abundance measures since 2001). Abundances at the Burns Beach sample site have increased over the eight years of sampling. Beaumaris densities are showing signs of recovery in the sub-tidal portion of the stock. The Waterman's Reserve, which is closed to fishing, shows stable abalone densities over the period. All reef platforms sampled show a decline in density of sub-legal abalone in 2003.

Incidental mortality describes the number of animals that are killed as a result of recreational fishing but are not retained, and remain dead or moribund on the reef. Incidental mortality in the Perth recreational fishery was estimated from two sites in 1997 to be at least 5–20% of the retained catch. The study was repeated at a third site in 2001 and gave a minimum estimate of incidental mortality of 21% of the retained catch, which indicates significant wastage by the fishery. Incidental mortality estimates are not available from the west and south coast regions, but are assumed to be lower for greenlip and brownlip abalone fishing, as these species are not taken from within the surf zone while fishing the reef platform. Estimates of the incidental mortality were not undertaken during the 2002 season.

The field surveys provide catch and effort data on a fine spatial scale that allows trends to be examined for each reef system. This provides a subsidiary means of stock assessment in areas which may have factors affecting abalone abundance that are independent of the overall view provided by the distribution of 'indicator' monitoring sites. Recreational abalone fishing at Cottesloe is one such instance. Since construction of the Cottesloe surf reef the pattern of sand deposition in the near-shore zone has altered, causing the abalone habitat at Cables Station to be covered in sand. This has removed at least one-third of the abalone population from the Cottesloe area. Effort and catch rates have declined in the remaining portion of the Cottesloe fishery resulting in catches falling to very low levels (Recreational Abalone Figure 3). Analysis of the recreational fishery data, results from occasional abundance surveys, and the genetic isolation of the area have led to the recommendation from Fisheries Research that the area be closed to abalone fishing for the foreseeable future.

West and south coast stock assessments are based on catch and effort data from the commercial fishery (see commercial fishery status report, pp. 113–118).

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Research has shown that abalone size at sexual maturity (50% of animals mature) is below the State minimum legal size for all species. This is 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.

The densities measured at all of the stock assessment sites surveyed in the Perth fishery were considered to be high enough to allow an adequate flow of abalone to the breeding stock, and the level of recruitment of juveniles to the reef remains strong.

NON-RETAINED SPECIES

Nil. See the commercial fishery status report.

ECOSYSTEM EFFECTS

Habitat effects: **Low**

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

Recreational catch of abalone is controlled through size and bag limits, as well as season and fishing time restrictions. Under present management arrangements the Perth abalone fishery is a nine-hour fishery, operating for 1.5 hours a morning for six mornings during the season. The number of licences available is not, however, limited and has been steadily increasing since 1995 (Recreational Abalone Figure 2).

There is no biological sustainability issue for the Perth Roe's stocks, given that the legal recreational minimum size (60 mm) is greater than the average minimum spawning size and fishers do not target significant stocks outside the aggregations. However, if preliminary data indicating a fall in average weight of abalone develop into a trend along with increasing participation rate, then changes in the operation of the recreational fishery would be advised to ensure the recreational and commercial fisheries are not negatively impacted.

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.

	TELEPHONE SURVEY				FIELD SURVEY				
YEAR	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**

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.

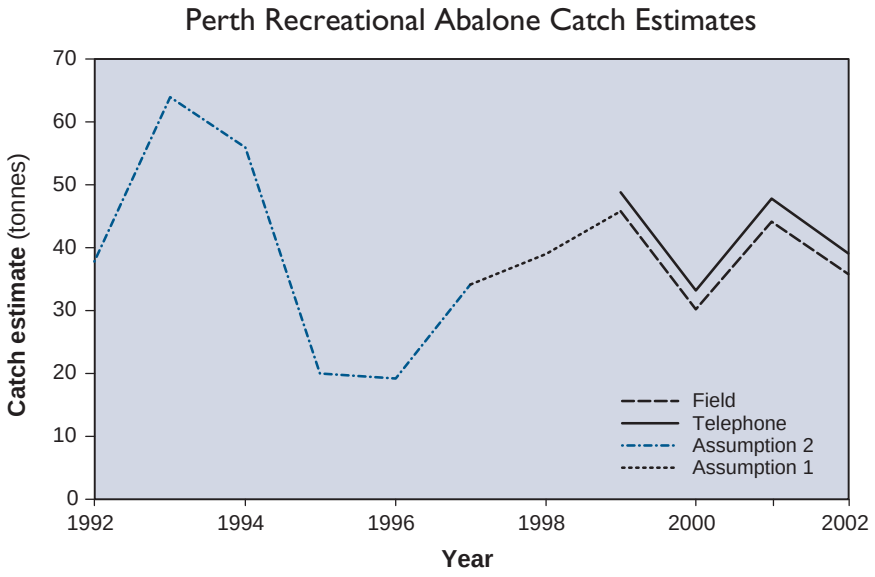
		ROE'S ABALONE			GREENLIP ABALONE			BROWNLIP ABALONE		
YEAR	EFFORT[1] (days)	CATCH RATE	CATCH (number)	CATCH[2] (tonnes)	CATCH RATE	CATCH (number)	CATCH[3] (tonnes)	CATCH RATE	CATCH (number)	CATCH[4] (tonnes)
WEST COAST										
1999	10,300	12.4	128,700	11.8	1.9	20,400	13.5	1.2	11,900	8.1
2000	9,800	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
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**

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 coast.

RECREATIONAL ABALONE TABLE 3

Preliminary mean densities of sub-legal abalone (5 mm to 59 mm) and mean densities of legal-sized abalone (60 mm and over) from the six reef platform monitoring sites in the Perth fishery, measured as abalone/m^2. Densities are from quadrats placed at repeated positions along fixed transects oriented perpendicular to the shore across the reef.

YEAR	BURNS BEACH		BEAUMARIS		WATERMAN'S RESERVE		METTAMS POOL		BAILEY STREET		PENGUIN ISLAND	
	<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**
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**

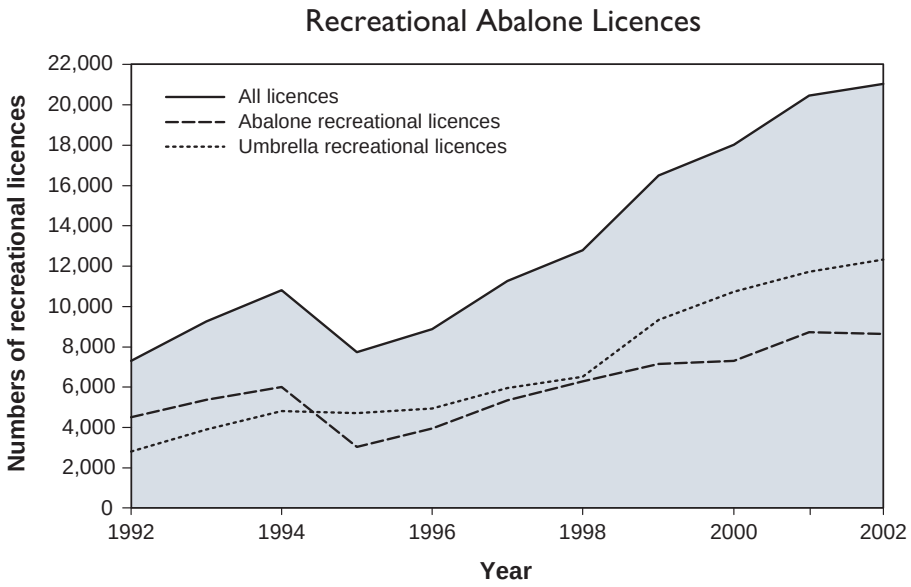


RECREATIONAL ABALONE FIGURE 1

Catch estimates for the Perth recreational abalone fishery for the period 1992 to 2001, including backwards projections through time based on two assumptions.

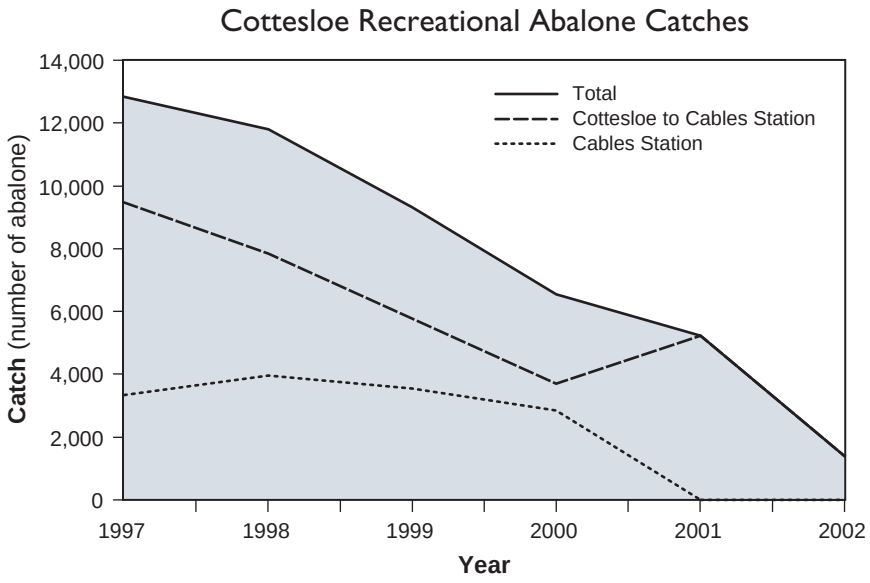
Assumption 1: assumes that the mean weight of abalone taken during 1997 and 1998 is equal to the average of the two mean weight values measured for 1999 and 2000 (i.e. 105.4 g, averaged from 119.5 g in 1999 and 91.3 g in 2000). Numbers caught are estimated using the field survey technique (Recreational 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.



RECREATIONAL ABALONE FIGURE 2

The number of licences issued in the recreational abalone fishery, by licence type, for the period 1992 to 2002.



RECREATIONAL ABALONE FIGURE 3

Catch history for the Cottesloe area, separated into Cables Station and other areas of the Cottesloe fishery, mainly the Muderup Rocks area south of the Cottesloe groyne.

Recreational Tailor Fishery

Management Summary

The recreational component of the fishery for tailor (*Pomatomus saltatrix*) is currently managed under a suite of broad input and output controls for inshore species common to the west coast. The recreational proportion of the total tailor catch on the west coast is likely to be greater than 80%.

Tailor 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. However the legal minimum size of 250 mm total length, which is well below the size at maturity, has not been adjusted.

The west coast regional review examined issues associated with ensuring the sustainability of tailor stocks, following which a reduced bag limit of 2 on tailor over 600 mm has been approved by the Minister for Fisheries for implementation on 1 October 2003. An increase in the minimum legal size to 300 mm is under consideration.

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 and south 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 recently been completed which investigated the basic biology of tailor to provide information on the age structure, growth and reproduction of this important recreational species. These data will be included in future modelling of the dynamics of tailor populations to support management needs.

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

Tailor Stocks Status Report

Prepared by S. Ayvazian and R. Steckis

FISHERY DESCRIPTION

Boundaries and access

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. This report presents available data from the west coast and Gascoyne bioregions.

The recreational catch limits for this species include a legal minimum length of 250 mm and a daily bag limit which during the season being reported was defined under the 'key angling and sport fish' category as a mixed bag of 8.

Main fishing method

Recreational: Rod and line.
Commercial: Haul net and gillnet.

RETAINED SPECIES

Recreational catch (season 2002): Not assessed

Recreational tailor catch estimates are not available for the current year (2002). The most complete estimates (all areas, all methods) 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 587,041 tailor were caught in Western Australia during this period. The average weight per tailor was 0.391 kg. Therefore, the recreational catch for the State was estimated at 229.5 t (Henry and Lyle 2003).

Previously completed surveys have been limited in either the areas sampled or the methods covered. A boat-based angler survey was conducted between Kalbarri and Augusta during 1996/97. This estimated the tailor harvest at 26,627 fish (10 t), with the majority of the catch landed from the southern Perth region (Sumner and Williamson 1999). However, there have been no comparable surveys of shore-based catches from this region. Thus, given the total recreational catch reported during the national survey, the shore-based component is almost certain to comprise the majority of the catch.

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 6,631 tailor kept (4.95 t) ($\pm$ 1,276 fish) with 1,567 tailor released. The greatest proportion of the Gascoyne tailor catch (87%) was taken from the Shark Bay Marine Park (Sumner et al. 2002). More recent 12-month boat-based-only creel surveys from Nanga, Denham and Monkey Mia, within Shark Bay Marine Park, reported a boat-based tailor catch of 1,774 fish (1.1 t) with 128 released during the 2001 survey, compared with 1,128 fish (0.8 t) and 72 released during the 2000 survey, and 1,294 fish during 1998/99 (Sumner and Malseed 2002).

Fishing effort

The participation level for the tailor fishery in the west coast bioregion is unknown for 2002. Further analyses of the national survey will be used to provide effort levels for all methods and regions for the 2000/01 period.

The boat-based survey conducted between Kalbarri and Augusta during 1996/97 found totals of 453,000 fisher days (722,000 boat hours or 1,730,000 angler hours based on a mean of 2.4 persons fishing per boat) but most of these fishers would not have been targeting tailor (Sumner and Williamson 1999).

Similarly, the boat- and shore-based angler survey in the Gascoyne region in 1998/99 estimated a total of 243,000 fisher days (Sumner et al. 2002). Boat-based-only creel surveys in Shark Bay (ramps at Nanga, Denham and Monkey Mia) have produced estimates of 34,000 fisher days in the 2001 season and 35,000 in the 2000 season (Sumner and Malseed 2002), compared to 49,000 from the 1998/99 survey. Again, little of this effort is directed at tailor.

Catch rate

The mean catch rate for boat-based anglers from the southern Perth district targeting tailor in 1996/97 was 1.73 fish per angler day (Sumner and Williamson 1999).

Commercial share: **West Coast/Gascoyne 5.7 tonnes**
Shark Bay 28.5 tonnes

Commercial catches of tailor are recorded in CAES returns from the coastal fishing blocks and three major estuaries along the lower west coast (Swan/Canning, Peel/Harvey and Hardy Inlet). Wetline fishers in the coastal fishing blocks between Kalbarri and Cape Naturaliste reported a catch of 0.7 t, representing approximately 2% of the total 2002 annual commercial catch. The three estuaries reported a combined catch of 3.6 t, which is approximately 10% of the total 2002 annual commercial catch.

Approximately 83% (28.5 t) of the 2002 total State commercial catch was recorded from the Shark Bay Beach Seine and Mesh Net Managed Fishery. A further 3.9% (1.4 t) was recorded from wetline fishers in the Gascoyne region.

Stock assessment completed: **Yes**

A full assessment of the status of the stock is not yet available, although previous tagging studies have provided a basis for preliminary assessments. These studies (Young et al. 1999) provided data on growth and migration, and indicated that the stock experiences a mortality rate of approximately 10% on release of sub-legal-size fish. They also showed that about 21% of the total stock in the metropolitan region is located offshore.

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.

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 however required on the more northerly (Gascoyne) components of the stock, to determine the overall breeding stock status.

As anecdotal evidence also suggests that the large breeding individuals along the west coast are increasingly being targeted by recreational fishers, there is also a need for specific data from this sector.

SOCIAL EFFECTS

The annual summer–autumn appearance of tailor along metropolitan Perth beaches is targeted by thousands of shoreline anglers each year.

ECONOMIC EFFECTS

Not available.

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.

EXTERNAL FACTORS

The offshore distribution of the spawning stock in the Gascoyne region suggests that the Leeuwin Current that flows through this area may be a significant factor influencing the larval distribution south into the west coast bioregion. Further work to assess the significance of this environmental influence on the fishery will be undertaken when sufficient years of recruitment data from the west coast estuaries become available.

GASCOYNE COAST BIOREGION

REGIONAL MANAGEMENT OVERVIEW

Recreational fishing activity in the Gascoyne has increased significantly since the early 1980s. The estimate of recreational fishing participation in the region is 5% of the State's fishers or 30,000 fishers a year (Baharthah and Sumner 2003).

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). A survey conducted between April 1998 and March 1999 (Sumner et al. 2002) has confirmed that the Gascoyne is a major focus of recreational fishing, with 243,000 fisher days being recorded over the survey period. Of these, 89,000 fisher 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.

Charter activity, although not covered in the 1998/99 survey, is also significant, with 72 fishing tour licences and 12 ecotour licences valid for the Gascoyne bioregion in 2003.

A review of recreational fisheries management arrangements for the Gascoyne bioregion has been completed and new management arrangements are due to be implemented in October 2003.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

The Gascoyne coast bioregion has eight Fisheries Officers working out of three District Offices located at Denham, Carnarvon and Exmouth. During 2003, these officers were supplemented by the seasonal deployment of a mobile recreational fisheries patrol of two additional Fisheries Officers. Collectively, the officers deal with a wide range of recreational fisheries within the region, encompassing boat and shore angling, rock lobster (including diving), netting, crabbing (mud crabs and blue swimmer crabs), and creek fishing.

Officers at Denham make extensive use of a 9 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. Additionally, several smaller boats are used to service 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 certain mangrove creeks and beaches to monitor illegal netting.

Recreational fishery compliance involves 'hands-on' checks of catches for compliance with bag, size and possession limits; observation and inspection of the gear and methods used and the areas accessed by anglers to take their fish; and extensive liaison with anglers regarding local rules and regulations.

As well as high-profile patrol activities aimed at maximising personal contacts with anglers, covert observation also plays an important role in ensuring high levels of compliance. While most recreational fishers are aware of and comply with the rules, some unscrupulous fishers are very careful to hide their illegal activities. Officers often covertly observe fishers, particularly in response to information provided to them through the toll-free Fishwatch service.

Activities during 2001/02

During 2001/02, Fisheries Officers delivered 6,848 hours of compliance work to recreational fisheries in the Gascoyne coast bioregion (Gascoyne Recreational Compliance Table 1), concentrating mainly on checking shore-based and boat-based anglers. A total of 11,138 'field' contacts were made and, as a result of these compliance activities, 16 infringement warnings and 22 infringement notices were issued, while 6 prosecutions were initiated for more serious offences.

During the same period (2001/02) the statewide 24-hour 'Fishwatch' telephone hotline, which is utilised by members of the public who wish to report instances of observed illegal fishing activity, generated a total of 26 investigations. In general, the complaints received by the Gascoyne bioregion tended to focus on the taking of fish in excess of bag or boat limits, the taking of under-size or totally protected fish, and some cases of people fishing in closed waters.

The Gascoyne's VFLO program also supplemented compliance activities conducted by Fisheries Officers in the bioregion throughout the year. The VFLOs focus solely on the education of recreational fishers and are generally very keen anglers committed to protecting the aquatic environment and promoting the 'Fish for the Future' ethic.

In 2001/02, the Gascoyne Region VFLO program recorded 83 contacts for the year through local patrols and attendance at the Gascoyne Expo and the Exmouth Aquafest. They also delivered a variety of other community education activities, both independently and in the company of Fisheries Officers, at primary schools, high schools and community group meetings.

GASCOYNE RECREATIONAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in recreational fisheries within the Gascoyne coast bioregion during the 2001/02 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	6,848
Fisher field contacts by Fisheries Officers	11,138
District Office contacts by Fisheries Officers	4,916
Fisher field contacts by VFLOs	83
Fishwatch reports *	26
OFFENCES DETECTED	
Infringement warnings	16
Infringement notices	22
Prosecutions	6

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

Initiatives in 2002/03

During 2002/03, Fisheries Officers at the Carnarvon District Office completed a number of coastal patrols accompanied by Perth-based management staff. This exercise was designed to provide Perth-based staff with exposure to practical compliance issues, with benefits expected to arise in the form of more practical management decisions being taken in relation to fieldwork/regional compliance services and associated activities. Given the success of these patrols it is expected they will be continued in coming years.

Given ongoing concern over the status of the Shark Bay snapper stocks, Fisheries Officers at Denham continued to conduct a mix of high-profile at-sea and on-land patrols to remind locals and visitors of the need to protect local pink snapper stocks in both the western and eastern gulfs of Shark Bay. Further changes to the management arrangements for these inner gulf snapper stocks introduced in March 2003 have required significant effort to be directed to developing and implementing the associated community education programs.

Exmouth Fisheries Officers again combined efforts with VFLOs to deliver an extensive workshop at Coral Bay during school holidays, providing education about minimum legal sizes, bag limits, possession limits and areas closed to certain fishing activities, as well as promoting the important 'Catch Care' message.

The implementation of the outcomes of the Gascoyne Review process is anticipated later in 2003, and planning for the development of appropriate educational material, signage and communications strategies is already under way. This will require educational and compliance patrols to be conducted throughout the bioregion utilising both Fisheries Officers and VFLOs.

REGIONAL RESEARCH OVERVIEW

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*).

In addition, two dedicated studies are being carried out to provide specific information on the status of the inner Shark Bay stocks of pink snapper and black snapper (*Lethrinus laticaudis*). An individual stock status report has been prepared for each of these two snapper species.

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 undertaken in 1998/99 (Sumner et al. 2002). This survey estimated the recreational catch and fishing effort for the region. 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 since 2000.

Inner Shark Bay Recreational Fishery

Management Summary

As a result of excessive fishing pressure on the inner Shark Bay pink snapper (*Pagrus auratus*) stocks, new management arrangements were introduced in March 2003.

As part of the new management arrangements, for the first time in the history of fisheries management in Western Australia a total allowable catch (TAC) has been set for a fishery which includes explicit catch allocations for the commercial and recreational sectors.

The following TAC has been set for each area of the fishery:

- Eastern gulf – 15 t (about 5,000 fish)
- Denham Sound – 10 t (about 3,300 fish)
- Freycinet Estuary – 5 t (about 1,200 fish)

The recreational sector will be allocated 75% and the commercial sector will be allocated 25% of the available catch.

To manage the recreational share of the catch the following recreational fishing regulations were introduced for Shark Bay pink snapper in March 2003:

- Bag limit 1
- Minimum size 50 cm
- Maximum size 70 cm
- Closed season 1 April – 31 July (Eastern gulf)
- Closed season 15 August – 30 September (Freycinet Estuary)
- To limit the take of pink snapper in Freycinet Estuary a limited number of 'snapper tags' were made available to recreational and commercial fishers. Only tagged snapper can be landed in Freycinet Estuary.

The latest package is designed to manage the total catch in each area of the fishery and allow stocks to rebuild to at least 40% of the estimated unfished biomass.

The recreational catch of black snapper or grass emperor (*Lethrinus laticaudis*) comprises a significant part of the recreational catch in Shark Bay and other areas of the Gascoyne, and community concerns have been regularly expressed about transfer of effort to this species in the wake of tighter management of the pink snapper catch.

To provide additional protection for species such as black snapper and others which are considered to have a high risk of over-exploitation, reduced individual bag limits and mixed species bag limits will be introduced as part of the Gascoyne Recreational Fishing Strategy in 2003/04.

Research Summary

Research to support the management of Shark Bay pink snapper undertaken during the 1980s identified separate stocks in the inner gulfs. Concerns about increasing recreational fishing pressure on these stocks during the early 1990s, and the outcome of research surveys for juvenile snapper in November 1996 and February 1997, resulted in a comprehensive research project commencing in June 1997. This research has provided scientific assessments of the status of inner gulf stocks each year since 1998. In late 2002, a review of the research and results of model-based stock assessments was provided to a Ministerial Working Group considering management options for this key recreational species for the 2003 season onwards.

Research to support the management of black snapper or grass emperor, the second most commonly taken recreational species in the inner gulfs of Shark Bay, commenced in July 1999, with results due by the end of 2003. The specific objectives of this research were to examine stock delineation using stable isotope analysis of otolith carbonate, determine age structure, growth rate and reproductive biology, and develop a stock assessment model for black snapper in the inner gulfs of Shark Bay. For this year's first full status report on black snapper, the catches and effort for 2001 are reported. Data for the 2002 season being incorporated in the final project report will be given in next year's *State of the Fisheries Report*, when black snapper will be included in a broader status report for inner Shark Bay angling.

Estimates of recreational catch and effort inside Shark Bay have been derived from creel surveys undertaken initially during the 1998 season as part of a broader survey of the whole Gascoyne region (Sumner et al. 2002), and since then at key boat ramps inside Shark Bay during the 2000 (Sumner and Malseed 2001), 2001 (Sumner and Malseed 2002) and 2002 seasons.

Inner Shark Bay Pink Snapper Stocks Status Report

Prepared by G. Jackson and N. Sumner

FISHERY DESCRIPTION

Boundaries and access

Evidence from stock identification studies conducted since the 1980s suggests that several reproductively isolated populations of snapper (*Pagrus auratus*) inhabit the inner gulfs of Shark Bay. Because there is little or no apparent mixing between these, management recognises three separate fishable 'stocks' in gulf waters. An eastern 'stock' is found in the eastern gulf, i.e. in waters approximately to the east of the Peron Peninsula and to the south of Cape Peron (Inner Shark Bay Figure 1). In the western gulf, separate 'stocks' are found approximately to the north (Denham Sound) and south (Freycinet Estuary) of a line running west from Goulet Bluff to Heirisson Prong. Research advice is provided on the basis of these divisions.

Pink snapper in these waters are mostly caught by recreational fishers. Although a limited number of licensed charter vessels operate out of Monkey Mia and Denham, these seldom target inner gulf pink snapper. Commercial snapper fishing in gulf waters is limited to the 11 licensed fishing units of the Shark Bay Beach Seine and Mesh Net Managed Fishery.

The eastern gulf snapper fishery was closed in June 1998 to allow the recovery of the spawning stock and remained closed during 2002. Bag/size limits and a seasonal spawning closure (Freycinet Estuary only) applied in the western gulf.

Main fishing method

Recreational: Rod and line, handline.
Commercial: Handline, beach seine, haul net.

RETAINED SPECIES

Recreational catch estimates (season 2002):
Eastern gulf closed
Western gulf:
Freycinet Estuary 19 tonnes
Denham Sound 15 tonnes

Although a survey of recreational fishing within this region was undertaken in 1983, annual estimates of recreational effort, and the retained catch of key species, have only been available since 1998. During 2002, the recreational pink snapper landed catch was estimated at 15 t in Denham Sound and 19 t (Nanga 15 t, Tamala 4 t) in the Freycinet Estuary (Pink Snapper Table 1). There was no catch of pink snapper in the eastern gulf, which has been closed since June 1998. The Denham Sound catch in 2002 was the largest since recreational fishing surveys commenced in 1998 and represents almost twice that caught in 2001. In comparison, the catch in Freycinet in 2002 was similar to that in 2001.

In 2002, the proportion of the snapper captured by recreational fishers that were subsequently released was 93% in Denham Sound, and slightly lower in the Freycinet Estuary (79% at Nanga, 89% at Tamala).

Fishing effort

In 2002, approximately 44,000 fisher days were expended in the inner gulfs by boat fishers launching from public ramps, with approximately 76% of the effort in the western gulf and 24% in the eastern gulf (Pink Snapper Table 1). Compared with 2001, effort in 2002 had increased by approximately 55% in Denham Sound and 46% in the eastern gulf but had decreased by 5% in Freycinet.

Commercial share: **Eastern gulf closed**
Western gulf 5% (approx.)

In 2002, the commercial catch taken in the western gulf was approximately 2 t, similar to the low level reported in recent years, again with no catch in the eastern gulf (fishery closed).

Stock assessment completed: **Yes**

The daily egg production method has been used to directly estimate the sizes of the snapper spawning stocks in the eastern gulf, Denham Sound and the 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 that has been used to measure recruitment. Results indicate that snapper recruitment is highly variable in the inner gulfs as is the case in oceanic waters outside Shark Bay.

Between 1998 and 2001 these data, combined with estimates of commercial (from CAES) and recreational catches (from boat ramp surveys), were used to independently determine the status of each inner gulf 'stock'. In 2002 the available biological and fishery information was incorporated into quantitative age-structured models to independently assess the status of each snapper 'stock'.

Exploitation status: **Eastern gulf closed**
Western gulf:
Freycinet Estuary over-exploited
Denham Sound fully exploited

Breeding stock levels:
Eastern gulf inadequate but increasing
Western gulf:
Freycinet Estuary inadequate (locally depleted)
Denham Sound adequate

In late 2002, following the move to model-based stock assessments, a limit reference point of 40% of the virgin mature (spawning) biomass (defined as the 1983 level), reflecting the level of uncertainty of some inputs, was adopted for each 'stock'.

The mature biomass of the eastern 'stock' has recovered steadily since the fishery was closed in 1998 and is currently estimated to be just above the reference level (using a virgin biomass of approximately 250 t).

In Denham Sound, the most recent assessment is more optimistic than previously calculated and indicates that the mature biomass, although having declined steadily since the early 1980s, has been slowly rebuilding since the late 1990s and is currently estimated to be above the reference level (using a virgin biomass of approximately 300 t).

In Freycinet however, the mature biomass remains critically low relative to the reference level (virgin biomass approximately 300 t). Nonetheless, the high proportion of under-sized snapper (i.e. fish less than 500 mm) released by recreational fishers in both Denham Sound (99% in 2000) and Freycinet (98% in 2000) indicates encouraging levels of good recruitment in both areas in recent years.

SOCIAL EFFECTS

Shark Bay is a very popular destination for anglers, especially during the winter months and in school holiday periods.

ECONOMIC EFFECTS

Not available.

FISHERY GOVERNANCE

In late 2002, following extensive community consultation through a ministerial working group, a TAC was set for each pink snapper 'stock' for the 2003 fishing season with an allocation between sectors made on the basis of 75% recreational and 25% commercial.

In 2003, the eastern gulf fishery will partly re-open and be managed to a notional TAC of 15 t (commercial 3 t,

recreational 12 t) using a combination of a spawning season closure (April–July inclusive), a daily bag limit of one, and minimum (500 mm) and maximum (700 mm) legal sizes.

In the western gulf in 2003, the Denham Sound fishery will be managed to a notional TAC of 10 t (commercial 2 t, recreational 8 t) using a combination of a daily bag limit of one and minimum (500 mm) and maximum (700 mm) legal sizes.

In Freycinet, where the spawning stock has been shown to be at a very low level, the fishery will be managed to a TAC of 5 t (commercial 1 t, recreational 4 t), using a combination of 'management tags' (only 1,200 available for 2003), minimum (500 mm) and maximum (700 mm) legal sizes, and a six-week spawning season closure (mid-August to the end of September).

EXTERNAL FACTORS

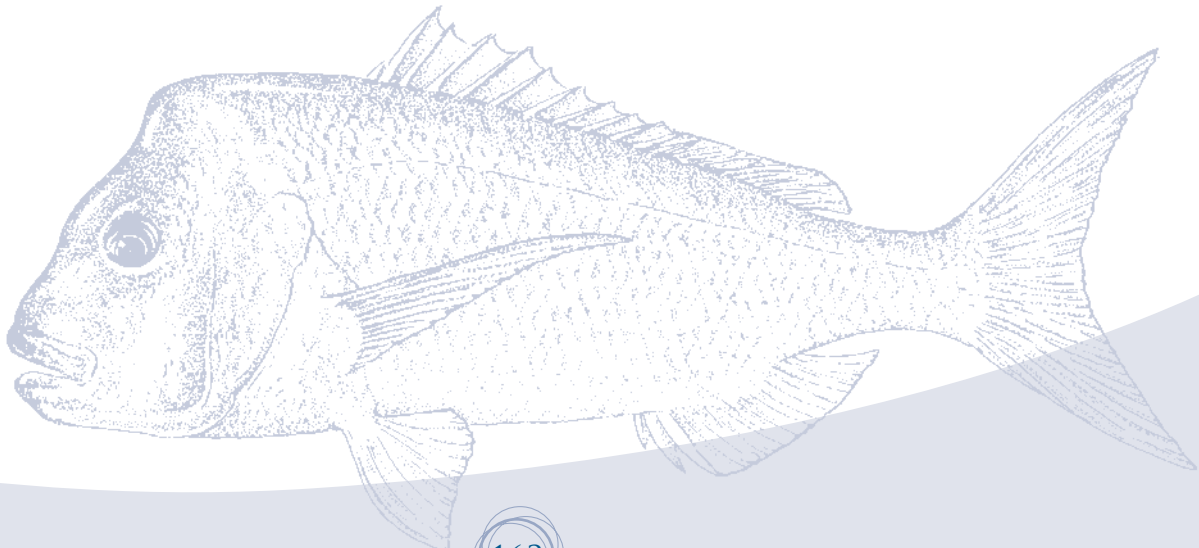
A comprehensive investigation into the potential impact of prawn trawling in Denham Sound on juvenile snapper recruitment and the consequences for the recreational snapper fishery in this area has recently been completed (Moran and Kangas, in prep.). The study utilised historical snapper trawl data and new information from a series of trawl experiments conducted in 2000/2001 and snapper trap surveys conducted during 1998–2000. The study estimated the number of one-year-old snapper remaining at end of a prawn fishing season to be 75% of the numbers expected to be present if no prawn trawling had occurred in the area. Put in other terms, the mortality of juvenile snapper as a direct consequence of the trawl fishery was estimated to result in a loss in yield of 2–4 t of adult snapper per year in Denham Sound (assuming they had not been caught as one-year-olds by the trawl fishery). It was also determined that the impact of the prawn fishery (on juvenile snapper mortality) could be reduced by some changes to the trawl fishery boundaries (moving fishing activity away from areas of highest juvenile snapper abundances). Discussion between the local community, the prawn trawl industry and the Department of Fisheries will take place in late 2003.

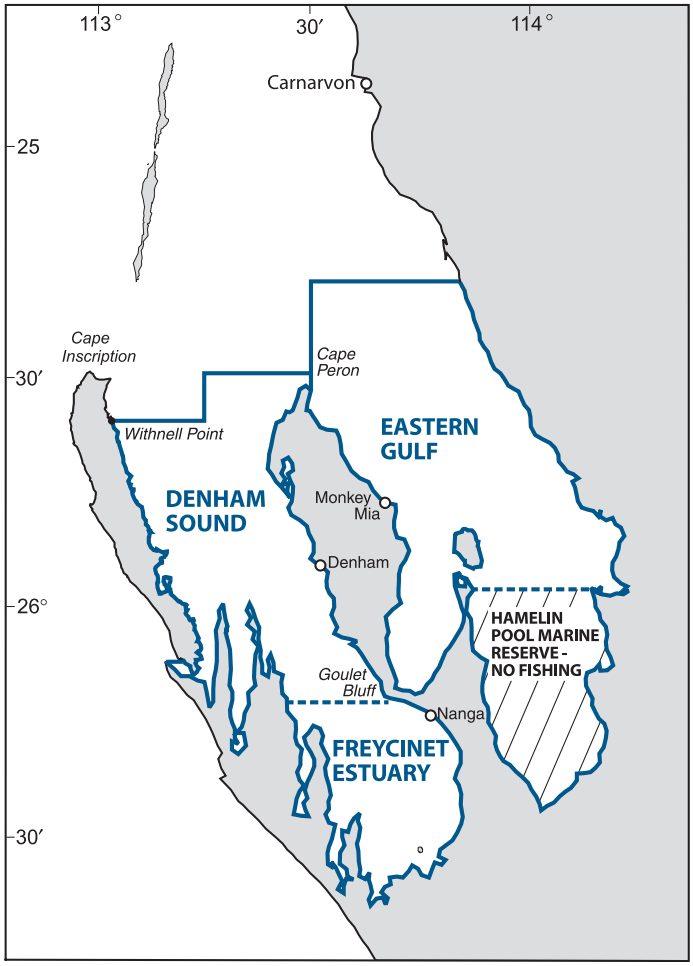
PINK SNAPPER TABLE 1

Estimates of total recreational boat fishing effort (fisher days) and retained pink snapper catch (t) in inner Shark Bay 1998–2002 (no data avilable for 1999).

	EASTERN GULF		*DENHAM SOUND*		*FREYCINET*	
YEAR	*EFFORT (days)*	*CATCH (tonnes)*	*EFFORT (days)*	*CATCH (tonnes)*	*EFFORT (days)*	*CATCH (tonnes)*
1998	11,100	2.9*	21,000	12.2	17,200**	25.7**
1999	n/a	n/a	n/a	n/a	n/a	n/a
2000	9,400	0	15,800	9.5	9,600**	15.8**
2001	7,300	0	12,000	7.5	15,400***	21.8***
2002	**10,600**	**0**	**18,500**	**14.5**	**14,700*** **	**19.3*** **

* For period April–June only (fishery closed June 1998).
**Estimates for Nanga boat ramp only, does not include Tamala.
***Estimates for all Freycinet, including Tamala.





INNER SHARK BAY FIGURE 1
The recreational fishing areas of inner Shark Bay.

Inner Shark Bay Black Snapper Stock Status Report

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

A stock discrimination study has used stable isotope analysis of otolith carbonate to determine the level of stock separation of black snapper or grass emperor (*Lethrinus laticaudis*) in the gulfs of Shark Bay. This indicated that samples of black snapper from waters of different salinity can be distinguished by their O^{18} values. Initial results of a tagging study indicate that movement of the species within Shark Bay is localised (within 10 km of the original tag site). These results suggest that this species is not wide-ranging within the bay.

Black snapper are taken primarily by recreational fishers in Shark Bay. Although the fishers in the Shark Bay Beach Seine and Mesh Net Managed Fishery take a small quantity of black snapper, it is not a target species for this fishery.

Main fishing method

Recreational: Rod and line.
Commercial: Beach seine, haul net and mesh net.

RETAINED SPECIES

Recreational catch (season 2001/02): 7 tonnes (boat only)

Recent recreational boat-based catch estimates for black snapper from Shark Bay indicate a decline in the level of catch between the 1998 and 2001 seasons (Black Snapper Table 1). The Gascoyne Recreational Fishing Survey of 1998 estimated a total recreational catch from shore-based, boat-based and dinghy fishers of 33,400 black snapper retained (approximately 34 t) for the Gascoyne bioregion. The majority of this catch (17,073 fish weighing 15.9 t) was taken by boat-based fishers from public boat ramps in the Shark Bay Marine Park (Sumner and Malseed 2002). The black snapper was the third most popular species caught (in order of estimated number kept) after whiting and pink snapper. Subsequently, a 12-month boat-based survey in Shark Bay that interviewed recreational

anglers at Nanga, Denham and Monkey Mia boat ramps during the 2000 season indicated a decline in the recreational catch to 10,042 black snapper retained (11.6 t) and 18,272 released. A further 12-month boat-based recreational survey in Shark Bay during the 2001 season, also targeting fishers at Nanga, Denham and Monkey Mia, showed a further decline in the catch estimates to 7,302 black snapper retained (7 t) and 15,374 released.

Fishing effort

The recreational fishing effort (as fisher days) has been reported during the recreational boat-based fishing surveys in Shark Bay. The fishing effort reflects the number of fisher days for all species caught. During the comprehensive 1998 creel survey there were approximately 49,000 fisher days reported from boat ramps at Nanga, Denham and Monkey Mia, which declined to 35,000 fisher days during 2000 and 34,000 fisher days during the 2001 creel survey.

Catch rate

The mean catch rates of black snapper for boat-based anglers in Shark Bay in the 1998, 2000 and 2001 surveys were 0.34, 0.29 and 0.24 fish kept per angler day respectively. This indicates a declining catch rate over this period.

Commercial share (season 2001): **Negligible**

Commercial catches of black snapper are taken in small quantities by the 11 licensed fishing units of the Shark Bay Beach Seine and Mesh Net Managed Fishery. The 2001 commercial catch reported from the western and eastern gulfs was almost none.

Stock assessment completed: **Not assessed**

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

A preliminary egg-per-recruit model was developed for the black snapper stock in Shark Bay using biological data for the Shark Bay population derived from research conducted between 1999 and 2001. The length at 50% maturity is 228 mm for females. Because the size at maturity is less than the legal minimum length (280 mm) and assuming a low release mortality of recreationally caught fish, breeding stock levels are believed to be adequate. Black snapper possess different growth rates in different localities within the bay. In all cases, the legal minimum length is set above the length at maturity.

SOCIAL EFFECTS

Shark Bay is a very popular destination for anglers, especially during the winter months and in school holiday periods.

ECONOMIC EFFECTS

Not available.

FISHERY GOVERNANCE

At this time, control of the exploitation rate is managed through a daily bag limit and a legal minimum size limit. The recreational catch limits for black snapper include a legal minimum length of 280 mm and a recreational daily bag limit described under the 'reef fish' category as a mixed bag of 8. The legal minimum length for commercial fishers is 280 mm. Community support for an increase in the minimum legal size for black snapper is being considered under the current review of recreational fishing management arrangements in the region. Under new regulations to be introduced from 1 October 2003, black snapper will be part of the 'finfish category 1' with a mixed bag limit of 7 per day, with a further limit of 4 fish of Lethrinid (emperor) species. The results from the black snapper research program should be available by the end of 2003 to assist with the future sustainable management of this species.

BLACK SNAPPER TABLE 1

Recreational catch of black snapper in Shark Bay from three angler surveys (Sumner and Malseed 2002).

SEASON	AREA	FISHING EFFORT (days)	NUMBER KEPT	STANDARD ERROR	NUMBER RELEASED	WEIGHT KEPT (tonnes)
1998	Total	49,321	17,073			15.9
2000	Western Gulf	25,378	5,425	936	11,404	6.0
	Eastern Gulf	9,438	4,617	686	6,868	5.6
	Total	34,816	10,042	1,160	18,272	11.6
2001	**Western Gulf**	**26,783**	**5,152**	**905**	**12,314**	**4.9**
	Eastern Gulf	**7,254**	**2,205**	**320**	**3,156**	**2.1**
	Total	**34,037**	**7,357**	**960**	**15,470**	**7.0**

NORTH COAST BIOREGION

REGIONAL MANAGEMENT OVERVIEW

In recent years the Pilbara and Kimberley regions have experienced significant growth in recreational fishing activity, with a booming fishing-based tour and ecotourism industry based around the region's reputation as remote and pristine.

Recreational fishing participation for marine waters between Onslow and the WA/NT border is estimated at about 8% of the State's recreational anglers, or some 48,000 anglers per year (Baharthah and Sumner 2003). Recreational fishing shows distinct seasonal peaks, with the highest number of visitors during the winter months.

A survey conducted between December 1999 and November 2000 (Williamson et al., in prep.) has confirmed that the Pilbara region is a major focus of recreational fishing, with 190,000 fisher days being recorded over the survey period in an area stretching from Onslow to Broome.

Charter activity is also significant, with 97 fishing tour licences and 13 ecotour licences valid for the north coast bioregion in 2003.

Creek systems, mangroves and rivers, and ocean beaches provide shore and small boat fishing for a variety of species including barramundi (*Lates calcarifer*), tropical emperors (Lethrinidae), sea perches such as mangrove jack (*Lutjanus argentimaculatus*), trevallies (Carangidae), sooty grunter (*Hephaestus jenkinsi*), threadfin (Polynemidae), mud crabs (*Scylla serrata*), and cods (Serranidae).

Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including many members of the demersal sea perch family (Lutjanidae) such as scarlet sea perch (*Lutjanus malabaricus*) and red emperor (*Lutjanus sebae*), cods, coral and coronation trout (*Plectropomus* and *Variola* spp.), sharks, trevally, tuskfish, tunas, mackerels and billfish.

Fishing charters and fishing tournaments are also areas of growth in the region, and have seen surges in popularity over the past five years or so. The Dampier Classic and Broome Sailfish tournaments are both State and national attractions, and Western Australia is gaining an international reputation for the quality of its offshore pelagic sport and game fishing.

The popularity of barramundi fishing and competition for available fish by different user groups places significant pressure on barramundi stocks. To protect the future quality of the barramundi fishery and resolve resource-sharing issues in the fishery, new management arrangements were implemented in 2002.

The new management arrangements included reducing the recreational fishing possession limit for barramundi from five to two. In addition, separate rules were developed for three special barramundi conservation areas. These are:

- Ord River – this includes the Dunham River, which flows into the Ord River. In this area the possession limit remains at one, the maximum size 80 cm.
- Fitzroy River – all waters upstream of 17°27' S latitude (lower reaches of King Sound). A maximum size of 80 cm and a possession limit of two apply in this area.
- Broome area – all waters from Cunningham Point (east of Cape Leveque) to 19° S latitude (northern end of Eighty Mile Beach). In this area there is a daily bag limit of one and a possession limit of two.

To improve the quality of recreational fishing in the region and resolve resource-sharing conflict, commercial barramundi fishing was closed or restricted in the Ord and Fitzroy Rivers, around the townsite of Derby, and in key recreational fishing areas around Broome.

A spatial closure to commercial mud crabbing was also implemented around the town of Derby to resolve resource-sharing conflicts associated with an escalation in commercial activity.

To further manage for increases in recreational fishing pressure and protect recreational fishing quality, a review of recreational fishing in the Pilbara/Kimberley region will be undertaken in 2003/04.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Recreational fishing compliance and education in the north coast and northern inland bioregions is carried out by Fisheries Officers stationed in Karratha and Broome, with the assistance of VFLOs from both centres. Please note that, as compliance activities in the inland areas relate almost exclusively to barramundi fishing, they have been included in this report on the coastal bioregion, which covers the more significant estuarine breeding component of the barramundi stock.

Officers from Broome conduct regular patrols to the Fitzroy River catchment area, Derby region and Kununurra and Wyndham on the Ord River, while Karratha-based officers conduct regular patrols of the Dampier Archipelago, Port Hedland and Eighty Mile Beach areas. Monthly patrols are undertaken to inspect fishers in the Onslow district.

Compliance patrols focus on checking netting practices, inspecting gear, and checking catch for compliance with bag, size and possession limits.

Activities during 2001/02

A total of 3,728 hours of field activity were undertaken by Fisheries Officers during 2001/02 in relation to coastal boating and land-based recreational fishing activities, particularly netting, with a total of 3,539 field contacts and 2,253 office contacts recorded in the 12-month period.

In general, compliance levels were high, although several offences were detected relating to netting and catches in excess of bag limits. As a result of compliance activities, four infringement notices and eight infringement warnings were issued during the year for a variety of recreational offences, while a further 11 incidents resulted in prosecution.

During 2001/02, close liaison was maintained with the WA Police Service, and on several occasions Police Officers accompanied Fisheries Officers on patrols.

The VFLO programs in Broome, Derby and Karratha provide assistance in educating recreational fishers about rules, fish care and handling, and in 2001/02 they contacted 50 individuals.

Three separate Regional Recreational Fishing Advisory Committees operate in the Kimberley and Pilbara, with meetings generally held once a quarter. Issues affecting recreational fishers in each area are addressed locally with recommendations from these regional meetings being progressed to the parent committee in Perth. Executive support is provided for these committees by the Department of Fisheries.

NORTHERN RECREATIONAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in recreational fisheries within the north coast and northern inland bioregions during the 2001/02 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	3,728
Fisher field contacts by Fisheries Officers	3,539
District Office contacts by Fisheries Officers	2,253
Fisher field contacts by VFLOs	50
Fishwatch reports *	44
OFFENCES DETECTED	
Infringement warnings	8
Infringement notices	4
Prosecutions	11

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

Initiatives in 2002/03

Increased emphasis is being placed on ensuring recreational compliance, and patrols are being conducted in popular fishing destinations throughout the region. The appointment in 2002 of a regional coordinator for the VFLO program and the location of an extra Fisheries Officer in the Region in early 2003, together with the publication of a new fish identification brochure and installation of new signage regarding the barramundi rules, have improved community awareness. Major events to be attended by VFLOs include the North West Expo over two days in Broome, and the Derby King Tide Day in May 2003.

REGIONAL RESEARCH OVERVIEW

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 which began in July 2000 collected baseline data on the inshore finfish species targeted by recreational anglers across the north coast bioregion. In addition, a collaborative project is being undertaken with Murdoch University to provide 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 equated to 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.

SOUTH COAST BIOREGION

REGIONAL MANAGEMENT OVERVIEW

Recreational fishing participation for the south coast of Western Australia, between Augusta and the WA/SA border, is estimated at around 16% of recreational anglers (Baharthah and Sumner 2003), or some 96,000 anglers per year generating 330,000 fishing days.

Charter activity is also important, with 20 fishing tour licences and 3 ecotour licences valid for the south coast bioregion in 2003.

Key recreational fishing areas include the major estuaries of Walpole-Nornalup, Wilson Inlet, the Albany harbours, Bremer Bay, Hopetoun, and Stokes Inlet.

Major target species in estuaries include black bream (*Acanthopagrus butcheri*), King George whiting (*Sillaginodes punctata*) and trevally (Carangidae), while shore fishing focuses on western Australian salmon (*Arripis truttaceus*), herring (*Arripis georgianus*), whiting (Sillaginidae) and trevally. Boat fishing is concentrated near major population centres with the major target species being pink snapper (*Pagrus auratus*), queen snapper (*Nemadactylus valenciennesi*), blue groper (*Achoerodus gouldii*), shark, red snapper (*Centroberyx* spp.) and samson fish (*Seriola hippos*).

Management issues include resource-sharing conflicts between the recreational line fishery and the commercial estuarine fishery, particularly in Wilson and Stokes Inlets.

Since 1996 a number of commercial fishing licences have been bought out in fisheries important to the recreational sector, including significant numbers of herring trap net endorsements and estuarine fishing licences.

A review of recreational fisheries management on the south coast and development of a recreational fishing management strategy will be undertaken in 2003/04.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Fisheries Officers working from District Offices located at Esperance and Albany deal with a number of recreational fisheries within the region, including abalone, rock lobster, boat- and shore-based angling and estuarine net fisheries. Compliance patrols in recreational fisheries principally involve checks to ensure that fishers are adhering to size and bag limits and complying with the attendance and closed waters restrictions that apply in the recreational net fishery. These patrols can be land-based, or Fisheries Officers may utilise a 6 m patrol vessel or several smaller craft to conduct inspections at sea or in the estuaries and river systems.

The compliance and education program in this bioregion is supported by the Volunteer Fisheries Liaison Officers who conduct interactive education programs within the school system and present static displays at various community events throughout the region. The VFLOs have access to a display trailer and the necessary equipment to conduct fishing clinics and the 'Learning Circles for Fishers' program, a conservation-based community education initiative.

Activities during 2001/02

During 2001/02, Fisheries Officers delivered 3,583 hours of compliance work to recreational fisheries in the south coast bioregion (South Coast Recreational Compliance Table 1), concentrating mainly on checking shore- and boat-based anglers, net fishers and shellfish collectors. The areas of highest risk of non-compliance with the management arrangements were considered to be abalone, cockles, marine finfish and estuarine netting. During 2001/02, Fisheries Officers recorded 2,742 field contacts and 1,048 office contacts with recreational fishers.

Members of the public and commercial fishers are able to report instances of observed illegal activity through the Fishwatch system, a statewide 24-hour telephone hotline. There were 14 reports of illegal fishing activity to the Fishwatch hotline in 2001/02 in the south coast bioregion. Areas of greatest public complaint, as reported to Fishwatch, related to abalone poaching, exceeding bag limits, and illegal sale of marine finfish.

In 2001/02, the VFLO program involved 24 volunteers in the Albany and Denmark areas and 7 in Esperance, accounting for 2,698 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.

As a result of compliance activities, 16 infringement warnings and 8 infringement notices were issued, with 9 prosecutions initiated in the south coast bioregion. Prosecutions occur for more serious offences, and in 2001/02 most of these arose from illegal take of abalone and illegal net fishing.

With increasing restrictions being placed on the high-profile metropolitan abalone fishery, there is a growing awareness of the open season and availability of abalone on the south coast. The number of people taking abalone in this region continued to increase during 2001/02. This trend is likely to continue in coming years, with consequent increases in the demand for compliance services.

SOUTH COAST RECREATIONAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in recreational fisheries within the south coast bioregion during the 2001/02 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	3,583
Fisher field contacts by Fisheries Officers	2,742
District Office contacts by Fisheries Officers	1,048
Fisher field contacts by VFLOs	2,698
Fishwatch reports *	14
OFFENCES DETECTED	
Infringement warnings	16
Infringement notices	8
Prosecutions	9

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

Initiatives in 2002/03

The south coast recreational fishing survey process commenced in December 2002, with researchers gathering data on recreational fishing activities at key regional locations. This will provide important data on fishing frequency and target species, as well as participants' attitudes towards conservation and the Department's compliance and education activities. This information will in turn feed into the south coast review commencing later in 2003.

The new weekend closures in the commercial South Coast Estuarine (Interim) Managed Fishery, introduced in July 2002, have helped to mitigate perceptions among recreational users that this particular fishery is impacting on their catches within the local waterways.

Projected changes to recreational fishing regulations, due to be implemented in October 2003, will impact on south coastal compliance activities in the areas of recreational abalone restrictions and statewide fish possession and filleting rules.

The appointment of a Community Education Officer for the southern region has provided a more structured and coordinated regional approach to the community education and VFLO programs, and may assist in expanding the 'Fishers with Disabilities' program outside the metropolitan area.

REGIONAL RESEARCH OVERVIEW

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 during the 1980s and 1990s by the Department of Fisheries with Murdoch University postgraduate students, particularly on recreationally important species in Wilson and Nornalup/Walpole 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, cobbler (*Cnidoglanis macrocephalus*) and King George whiting. Relevant abundance information and stock status for these recreational/commercial stocks are reported on pp. 119–122.

For the south coast beach fishery the major target species of salmon and herring 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. Further survey work to estimate the impact of recreational fishing on key species in the south coast estuaries is currently under way.

The significant gap in biological and fishery data in this region relates to the offshore boat angling species (e.g. trevally, queen and red snapper, blue groper and samson fish), 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. 132). Recreational catch data for these species will be extracted from the National Recreational Fishing Survey database when it becomes available.

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.

NORTHERN INLAND BIOREGION

REGIONAL MANAGEMENT, COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

The major management and compliance activities in the northern inland bioregion relate to the fishing of the freshwater component of the barramundi (*Lates calcarifer*) stock. For simplicity of reporting, these activities are included under the section on recreational fishing in the north coast bioregion (pp. 166–167), which covers the more significant estuarine breeding component of the barramundi stock.

Recreational fishing participation for inland freshwater fishing (including cherabin or freshwater prawns, *Machrobrachium rosenbergii*) in the north of Western Australia is estimated at around 1% of recreational fishers (Baharthah and Sumner 2003), or some 6,000 fishers per year generating 30,000 fishing days. With the increase in Fisheries Officer numbers in the Broome office in 2002/03, recreational patrols to the northern inland bioregion have increased. Among the new activities is the development of an education program to emphasise the need for care with freshwater ray sharks (family Pristidae), an endangered group recently identified in the Fitzroy River.

REGIONAL RESEARCH OVERVIEW

Scientific information for the management of northern freshwater species, particularly barramundi, 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. 80–84. In addition to barramundi, Lake Argyle catfish (*Arius midgleyi*) and cherabin 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.

SOUTHERN INLAND BIOREGION

REGIONAL MANAGEMENT OVERVIEW

The major species fished recreationally in southern inland waters are native marron (*Cherax tenuimanus*), trout (both rainbow trout, *Oncorhynchus mykiss* and brown trout, *Salmo trutta*) stocked by the Department of Fisheries into public dams and rivers, and redfin perch (*Perca fluviatilis*), an introduced, self-perpetuating exotic stock. The native freshwater cobbler (*Tandanus bostockii*) is also taken in small numbers, as are black bream (*Acanthopagrus butcheri*) artificially stocked into some inland impoundments.

In 2002/03 21,448 licences were issued for recreational inland freshwater fishing (including marron) in the south of Western Australia, however participation rates for both the marron and angling fisheries are generally less than 50%.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Fisheries Officers stationed in Geraldton, Fremantle, Mandurah, Bunbury, Busselton and Albany conduct recreational fishing compliance and education activities in the southern inland bioregion. Volunteer Fisheries Liaison Officers located in major coastal centres also assist these officers with education and research activities. Please note that, as the records of VFLO contacts do not differentiate between coastal and inland activities, their statistics have been included in the table for the south coast bioregion (p. 169).

The recreational marron fishery presents the highest risk of non-compliance with the management arrangements in this bioregion. These risks include illegal fishing during the closed season (March–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.

The other main fishery in the southern inland bioregion is the recreational trout fishery. Compliance and education in this fishery focus 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 2001/02

During 2001/02, Fisheries Officers delivered 3,014 hours of compliance work to recreational fisheries in the southern

inland bioregion (Southern Inland Recreational Compliance Table 1), recording 2,379 field contacts and 2,999 office contacts with recreational fishers.

The marron fishery was again the major focus for the compliance and education program in this bioregion. The season ran from 5 January to 28 February 2002 and catches were well below average in all areas. Whilst there was dedicated compliance and educative input from Fisheries Officers and VFLOs during the season, Fisheries Officers also conducted targeted patrols during the 'peak' period for poaching activity in November and December, prior to the season commencement. The other major area of non-compliance was the use or possession of illegal gear in 'snare only' areas.

The VFLOs conducted education displays for the opening of the marron season, and focused on dams in the south-west during the opening weekend. Several VFLOs from Albany conducted a display at the Broomehill Aquafest.

SOUTHERN INLAND RECREATIONAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in recreational fisheries within the southern inland bioregion during the 2001/02 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	3,014
Fisher field contacts by Fisheries Officers	2,379
District Office contacts by Fisheries Officers	2,999
Fishwatch reports *	14
OFFENCES DETECTED	
Infringement warnings	15
Infringement notices	16
Prosecutions	12

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

Initiatives for 2002/03

Due to pressure from low rainfall, environmental factors leading to habitat loss and illegal and legal fishing, the marron fishery was the focus of a major review in 2002/03. This review led to the introduction of a reduced fishing period and other restrictions for the 2003 season, including special bag and size limits for the Harvey Dam. Additionally, to protect the recently identified species known as 'hairy marron', fishing for marron was banned in the waters of the Margaret River upstream from the Ten Mile Brook junction. To maximise compliance with these new restrictions, patrols were used to conduct an intensive education campaign in the lead-up to the season, with an added focus during the season on Harvey Dam and the Margaret River.

Following a workshop in June 2002 involving the Department of Fisheries, WA Police Service and the Marron Growers Association, Fisheries Officers initiated joint patrols with the police to address the issue of the theft of marron from licensed aquaculture farm dams. Although there were no apprehensions resulting in conviction for stealing, the presence of these patrols in the high-risk areas has been well received by the public and increased the Department's contact with people at risk of offending.

It is planned to increase the community education program in inland areas, with VFLOs taking the 'Learning Circles' program to schools in this bioregion. Also, following the appointment of a Community Education Officer based in Busselton, the education program will be stepped up in popular marron and trout fishing areas such as Collie, Pemberton and Manjimup.

REGIONAL RESEARCH OVERVIEW

Research for managing and enhancing the State's southern freshwater fisheries for marron and trout has been largely undertaken by the Department of Fisheries. In addition, collaborative university projects have provided data on redfin perch and freshwater cobbler and their relationships to the small native freshwater species.

Recreational Marron Fishery

Management Summary

Marron (*Cherax tenuimanus*) are endemic to Western Australia and are the third largest crayfish in the world. The recreational fishery operates in freshwater dams and rivers throughout the State extending from as far north as Geraldton to Esperance in the east.

Management controls for the fishery include bag and size limits, gear restrictions and a lengthy closed fishing season, with the open season operating in January–February each year.

A number of management changes have been introduced to the recreational marron fishery in the past decade in an attempt to manage fishing effort at a sustainable level and maintain the quality of the fishing experience. In 1990, 'snare only' areas were introduced and the fishing season was reduced from six months to 10 weeks. In 1995 new 'snare only' areas applied, there was a licence fee increase, the season was further reduced to eight weeks and the bag limit was adjusted from 20 to 10 marron per fisher per day. In 2000 a program was put in place to introduce additional 'snare only' areas regularly until 2005 when all dams would be 'snare only'.

These measures have had limited success in maintaining catch rates, largely as a result of the impacts of reduced rainfall and environmental degradation on the productivity of the marron stock.

To ensure the long-term sustainability of the marron stocks a community-based working group appointed by the Minister in 2002 developed a strategy designed to keep the catch to

sustainable levels (i.e. at or below the 2002 catch level of 17 t). The key features of this strategy, introduced for the 2003 season, included a fishing season reduced from 55 days to 16 days, the inclusion of all Water Corporation dams as 'snare only' fishing areas, additional 'marron waters' (where fishers may only be permitted to carry legal marron gear) and separate bag and size limits for the Harvey Dam.

Preliminary results for the 2003 season show a significant drop in both fishing effort and total catch, but a marginal improvement in catch rates, indicating that the management package has been successful in meeting its key objectives of managing down the fishing impact on a reduced legal-size stock in years of poor recruitment. Further review of long-term management strategies is planned.

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 logbook 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.

An additional research focus during 2002 has been the situation of the sotcks of marron in the Margaret River system. Recent research indicates that there may be two species or sub-species of marron, with one, the Margaret River marron, under serious threat, apparently as a result of habitat changes and competition with the introduced marron from other river systems. A workshop on the status and conservation of the Margaret River marron was held in May 2002 and recently, the Department of Conservation and Land Management (CALM) has declared the Margaret River marron a threatened species. The Department of Fisheries is working with CALM to ensure that appropriate action occurs to protect the Margaret River marron. In late 2002, it was proposed to stop recreational marron fishing above Cane Break Road on the Margaret River to remove the impacts of fishing on the remaining Margaret River marron stocks. Breeding stocks of Margaret River marron are being held at the Pemberton Freshwater Research Centre as part of the research program.

A major FRDC research project has also been approved to commence 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.

Licensed Recreational Marron Fishery Status Report

Prepared by B. Molony

FISHERY DESCRIPTION

Boundaries and access

The recreational marron fishery extends from the Hutt River north of Geraldton to waters near Esperance. There is a specific annual licence for the open season during January and February. In 2002, the season was open between 5 January and 28 February (55 days).

Some waters have been declared 'snare only' in order to reduce the effect of high levels of effort placed on these water bodies. These waters are: Warren River National Park (since 1990); Shannon River (1990); Margaret River (1993); Harvey Weir (1994); Wellington Dam (1996); Samson Dam (1996); and Waroona Dam (2002).

Main fishing method

One scoop net (preferred for dams), or six drop nets (rivers), or one bushman's pole snare ('snaring only' applies to some waters). Anglers can only use one gear type at a time. Dimensions and mesh sizes of the scoop and drop nets are specified in an information brochure sent annually to licence holders. All methods involve bait, which is typically chicken layer pellets.

RETAINED SPECIES

Recreational catch (season 2002): 17 tonnes

An estimated total of 135,700 legal-sized marron (minimum of 17 t) were taken in the 2002 season, similar to the 2001 season (138,593 marron, 17.3 t) but low relative to the long-term data (Recreational Marron Figure 1). A minimum total weight of landed marron is calculated using the average weight of a legal-sized marron (76 mm carapace length – 125 g) to convert the estimated catch in numbers to biomass. The total catch in weight is likely to be an under-estimate as larger, and therefore heavier, marron are captured during the season.

A second estimate of total catch can be generated using the size and weight distributions of marron recorded by logbook holders. In 2002, the total catch of marron was estimated at approximately 29 t using the average weight of marron landed by logbook holders (214 g). (2001: 32.3 t, average marron weight 234 g). Both estimates indicate a slight decline in recreational catch compared to the 2001 season and are relatively low compared to long-term catches (Recreational Marron Figure 1).

Fishing effort

The number of licences issued for the 2002 season was 21,671, with an estimated 10,269 of these (47.9%) used to marron on one or more days, at an estimated average of 3.16 days of marroning per active licence holder. In general the percentage of licence usage has declined as the management restrictions have been increased over the past few years (Recreational Marron Table 1).

Since 2001, the telephone survey has recorded days of effort, whereas in previous years the number of fishing trips was reported. A total of approximately 32,402 days were spent marroning in 2002, comprising an estimated 10,369 days of marroning in dams and 22,033 days in rivers, compared to a total of 32,875 days in 2001 (8,686 days marroning in dams and 24,185 days marroning in rivers). Overall the 2002 season was similar to the 2001 season.

Catch rate

The average catch rate in 2002 was estimated at 4.19 legal-sized marron per licence holder per night, similar to the 2001 catch rate of 4.22. Catch per unit effort data continues to show a long-term decline that appears unlikely to recover to historic levels (Recreational Marron Figure 2).

Commercial share: **Nil**

There is no commercial fishery for marron.

Stock assessment completed: **Yes**

As the marron fishery operates on a series of discrete river and dam stocks where growth and productivity vary, the stock assessment process currently treats the river and dam sectors separately. Further, stock levels are affected by rainfall levels, with higher winter rainfall resulting in larger catches in subsequent marron seasons. Marron catch and effort data are collected and assessed from logbook records from recreational fishers, an end-of-season telephone survey of licence holders, and pre- and post-season research sampling.

Total numbers of landed marron are calculated by using the mean number caught per day from the logbook and telephone survey data. This number is then multiplied by the number of active licence holders. The estimated number of days (effort) to dams and rivers is calculated in a similar manner.

The status of the stock is also currently assessed by examination of the relationship between catch (numbers) and fishing effort for dams and rivers separately. This analysis indicates that although the catches and catch rates were higher at similar levels of effort in earlier decades, the stock abundance, as indicated by catch rate, is lower but has been relatively stable from the mid to late 1990s onwards.

A good correlation exists between the total number of marron captured and rainfall during the previous winter relative to the long-term rainfall of the south-west. This preliminary model is used to predict the future season's total catch.

Exploitation status: **Fully exploited**

As catch rates and total catch have declined compared to historical levels, it is likely that most marron stocks are fully exploited.

Breeding stock levels: **Adequate**

Breeding stocks are protected from recruitment over-fishing by the minimum legal size limit, gear escape meshes and the tendency for snare fishers to target larger marron. Most females in dams are capable of breeding at least once prior to attaining legal size, while those in rivers are capable of breeding at least twice. Small animals and females carrying eggs and young are fully protected. However, some individual stocks (e.g. Harvey Weir stock) do not appear to reproduce below the legal size and thus may not be protected by the size limits. Broodstock levels may be decreasing in these areas.

Projected catch next season (2003):
Approx. 146,700 marron (18.3 tonnes)

Based on rainfall records during the year 2002, the catch for the 2003 season is likely to be higher than the catch in 2002. Bureau of Meteorology data indicate that the rainfall during 2002 was approximately 87.3% of the long-term average (2001: 68.4%). Based on this figure, the expected catch of marron is predicted to be approximately 146,700 animals. However, the relationship between rainfall and marron catches needs further analysis. For example, when river and dam levels are low, marron are concentrated and are easier to catch, therefore catch rates may be much higher than expected. However, this may impact on catches in future years. Further, modifications to several major dams in the Harvey River catchment have curtailed access to certain marron stocks (e.g. Stirling Dam, Harvey Weir, Waroona Dam). As a result more effort was directed into Wellington Dam in 2002 which may have a long-term impact on the marron stock in Wellington Dam. The catch for the 2003 season will also be affected by the management changes to be implemented before the start of the 2003 season.

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, or are released.

Protected species interaction: **Negligible**

This fishery does not interact with protected 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 2002 season involved approximately 10,269 licence holders and their families undertaking about 32,400 fishing days, and provided a major recreational activity in regional areas of the south-west of the State.

ECONOMIC EFFECTS

The 'commercial' value of the 2002 season recreational marron catch was in the approximate range $407,000–$696,000 (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). Revenue from licence sales was estimated at approximately $284,000 which is used to support recreational fishery management, research and compliance. In addition, the estimated 32,400 days of marroning in regional locations provided a significant boost to regional towns in the south-west.

FISHERY GOVERNANCE

Contemporary catches of marron are much lower than those of the 1970s and 1980s (Recreational Marron Figure 1). However, since the 1991 season, the total marron catch has fluctuated at a relatively low level despite large fluctuations in effort (total number of trips). The reasons for the lower catches after 1990 are thought to include changes in land practices (including clearing and water diversion), a reduction of access to large dams, and salinisation of the upper reaches of many rivers – all issues outside the control of Department of Fisheries legislation. The impact of introduced feral fishes and the presence of the introduced yabby may also be having a significant impact, as may illegal fishing, including fishing out of season, retention of under-size marron and retention of more marron than permitted by the daily bag limit. At this stage, the ranking of these fishery-related impacts on the marron stocks is not possible and is likely to vary among different water bodies and catchments. However, as the major driving influences in the fishery appear to be rainfall and water flow, it is likely that water management issues are much more important than fishery governance issues.

The new FRDC project commencing in July 2003 will assist in quantifying the factors influencing the marron fishery.

EXTERNAL FACTORS

The fishery currently appears to be capable of producing between 118,000 and 309,000 marron per season. However, 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.

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 is currently refurbishing Waroona Dam, which has involved the complete draining of the dam. Thus a redistribution of fishing effort occurred during the 2002 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 providing 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 appear to 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.

Trout will also predate on marron but to a lesser extent than redfin due to the wider diet of trout, particularly rainbow trout, which prey predominantly on freshwater insects.

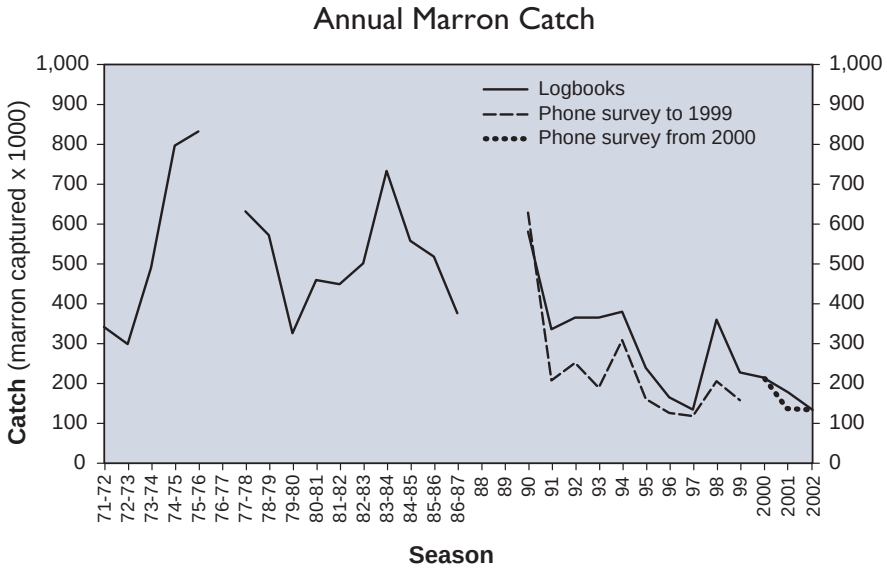
Preliminary results of Department of Fisheries research indicate considerable potential for increasing marron survivorship rates and the carrying capacity of water bodies by installing artificial structures. Large artificial habitats have already been installed in Harvey Dam and will be installed in Waroona Dam in mid-2003.

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. Yabbies were introduced from the Eastern States and have escaped from farm dams or have been deliberately released into rivers and irrigation dams. Yabbies can also carry diseases such as *Thelohania* which may be passed on to other freshwater crayfish, including marron. Murdoch University is currently examining the marron stocks co-existing with yabbies in Hutt River (Geraldton) and will provide information to the Research Division of the Department of Fisheries.

RECREATIONAL MARRON TABLE 1

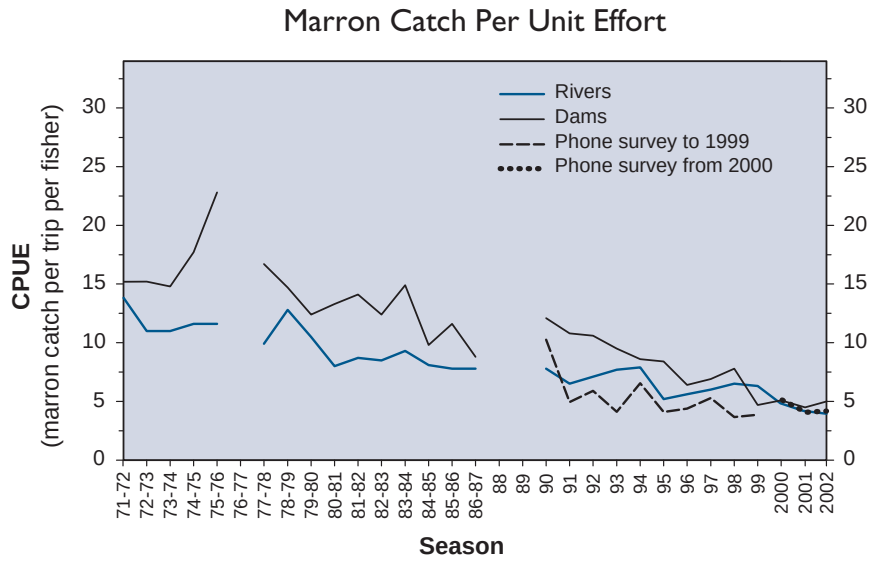
Total recreational marron licences issued (including umbrella licences) and percentage of licences utilised, 1999–2002.

YEAR	LICENCES ISSUED	LICENCES USED	PERCENTAGE USAGE
1999	21,330	13,899	65%
2000	21,894	11,493	53%
2001	21,888	9,783	45%
2002	**21,671**	**10,269**	**47%**



RECREATIONAL MARRON FIGURE 1

Total annual recreational marron catch, 1971 to 2001.



RECREATIONAL MARRON FIGURE 2

Catch per unit effort in the recreational marron fishery as recorded from logbook holders and from the telephone survey.

Recreational Freshwater Angling

Management Summary

Fishing for trout and other freshwater fish species (other than crustaceans) in waters south of latitude 29° S requires a freshwater angling licence. People under 16 years of age are not required to hold a licence.

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 allowed on the Serpentine, Murray, Blackwood, Donnelly and Warren Rivers. However, fishing on the streams, brooks and tributaries flowing into these rivers is prohibited during the closed season.

A combined daily bag limit of 4 applies to rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), together with a minimum legal size limit of 300 mm.

A daily bag limit of 40 applies to freshwater cobbler. No minimum legal size limit applies to this species. No bag limit or size limit applies to redfin perch (*Perca fluviatilis*). However, anglers are encouraged not to return small perch due to the negative impacts that perch have on trout and marron fisheries and the tendency for the average size of redfin to reduce over time, forming populations where fish under 10 cm – well below useful size – will breed, thus reducing the quality of the redfin fishery.

To improve the quality of the trout fishery, several dams have now been made 'artificial lure only' (no bait). Reduced bag limits have also been established in these select 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 occurred since the 1930s. Advice to the Department is provided by an informal stocking committee composed of management and research staff and representatives of recreational fishing groups. The stocking of trout is currently under review against a range of environmental impact criteria as part of a translocation assessment process.

A restocking program for Waroona Dam (Lake Navarino) is planned for marron, native minnows and trout once the dam has refilled and water conditions have improved.

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 Pemberton Freshwater Research Centre (PFRC), formerly known as the Pemberton hatchery. A limited survey of licence holders was performed for the 1998/99 season and results provided information on catch and effort within the fishery, as well as other data. An annual telephone survey commenced in 2001 to provide 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, a natural strain and hybrids of rainbow trout. Research information from these projects and the annual report from the manager of the PFRC have been used to compile the following status report.

Recreational Freshwater Angling Status Report

Prepared by B. Molony

FISHERY DESCRIPTION

Boundaries and access

The south-west inland fishing licence includes trout, redfin perch and freshwater cobbler (but not marron). Waters with public access are limited to the major rivers and Government irrigation water supply dams. The only public rivers and dams that are stocked are those with a long history of trout stocking. There is a closed season for trout fishing between 1 May and 31 August in most public waters. Private waters, mainly large gully farm dams and waterlogged and salt-affected south coast areas, are also regularly stocked by private owners as part of put-and-take trout fisheries. Rainbow trout yearlings are also being trialled for their aquaculture potential in inland saline waters, which may provide some recreational fishing opportunities.

Main fishing method

Angling with rod and line.

RETAINED SPECIES

Recreational catch (season 2001/02): 20.8 tonnes

Based on an annual telephone survey, an estimated total of 64,900 fish were captured by freshwater anglers during the 2001/02 season, with an estimated weight of 20.8 t. This comprised approximately 6.5 t of rainbow trout (21,000 fish), 1 t of brown trout (3,300 fish), 11.3 t of redfin perch (33,400 fish) and 2 t of native catfish (7,300 fish). This is below the 2000/01 estimates of 29.3 t overall catch (91,300 fish), the main difference being that more trout were caught in 2001/02 (up from 4.5 t) but significantly less redfin perch were caught (down from 22.6 t).

The change in catch composition is likely to be due to a dedicated trout angling competition held in late 2001, which involved the stocking of additional yearling rainbow trout and more effort applied to trout fishing than in 2000/01. The lower

catch of redfin compared to previous seasons is probably a result of less effort occurring in dams (where redfin dominate the fish community) due to lower water levels and because several dams were being refurbished.

Fishing effort

The total number of licences issued during the 2001/02 season was 16,315, but only an estimated 3,916 of these (24%) were used to make one or more fishing trips, at an average of 6.4 days per active licence holder. This compares to 4,039 of 15,242 licences (26.5%) used to make one or more trip in 2000/01.

A total of approximately 24,600 days of angling occurred in 2001/02, with approximately 6,000 days spent fishing in dams and 18,600 days in rivers, compared to 28,300 days of angling (10,400 days in dams and 17,900 days in rivers) during 2000/01. Thus, the major difference was that there was less fishing effort applied to dams in 2001/02.

Catch rate

The average catch rate in 2001/02 was estimated at 3.6 fish per active licence holder per day, consisting of 1.99 fish retained and 1.61 fish released. This is similar to the estimated catch rate in 2000/01 of 3.77 fish per active licence holder per day, consisting of 2.72 fish retained and 1.05 fish released. The lower retention rate of fishes (especially trout) and the higher release rates are likely a result of the catch-and-release philosophy encouraged by the Department of Fisheries and the organisers of the trout fishing competition.

Commercial share: **Nil**

There is no commercial fishery for these species.

Stock assessment completed: **No**

Rainbow and brown trout for stock enhancement are produced at the PFRC and released annually into public waters. A total of 291,000 trout fry (271,000 rainbow trout fry and 20,000 brown trout fry) produced at the PFRC were stocked into public waters during 2001/02 (2000/01: 515,000 trout fry including 490,00 rainbow trout fry and 25,000 brown trout fry). In addition, approximately 138,000 rainbow trout fry were sold to private dam owners for tourist fishing and private club fishing (2000/01: 310,000) and 65,000 rainbow trout fry were sold to commercial producers (2000/01: 70,000). Older fish were also produced and sold from the PFRC during the year. Approximately 48,800 rainbow trout yearlings were stocked into the public fishery (2000/01: 21,000), while 2,000 ex-broodstock rainbow trout entering their second and third years of life and 500 ex-broodstock brown trout entering their third and fourth years of life were also stocked into the recreational fishery for the 2001/02 season (2000/01: 2,700 rainbow trout ex-broodstock and 700 brown trout ex-broodstock). Significantly more rainbow trout yearlings were produced and stocked during 2001/02 than for previous years, resulting in a lower production and stocking of rainbow trout fry. Assessment of the success of fry and yearling stocking in an impoundment is being finalised.

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

Trout need annual stock enhancement by hatchery releases in most waters, as there is very little natural breeding due to high summer temperatures and limited nesting areas. Native cobbler are self-sustaining. Introduced redfin perch breed uncontrollably in south-west waters.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

Protected species interaction: **Low**

Currently, no species of south-west native fish are protected, although two species are listed as 'restricted' and one species listed as 'vulnerable' by the Australian Society for Fish Biology. 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 small redfin caught by anglers, although not recommended, still occurs and may result in a decline of fishing quality. The Department of Fisheries encourages anglers to retain any redfin caught, regardless of size. Data from 2001/02 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 29 locations and not throughout the entire range of fresh waters in the south-west. Thus, although trout are also predatory fishes, the lack of natural reproduction means they are more controllable than redfin and are thus more acceptable as an introduced recreational species.

Stocking in future will be influenced by a translocation evaluation, currently being finalised. Further, detailed research on the survival of fry and yearling trout has commenced, as has an analysis of the diets of trout and redfin. This information will allow the environmental impact of trout and redfin to be evaluated and compared.

Habitat effects: **Negligible**

SOCIAL EFFECTS

A large number of freshwater angling licences are sold annually. For the 2001/02 season, a total of 16,315 licences were sold, including umbrella licences. This is an increase of approximately 7% compared to the 2000/01 season.

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 $143,000 of revenue which is used to support breeding, stocking, research, management and monitoring activities.

FISHERY GOVERNANCE

Management of the fishery involves regular stocking of trout, and catches are controlled by bag and size limits and closed seasons. Trout stocking quantities and locations are decided at twice-yearly meetings involving managers, research scientists and user groups.

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 has a negative influence on the freshwater angling fishery.

A major issue in this fishery is access to irrigation dams. The Water Corporation closed access to Stirling Dam in 2001 owing to the diversion of 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 is also undergoing refurbishment and no stocking will occur until the dam is refilled in late 2003. 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 general condition of most rivers makes many areas unsuitable for trout. Stock access, cleared banks and de-snagging of streams all reduce the quality of the stream for trout and other aquatic species. Rehabilitation projects in the USA have produced better stream quality and better angling and similar initiatives may be considered in Western Australia, particularly in irrigation dams, where the installation of artificial habitats is being trialled by Fisheries researchers in collaboration with the Water Corporation.

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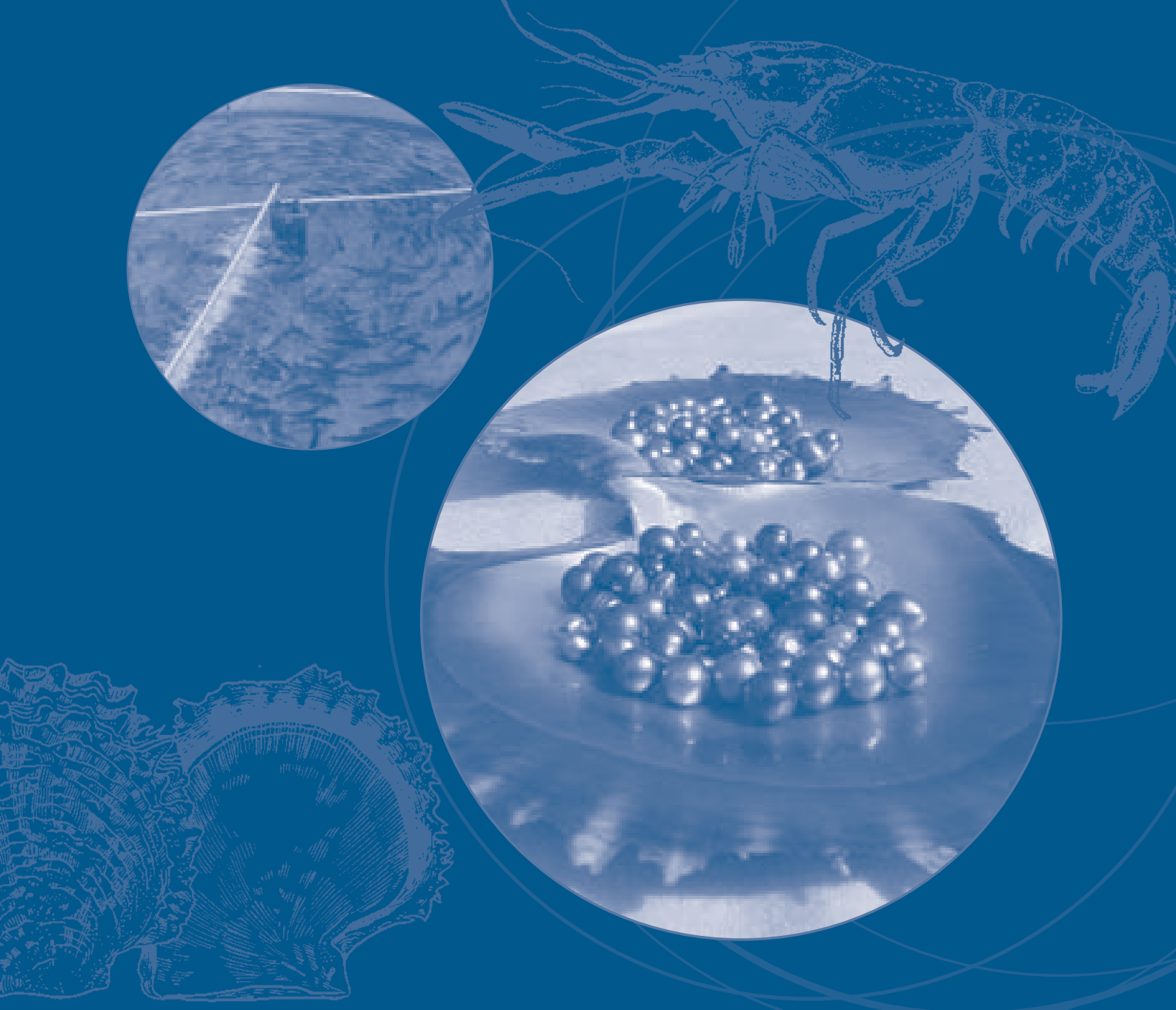
PEARLING AND AQUACULTURE



PEARLING AND AQUACULTURE

General Overview

The Pearling and Aquaculture Program is responsible for the management of the pearling and aquaculture sectors throughout Western Australia.

The production of South Seas pearls dominates the State's commercial aquaculture industry.

In 2002 the Minister for Fisheries announced the commencement of a review of the aquaculture industry in Western Australia. The review has two components: a legislative review, and the development of a five-year strategic aquaculture plan. In this reporting period the Minister has issued two reports: *Draft Report on the Review of Legislative Arrangements in the Aquaculture Industry in Western Australia* and *A Draft Strategy for Development of the Western Australian Aquaculture Industry.* It is anticipated that the review and Government response to the review will be settled in 2003/04.

Pearling Activities

The Pearling Sub-Program is responsible for the development, implementation and review of management of the *Pinctada maxima* pearling industry. Its projects relate to the management of the wild-capture pearl oyster fishery and the hatchery sector; research and monitoring of the wild pearl oyster stocks; disease management; compliance and education; and lease and licence assessment and administration.

The Sub-Program provides executive support to the Pearling Industry Advisory Committee, a statutory management advisory committee established under the *Pearling Act 1990*, and its sub-committees. Strong linkages are also maintained with the peak industry representative body, the Pearl Producers Association.

The management of pearling is discussed in detail under the north coast bioregion (pp. 188–189).

Aquaculture Activities

The Aquaculture Sub-Program is responsible for implementation of the Government's aquaculture development initiative. It provides support to the Aquaculture Development Council, a statutory management advisory committee established under the *Fish Resources Management Act 1994*, and its associated sub-committees.

Excluding *Pinctada maxima* and marine algae, the total increases in value and tonnage of aquaculture product for 2001/02 were 2.5% and 3.3% respectively, compared to 2000/01. Commercial enterprises in Western Australia include production of mussels, edible oysters, marron, yabbies, trout, algae (for beta carotene), barramundi, abalone, ornamental fish and non-*maxima* pearl oysters.

The continuing commercial harvest of black pearls from Shark Bay and the Abrolhos Islands is important in the development of this new industry for Western Australia. The quality of the pearls has been encouraging.

The first commercial sale of abalone produced in Western Australian farms is a milestone along the road to seeing this industry sector become a significant producer of quality abalone.

The continued development of the abalone grow-out farm at Bremer Bay, combined with excellent progress made at the established hatchery at the Albany Aquaculture Park, will provide a basis for the establishment of a major industry in years to come. It is anticipated that in the next few years, another three or four ventures will begin development. There is potential for the abalone aquaculture sector to have a higher value of production than the wild-caught sector in the future.

The commercial hatchery production of scallop spat and the 'seeding' of an aquaculture site off Geraldton in the Mid West Region is an exciting component in the process of developing a new industry. It is expected that the success of this pioneering activity will be known in 2003/04.

Barramundi is the fastest growing aquaculture industry in Western Australia, with production increasing strongly in this

financial year. Major supplies came from the farm at Lake Argyle and from smaller recirculation systems, which are located throughout the State. Interest from other proponents indicates that this sector will expand rapidly in the coming years.

The continued establishment of 'new' mussel farms on the Southern Flats site in Cockburn Sound is important for the growth of what is becoming an important industry.

The funding approval from the Kimberley Sustainable Regions Program (KSRP) for a prawn aquaculture project in the Kimberley is seen as a major positive. This project, with the continued capture of *Penaeus monodon* prawn broodstock and the production of post-larvae in Broome, is an important milestone, underpinning the development of the prawn aquaculture industry in Western Australia.

This industry is likely to see the first pilot production of prawns in 2003/04. A pilot development has occurred at Derby, and additional ponds are being developed as part of the KSRP project. Prawn farming is therefore positioned to be a major contributor to regional economic development and employment in the next few years.

Licensing

The growth in the number of aquaculture licences granted is encouraging. As of 30 June 2003, the Department of Fisheries had issued 470 aquaculture licences – an increase of approximately 2% on the previous year (462).

Growth of about 392% in the number of licences issued since 1994 gives a clear indication of the level of interest and activity in the aquaculture sector in Western Australia. This figure actually understates the real level of involvement in aquaculture, given that yabby farmers generally do not require an aquaculture licence and anecdotal evidence suggests that the interest and activity in this area have increased substantially.

The breakdown of licences in 2002/03 was as follows:

- 288 marron licences;
- 111 mariculture or non-freehold land licences (including mussels, abalone, non-*maxima* pearls); and
- 71 others (including yabby, silver perch, trout, ornamental fish).

Two new larger-scale land-based aquaculture licences were issued, one for the first commercial finfish farm in the State, located at Exmouth, and the other for a prawn hatchery at the Broome Tropical Aquaculture Park. One new marine-based aquaculture licence was issued.

The Department assessed 40 new applications, 10 variations and seven transfers for licences on freehold land during the year. Public consultation and assessment of coastal water applications under Ministerial Policy Guideline no. 8 also continued.

Value of Production

The value of aquaculture in Western Australia is growing strongly, having increased by 23% from 1998/99 to 2001/02. Some indications suggest that yabby and marron farming were affected by drought conditions.

It is predicted that significant growth will occur in the next decade as licences granted in the late 1990s result in the construction of facilities, and as projects move from pilot status to commercial maturity. Whilst no estimate of capital expenditure on aquaculture facilities is available, it is significant and will increase substantially in coming years.

WEST COAST BIOREGION

REGIONAL AQUACULTURE DEVELOPMENT OVERVIEW

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

The Department of Fisheries manages mussel farming in Cockburn Sound in liaison with the Fremantle Port Authority and has recently commenced a process of reallocation of farm sites, with further reallocations planned for 2003/04. The tenure for farmers operating at the Kwinana Grain Terminal has been uncertain for some time. Consequently the Department of Fisheries secured an alternative farming site at Southern Flats within Cockburn Sound several years ago. Discussions are continuing around an additional 12 ha of water at this site, following the loss of a farm site within the waters controlled by the Royal Australian Navy.

The WA Shellfish Quality Assurance Program (WASQAP) monitors and regulates the quality of shellfish harvested in Western Australia for domestic and export markets. The WASQAP is conducted jointly with industry and the WA Department of Health. The program involves regular sampling of bivalve shellfish-growing areas for toxic algae and contaminating bacteria in order to monitor shellfish quality and permit the classification of shellfish growing areas. The two principal areas used for the production of shellfish in Western Australia, Cockburn Sound and Oyster Harbour near Albany, have been classified in accordance with the procedures outlined in the WASQAP and are approved for export status by the Australian Quarantine and Inspection Service (AQIS).

Activities during 2002/03 included the completion and submission to AQIS of update reports on the farm sites at the Kwinana Grain Terminal, Southern Flats and Oyster Harbour. AQIS conducted its annual audit of the WASQAP in March 2003, according it 100% accreditation.

The emerging aquaculture sector at the Abrolhos Islands continues to be carefully managed to ensure its sustainable development. In the past 12 months, the seven licensees engaged in the culture of black pearls have increased the utilisation of their sites, with growth of approximately 58% in the numbers of adult pearl oysters held. Although the number of pearls produced at the Abrolhos is still small by comparison with the established pearl industries, the prospects for increased production are encouraging.

During the past year a trial of tuna yellowfin tuna farming near the Abrolhos Islands has been proposed. The applicants are currently involved in consultation with community groups and Government departments to identify issues that need to be addressed and approvals required. The pilot trials being proposed are planned to determine operational feasibilities and to identify further environmental issues requiring management.

The principals involved with the saucer scallop seeding project near Geraldton have, with funding from the FRDC, developed techniques to seed hatchery-produced spat on the seabed. Over the past year the production capacity of the hatchery has been increased, with the operators now able to produce spat reliably, which in turn has led to a significant increase in spat successfully seeded in the Geelvink Channel.

Development activities included handling public enquiries and providing technical support, particularly for black pearl farmers at the Abrolhos Islands. Results of small-scale 'on-farm' experiments, comparing a range of husbandry techniques used by the growers in the region, were presented to growers at their annual general meeting.

During 2002/03, compliance activities within the Cockburn Sound mussel industry focused on ensuring mussel farmers comply with the navigational lights and boundary marking requirements and that all mussel farming equipment remained within the boundaries of farm sites. This was achieved through regular water- and land-based inspections of mussel farm sites. Compliance with these requirements was generally good, with the exception of the Garden Island mussel farm sites where there is a continued need to notify mussel farmers to maintain the required navigation lights and boundary markers.

Fisheries Officers also supervised the collection of samples under the WASQAP. When the presence of contaminates exceeds levels specified under WASQAP, formal notification to cease mussel collection is given to mussel farmers and Fisheries Officers enforce the closure through monitoring until further testing indicates that mussel harvesting can commence again. There were four formal mussel harvesting closures in 2002/03.

Black pearl compliance activities involved informal inspections of navigational marking requirements and boundary leases. A number of licensees were formally notified regarding inadequate marking of lease sites. Formal operations involving audits of licensee operations will be carried out during 2003.

REGIONAL RESEARCH OVERVIEW

The research undertaken within the Perth region included joint activities with the WA Maritime Training Centre (Challenger TAFE) on marine finfish. This has produced encouraging results in larval and nursery trials as well as a grow-out trial using an intensive system for yellowtail kingfish (*Seriola lalandi*) culture as part of an Aquaculture Development Fund project. Broodstock collection, and conditioning of these fish at Challenger TAFE, has continued. Other related activities included farming trials with this species in rock

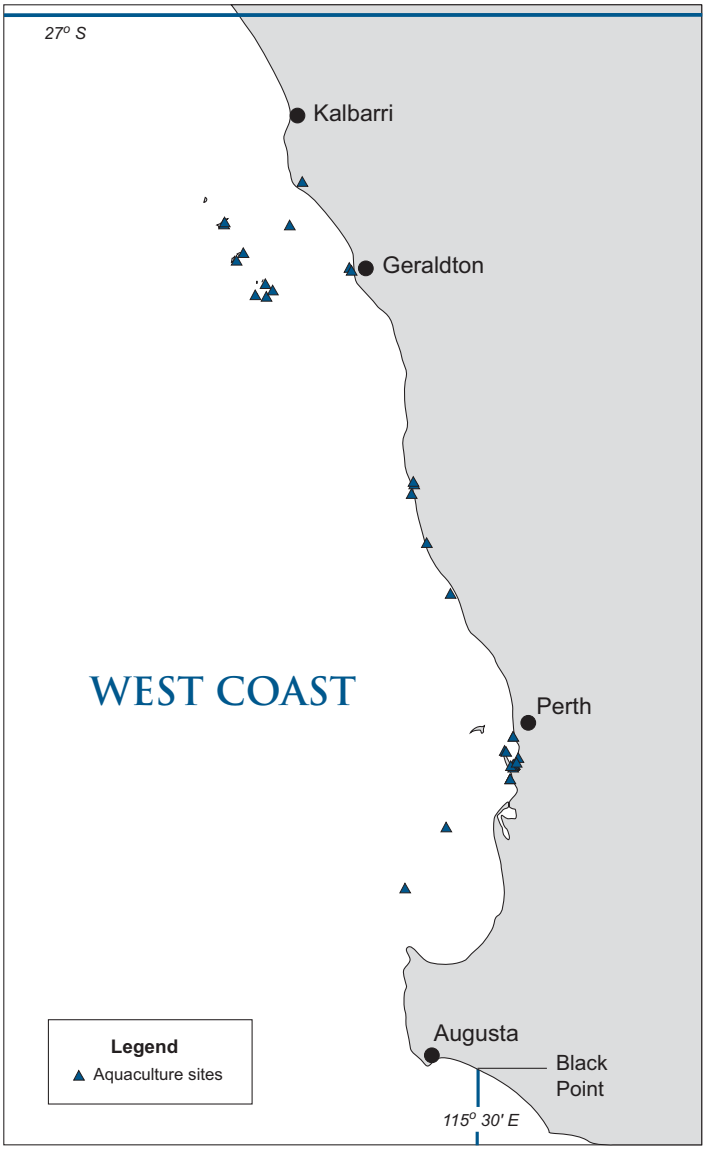
lobster holding systems in Geraldton and in a seawater supply channel for a marine algae (beta carotene) farm at Port Gregory. Growth rates, product quality and trial marketing results have been very encouraging. Efforts have continued to collect more yellowtail kingfish broodstock locally to allow commercialisation of this initiative.

Barramundi larvae have been reared in an automated larval rearing system designed by research staff, with funding support from FRDC. This project, assisted by Department of Agriculture staff, has evaluated different experimental and commercial products claiming to improve the nutritional content of brine shrimp larvae while minimising transfer of bacterial load to finfish larval tanks when brine shrimp are used as a feed. An automated system has been developed for enriching brine shrimp larvae and a finfish system adapted for growing brine shrimp adults from cysts.

Research has also commenced at the Port Gregory marine algae farm to determine how to grow brine shrimp for cyst and adult biomass production. Reliance on unpredictable supplies of imported cysts poses a major risk for marine finfish and prawn farming initiatives.

The algal facility at Challenger TAFE has been used by abalone researchers to quantify the grazing rates on attached diatoms (a type of algae) by juvenile abalone. Use of low light levels was found to improve the growth rates of abalone when fed some species but not others, probably because low light can inhibit the growth of some diatoms.

Collaboration with various universities has continued, with research students providing valuable results on food intake by juvenile abalone, physical characteristics of formulated microdiets for finfish larvae, rock lobster larval rearing, feed ingredient evaluation with juvenile snapper, yabby aquaculture, and capacity for natural marine habitats to utilise waste outputs from finfish sea cages.



WEST COAST AQUACULTURE FIGURE 1

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

Mussel Farming

Mussel Farming Status Report

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Mussel (*Mytilus edulis*) farms are found in Cockburn Sound and Warnbro Sound (as well as in the Albany harbours and King George Sound in the south coast bioregion). Resource-sharing issues are a major constraint to securing 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 productive growing areas.

Production method

Vertical rope and bag culture on longlines.

AQUACULTURE PRODUCTION

Production current season (2001/02): **989 tonnes**

Number of producers for year 2001/02: **14**

Production projection next year (2002/03): **900–1,100 tonnes**

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 nutrient inputs into waterways from domestic and industrial sources, as algae that take up these nutrients are consumed by mussels and are then removed as harvested mussel biomass. Secondly, faecal wastes from the farms 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 low food (plankton) levels. Monitoring of potential impact on seagrass beds below mussel lines at Albany indicated negligible impact. In Cockburn Sound, large pink snapper which 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 2001/02: $2.82 million

INDUSTRY GOVERNANCE

Licence approvals are required and regular site inspections are carried out to ensure farmers are operating within their site coordinates and 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.

EXTERNAL FACTORS

Productive areas are generally in protected waters where nutrients from terrestrial sources raise the food levels above those in coastal waters dominated by the low-nutrient, tropical Leeuwin Current.

GASCOYNE COAST BIOREGION

REGIONAL AQUACULTURE DEVELOPMENT OVERVIEW

The production of pearls and pearl oysters remains the primary coastal activity in the Gascoyne. Given that recruitment of oysters in the wild is irregular in this region and cannot be relied upon for commercial operations, hatchery production is of critical importance. Two hatcheries, one in Carnarvon and one in Exmouth, are producing significant quantities of *Pinctada maxima* spat to supply pearl farms in Exmouth Gulf and the Montebello Islands, while several hatcheries continue to supply *Pinctada margaritifera* juveniles selected from high-quality broodstock, providing a sustainable production base for this growing industry.

Black pearl production through culture of *P. margaritifera* has continued to expand during 2002/03, with farms increasing carrying capacity and also holding greater numbers of 'seedable' shell. Culture of *Pinctada albina* in Shark Bay and *Pteria penguin* in the far north-west of this region provides a diverse production base to the 'non-*maxima*' pearl industry in Western Australia. Pearl growers are improving production systems and decreasing costs through implementation of best practice methods, utilising more advanced equipment and experienced staff.

Despite the pre-eminence of pearl production, there has been recent development in the production of a range of other aquaculture species on the Gascoyne coast. In the north-west of the region, culture of high-value marine crustaceans has advanced with the further development of innovative and highly productive raceway culture systems for the nursery culture of prawns. These experimental techniques have provided alternative culture methods for the intensive production of brown tiger prawns (*Penaeus esculentus*) and should increase future productivity of black tiger prawns (*Penaeus monodon*). In 2002/03, one company was given approval to release significant hatchery-raised juvenile brown tiger prawns in Exmouth Gulf as part of a FRDC project to evaluate the viability of stock enhancement for prawn fisheries. Other species being examined for potential aquaculture production include two species of tropical rock lobsters – the painted rock lobster (*Panulirus ornatus*) and the green rock lobster (*Panulirus versicolor*).

Development of techniques for the aquaculture production of serranid finfish such as estuary cod (*Epinephelus coioides*) in the Gascoyne has again made considerable progress, building upon last year's production of hatchery-reared juveniles.

The profile of inland aquaculture on pastoral rangeland stations continues to grow, with an increase in membership of the Gascoyne Inland Aquaculture Group and the establishment during 2002/03 of pilot aquaculture operations in artesian bore water on Callagiddy and Hamelin stations. Marine ornamental finfish culture has also progressed with the production of juvenile clown fish and sea horses this year.

Development and extension activities during 2002/03 included the development of grower groups and the facilitation of related meetings. Aquaculture licensing advice, and assessment of applications for licences or variations to licences, remained important responsibilities.

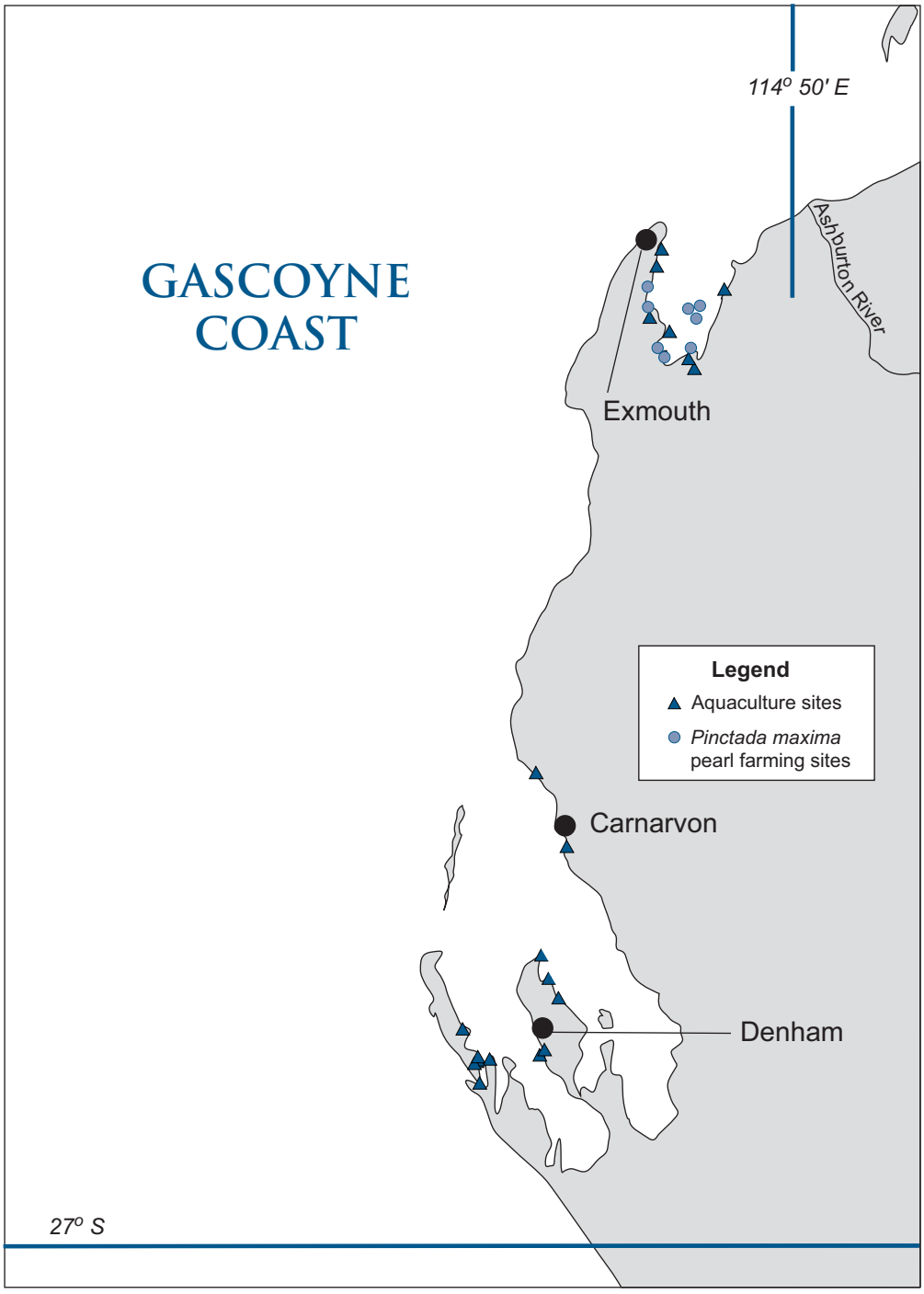
Liaison with existing and prospective aquaculturists and the provision of information, advice and assistance continued through field visits and remote communication. Further assistance was provided in identifying sites for pearl production in Shark Bay and Exmouth Gulf, and in site selection and systems design for inland stations. Significant advice and support was also provided in relation to the development of a marine finfish aquaculture facility in Exmouth Gulf. In March, an aquaculture pond construction workshop was conducted in Carnarvon and was well attended by both farmers and earth moving contractors.

During 2002/03, compliance staff in the bioregion completed audits of aquaculture sites and facilities, including inspections of lease sites, facilities, authorisations and product, both at sea and on land. Compliance activities utilised the newly introduced Aquaculture Compliance Checklist during site inspections and audits.

Gascoyne Coast Aquaculture Figure 1 shows the major licensed aquaculture sites in this bioregion.

REGIONAL RESEARCH OVERVIEW

There have been no major research activities 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.



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.

NORTH COAST BIOREGION

REGIONAL AQUACULTURE DEVELOPMENT OVERIVIEW

The north coast bioregion is dominated by the production of pearls from the species *Pinctada maxima*. This industry is reported separately in the following pages.

Other aquaculture activities are focused on production of barramundi (*Lates calcarifer*), redclaw (*Cherax quadricarinatus*), and trochus (*Trochus niloticus*) for reef enhancement, and on developing the black tiger prawn industry and indigenous aquaculture.

An Indigenous Aquaculture Development Working Group was formed with representatives from relevant Government agencies to assist with the promotion and development of a pathway for indigenous aquaculture and to work closely with the recently formed national Indigenous Aquaculture Unit on overcoming issues affecting indigenous groups entering the industry.

Focus has been placed on coordinating feasibility studies in strategic locations across the Kimberley aimed at establishing two model farms for indigenous aquaculture in the East and West Kimberley. Cherabin (*Macrobrachium rosenbergii*), redclaw (*Cherax quadricarinatus*) and barramundi (*Lates calcarifer*) have been identified for these demonstration sites.

The multi-species hatchery in the Broome Tropical Aquaculture Park (BTAP) is producing trochus to supply 19 commercial harvesting licences issued to indigenous groups on the Dampier Peninsula. Commercial reseeding activities have been complemented by broodstock enhancement to further increase juvenile recruitment to depleted areas of traditionally fished reefs.

An indicative grow-out trial of black tiger prawns was conducted at the BTAP during the dry season of 2002. Post-larvae were produced at the BTAP during the Kimberley Aquaculture Research Project (KARP). This project, initiated by the Kimberley Development Commission, was aimed at developing hatchery technology for the Kimberley region. The Kimberley College of TAFE, Tiger International Hatcheries and staff from the Multi Species Hatchery Pty Ltd assisted the trial, the results of which are providing information to be used in the development of a model for predicting pond temperatures.

Following the KARP project last year, a collaboration of industry and Government stakeholders has been funded by the Kimberley Sustainable Regions initiative for a project titled 'The Commercialisation of Black Tiger Prawns in the Kimberley' (see Research Overview below). It is anticipated the results will contribute significantly to the expansion of the prawn industry in Western Australia.

Promotional activities have resulted in further interest at the Broome Tropical Aquaculture Park, with six of the seven sites now leased. The most recently joined lessee will establish facilities integral to future development of the prawn industry in the region and complement existing facilities in the park.

The principal development activities for 2002/03 focused on public enquiries, delivery of extension services, ongoing technical and licensing advice, and planning for future aquaculture expansion in the region.

In accordance with compliance risk assessments, Fisheries Officers carried out compliance inspections of existing licensees in the north coast bioregion to ensure licence conditions were being met. All licensees were found to be compliant.

REGIONAL RESEARCH OVERVIEW

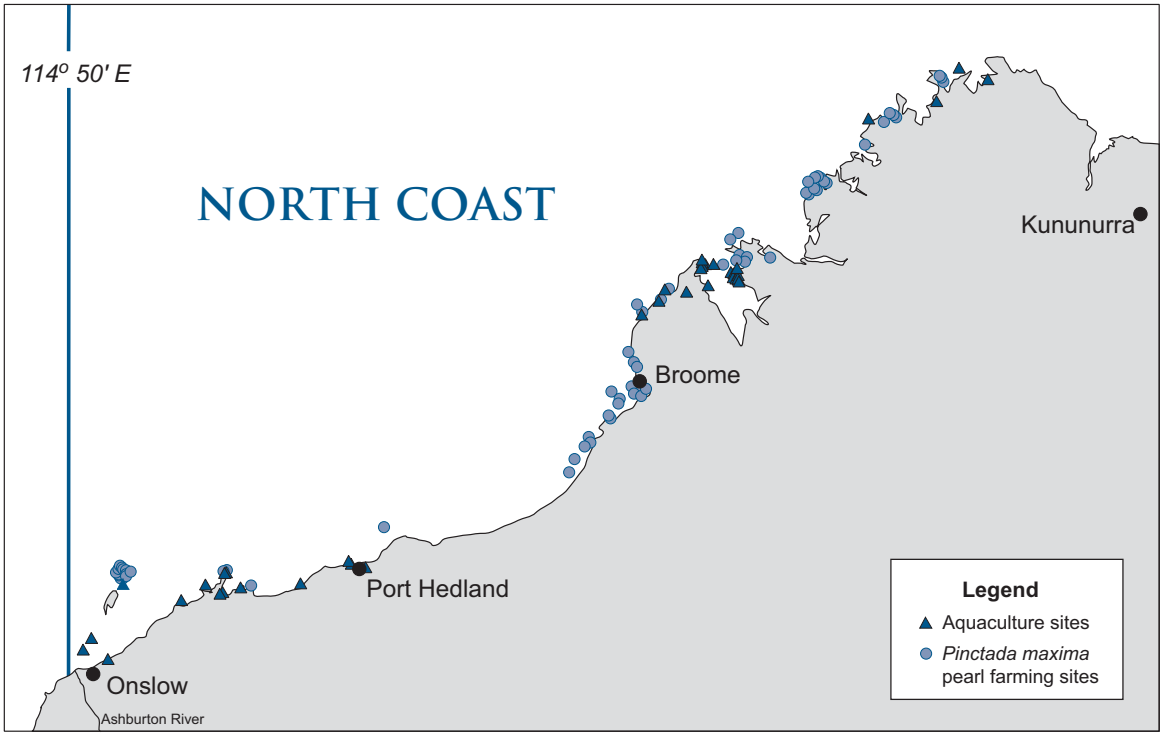
Research staff took on leading roles in a new project funded by the Australian Centre for International Agricultural Research (ACIAR) and managed by the Kimberley Aquaculture Aboriginal Corporation (KAAC). The project will evaluate, through intensive sampling, the effectiveness of moving broodstock trochus to reefs to try to improve recruitment of juveniles in the Dampier Peninsula (north of Broome). This complements the broodstock transfers associated with commercial harvesting licences (see Regional Development Overview above). Comparable ACIAR programs are being completed in both Vanuatu and Western Samoa.

The sampling and analysis for an FRDC project to characterise the disease and parasite profile of marine prawns in this region has now been completed. *Penaeus monodon*, the key species for aquaculture, has so far been shown to be free of the major viruses that have impacted on prawn farming in Queensland and overseas. The KARP pilot-scale hatchery trial with this species, discussed in the Regional Development Overview, helped to generate samples for the disease survey. A joint project with the University of Western Australia modelled local climatic and inshore seawater data to predict pond water temperature and salinity at Exmouth and Wyndham.

Research staff were also involved in assessing a range of potential sites in areas occupied by local indigenous communities interested in joint prawn farming ventures.

A major Kimberley Sustainable Regions Program grant application, prepared by research staff for the KAAC, has been successful. This will be led by an experienced Research Division scientist and will involve all facets of *P. monodon* production from wild broodstock surveys and collection through to hatchery production, grow-out and trial marketing. It will also allow further sampling for disease incidence with this species.

Initial work with the Aboriginal-owned marine hatchery at One Arm Point on the Dampier Peninsula has shown potential for transferring nursery techniques, originally developed by researchers for the abalone farming industry in the south coast bioregion, to trochus and tropical abalone culture.



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.

Pearl Production

Management Summary

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 Western Australian 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 pearling industry is the most valuable aquaculture industry in Western Australia and second only to the State's rock lobster fishery in the value of its export earnings. The global decline in pearl prices sees the pearling industry now worth around $126 million per annum. The industry employs approximately 1,500 people, primarily based in Broome or Darwin. Sixteen licensees have been granted rights to fish and farm pearl oysters for pearl production.

The Department of Fisheries carries out management of the pearling industry in accordance with the *Pearling Act 1990* (the Pearling Act), *Pearling* (*General*) *Regulations 1991* and associated operational policies. The Department works collaboratively with industry to ensure that the benefits derived from the use of public resources (i.e. the wild stocks of pearl oysters and use of the marine waters) are maximised for both industry and the State.

A Pearling Industry Advisory Committee (PIAC) is established under the Pearling Act to provide the Minister with independent advice on the management of the industry.

The Pearling Act provides for the preparation of Ministerial Policy Guidelines to guide the Executive Director in his use of discretionary powers under the Act. To date, two Ministerial Policy Guidelines for pearling have been approved by the Minister – Ministerial Policy Guideline no. 8, which specifies the public consultation process required before the grant of a pearl farm lease, and Ministerial Policy Guideline no. 17, which details the operational arrangements for management of the fishery and covers such topics as separation of pearl farm leases, hatchery options to quota conversion criteria and foreign investment guidelines.

Disease management is an important consideration, owing to the risks of spread of disease through the transportation of

pearl oysters from a hatchery to a pearl farm, between farms or from a farm to the wild stocks. The Department of Fisheries in conjunction with the Department of Environmental Protection has developed a translocation protocol to educate industry members on the disease risks and encourage industry to obtain the necessary health clearances prior to transporting pearl oysters.

There are currently 572 wild-stock quota units and 350 hatchery options/quota units allocated amongst the 16 pearling licensees. The status of wild stocks is reviewed each year by the Department of Fisheries in liaison with pearling licensees and PIAC to enable the total allowable catch to be set for each zone of the fishery.

The TAC for Zone 1 for 2002/03 was maintained at 55,000 shell, reduced the previous year from 115,000 shell to relieve pressure on stocks that were impacted by earlier cyclone events. Zone 1 licensees are permitted to substitute hatchery-reared pearl oysters for wild-captured oysters to maintain their annual pearl production. A maximum size limit of 160 mm was also maintained for shell taken from Exmouth Gulf to protect breeding stock.

The TAC in Zone 2/3 was reduced to the long-run average of 1,000 oysters per unit from the previous year's level of 1,050. This reduction was made in response to the catch rate data, which indicated that a past peak in recruitment had now moved through the target size class and the stocks had returned to their more normal catch levels.

Seeding of hatchery-produced oyster continued in 2002/03, with a maximum of 350,000 hatchery shell able to be seeded. All but three companies have now fully converted their hatchery options to hatchery quota. Full conversion of hatchery options is expected in 2003/04.

During 2002/03 key activities focused on the review of the Pearling Act and preparation of the Department's submission to Environment Australia on ecologically sustainable development of the pearl oyster fishery.

The Department worked closely with industry to develop a set of proposed amendments to the current Act, which will be considered by PIAC in mid-2003. Many of the outcomes of the National Competition Policy review of the Pearling Act will be progressed through these proposed legislative amendments. It is anticipated that a draft Bill will pass through the usual Parliamentary processes and public consultation phases, with a view to proclamation of a new Pearling Management Act in late 2004.

Consultants were engaged and a working group established to provide the Department with advice on public policy issues surrounding possible future allocation of additional hatchery quota units. The working group comprised officers of the Departments of Fisheries, Premier and Cabinet, and Treasury, and an industry representative.

The Department's ESD report was lodged with Environment Australia in October 2002. A final recommendation from EA is pending.

Resource-sharing issues progressed during 2002/03, with the Minister determining several appeals against pearl farm leases in the Kimberley. An independent consultant was engaged by the Minister to provide advice on significant applications. The Department facilitated a meeting of marine tourism and pearling industry representatives, in which an agreement was struck regarding future sharing of the waters between Broome and the Northern Territory border.

PIAC met twice, primarily to consider the proposed legislative amendments and progress toward implementation of NCP outcomes.

Other issues, including budget development and management and operational planning, continued to be a focus of attention in 2002/03. Significant progress was made toward the introduction of a 'fee for service' model in the area of disease testing. A comprehensive review of compliance within the pearling industry continued.

Governing Legislation/Fishing Authority
Pearling Act 1990
Pearling (General) Regulations 1991

Consultation Process
Pearling Industry Advisory Committee
Department–industry meetings

Compliance and Community Education Summary

During 2002/03, Fisheries Officers based in Broome, Karratha and Exmouth again undertook compliance monitoring across all four zones of the pearl oyster fishery. Fishing operations (harvest of pearl oyster shell) in Zone 1 of the fishery are now all monitored by the Vessel Monitoring System (VMS).

At the start of the pearling season, officers accompanied pearl catcher boats to sea to monitor fishing activity on a daily basis and also to investigate ways of reducing compliance costs to the pearling industry.

Companies have continued to increase production of hatchery-reared shell, and compliance has placed increased emphasis on the monitoring and control of this product. Compliance issues involving the verification of the numbers of shells seeded, plus the movement of hatchery shell within and between farms, have been made a higher priority. Regular farm and nursery site inspections were conducted to monitor hatchery shell grow-out, and to ensure that farms and leases were appropriately marked with navigational markers to approved standards.

Wild-stock quotas continued to be monitored through a combination of quota tags and a paper audit trail using catch, dump, transport and seeding operations logbooks submitted by licensees to the Department. The production and translocation of hatchery-produced pearl oysters is also monitored by the system of hatchery and transport logbooks, combined with a system for disease testing, quarantine and health certificate clearances from the Department's Fish Health section.

Patrols to verify compliance with tagging and associated logbook systems utilised diving inspections, aircraft, both large and small agency patrol vessels and industry boats. The majority of at-sea inspections and patrols were carried out using the Department of Fisheries' ocean-going patrol vessel *Walcott*, with smaller agency vessels being used as dive platforms.

There were no major breaches of regulations recorded in the pearling industry during 2002/03. However, there were some minor breaches, in particular a failure to adequately advise the Department (within the required timeframes) of seeding and other activities.

Research Summary

Research for managing the pearl oyster stocks utilises detailed diver logbook records (catch and effort), at-sea sampling of catches and information gather during research projects. This information is used to monitor the status of the stocks and to review and set catch quotas each year.

An FRDC project, which began in 2000, seeks to determine an index of recruitment for the pearl oyster fishery by assessing settlement of spat of *Pinctada maxima* on adult oysters (piggyback spat). It will also assess spatial differences in size-frequency of catch, shell quality, and oyster habitat. The 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.

Pearl Oyster Fishery Status Report

Prepared by A. Hart and D. Murphy

FISHERY DESCRIPTION

Boundaries and access

The pearl oyster fishery of Western Australia accesses silver-lipped pearl oysters, *Pinctada maxima*, in shallow coastal waters along Western Australia's North West Shelf. There are currently 16 licences operating in the fishery, with a total of 12–16 vessels fishing for pearl oysters in any given year. The fishery is separated into four zones (Pearl Figure 1), and each licence is allocated an individual shell quota as part of an overall TAC.

The four management zones of the pearl oyster fishery are as follows:

Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30′ E.
5 licensees.

Pearl Oyster Zone 2: East of Cape Thouin (118°20' E) and south of latitude 18°14′ S. 9 licensees.
Note: full access for Zone 2 licence holders to Zone 3.

Pearl Oyster Zone 3: West of longitude 125°20′ E and north of latitude 18°14′ S.
2 licensees.
Note: partial access for Zone 3 licence holders to Zone 2.

Pearl Oyster Zone 4: East of longitude 125°20′ E to WA/NT border.
Note: although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not viable. However, pearl farming does occur.

Main fishing method

Diving.

RETAINED SPECIES

Commercial production (season 2002): 508,688 shell

Landings

In 2002 the number of wild-caught pearl shell was 508,688 shells. The total allowable catch for the pearl oyster fishery was 534,750 shell (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 29,126 shell from the wild fishery, out of a total TAC of 55,000. The remainder was obtained from hatchery production. This conversion to hatchery stock is due to 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 2002 was 479,562 shell from a TAC of 479,750. This TAC was 5% less than in 2001 (502,500), but was still 5% above the normal TAC for this region. See 'Fishery Governance' section for details.

Fishing effort

Total effort in all zones was 18,390 dive hours, which is within the acceptable range (14,071–20,551 dive hours) defined for all zones in 2002. The total effort for 2002 in Zone 2/3 was 15,661 dive hours (acceptable range 11,456–15,819 dive hours), which represented a 30% increase on the 2001 Zone 2/3 effort of 12,054 dive hours. This increase reflects a shift in effort towards a more traditional figure for Zone 2/3, as the effort in 2000 of 9,258 hours was the lowest ever recorded. The total effort in Zone 1 during 2002 was 2,729 dive hours, representing a 71% decrease on the 2001 total effort of 9,480 dive hours, and at the lower end of the acceptable range (2,615–4,732 dive hours) defined for Zone 1. This decrease in Zone 1 occurred with 58% less catch than 2001(Pearl Table 2), and is due principally to a shift to the increased use of hatchery shell.

Catch rate

The catch rate for the pearl oyster fishery (all zones) was 27.7 shells per dive hour (shells/hr) in 2002. This is similar to the overall catch rate for last year (26.5 shells/hr) but this masks the substantial drop that occurred in Zone 2/3. The CPUE for this region 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.

For Zone 1, the 2002 CPUE was 10.7 shells/hr, an improvement compared to the 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 to 14 shells/hr. In the southern sector, catch rates fell to 3.3 shells/hr in 2001 but have also increased in 2002 to 7 shells/hr. Whilst catches have decreased in the middle sector during 2002 as a result of decreased effort, the CPUE has remained steady at 7.3 shells/hr.

Recreational component (2002): **Nil**

Stock assessment completed: **Yes**

Zone 2/3: The high catch rates recorded in recent years in these zones (1994–1996 and 1999–2001) had previously only been experienced during the late 1970s and early 1980s when both culture and mother-of-pearl (MOP) shell were collected. However, to compare historical catch rates with more recent data, the impact of technological changes, such as those related to the introduction of GPS in the early 1990s, must be considered. The increased efficiency these changes have produced would have stabilised by the mid-1990s, allowing catch rates since this time to be directly compared.

The high catch rates recorded during 1994–96 and 1999–2001 were caused by large pulses of recruits that passed through the size range targeted by the fishery. These increases in recruitment are probably attributable to favourable environmental conditions that enhanced larval and juvenile survival during the preceding two years. These improved conditions are possibly related to El Niño/Southern Oscillation events, the latest of which occurred in 1997/98 and 2002/03.

In 2002, 75% of the pearl shell catch was taken from the top three grids (10 x 10 mile areas) in Zone 2. The decrease in effective search time and fishing area in recent years reflects increased stock abundance and the fleet's ability to target productive areas through the use of GPS and plotter technology. During the last six years the average depth fished has generally decreased, which further increases efficiency by providing additional bottom time, although average depth fished in 2002 was the deepest (13.4 m) since 1996 (Pearl Table 1), indicating that diving conditions (visibility) were not as good.

Around 60% of the catch within Zone 2/3 is from the 120–140 mm shell height size classes. These are the smaller, newly recruited oysters that are preferred for pearl culture. These results, together with the fact that a decreasing proportion of the fishable area off the Eighty Mile Beach is being fished annually, suggest that the overall exploitation rate in this sector of the fishery is decreasing.

Zone 1: In 2002, only 29,126 pearl shell were taken from Zone 1 stocks, compared to 68,931 in 2001 (Pearl Table 2). This low catch from Zone 1 was primarily the result of hatchery substitution, with industry operators preferring to obtain pearl shell from the hatchery rather than the wild stock. The CPUE in 2002 of 10.7 shells per diver hour, though 30% higher than in 2002 (7.3 shells/hr), remained the second lowest ever recorded in Zone 1 (Pearl Table 2). However, it needs to be recognised that substantial changes in patterns of fishing and decreases in availability of experienced pearl divers during the period 1999–2002 have negatively affected the time series of catch and effort data, so that all interpretation must proceed with caution.

Issues with the fishery data notwithstanding, the evidence is that the Zone 1 stocks remain in a depleted state, primarily as a result of reductions in the middle and Exmouth Gulf sectors, which sustained an annual fishery of around 40,000–50,000 shell between 1984 and 1992. The reasons for these depletions are simultaneously environmental (major cyclones impacting stocks in Onslow and Exmouth) and fishery-related (Exmouth Gulf experienced an average harvest of 70,000 shell between 1993 and 1998 which was well above historical levels). The 40,000 shell quota set for Exmouth Gulf from 1998 to 2002 has also not been achieved. However, as a result of increasing, now substantial substitution of hatchery stock (1998–2002), the fishing pressure in Zone 1 has been reduced. This effect, coupled with the 2002 upturn in catch rate and recent recruitment data from Exmouth Gulf, suggests that the stock may be beginning to re-build.

Based on the historical catch and effort data and the effect of more recent higher catches, the maximum sustainable catch from Zone 1 is assessed to be below the current 55,000 level.

Exploitation status: **Fully exploited**

Pearl oyster stocks are considered to be fully exploited within the management parameters of diver safety and the maximisation of the value of the pearl crop.

Breeding stock levels: **Adequate**

As *P. maxima* are protandrous hermaphrodites, oyster stocks do not have a full complement of females until shell sizes reach approximately 180 mm shell height. Pearl oyster fishers prefer to harvest oysters between 120 and 165 mm shell height, hence oysters larger than 165–170 mm remain as breeding stock.

Zone 2/3: The fishery focus has moved away from deep-water pearling grounds that now remain unfished or only lightly fished. Research surveys of these areas confirm good abundance of larger mother-of-pearl shells. The stocks remaining on these deeper and more distant pearl grounds will be contributing to an increased abundance of breeding stock given the longevity of the species.

Zone 1: The breeding stock levels in Zone 1 are maintained by the upper size limit, but are of greater concern due to the high levels of fishing pressure on recruits. The setting of separate quotas for previously heavily fished areas such as Exmouth Gulf has been designed to generate flow-through to breeding stock and this effect should result in an increased recruitment.

Breeding stocks in the south of Zone 2 are also expected to provide recruitment to the northern area of Zone 1.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

Divers have the ability to target pearl oysters of choice (species, sizes and quality of *P. maxima*) and do not inadvertently harvest any bycatch in their normal fishing activities. 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 more significant 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 to culture pearls, has limited impact on the environment. Physical effects are limited to static anchoring systems in typically sand/mud habitats. Material released when cleaning off naturally occurring biofouling from longlines is also dispersed by the high tidal flows characteristic of farm sites, and unlikely to cause detectable effects on the sea floor.

SOCIAL EFFECTS

Pearl oyster fishing vessels operate from the Lacepede Islands south to Exmouth Gulf. The 12–16 fishing vessels presently operating each have 10–14 crew involved with the fishing of pearl oysters between January and July 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.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001/02): $130 million

The value of cultured pearls and by-products is considered to be approximately $130 million for the financial year 2001/02. 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: **14,071–20,551 dive hours**

The decision rules used in this fishery operate such that if the catch rates increase by more than 50% above the long-term average, the TAC in the following year will be increased by 10%. Consequently, the increased catch rates observed during 2000 resulted in the quota for Zone 2/3 in 2001 being increased from its traditional level by 10% to 502,500 shell. For 2002, the TAC was decreased to 479,750 shell (which was still 5% above the traditional level) as a precautionary measure reflecting the slightly lower abundance observed in 2001. Moreover, the lower catch rate of 30.6 shells/hr observed in 2002 has resulted in the 2003 quota being set at the original level (457,000 shell). It is expected that Zone 2/3 of the pearl oyster fishery should achieve its 2003 quota within the five-year range (1994–1998) of 11,456–15,819 dive hours, although catch rates may fall again if the previous level of recruitment is not maintained.

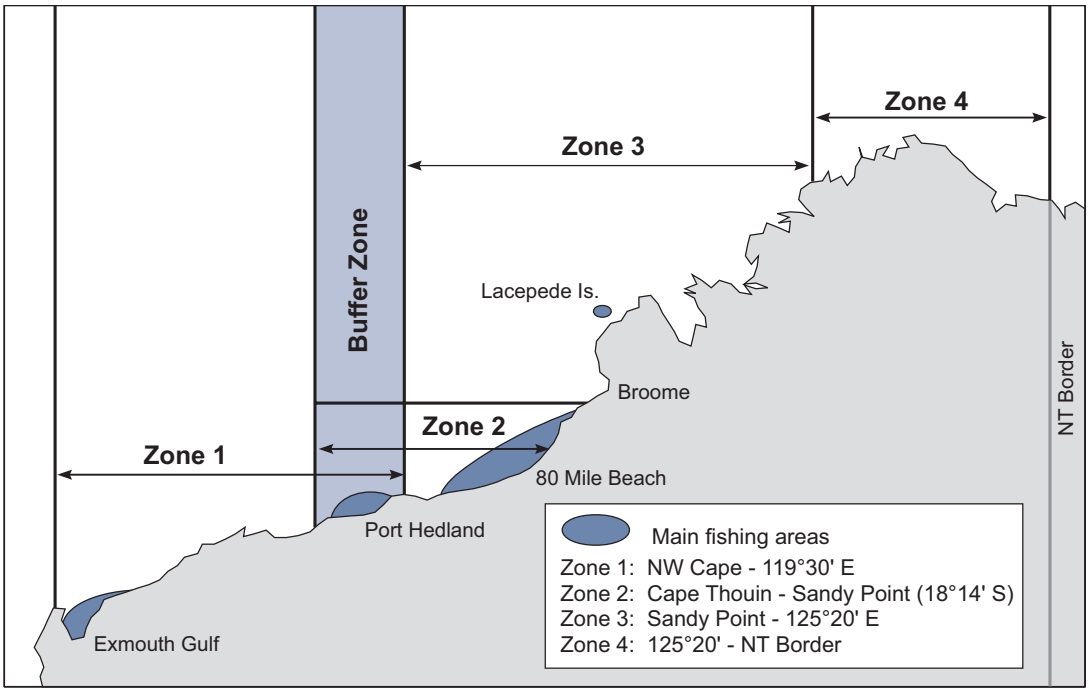
The wild-stock TAC for Zone 1 licensees remains at 55,000 shell in 2003, though current hatchery substitution arrangements mean that the actual catch cannot exceed 45,000 shell. However, it is expected that the catch will be well below this figure due to further hatchery substitution.

The acceptable effort range for Zone 1 to achieve a catch of 55,000 shell is estimated to be 2,615–4,732 dive hours (based on a pro rata effort estimation for 55,000 shell for the five-year period 1994–1998). However, because catches are expected to be well below 55,000 shell, the effort is likely to fall under this range.

Overall, the acceptable range of effort for the entire fishery for the 2003 season is 14,071–20,551 dive hours.

EXTERNAL FACTORS

The pearl oyster stocks underpinning the fishery in Zone 2 (> 80% of total pearl oyster catch in 2002) continue to provide sufficient level of production to support this major Western Australian industry. A current FRDC-funded project will determine whether there is a reliable relationship between numbers of spat of *P. maxima* on adult oysters (piggyback spat) and catch rates two to three years later. If this can be demonstrated, the relationship could be used to predict future abundance. In addition, the relationship between recruitment and environmental factors could be further evaluated to extend the predictions. This information would greatly assist managers in determining quota allocations, as there is currently a heavy reliance on retrospective catch data to determine TACs. Noting that pearl oysters are fished for approximately three years after reaching legal size, projections based on past catch data can under- or over-estimate available stock.



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**

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[3]**	**29,126[2]**	**0**	**29,126**	**2,729**	**10.7**	**0**	**10.7**

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 1999–2002 reduced the need for wild-stock shell.
3. In 2002, the 115,000 Zone 1 quota was still maintained, however only 55,000 could be caught from wild stock.

SOUTH COAST BIOREGION

REGIONAL AQUACULTURE DEVELOPMENT OVERVIEW

The south coast bioregion encompasses the major centres of Albany and Esperance. The predominant mariculture activities undertaken in the region centre on the commercial production of oysters (principally the western rock oyster, *Saccostrea* affin. *glomerata commercialis*) and mussels (*Mytilus edulis*) in Albany. Hatcheries and grow-out facilities for greenlip abalone (*Haliotis laevigata*) have been established in Albany and in Bremer Bay. Cultured abalone (other than spat) was sold for the first time this year.

Several sites along the south coast have been identified as potentially suitable for abalone aquaculture. One of these sites in Esperance adjacent to the Bandy Creek boat harbour has had temperature dataloggers installed and 12 months of data had been collected as of March 2003. These types of monitoring activities assist proponents in selecting suitable sites.

Management activities concentrated on the Albany Aquaculture Park, which contains two sites leased for oyster and abalone production. Two sites remain available for lease. Leaseholders in King George Sound prepared an environmental monitoring plan to meet licensing requirements for sea-based abalone grow-out. These leaseholders also investigated the requirements for participation in the WA Shellfish Quality Assurance Program and as a result will be implementing a monitoring program to ensure shellfish quality.

Fisheries Officers continued to supervise the sampling of waters and shellfish and monitor harvest closures as part of WASQAP. At-sea inspections were conducted on all lease sites in Oyster Harbour, King George Sound and Wilson Inlet to ensure compliance with marking and lighting requirements along with adherence to the restriction of aquaculture activity to within approved lease boundaries. There were some reports of the alleged theft of marker lights from leases in King George Sound, with leaseholders experiencing delays of up to eight weeks in sourcing appropriate replacement lights. Officers also monitored the collection of abalone broodstock for both abalone hatcheries in this bioregion. This year broodstock was collected under exemption as well as through nominated divers operating under the authority of an Abalone Managed Fishery Licence. One prosecution brief has been submitted relating to broodstock collection.

REGIONAL RESEARCH OVERVIEW

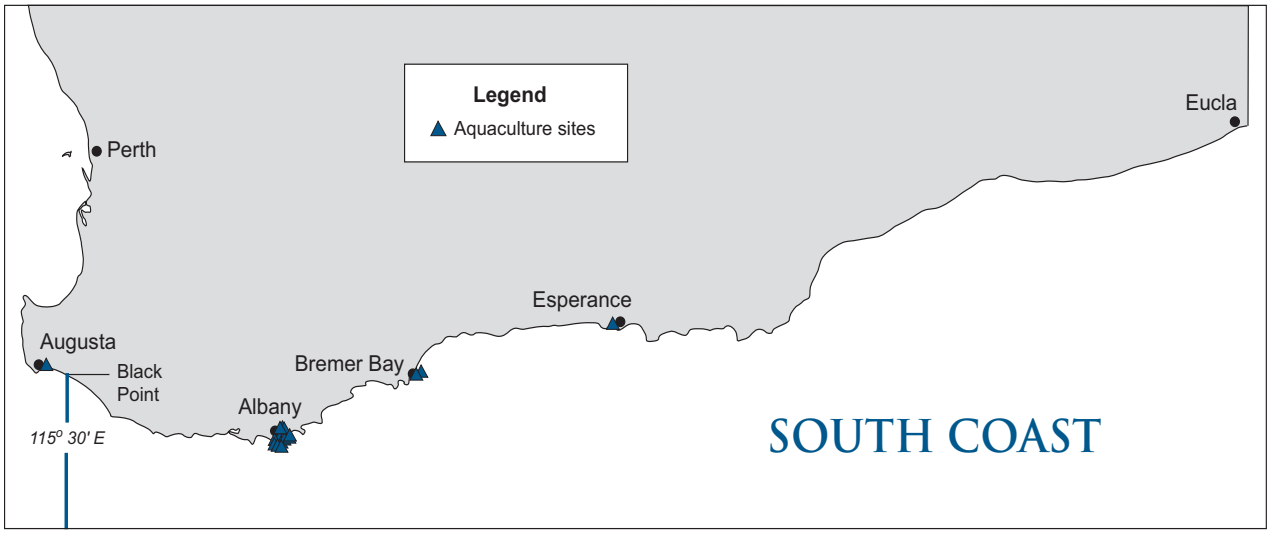
The use of novel types of algae feeds has greatly increased production of greenlip abalone in experimental and commercial nursery tanks. Using a succession of algal types allows farmers to now induce the abalone larvae to settle onto nursery plates and initially grow well feeding on a diatom film. Later, they grow better using the green alga, *Ulvella lens*, which grows vigorously on the plates.

A new FRDC-funded project, based mainly at the Great Southern Marine Hatcheries (GSMH) in Albany, will assess ways to extend the nursery tank phase and delay the transfer of juveniles to the large, shallow land-based tanks, as current weaning losses can be substantial. Initial trials using a weaning diet formulated by Departmental research staff, and an experimental habitat that can be fitted into commercial nursery tanks, have produced by far the best growth rates achieved nationally in nursery systems supplied with a formulated feed.

This new grant will also assess better ways of feeding captive broodstock held over long periods. Whilst earlier broodstock conditioning research at GSMH was successful in obtaining controlled spawnings outside of the normal breeding season, there is some evidence that, after lengthy holding periods, the eggs produced may be nutrient-deficient.

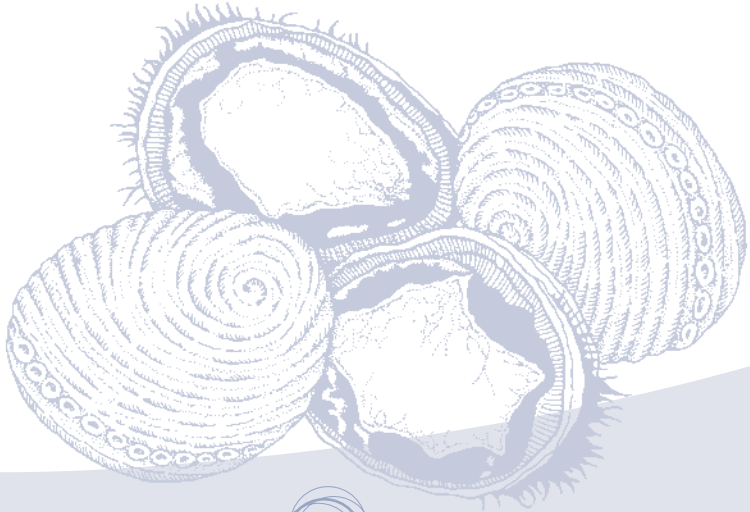
Another FRDC-funded study is assessing the health status of farmed and wild abalone stocks (see Appendix 5).

Finally, a collaborative research project with the Department of Agriculture has established that there is very little risk of successful breeding on natural reefs by abalone that have grown from fertilised eggs released in discharge from land-based farms. A complementary genetics study undertaken with CSIRO has shown that three populations of wild greenlip abalone on the south coast of Western Australia are relatively similar. These two outcomes will be used in a review of the genetic zones for sourcing wild broodstock for aquaculture purposes. The risk of impact from land-based abalone farms on the genetic profiles of wild populations now seems to be very low.



SOUTH COAST AQUACULTURE FIGURE 1

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



NORTHERN INLAND BIOREGION

REGIONAL AQUACULTURE DEVELOPMENT OVERVIEW

Development activities in the northern inland bioregion for 2002/03 included facilitation of the necessary approvals to commence major aquaculture ventures, provision of extension services to new and existing clients, and assistance to Aboriginal communities to meet their aquaculture development objectives.

Technical advice was provided to landholders on the Ord irrigation system around Kununurra in relation to the production of redclaw (*Cherax quadricarinatus*), aquarium fish and barramundi, with particular emphasis placed on the development of community-based indigenous aquaculture projects. Barramundi production on Lake Argyle has increased and the diversification of pastoral leases to include aquaculture also increased last year.

Cage farming of barramundi (*Lates calcarifer*) on Lake Argyle has undergone recent expansion and is on track for the initial targeted 600 t per annum. Significant investment together with environmental approvals gained during 2001/02 have seen a restructuring, with the Ord River Co-op, sole shareholders in Lake Argyle Industries, expanding the facilities in 2002/03 to allow for increased production. This expansion has been supported by environmental monitoring of the lake undertaken by Departmental research staff.

Redclaw production has increased significantly this year, with an 8 ha farm in the East Kimberley now supplying redclaw to local markets. Pilot production has exceeded expectations and resulted in an increase in general enquiries for this species. Aquaculture site identification for preliminary planning trials on pastoral leases using cherabin and black tiger prawns were also a focus for development activities.

Diversification of pastoral activities in the West Kimberley, and a trial of redclaw production last year, have resulted in efforts to develop a commercial grow-out site on a pastoral lease south of Broome.

Interest in aquaculture projects from indigenous groups in the Pilbara was strong, with several preliminary site investigations conducted and workshops held for native title claimant groups in the area. These efforts have resulted in a broader understanding and acceptance of aquaculture in the region.

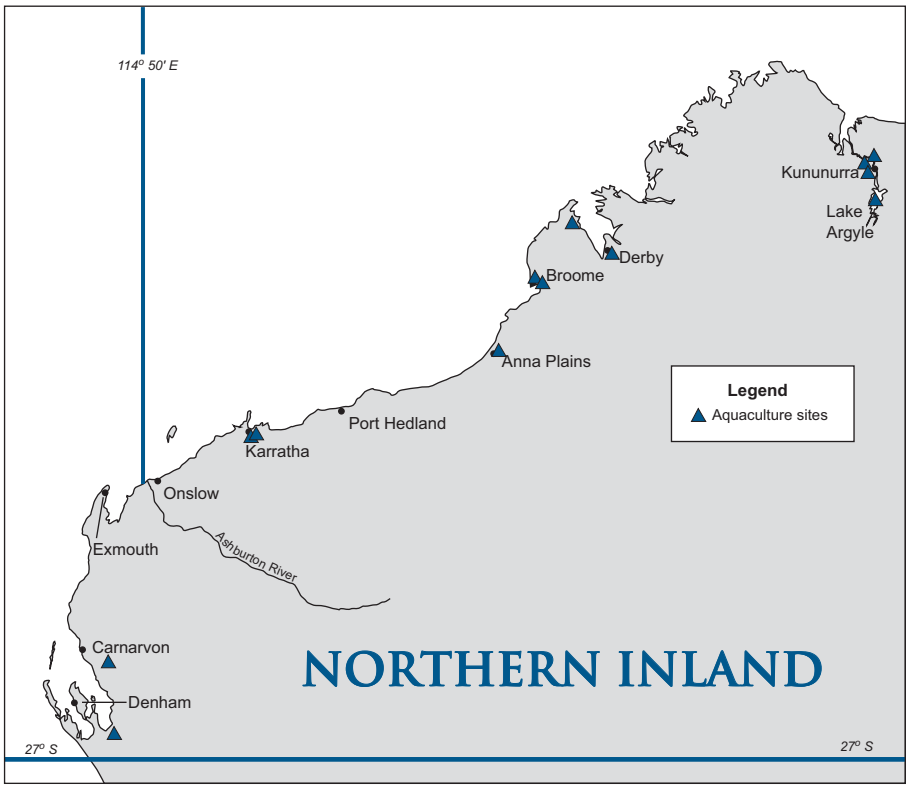
Fisheries Officers carried out compliance inspections of existing licensees in the inland bioregion and conducted risk assessments in line with the audit plan now in place to ensure compliance with existing licence conditions. All licensees were found to be compliant.

REGIONAL RESEARCH OVERVIEW

A project to evaluate waste outputs from a range of barramundi feeds, part-funded by the Aquaculture Development Fund (ADF), has been completed at Lake Argyle with Lake Argyle Industries. The outcomes highlight the advantages of high-energy feeds, in terms of both high growth rates and low levels of waste output. This work has permitted the updating, for barramundi, of an internet-based model for predicting potential waste output for a range of farmed species.

A further project proposal to the FRDC on minimising phosphorus and other nutrient inputs into Lake Argyle from this barramundi farm was approved during the year. This complements the environmental monitoring program developed for this farm by research staff.

Additional monitoring to characterise the annual Lake Argyle ‘turnover event’, when bottom water containing little oxygen moves to the surface where the cages are located, has commenced using ADF funding. The significant level of effort being made on barramundi projects in this region reflects the requirement for Lake Argyle to sustain the very large barramundi farms needed to achieve an attractive return in high-cost, isolated tropical sites.



NORTHERN INLAND AQUACULTURE FIGURE 1
Map showing the major licensed aquaculture sites of the northern inland bioregion.

Barramundi Farming

Barramundi Farming Status Report

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Barramundi (*Lates calcarifer*) is produced intensively in cages in Lake Argyle or in recirculating systems in the southern half of the State. Interest in producing barramundi is growing strongly.

Production methods

Barramundi can be farmed in cages in Lake Argyle or coastal areas, in inland saline ponds, or in intensive recirculating culture systems using fresh water, inland saline water or seawater.

AQUACULTURE PRODUCTION

Production current season (2001/02): 38 tonnes

Number of producers for year 2001/02: 11

Production projection next year (2002/03): 160–200 tonnes

ECOSYSTEM EFFECTS

Barramundi farming is considered to present a medium 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.

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

The industry is becoming a small but valuable source of regional employment, and has local tourism potential.

ECONOMIC EFFECTS

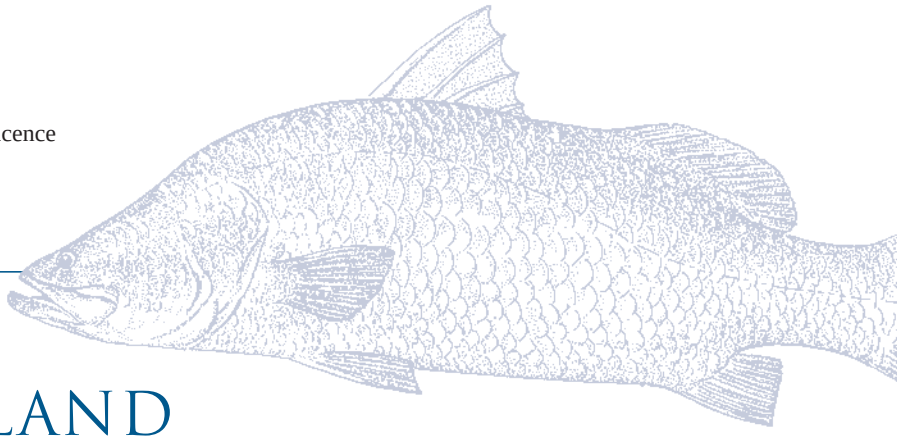
Estimated annual value (to producers) for year 2001/02: $420,000

INDUSTRY GOVERNANCE

To undertake barramundi farming, a Department of Fisheries aquaculture licence is required. A water quality monitoring program that is to the satisfaction of the Department of Environmental Protection must also be developed and maintained.

EXTERNAL FACTORS

This industry has the potential to grow significantly, particularly in Lake Argyle where a 600 t production licence has been issued. Anticipated increases in production have been delayed by three factors. Some farmers have encountered marketing delays, while production issues have included growing more 3 kg fish for fillets rather than smaller, plate-size fish, and slower growth of barramundi in over-stocked production systems. The latter challenge is being overcome through significant capital investment. Further increases in production licence limits in Lake Argyle will only occur if the environmental monitoring program designed by research staff indicates that impact has not been significant.



SOUTHERN INLAND BIOREGION

REGIONAL AQUACULTURE DEVELOPMENT OVERVIEW

The southern inland bioregion is dominated by production of yabbies (*Cherax albidus*), marron (*Cherax tenuimanus*) and freshwater finfish, while inland saline aquaculture continues to develop. However, 2002/03 has seen drought conditions continue throughout the region, which has had a negative impact on the development and growth of many sectors within the industry.

No significant changes have occurred with respect to management and licensing arrangements over the past year.

Aquaculture Development Officers stationed at Albany and Narrogin provide an extension service to farmers as well as providing displays and information at country shows and workshops. In 2002/03 a strategic extension campaign for marron aquaculture was developed, including a series of workshops on the feasibility of marron farming (the 'marron aquaculture roadshow'), a training course on the construction of aquaculture ponds and an open day conducted at the Pemberton Freshwater Research Centre (PFRC). These activities facilitated progress towards the construction of several new marron farms and allowed participants to make informed decisions about whether or not marron farming would be appropriate under their particular circumstances.

The two main trout grower groups have amalgamated to deal with common issues facing their industry, which produces both rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*). Trout ova, fry and yearlings from the PFRC were again sold to freshwater trout farmers.

The Silver Perch Growers' Association is continuing to work on marketing strategies and product placement for the growing silver perch (*Bidyanus bidyanus*) industry.

In the southern inland bioregion, barramundi (*Lates calcarifer*) is farmed chiefly in intensive production systems. Production is going well, with growers supplying local niche markets such as live fish for the Perth restaurant trade. The availability of fingerlings has improved with Challenger TAFE and the Department of Fisheries jointly producing fingerlings from eyed ova. The barramundi growers are working together under a loose, informal system.

The first Murray cod hatchery was licensed and is currently under development. A number of licences have been issued for the grow-out of Murray cod (*Maccullochella peelii*) in closed recirculating aquaculture systems.

The production of freshwater and marine ornamental fish species continues as a small but rapidly growing sector of the industry.

The south-west freshwater aquaculture industries are monitored by Fisheries Officers based in Esperance, Albany, Bunbury, Mandurah and Fremantle to ensure continuation of a high level of awareness of, and compliance with, management rules.

Joint operations involving Fisheries Officers and police carrying out targeted patrols and roadside checks in high-risk areas have resulted in a significant reduction in reports of the theft of marron from farm dams. These patrols will continue in 2003/04.

REGIONAL RESEARCH OVERVIEW

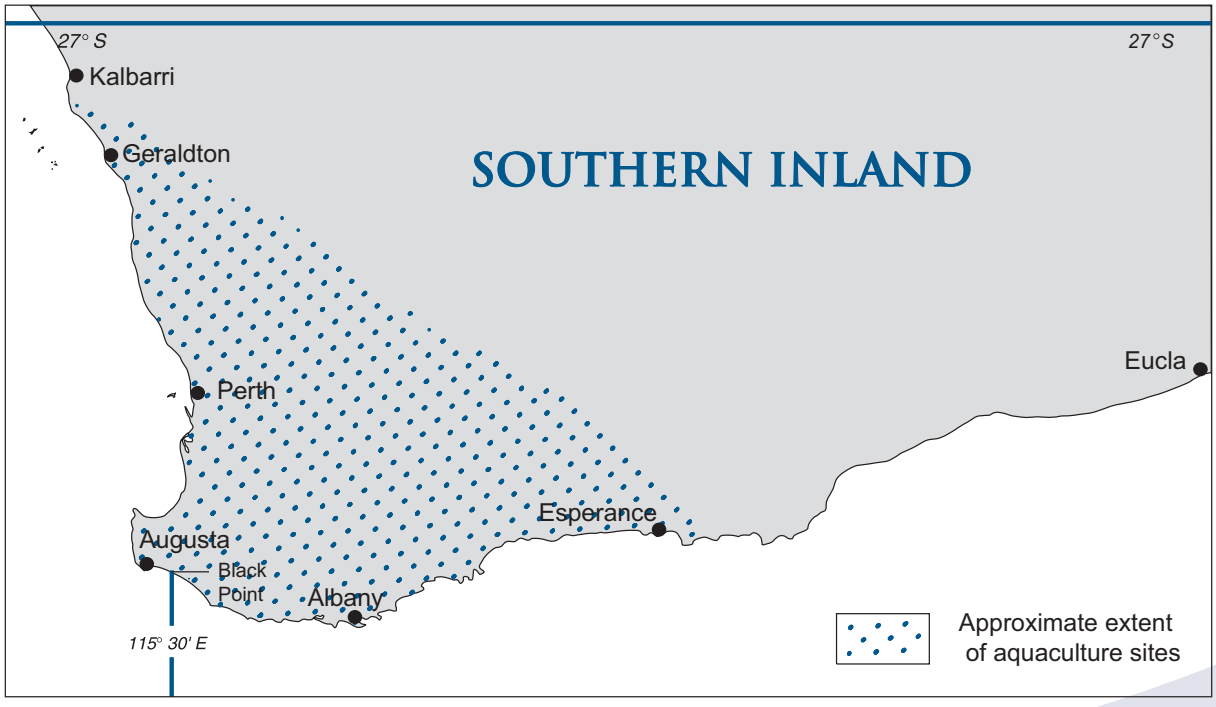
Research activities in this region have continued to focus on work to assist the marron, yabby, and rainbow trout farming industries and the aquaculture feeds industry. Research staff based at Perth and Pemberton have provided advice to many farmers, particularly through workshops and major field days held at the research facilities and commercial farms.

The research facilities have been greatly expanded to accommodate research that should boost the profitability of marron farming, both through improved genetic and pond management and by treating discharge water to enable reuse, particularly in summer. Model ponds and aquaria are operated jointly with the University of WA at Shenton Park, with additional funding from the ADF, FRDC and industry. At the Pemberton Freshwater Research Centre, a new pond complex commissioned with funding support from the Commonwealth Regional Assistance Program, South West Development Commission, the Department of Training and the Water Corporation of WA has yielded excellent survival and growth rates. This has added to the credibility of the PFRC as a demonstration facility (see Appendix 4).

Research trials involving commercial farms and the research facilities at Shenton Park and Pemberton have shown great potential for improving the quality of commercial marron farming lines. A grant from the Australian Academy of Technology, Science and Engineering has allowed the use of Danish expertise and software to establish the next phase of genetic improvement through pedigreed lines and mass selection strategies.

Commercialisation (in conjunction with the Department of Agriculture) of fast-growing hybrid yabby technology has been impeded by a lack of rainfall at Avondale for supplying water to breeding ponds. However, *Thelohania*-free lines for both parental species have now been developed with the assistance of the Fish Health Unit, CSIRO and the University of New England.

A further collaborative program with the Department of Agriculture, the University of Western Australia and industry, with funding support from the Grains Research and Development Corporation, involves the improvement and evaluation of local agricultural products such as lupins and canola for aquaculture feeds. This program includes processing trials to enhance protein content and digestibility of lupin kernel meals. Much of the product evaluation work is being conducted at the PFRC in a new finfish feeds research system stocked with rainbow trout. Complementary research was conducted with Tasmanian researchers using Atlantic salmon because there is a larger world market for salmon feeds than trout feeds. This information is being communicated to feed companies and nutritionists worldwide, and lupin kernel meals are now being used widely in aquaculture feeds in Australia and increasingly overseas. Most of this product comes from Western Australia. The annual value of lupin kernel meals used in Australian aquaculture feeds ($1.75 million) exceeds the value of each of the individual aquaculture industries in this bioregion.



SOUTHERN INLAND AQUACULTURE FIGURE 1

Map showing the approximate extent of aquaculture sites in the southern inland bioregion.

Marron Farming

Marron Farming Status Report

Prepared by C. Lawrence

INDUSTRY DESCRIPTION

Production areas

Licensed purpose-built farms for marron (*Cherax tenuimanus*) extend from Esperance to Hutt River, north of Geraldton. The bulk of farms are, however, concentrated in the higher-rainfall south-west coastal areas.

Two types of marron licence are available:

- An Aquaculture Licence (Marron) allows the holder to sell marron of any size to any person. Applicants must demonstrate that they own or occupy private property with a minimum of 2,500 m^2 of impounded water available for marron aquaculture purposes.
- An Aquaculture Licence (Marron Limited) allows the licence holder to sell marron of 76 mm carapace length or greater to the holder of a Fish Processor's Licence or an Aquaculture Licence (Marron).

Production methods

Semi-intensive farming in purpose-built earthen ponds; extensive farming in gully dams.

AQUACULTURE PRODUCTION

Production current season (2001/02): **46 tonnes**

Number of producers for year 2001/02: **187**

Production projection next year (2002/03): **50–60 tonnes**

Marron production has been impacted by the drought conditions experienced throughout the growing areas during the three years to 2002/03. Production capacity is increasing, and this is expected to maintain the existing total production despite the low water supply. Furthermore, some product is being retained in ponds because of the current adverse export marketing conditions for luxury crustacean products such as marron. Finally, while some farmers have recognised the need for high feed rates, production gains may not be evident at some locations unless electric fences are installed to exclude water rats as they can cause high mortality 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, as a result of the use of efficient feeding strategies and feeds of relatively low nutrient content, particularly as regards nitrogen and phosphorus.
The Department of Fisheries recommends treating discharge water using settlement and reed ponds to improve the quality of this discharge for reuse on the farm. A demonstration facility including settlement and reed ponds has operated well at the PFRC.

Escape of farmed stock into natural waterways is of concern, particularly if genetically selected stocks are used for 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 bird 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, 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 2001/02: $1.1 million

This figure excludes ornamental marron for the first time.

INDUSTRY GOVERNANCE

Licence approvals are required.

EXTERNAL FACTORS

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. Development of a new farm to full production usually requires around three years and, for most farms, production is influenced by rainfall.

The recent drought has attracted considerable interest in the water reuse systems at PFRC. These have the potential to help drought-affected marron farms, although a reduction in pond numbers may be required in some cases to match the available water supply. Typically farmers harvest whole ponds and restock in cooler months with advanced juveniles. As production expands, the industry will need to efficiently harvest and restock more ponds in drier, warmer months, by draining the ponds, to allow continuity of supply of marron. This will increase the need for efficient water reuse systems. Initial trials by research staff have shown that young summer juveniles can be farmed quite successfully and that marron harvested in summer can be sold live. New, very effective harvesting and post-harvest holding and live processing systems have been developed and highlighted in a major field day at the PFRC.

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 being developed with such industries to help minimise the risks.

Yabby Farming

Yabby Farming Status Report

Prepared by C. Lawrence

INDUSTRY DESCRIPTION

Production areas

Yabbies (*Cherax albidus*) are an introduced species and so for translocation reasons, the licensed commercial yabby farming industry is restricted to the drier inland agricultural area of the south-west, to the north of Perth and to the east of Albany. Agricultural farms may sell yabbies without a licence to licensed farmers/processors.

Production method

Harvesting of farm dams by baited traps.

AQUACULTURE PRODUCTION

Production current season (2001/02): **103 tonnes**

Number of producers for year 2001/02: **19**

This number refers to licensed farmers or processors. Note most farmers do not require licences.

Production projection next year (2002/03):
80–120 tonnes

Production is limited by water levels in farm dams which have been restricted by low rainfall in the three years to 2002/03.

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 as a result of the low feed rates used. As 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. If all-male hybrid yabbies, which are currently under development, can be used, these should further reduce environmental risks as they do not breed with the parental strains. 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 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 2001/02:
$1.28 million

Wholesale value is reported rather than farm gate value. Emphasis is being placed on more winter harvesting and on producing larger, more valuable yabbies.

INDUSTRY GOVERNANCE

Licence approvals are required for yabby processors and commercial harvesters. 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.

EXTERNAL FACTORS

The discovery of the parasite *Thelohania* in a variety of farms was a major setback in 1998/99 although it posed no threat to consumers. Researchers have developed a non-sacrificial test for identifying *Thelohania*-free broodstock. Prospects for the industry are very good as FRDC research results are adopted by industry. These include monosex grow-out, improved feeding regimes and better trapping strategies that reduce juvenile densities and avoid negative selection for growth.

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 probably 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.

Trout Farming

Trout Farming Status Report

Prepared by C. Lawrence

INDUSTRY DESCRIPTION

Production areas

Intensive culture of trout (both rainbow trout, *Oncorhynchus mykiss* and brown trout, *Salmo trutta*) is confined to the lower south-west by summer water temperatures and limited by the need for a large through-put 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, farmers with saline underground water are evaluating the performance of rainbow trout, stocked as yearlings and grown out in dams during cooler months.

Production methods

Highly intensive pond culture for food and extensive farming in large gully dams stocked for pay fishing. Low-intensity purpose-built ponds are being constructed by inland saline farmers.

AQUACULTURE PRODUCTION

Production current season (2001/02): 23.6 tonnes

Number of producers for year 2001/02: 9

Production projection next year (2002/03):20–25 tonnes

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 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 2001/02: $150,000

This estimate includes the value of yearlings provided to inland saline farmers but not production by these farmers, as they are not licensed and hence do not provide aquaculture returns.

INDUSTRY GOVERNANCE

A licence must be issued. Translocation approval can also be a requirement.

EXTERNAL FACTORS

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 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.

Except for niche marketing, trout prices are restricted by competition from large-scale producers, particularly those in Victoria. Internationally, prices for farmed trout and salmon (salmonids) are being depressed by massive increases in production, particularly in Norway and Chile.

Silver Perch Farming

Silver Perch Farming Status Report

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Silver perch (*Bidyanus bidyanus*) is an introduced species and so for translocation reasons, the licensed commercial silver perch farming industry is restricted to individually approved sites.

Production method

Harvesting from purpose-built ponds by netting or drainage.

AQUACULTURE PRODUCTION

Production current season (2001/02): 26.2 tonnes

Number of producers for year 2001/02: 16

Production projection next year (2002/03):25–35 tonnes

Production is limited by water supply to some farms due to low rainfall in the three years to 2002/03, however, some farms have reliable bore water supplies.

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 2001/02: $260,000

INDUSTRY GOVERNANCE

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.

EXTERNAL FACTORS

While the industry has been limited by availability of juveniles in previous years, local juvenile production is now adequate. The industry now seems more limited by available markets.

Ornamental Fish Farming

Ornamental Fish Farming Status Report

Prepared by C. Lawrence

INDUSTRY DESCRIPTION

Production areas

Production occurs throughout the State, but is mainly focused in metropolitan areas adjacent to the main markets. Both native and non-native species are produced.

Production methods

Dedicated small ponds and aquaria are used to breed and rear juveniles for live sales.

AQUACULTURE PRODUCTION

Production current season (2001/02): 159,204 fish

Number of producers for year 2001/02: 22

Production projection next year (2002/03): 100,000–300,000 fish

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 2001/02: $519,649

INDUSTRY GOVERNANCE

Specific licence approvals are needed for commercial production.

EXTERNAL FACTORS

Annual commercial production recorded for this sector indicates considerable volatility in production and prices for major aquarium fish groups. This can be affected by 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.

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FISH AND FISH HABITAT PROTECTION

FISH AND FISH HABITAT PROTECTION

General Overview

In the last decade, there has been a significant shift in the approach to natural resource management in Western Australia with a growing move toward ecologically sustainable development and integrated whole-of-ecosystem based management within a bioregional framework. This is a growing requirement under both the State Sustainability Strategy and Australian Government policies. The Department of Fisheries is fully committed to the principles of ESD for the resources it manages within the 200 nautical mile exclusive economic zone (EEZ).

The Fish and Fish Habitat Protection Program coordinates the Department's input into Western Australia's regional natural resource management planning processes. It also coordinates the Department's role in the protection of marine and estuarine environments as required by the Government's fisheries policy and the Department's role in protecting marine biodiversity within the EEZ.

The Program develops policy and manages projects which have application to the Department's other Programs of Pearling and Aquaculture, Commercial Fisheries Management and Recreational Fisheries Management. Fisheries Officers in the regions contribute to environmental protection in the field and staff from the Research Division also contribute to the Program's work.

The Program's responsibilities include the management of fish kills, and leading the Western Australian input into the process to develop a national system for the prevention and management of marine pest incursions. It also coordinates the Department's input into the decision-making processes of the Department of Environmental Protection (DEP), the WA Planning Commission and the Department of Industry and Resources.

To facilitate these activities on behalf of the wider community, a stakeholder reference group provides input on fish habitat protection, ESD and related activities of the Department of Fisheries. This group incorporates representatives of the commercial fishing industry, recreational fishers, the aquaculture industry, the Aboriginal sector, the Conservation Council of WA, the Department of Conservation and Land Management (CALM), the DEP and the Office of the Auditor General.

Activities relevant at a bioregional level are discussed in the appropriate sections which follow. Progress towards statewide initiatives is reported below.

ESD Assessment of Western Australian Fisheries

In 2000/01 the Department of Fisheries began to prepare ESD assessment reports for the major export fisheries in Western Australia. By December 2004, all fisheries that export products must have completed applications to Environment Australia on the sustainability of commercial fisheries to enable continued export of products past 2004. During 2002/03, the Department of Fisheries continued its progress toward that goal by producing final assessment reports for the Pearl Oyster, Abalone, Shark Bay Snapper, West Coast Deep-Sea Crab, Nickol Bay and Onslow Prawn Fisheries. In addition, draft assessment reports have been prepared for another 18 fisheries. These comprehensive ESD reports are used to produce specific applications to EA for export approval.

Fishcare WA

Community groups and organisations are encouraged to play an active role in the management and conservation of the State's fish and fish habitats through the State program Fishcare WA and the national Fisheries Action Program.

In 2002/03, changes to the structure of the Natural Heritage Trust resulted in the conclusion of the Fisheries Action Program and no new funding was granted. However, seven projects were successfully completed during the year.

The State community grants program, Fishcare WA, provided $45,572 in funding to 14 projects. This brings the total amount of funding granted under Fishcare WA to $285,355 since 1996.

Most projects were regionally based and are listed in the relevant bioregional sections below. However, two projects provided benefit across more than one bioregion. These were:

- Environmental impacts of three exotic fish species in WA (Murdoch University).
- Seaweek Teachers Expo (Rottnest Island Authority).

Marine Reserves and Marine Planning

The Department of Fisheries continues to work with CALM to implement the Government's marine reserves planning program. Both the Minister for Fisheries and the Department of Fisheries have a vital role in these processes. The Department of Fisheries manages all fishing activity including pearling and aquaculture in all marine reserves. It also works with EA in the planning of marine protected areas in Commonwealth waters.

Areas of the waters of Western Australia may be reserved as fish habitat protection areas (FHPAs) pursuant to Section 115 of the *Fish Resources Management Act 1994*. These areas are vested in the Minister for Fisheries and may be established for a number of purposes including the protection of the aquatic environment, protection of fish, and education. Before an FHPA can be established, a draft plan of management must be prepared and a public consultation process undertaken. Under this process, the Minister has wide powers to control or prohibit fishing activity, and may also make regulations to prohibit other human activities that may harm or alter the environment. The waters of the Abrolhos Islands, Cottesloe Reef, Lancelin Island Lagoon and Miaboolya Beach have been declared as FHPAs. During the year, the draft plan of management for the proposed Point Quobba FHPA was released and additional FHPAs are also being considered at Kalbarri and in the Kimberley.

Fisheries regulations may also be used to limit or prohibit fishing in specific locations to enable people to observe a part of the marine environment which is not affected by fishing. These areas are often established at the request of local communities and are described as reef protected areas (RPAs). RPAs exist at a number of locations around Western Australia including Cowaramup Bay, Esperance Jetty and Yallingup Reef and around wreck sites near Point Samson, Dunsborough, Esperance and Albany.

Marine Environmental Management

Successful collaborations between the Department of Fisheries and industry, community and other stakeholder groups continued throughout the year to ensure the protection of fish and fish habitat. Major achievements were as follows:

- As a member of the National Consultative Committee on Introduced Marine Pest Emergencies, the Department acts as lead agency in the State in providing emergency response to prevent the introduction of marine pests. During the year, the Department worked cooperatively with a number of State and Commonwealth agencies, including the Geraldton Port Authority and the Department of Defence, in successfully responding to incidents where there was a concern that vessels entering local waters had the potential to introduce exotic species.
- The Department has also provided advice and responded to disease issues through the development of national and State policy and in disease response and management situations.
- The Department provided advice to State and Commonwealth agencies on the potential impact on fisheries, pearling, aquaculture and the marine environment of proposed coastal and marine developments. During the year, advice was provided on a wide variety of proposals including dredging, port development, heavy industry development,

petroleum industry exploration and development, and at-sea dumping such as the sinking of vessels as artificial reefs.

- The Department, in collaboration with the Water and Rivers Commission, has maintained a fish kill response capability aimed at responding to fish kill incidents in a timely way in order to identify the cause of kills and institute appropriate management actions.
- The Department coordinated a whole-of-Government Shark Management Strategy, which included coordinated aerial and boat patrols of the Perth metropolitan area and a 'Shark Hotline' telephone information service.

Geographic Information System

The Department's corporate spatial data is currently stored in digital form in a Geographic Information System (GIS) administered by the Fish and Fish Habitat Protection Program.

The spatial data component of the GIS includes all fisheries boundaries, zones and closures, and a range of other State and Australian Government administrative boundaries as well as a significant amount of physical and biological data relevant to the Western Australian environment.

Departmental data sets are generated or modified within the GIS by Fish and Fish Habitat Protection Program staff, other Departmental staff or external contractors as required. Non-departmental data sets are updated when necessary. The GIS is used by all Programs for map production, project planning, spatial analysis and decision support. Non-confidential Departmental spatial data is provided to other Government agencies, federal and State, and to consultants and the general public as requested.

The Fish and Fish Habitat Protection Program also provides diver support to other Programs for activities such as benthic habitat surveys, underwater visual census of marine organisms and underwater videography.

Translocation

In response to industry requests, translocation assessments have been undertaken to manage the translocation of non-endemic species into and within the State, in accordance with the Memorandum of Understanding established between the Environmental Protection Authority and the Department of Fisheries in 1997. A total of 46 assessments have been undertaken throughout the year, providing for the sustainable development of the aquaculture industry within Western Australia.

Fisheries Management Paper no. 156 (Department of Fisheries 2002), a discussion paper released for public comment in June 2002, identifies the issues surrounding the translocation of brown and rainbow trout, and will be used in the development of a policy to guide the translocation decision-making process for these species.

WEST COAST BIOREGION

ENVIRONMENTAL MANAGEMENT OVERVIEW

During the year, progress occurred with respect to a number of Fish and Fish Habitat Protection matters on the west coast.

The Jurien Bay Marine Park will be declared on 31 August 2003, and staff of the Department of Fisheries are currently preparing notices to give effect to the fishing prohibitions in the marine park, in accordance with the zoning scheme outlined in the management plan.

Work is well advanced on the proposed Blue Holes FHPA at Kalbarri and a draft plan has been circulated for public comment.

Management of the Abrolhos Islands continued to be progressed with the assistance of the Abrolhos Islands Management Advisory Committee in accordance with the approved management plan released in December 1998.

Significant progress towards the management plan strategies was made in the following areas:

- The new operations and research centre at the Abrolhos Islands was completed. This facility will enable an increased research and management emphasis at the islands.
- A research report was published describing the relationship between the fishing industry and seabirds near the Abrolhos Islands (Gaughan et al. 2003). The outcomes of the research will be used to ensure that fishing occurs in a manner that does not affect seabird populations.

Two new Fishcare WA projects were funded in the west coast bioregion. These were:

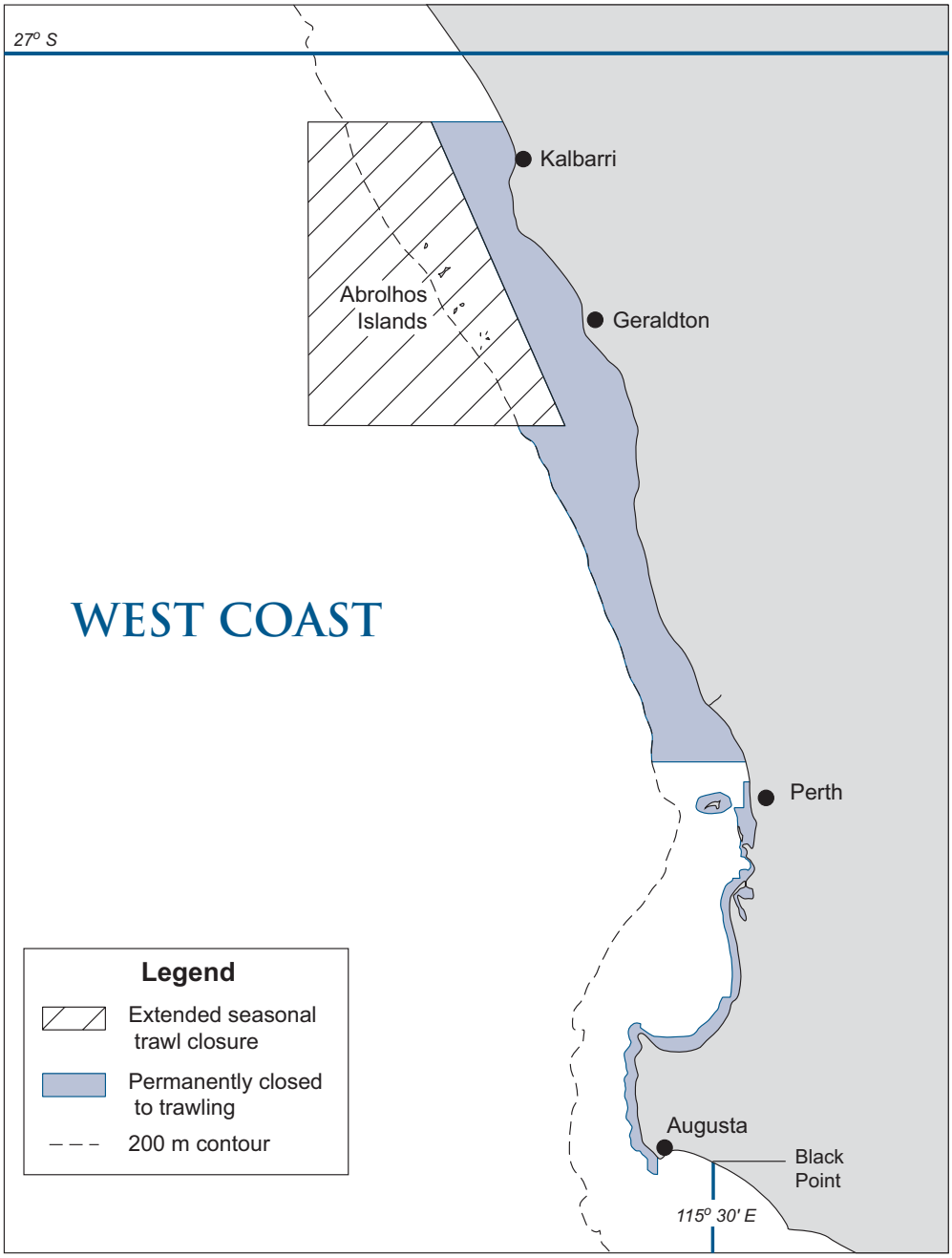
- Guardianship of Yallingup Reef (Yallingup LCDC).
- Species ID video supplement to 'Ocean Walking' (Cape to Cape Clean Waters Project).

FISH HABITAT PROTECTION OVERVIEW

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

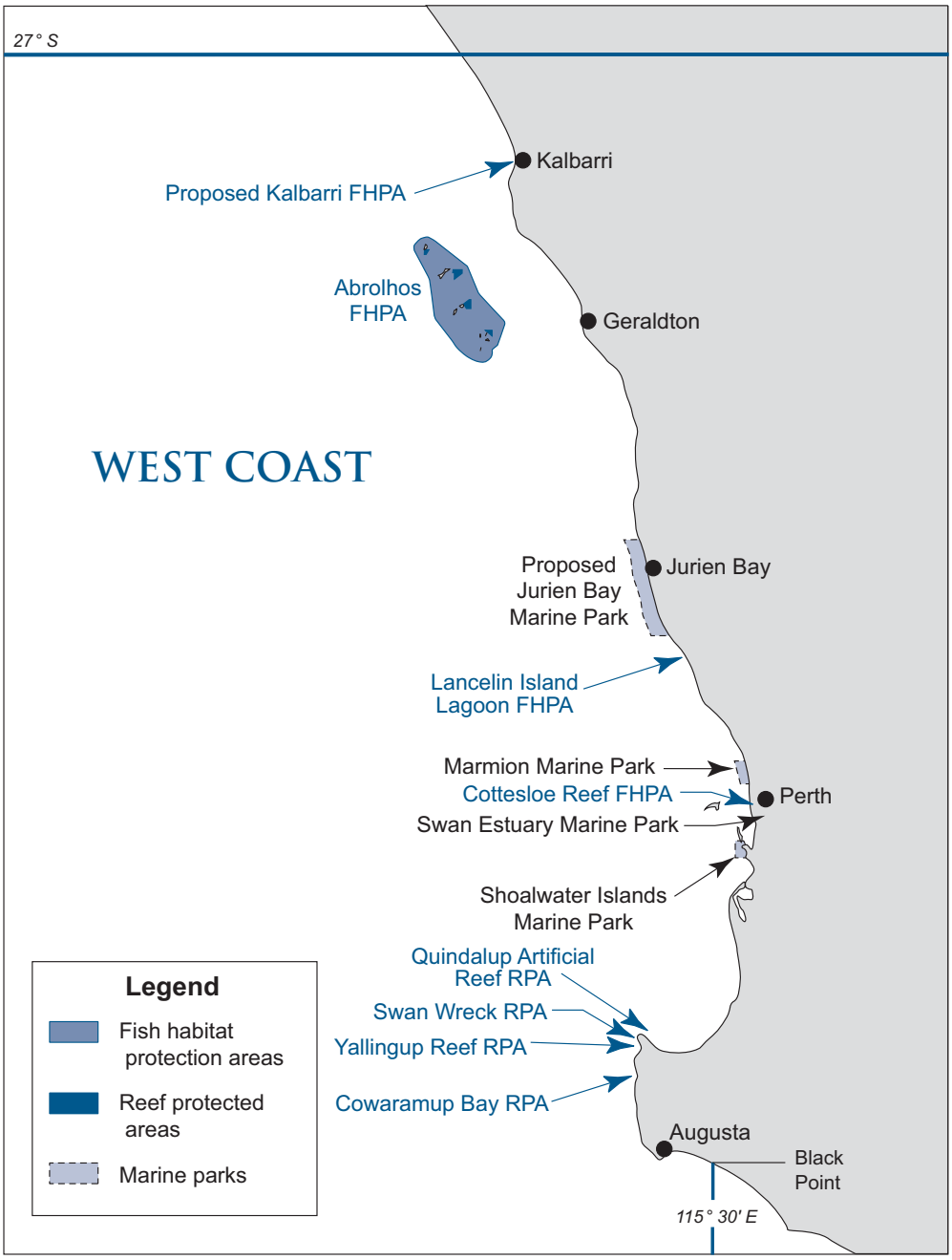
On the west coast, marine habitats are largely protected from any physical impact of commercial fishing by extensive closures to trawling, the only permitted fishing method which can significantly affect the sea floor. Essentially, all coral and seagrass habitats are protected, with trawling limited to sand areas inhabited by target species such as scallops (West Coast Habitat Protection Figure 1).

In addition, habitat protection is provided by specific FHPAs, RPAs and marine parks in sensitive areas (West Coast Habitat Protection Figure 2).



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.

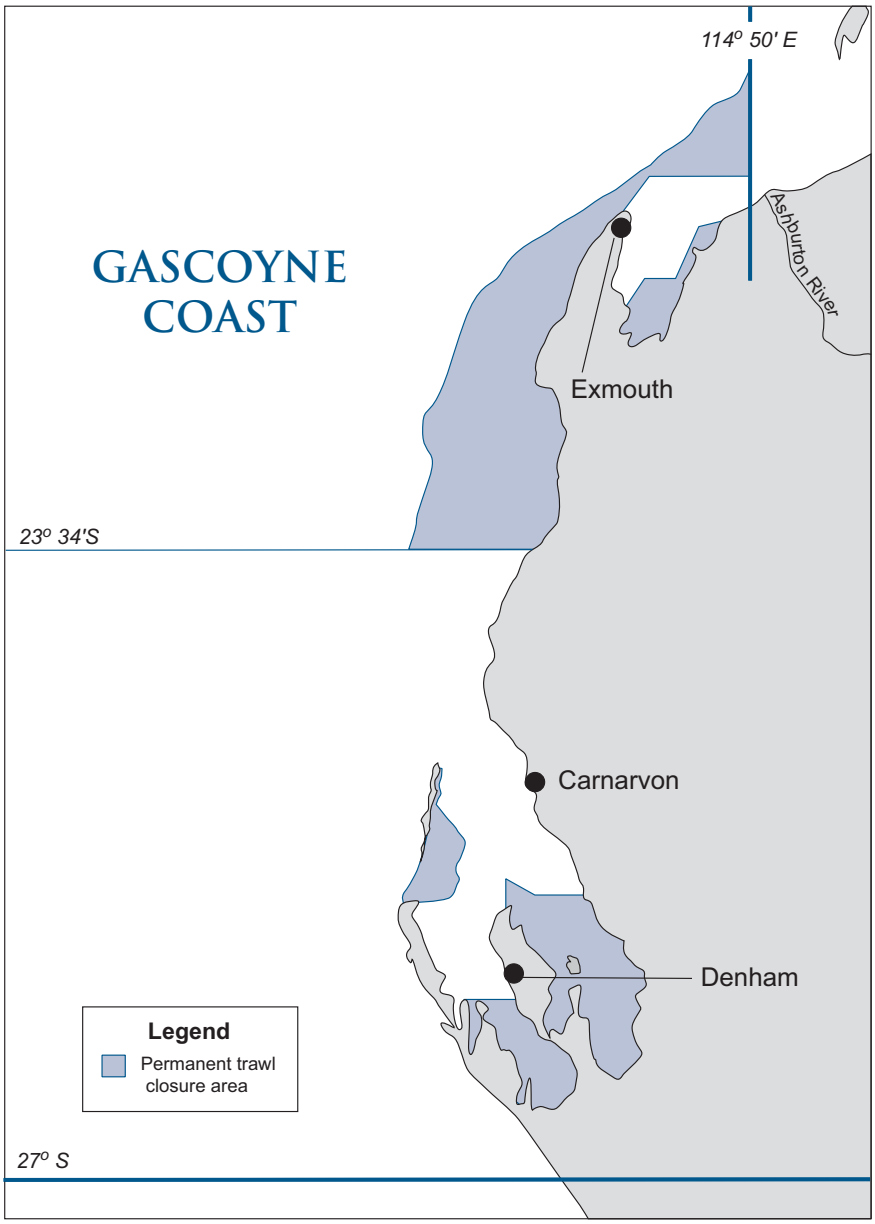
GASCOYNE COAST BIOREGION

ENVIRONMENTAL MANAGEMENT OVERVIEW

The management of the environmental effects of fishing continues to be a major focus of the Department's operations in the Gascoyne bioregion.

Research on bycatch reduction devices is continuing. BRDs (grids) were used on all prawn trawl and scallop boats this season. Work is continuing on the development and trial of fish escapement devices.

Following a period for public review, the final plan of management for the Miaboolya Beach FHPA at Carnarvon was completed during 2002/03 and will be gazetted early in 2003/04. The draft plan of management for the proposed Point Quobba FHPA was also released during the year.



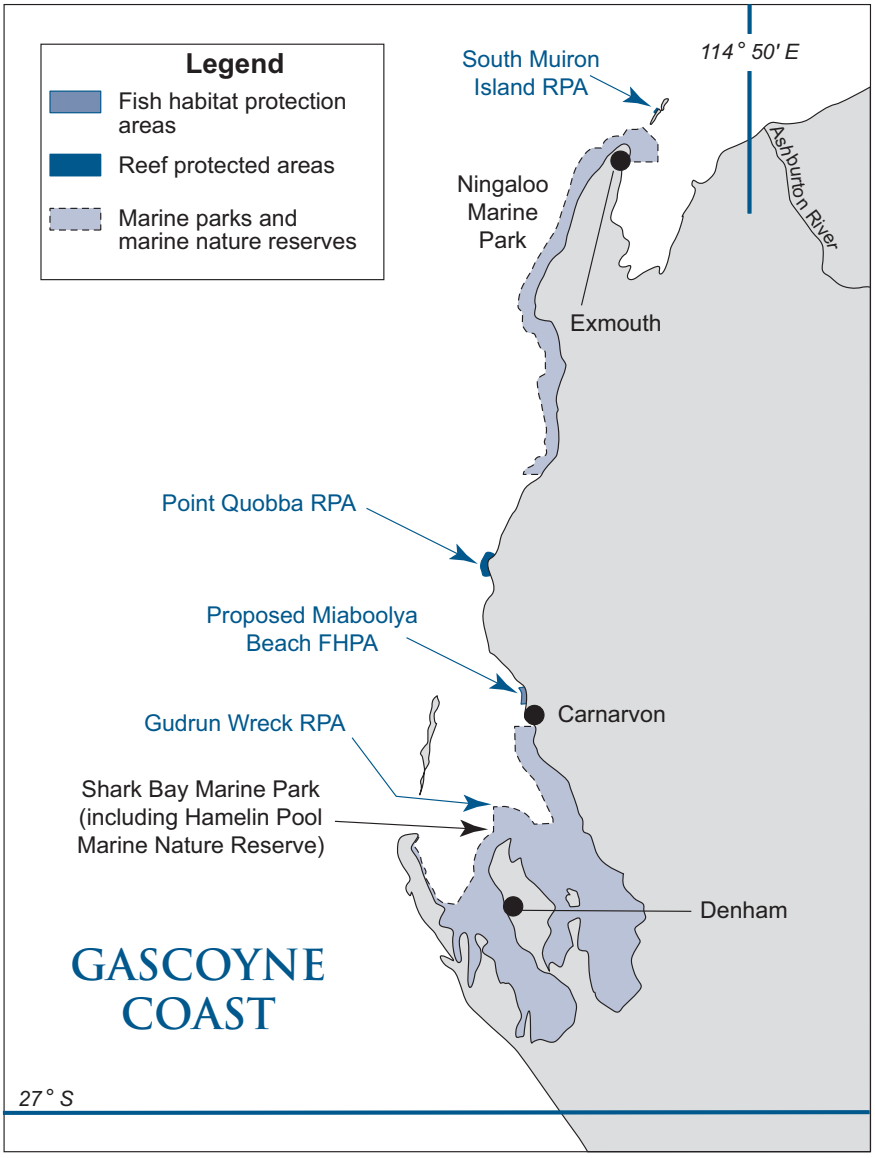
GASCOYNE COAST HABITAT PROTECTION FIGURE 1

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

FISH HABITAT PROTECTION OVERVIEW

In the Gascoyne bioregion, most sensitive habitats in the main embayments are closed to trawling to protect prawn nursery areas. Similarly, the whole sector offshore from Ningaloo Reef has been closed following an evaluation of fish trawling in the area (Gascoyne Coast Habitat Protection Figure 1).

The bioregion also has significant marine parks (Ningaloo and Shark Bay) in environmentally significant areas (Gascoyne Coast Habitat Protection Figure 2).



GASCOYNE COAST HABITAT PROTECTION FIGURE 2

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

NORTH COAST BIOREGION

ENVIRONMENTAL MANAGEMENT OVERVIEW

During 2002/03, the Department of Fisheries has worked with CALM as part of the planning process for the Dampier Archipelago and Montebello Islands marine reserve proposals. These plans have been completed and sent to the Marine Parks and Reserves Authority for consideration.

The data required to prepare the Fisheries Environmental Management Review for the northern bioregion has been completed.

Bycatch reduction devices or grids have been incorporated in all of the prawn trawl fisheries in the bioregion, with trials of fish escapement devices to occur in the coming season. The bycatch action plan process for these fisheries will be undertaken in conjunction with the ESD reporting process. This is due to be completed by December 2004 for all fisheries exporting product.

The bycatch survey in the Pilbara Fish Trawl Fishery, funded by the Fisheries Action Program, was completed during the year.

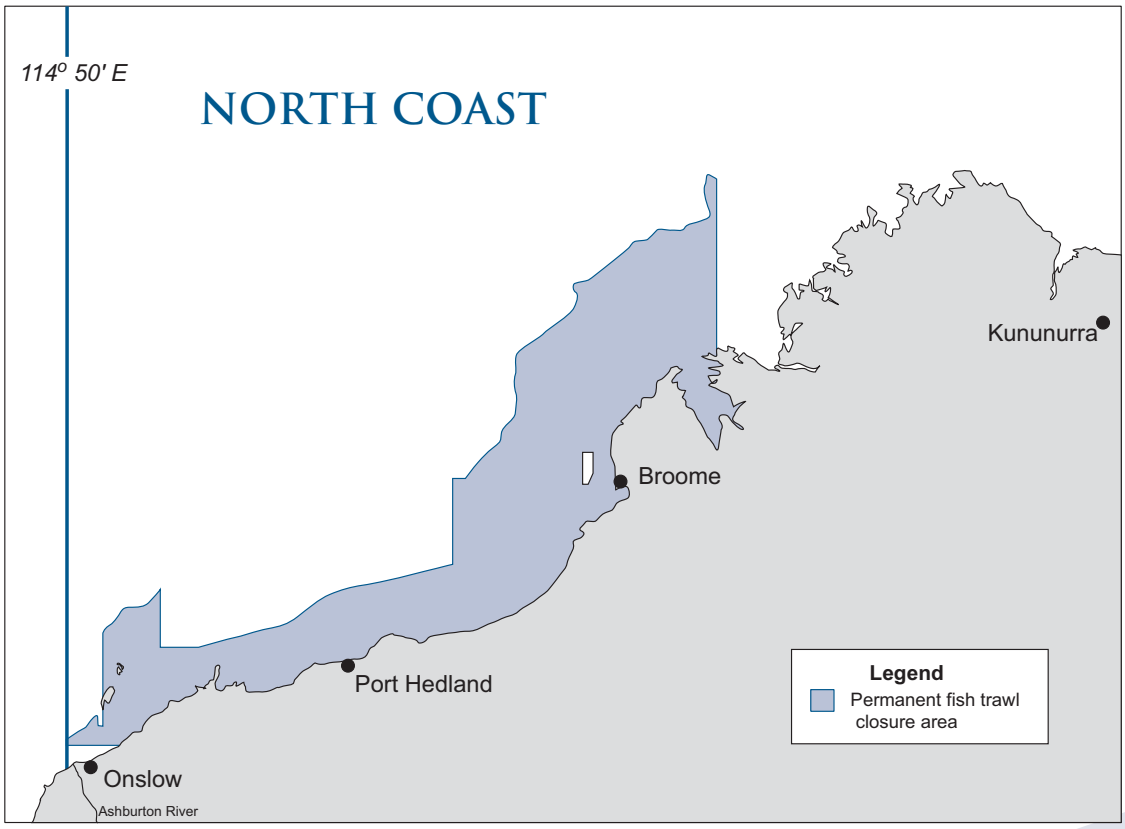
One new Fishcare WA project was funded in the north coast bioregion. This was:

- Beadon Creek crab research (Onslow Primary School).

FISH HABITAT PROTECTION OVERVIEW

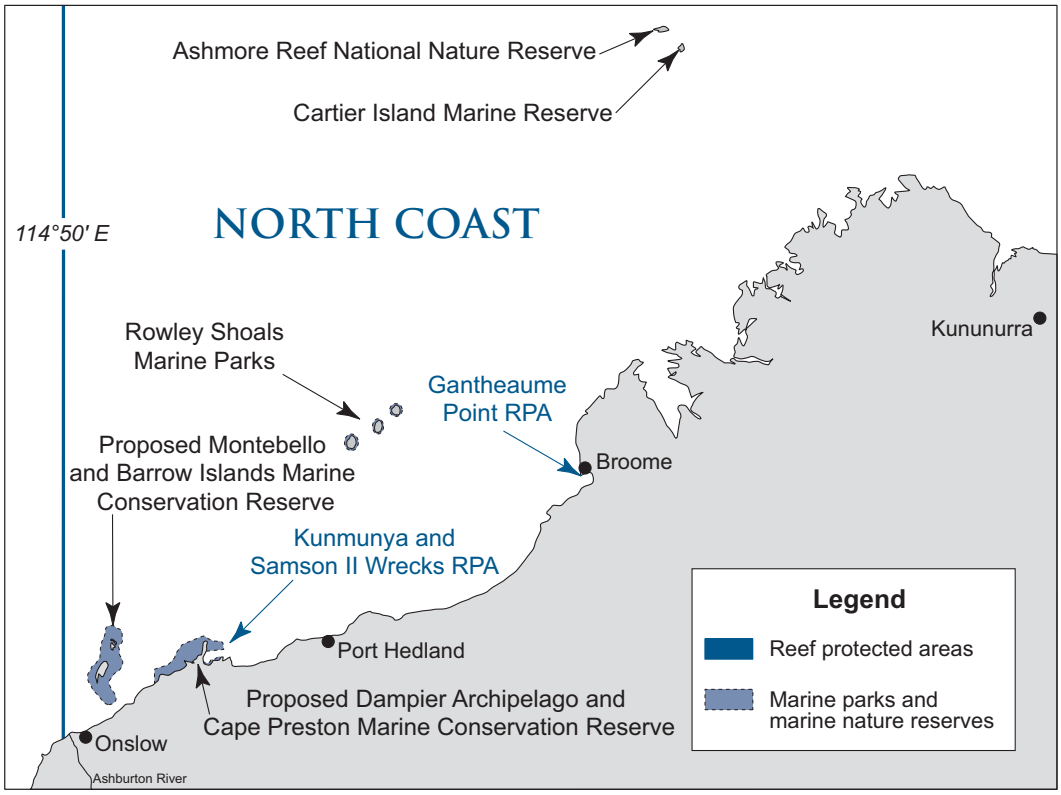
The north coast bioregion has extensive closures to fish trawling in all coastal waters west of longitude 120° E to protect inshore fish nurseries. Similarly, the coastal area off Eighty Mile Beach and north to King Sound, apart from a suitable prawn trawling habitat area, has been permanently closed to trawling to protect important pearl oyster habitats from exploratory trawling (North Coast Habitat Protection Figure 1).

The region also has a range of RPAs and marine parks and reserves at sensitive coastal and offshore locations (North Coast Habitat Protection Figure 2). The Department of Fisheries continues to provide input to the planning process for the proposed marine reserves at the Dampier Archipelago and the Montebello Islands.



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.

SOUTH COAST BIOREGION

ENVIRONMENTAL MANAGEMENT OVERVIEW

The extensive survey of the fish habitats of the Recherche Archipelago being undertaken by the University of WA continued during 2002/03. The Department serves on the coordinating committee guiding this work.

Work has commenced on the Fisheries Environmental Management Review for the south coast region. The study area includes marine waters out to the edge of the 200 nautical mile exclusive economic zone.

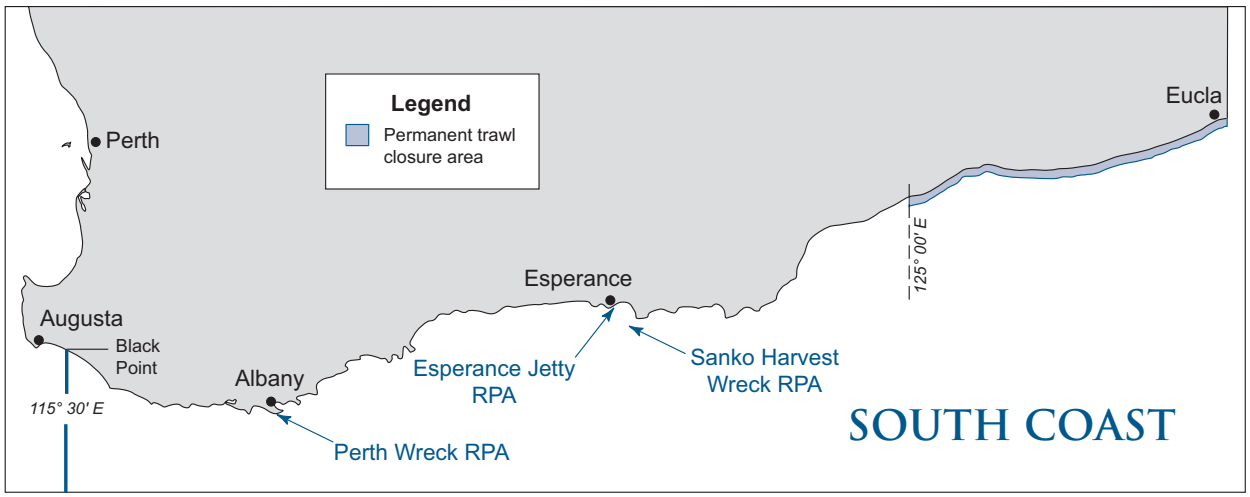
Two new Fishcare WA projects were funded in the south coast bioregion. These were:

- Monitoring fish abundance and diversity over transplanted seagrass (Friends of Oyster Harbour).
- Comparison of fish community structure in sand and seagrass habitats in Princess Royal Harbour (Albany Senior High School).

FISH HABITAT PROTECTION OVERVIEW

Along the south coast, fishing activities which can impact on marine habitats are limited to a small amount of scallop trawling off Esperance. There is a coastal trawling closure of State waters along the western Great Australian Bight sector, enacted under Commonwealth fisheries legislation, to ensure deep-sea trawlers do not venture into sensitive coastal areas (South Coast Habitat Protection Figure 1).

In addition, there are RPAs which cover the *Sanko Harvest* wreck site, the end of the old Esperance Jetty and the *Perth* wreck dive site.



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.

NORTHERN INLAND BIOREGION

ENVIRONMENTAL MANAGEMENT OVERVIEW

The Department of Fisheries recognises the need to further develop our understanding of native freshwater fish in this region. In 2002, the CSIRO coordinated a national study to determine broad-scale distribution patterns of freshwater sharks and rays in northern Australia. Fishcare WA funded a new project, 'The status of freshwater elasmobranchs in northern Western Australia', which enabled project partner Murdoch University to undertake a more detailed study and sampling in the Fitzroy River region. The Fitzroy River and associated systems in Western Australia have significantly higher numbers of the endangered freshwater sawfish (*Pristis microdon*) than other rivers sampled and the surveys to date have also led to the capture of a rare speartooth shark (*Glyphis* sp. C). These studies have extended our knowledge of the importance of the Kimberley waterways as habitats for marine and freshwater fish species.

Fishcare WA funded one continuing and one new project in the northern inland bioregion. These were:

- Biology and distribution of fish in inland waters of the North-West/Pilbara (Murdoch University).
- The status of freshwater elasmobranchs in northern Western Australia (Murdoch University).

SOUTHERN INLAND BIOREGION

ENVIRONMENTAL MANAGEMENT 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.

In 2002 the Department released for public comment a paper on the translocation of brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) into and within Western Australia. The comments have been considered and a management plan is now being prepared to minimise the effects of these species on native freshwater fish.

In January 2003, construction of a vertical slot fishway commenced on the gauging weir at Goodga River. This would enable the trout minnow (*Galaxias truttaceus*), which is extremely rare in Western Australia, and other native freshwater fish to access the upper reaches of the river, expanding available habitat by over 200% and providing access to valuable spawning areas. Work on the fishway was completed in April 2003 and monitoring has shown that fish are now successfully negotiating the weir.

In addition, a fishway was constructed on a dam on the Margaret River to allow the passage of native fish including lamphrays.

Five new Fishcare WA projects were funded in the southern inland bioregion. These were:

- Statutory protection of declining freshwater fish of south-west WA (World Wide Fund for Nature Australia).
- Riverwatch 2003 (Kelmscott Primary School).
- Nerrigen Brook habitat protection (Pioneer Village School).
- Fish migratory pathway extension (North East Catchment Committee).
- Margaret River rock ramp fishway (Margaret River Environment Centre).

FISH HABITAT PROTECTION OVERVIEW

The upper reaches of the Margaret River were closed to marron fishing in 2003 to protect the Margaret River marron, which is considered to be threatened because it is being displaced by other strains of marron. The upper reaches of the river are the last remaining stronghold of this fish.

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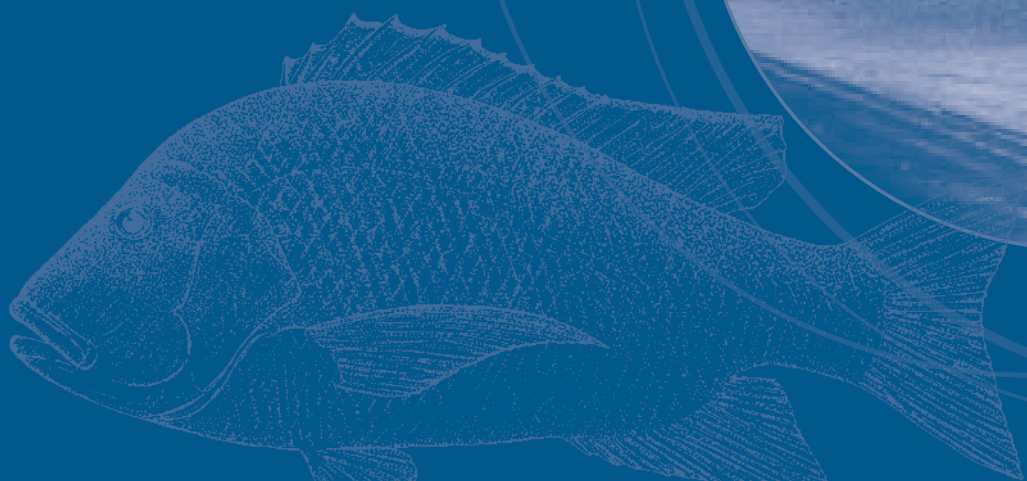

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APPENDIX 1

Stock exploitation status and catch ranges for major commercial fisheries

(Appendix 8 from Annual Report 2002/03[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	Comments on catch in reported season
WEST COAST BIOREGION								
Western rock lobster	Yes	Fully exploited	Adequate	8,166-14,523	8,966	2001/02	8,166-14,523	Low catch due to low puerulus settlement 3-4 years previously and environmental conditions experienced in November 2001
Roe's abalone	Yes	Fully exploited	Adequate	107.9 (Q) (725-929 days)	98 (655 days)	2002	107.9 (Q) (679-914 days)	Some exploratory quota was not utilised
South West trawl	NA	NA	NA	Not available	Prawns 15 Scallops 6	2002	Not available	
Abrolhos Islands and Mid West trawl	Yes	Fully exploited	Adequate	50-600	195	2002	50-600	Annual recruitment (and therefore catch) is highly variable depending upon environmental conditions
West coast purse seine	Yes	Fully exploited	Increasing	NA	1,365	2002	Not available	Catch limits imposed to allow stock recovery
West coast beach bait	Yes	Fully exploited	Adequate	106-331	183	2002	106-331	Whitebait only
Estuarine fisheries (west coast)	Yes[3]	Fully exploited[3]	NA	Not available	230	2002	Not available	Includes fish and crustaceans. Recent reductions in the number of commercial fishers has affected catch levels
Deep-sea crab	NA	NA	Adequate	NA	205	2002	NA	Developing fishery, still undertaking test fishing
GASCOYNE COAST BIOREGION								
Shark Bay prawn	Yes	Fully exploited	Adequate	1,501-2,330	2,075	2002	1,501-2,330	All three target prawn species were within acceptable catch limits in 2002
Exmouth Gulf prawn	Yes	Fully exploited	Adequate	771-1,276	809	2002	771-1,276	There has been a recovery of the tiger prawn catch but king prawn catch still below acceptable range
Shark Bay scallop	Yes	Fully exploited	Adequate	1,250-3,000	1,770	2002	1,250-3,000	Improvement in catch due to better recruitment in Denham Sound region
Shark Bay snapper	Yes	Over-exploited	Declining	550 (Q) 820-950 days	487 (1,320 days)	2002	563.7 (Q) 709-930 days	Decline in snapper spawning biomass has resulted in actions to reduce exploitation on stock
Shark Bay beach seine & mesh net	Yes	Fully exploited	Adequate	95-140 (whiting)	100 (whiting)	2002	95-140 (whiting)	Next year, analysis will cover the four main species

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	Comments on catch in reported season
NORTH COAST BIOREGION								
Onslow prawn	Yes	Fully exploited	Adequate	60-130	135	2002	60-130	The relatively large tiger prawn catch due to a lack of cyclonic activity
Nickol Bay prawn	Yes	Fully exploited	Adequate	90-300	100	2002	90-300	Low catch of banana prawns predicted due to environmental conditions (low rainfall)
Broome prawn	Yes	Under-exploited	Adequate	King prawn 35-170	King prawn 121	2002	55-260	Increases in catch related to higher levels of effort. Both king and coral prawns included in future acceptable catch range
Kimberley prawn	Yes	Fully exploited	Adequate	240-500	378	2002	240-500	Banana prawn catches within expected range for observed rainfall. Tiger prawns exceeded range due to high recruitment
Pearl oyster	Yes	Fully exploited	Adequate	534,750 oysters (Q) (14,071-20,551 dive hours)	508,688 oysters (18,390 dive hours)	2002	512,000 oysters (Q) (14,071-20,551 dive hours)	Reduced catch and effort of oysters in Zone 1 offset by hatchery produced oysters
Pilbara trawl	Yes	Fully exploited	Adequate	1,900-2,200	2,310	2002	1,900-2,200	Catch exceeded acceptable range, therefore effort for 2003 has been reduced by 7%
Pilbara demersal trap & line	Yes	Fully exploited	Adequate	150-300 (trap)	306 (trap) 90 (line)	2002	150-300 (trap) 50-115 (line)	Trap effort for 2003 has been reduced by 7%
Northern demersal	Yes	Fully exploited	Adequate	600-1,000	434	2002	600-1,000	Catches remain around 500 t due to significant levels of unutilised effort
Kimberley gillnet & barramundi	Yes[3]	Fully exploited[3]	Adequate[3]	25-40 (barramundi)	39 (barramundi)	2002	25-40 (barramundi)	Shifted to calendar year reporting
Northern shark	Preliminary	Under-exploited	Adequate	NA	456	2001/02	< 117 (sandbar only)	The catch of sandbar sharks is considered suitable to monitor fishery
Spanish mackerel	Yes	Fully exploited	Adequate	249-358	468	2002	275-417	Catches exceeded acceptable ranges in Kimberley and west coast regions due to good recruitment
SOUTH COAST BIOREGION								
South coast rock lobster[4]	Yes	Fully exploited	Adequate	50-80	66	2001/02	50-80	Includes Esperance, GAB and Albany management zones
Abalone (greenlip/ brownlip)	Yes	Fully exploited	Adequate	229.54 (Q) (1,110 – 1,520 days)	194 (1,035 days)	2002	238.4 (Q) (1,095-1,511days)	Small voluntary reductions in catch (to improve abalone sizes taken) continue
WA salmon	Yes	Fully exploited	Adequate	1,300-3,600	2,623	2002	1,300-3,600	Environmental factors (e.g. Leeuwin current) influence recruitment and catch levels in subsequent years

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	Comments on catch in reported season
SOUTH COAST BIOREGION (cont.)								
Australian herring trap	Yes	Fully exploited	Adequate	450-1,200	508	2002	450-1,200	South Coast only
Southern & west coast demersal gillnet & longline	Yes3	Over-exploited[3]	Declining[3]	725-975	766	2001/02	725-975	Three key species only reported. Breeding stocks of two are declining and of concern
Estuarine fisheries (south coast)	Yes	Fully exploited	Adequate	200-500	260	2002	200-500	Includes fish. molluscs and crustaceans
Albany/King George Sound purse seine	Yes	Under-exploited	Adequate	NA	279	2001/02	909 (Q)	Quotas adjusted annually to ensure recovery. Effort levels not available
Bremer Bay purse seine	Yes	Under-exploited	Adequate	NA	490	2001/02	1,230 (Q)	Quotas adjusted annually to ensure recovery. Effort levels not available
Esperance purse seine	Yes	Fully exploited	Adequate	NA	401	2001/02	1,500 (Q)	Quotas adjusted annually to ensure recovery. Effort levels not available
NORTHERN INLAND BIOREGION								
Lake Argyle catfish	Yes	Over-exploited	Increasing	100-140	114	2002	100-140	Catch and effort reduced to be within historical range hence spawning biomass now increasing

1 The information in this table is also used in Appendix 8 of the Department of Fisheries' Annual Report 2002–2003, where it underpins some of the Department's Performance Indicators. Appendix 8 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 For key species only.

4 Previously reported as Esperance rock lobster.

NA No assessment.

Q Quota management.

APPENDIX 2

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APPENDIX 3

Table of catches from fishers' statutory monthly returns for 2001/02

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 logbooks 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*	2,999	2,999
Barracuda (northern pike)	Sphyraenidae	1,378	1,382
Barramundi (giant perch)	*Lates calcarifer*	23,089	34,931
Bigeye (not tuna)	Priacanthidae	71,257	71,257
Boarfish	Pentacerotidae	2,946	3,486
Bonito	*Sarda australis*	1,113	1,122
Bream, black	*Acanthopagrus butcheri*	45,623	45,623
Bream, buffalo	Kyphosidae	3,260	3,260
Bream, monocle	*Scolopsis* spp.	5,389	5,389
Bream, Robinson's	*Gymnocranius grandoculis*	66,751	66,959
Bream, sea	*Gymnocranius* spp.	1,208	1,208
Bream, silver (tarwhine)	*Rhabdosargus sarba*	10,593	10,593
Bream, western yellowfin	*Acanthopagrus latus*	7,387	7,387
Catfish, sea (golden cobbler)	Ariidae	25,280	25,784
Chinaman fish (not cod)	*Symphorus nematophorus*	13,123	13,259
Cobbler	*Cnidoglanis macrocephalus*	73,529	103,664
Cobbler, silver	*Arius midgleyi*	62,593	116,181
Cod	Serranidae	115,574	117,648
Cod, bar (grey-banded, 8-bar)	*Epinephelus octofasciatus*	8,902	8,931
Cod, chinaman	*Epinephelus rivulatus*	5,698	5,761
Cod, maori	*Epinephelus cyanopodus*	1,015	1,015
Cod, Rankin	*Epinephelus multinotatus*	58,484	60,429
Cod, spotted	*Epinephelus microdon, E. areolatus, E. bilobatus*	37,651	37,749
Dhufish, West Australian (jewfish)	*Glaucosoma hebraicum*	244,606	259,240
Emperor, blue-lined (grass, black)	*Lethrinus laticaudis*	833	995
Emperor, blue-spot	*Lethrinus hutchinsi*	224,453	224,453
Emperor, red	*Lutjanus sebae*	240,017	240,978
Emperor, red spot (snapper)	*Lethrinus lentjan*	82,917	82,917
Emperor, spangled	*Lethrinus nebulosus*	116,213	117,998
Emperor, sweetlip	*Lethrinus miniatus*	92,102	93,098

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
FISH (cont.)			
Flagfish (Spanish flag)	*Lutjanus vitta, L. quinquelineatus, L. carponotatus, L. lutjanus*	181,249	181,249
Flathead	Platycephalidae	12,487	12,502
Flounder	Bothidae	2,576	2,576
Footballer (footballer sweep, banded sweep)	*Scorpis georgianus*	873	1,002
Foxfish (hogfish, pigfish)	*Bodianus* spp.	1,022	1,037
Garfish, sea	*Hyporhamphus melanochir*	31,139	31,139
Groper	Labridae	5,260	5,358
Groper, baldchin	*Choerodon rubescens*	37,099	39,723
Groper, blue	*Achoerodus gouldii*	22,766	29,031
Halibut	*Psettodes erumei*	1,135	1,135
Hapuku	*Polyprion oxygeneios*	25,377	25,448
Herring, Australian	*Arripis georgianus*	598,954	598,989
Herring, Perth	*Nematalosa vlaminghi*	12,835	12,835
Javelin fish	*Pomadasys* spp.	24,249	24,255
Jewfish *see* dhufish			
Jobfish (*see also* snapper, goldband)	*Pristipomoides* spp.	97,093	97,098
Jobfish, rosy	*Pristipomoides filamentosus*	123,148	123,165
Jobfish (sharptooth snapper)	*Pristipomoides typus*	393	520
Kingfish, black (cobia)	*Rachycentron canadum*	27,905	28,698
Kingfish, yellowtail	*Seriola lalandi*	473	506
Knifejaw	*Oplegnathus woodwardi*	4,823	4,926
Leatherjacket	Monacanthidae	40,438	59,855
Mackerel, blue	*Scomber australasicus*	10,996	10,996
Mackerel, grey (broad-barred)	*Scomberomorus semifasciatus*	14,932	17,467
Mackerel, other	Scombridae	37,780	40,810
Mackerel, scaly	*Sardinella lemuru*	2,384,440	2,384,440
Mackerel, shark (salmon)	*Grammatorcynus bicarinatus*	972	1,011
Mackerel, Spanish	*Scomberomorus commerson*	338,780	436,523
Mackerel, spotted	*Scomberomorus munroi*	593	653
Mangrove jack	*Lutjanus argentimaculatus*	23,512	23,512
Maray	*Etrumeus teres*	61,165	61,165
Mullet, other	Mugilidae	523	523
Mullet, red	Mullidae	89,999	89,999
Mullet, sea	*Mugil cephalus*	332,192	332,871
Mullet, yellow-eye	*Aldrichetta forsteri*	49,608	49,608
Mulloway	*Argyrosomus hololepidotus*	75,028	77,289
Mulloway, northern	*Protonibea diacanthus*	1,038	1,074
Parrot fish	Scaridae	7,924	8,026
Perch, darktail sea (maroon sea perch)	*Lutjanus lemniscatus*	5,826	5,834
Perch, Moses	*Lutjanus russelli*	55,699	55,708
Perch, pearl	*Glaucosoma buergeri*	38,770	38,773
Perch, red	*Lutjanus* spp.	5,456	5,456
Perch, scarlet sea (saddletail sea)	*Lutjanus malabaricus*	169,320	169,373
Perch, yellowtail	Terapontidae	980	980
Perches, other	Lutjanidae	4,792	4,908

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
FISH (cont.)			
Pike, sea	*Sphyraena novaehollandiae*	1,609	1,609
Pilchard	*Sardinops sagax ocellatus*	1,610,692	1,610,692
Pomfret, black	*Parastromateus niger*	1,055	1,055
Queenfish	*Scomberoides commersonnianus*	442	1,138
Redfish	*Centroberyx affinis*	74,742	76,402
Redfish, Bight	*Centroberyx gerrardi*	22,249	22,355
Salmon, western Australian	*Arripis truttaceus*	2,621,189	2,621,358
Samson fish (sea kingfish)	*Seriola hippos*	105,459	113,011
Scad, yellowtail	*Trachurus novaezelandiae*	12,054	12,054
Shark, bignose	*Carcharhinus altimus*	2,650	4,213
Shark, blacktip	*Carcharhinus* spp.	90,638	222,777
Shark, blue	*Prionace glauca*	579	921
Shark, bronze whaler (dusky whaler)	*Carcharhinus obscurus*	175,129	275,353
Shark, creek whaler	*Carcharhinus fitzroyensis*	728	1,158
Shark, eastern school	*Galeorhinus galeus*	9,394	14,921
Shark, golden (copper whaler)	*Carcharhinus brachyurus*	31,319	49,797
Shark, grey nurse	*Carcharias taurus*	375	587
Shark, grey reef	*Carcharhinus amblyrhynchos*	3,554	5,610
Shark, gummy	*Mustelus antarcticus*	223,560	350,840
Shark, hammerhead	Sphyrnidae	68,241	112,128
Shark, lemon	*Negaprion acutidens*	16,651	26,475
Shark, mako (shortfin)	*Isurus oxyrinchus*	5,346	10,936
Shark, pencil	*Hypogaleus hyugaensis*	2,137	3,382
Shark, pigeye	*Carcharhinus amboinensis*	24,416	38,821
Shark, silky	*Carcharhinus falciformis*	2,185	3,321
Shark, silvertip	*Carcharhinus albimarginatus*	2,781	4,422
Shark, spinner (long-nose grey)	*Carcharhinus brevipinna*	635	1,010
Shark, spot tail	*Carcharhinus sorrah*	6,024	11,078
Shark, spurdog	Squalidae, Oxynotidae	795	1,192
Shark, thickskin (sandbar)	*Carcharhinus plumbeus*	150,399	239,309
Shark, tiger	*Galeocerdo cuvier*	40,402	59,637
Shark, whiskery	*Furgaleus macki*	116,792	174,223
Shark, wobbegong	Orectolobidae	52,592	83,486
Shark, other		131,268	207,376
Shovelnose (fiddler rays)	Rhinobatidae, Rhynchobatidae	8,487	28,262
Skates and rays, other		12,749	23,671
Snapper, bullnose (variegated emperor)	*Lethrinus* sp.2 (undescribed)	2,164	2,164
Snapper, frypan	*Argyrops spinifer*	45,071	45,071
Snapper, goldband (jobfish)	*Pristipomoides multidens*	258,617	259,290
Snapper, long nose	*Lethrinus olivaceus*	22,066	22,267
Snapper, north-west	Lethrinidae	57,293	64,173
Snapper, north-west (large)	*Lethrinus* spp.	28,876	28,886
Snapper, north-west (small)	*Lethrinus lentjan, L. choerorhynchus* etc.	155,363	155,652
Snapper, pink	*Pagrus auratus*	843,588	853,800
Snapper, queen	*Nemadactylus valenciennesi*	42,332	50,132
Snapper, red (swallowtail)	*Lutjanus erythropterus*	405,693	405,693
Snapper, ruby	*Etelis* spp.	4,854	4,854

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
FISH (cont.)			
Sole	Cynoglossidae, Soleidae	1,112	1,112
Sprat, blue	*Spratelloides robustus*	24,687	24,687
Sweep	*Scorpis aequipinnis*	1,884	2,184
Sweetlip	Haemulidae	85,351	86,734
Swordfish, broad-billed	*Xiphias gladius*	1,193	1,193
Tailor	*Pomatomus saltatrix*	37,983	37,983
Threadfin	Polynemidae	8,684	9,948
Threadfin bream (butterfish)	Nemipteridae	261,002	261,002
Threadfin, giant (king salmon)	*Eleutheronema tetradactylum*	151,517	164,747
Trevalla, deepsea	*Hyperoglyphe antarctica*	17,358	17,368
Trevally, golden	*Gnathanodon speciosus*	10,482	10,517
Trevally, other (skippy)	Carangidae	201,315	201,815
Trevally, skipjack	*Pseudocaranx dentex*	5,526	5,630
Tripletail	*Lobotes surinamensis*	776	776
Trout, coral	*Plectropomus maculatus*	22,101	22,360
Trout, spotted (duskytail groper)	*Epinephelus bleekeri*	776	776
Tuna, northern bluefin	*Thunnus tonggol*	9,905	9,905
Tuna, skipjack (striped)	*Katsuwonus pelamis*	729	834
Tuna, yellowfin	*Thunnus albacares*	4,274	4,631
Tuna, other	Scombridae	11,824	11,923
Tuskfish, bluebone	*Choerodon* spp.	12,274	12,275
Whitebait	*Hyperlophus vittatus*	153,578	153,578
Whiting, golden-lined	*Sillago analis*	1,494	1,494
Whiting, King George	*Sillaginodes punctata*	16,147	16,162
Whiting, other	Sillaginidae	1,284	1,284
Whiting, western sand	*Sillago schomburgkii*	156,371	156,387
Other fish varieties		137,245	147,309
Total fish		**15,439,708**	**16,534,918**
CRABS			
Crab, coral	*Charybdis feriata*	1,705	1,705
Crab, king	*Pseudocarcinus gigas*	13,486	13,486
Crab, mud	*Scylla serrata*	1,897	1,897
Crab, blue swimmer (blue manna, sand)	*Portunus pelagicus*	763,804	763,804
Crab, snow	*Chaceon bicolor*	230,242	230,242
Crab, spiny	*Hypothalassia armata*	14,788	14,788
Other crabs		62	62
Total crabs		**1,025,984**	**1,025,984**
PRAWNS			
Prawn, banana	*Penaeus merguiensis*	199,551	199,551
Prawn, brown tiger	*Penaeus esculentus*	907,158	907,158
Prawn, coral	*Metapenaeopsis* spp.	300,933	300,933
Prawn, endeavour	*Metapenaeus endeavouri*	181,994	181,994
Prawn, western king	*Penaeus latisulcatus*	2,004,238	2,004,238
Other prawns	Penaeidae	1,951	1,951
Total prawns		**3,595,825**	**3,595,825**

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (kg)	LIVE WEIGHT (kg)
ROCK LOBSTERS			
Bugs	Scyllaridae	26,972	34,197
Rock lobster, southern	*Jasus edwardsii*	65,892	65,892
Rock lobster, western	*Panulirus cygnus*	8,984,426	8,984,426
Other rock lobsters		4	4
Total rock lobsters		**9,077,294**	**9,084,519**
MOLLUSCS			
Abalone, brownlip	*Haliotis conicopora*	12,068	29,663
Abalone, greenlip	*Haliotis laevigata*	62,119	163,613
Abalone, Roe's	*Haliotis roei*	88,745	103,343
Cuttlefish	*Sepia* spp.	119,743	120,000
Mussel	*Mytilus edulis*	14,634	14,634
Octopus	*Octopus* spp. (mainly *O. tetricus*)	117,803	225,352
Scallop, saucer	*Amusium balloti*	413,564	1,990,928
Squid	*Sepioteuthis* spp., *Loligo* spp.	68,678	68,678
Other molluscs		54	54
Total molluscs		**897,408**	**2,716,265**
OTHER CLASSES			
Beche-de-mer	Holothuridae	36,064	71,360
Total other classes		**36,064**	**71,360**
GRAND TOTAL		**30,072,283**	**33,028,871**

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/fi/figis/concept/sectionI.html.

Reported catches from collectors' licences for 2001/02

SPECIES		QUANTITY	WEIGHT (kg)
Aquarium fish		167,871	
Hermit crabs	*Coenobita variabilis*	101,580	
Specimen shells		11,161	
Invertebrates		5,112	
Corals	Order Scleractinia		3,007
Soft corals, living rock, living sand, algae			9,994

APPENDIX 4

Pemberton Freshwater Research Centre activities 2002/03

The role of the Pemberton Freshwater Research Centre (PFRC) on Lefroy Brook continues to diversify, as reflected in the official re-naming of the facilities. The expanded PFRC was officially opened by the Minister in October 2002 with the official commissioning of the Thomson's Flat Annexe, which features 25 earthen ponds (including three 1,000 m^2 ponds), 28 above-ground pools and a post-harvest handling facility. The Thomson's Flat Annexe complements the 10 earthen ponds and 22 concrete ponds, the trout hatchery and the nutrition research facilities at the main hatchery site of the PFRC. 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. Major current project areas are 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 731,000 fry, 33,200 yearlings and 3,100 ex-broodstock fish were produced by the PFRC in 2002/03. Of these, approximately 445,000 fry, 27,000 yearlings and 3,100 ex-broodstock fish were stocked into public waterways to support recreational fishing (i.e. approximately 60%), with the balance sold to individuals and clubs to support private fishing opportunities (15%) and the commercial aquaculture grow-out of trout (25%).

Staff of the PFRC 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. In addition, staff provide extension support to commercial and private operators, especially in relation to stocking densities, water quality and feeding.

A range of trout research projects are under way at the PFRC. These include the evaluation of tagging techniques to allow trout captured in the fishery to be identified to year class, allowing 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 will soon be published. This project clearly shows the increased heat tolerance of PFRC rainbow trout, which may lead to interstate and international demand for these fish.

Marron aquaculture development

The PFRC is the site of two externally funded marron aquaculture projects. An FRDC project is currently evaluating growth and production differences among marron from different river systems, in order to identify faster-growing lines. Further, the project has bred marron from different lines 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 operation for the supply of juvenile marron from the fastest-growing lines for commercial on-growing. To support this project, a large tank facility has been constructed on Thomson's Flat to assist in the evaluation of hybrid marron lines. The security system of the entire complex has also been upgraded.

A second marron project has funding support from the Regional Assistance Program and the South-West Development Commission. This project is testing summer harvesting of marron in order to provide a consistent supply of marron throughout the year, thus stabilising the industry. Further, the grow-out of marron at different densities is being evaluated, as are post-harvest handling facilities and techniques.

Aquaculture feeds development

The feeds research area, comprising a shed and 48 independent tanks, has been almost continuously utilised during 2002/03. 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 trout diets. More research is being undertaken and an expansion of the program has resulted in the appointment of an additional staff member.

Water supply dam stock management and conservation

Three new 1,000 m^2 ponds have been constructed to allow the production of marron and native fish for restocking the refurbished Waroona Dam, due for completion in 2003/04. This is part of a jointly funded project involving the Department of Fisheries, Murdoch University, Alcoa and the Water Corporation. Overall project objectives encompass destocking of Waroona Dam during draining, the establishment of marron populations at the PFRC for breeding, and eventual restocking of the dam when refurbishment works have been completed. This is the first project of its kind in Australia, and others may follow as the Water Corporation is undergoing a major refurbishment of most 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, which is gathering support from the local community. Research into native fish, particularly into their breeding, is also under way, with future research to include an evaluation of the use of native fishes as mosquito control agents. The Centre is the base for artificial habitat trials in nearby 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. 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 2002/03.

APPENDIX 5

Fish Health Unit activities 2002/03

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.

The unit provides a diagnostic service to the 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.

Key activities and achievements of the unit during 2002/03 were as follows.

- A total of 240 diagnostic cases were received by the fish health laboratory during 2002/03, about the same number of cases as last year. During the year the notifiable disease *Perkinsus* sp. was detected in wild abalone, and two cases of estuarine fish with the notifiable disease epizootic ulcerative syndrome (EUS), caused by the fungus *Aphanomyces invadans*, were also submitted. Fifty export certificates for yabbies and marron were processed and 27 pearl translocation certificates were provided. Follow-up testing was also conducted for the undescribed intracellular ciliate which occurs only in small *Pinctada maxima* pearl oysters (below 40 mm diameter) in Zone 1.
- In collaboration with staff from the Water and Rivers Commission, 18 reports of fish kills throughout the State were investigated, including 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 caused by algal bloom, in turn caused by a flush of fertilisers after heavy rain.
- In collaboration with the Department of Agriculture and Murdoch University, an FRDC-funded project was undertaken 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, was held with the non-maxima pearl producers' association, Amwing, in October 2002.
- Work began on the Western Australian component of an FRDC-funded national survey of abalone for parasites and diseases.
- Work began on a collaborative project with the Australian Animal Health Laboratory of CSIRO and the University of Sydney to develop techniques for detecting pilchard *Herpesvirus* in local and imported pilchards.
- Work continued on an FRDC-funded investigation of the disease status of prawn stocks on the North West Shelf. Examination of over 100 *Penaeus monodon* from Western Australian waters has failed to detect gill associated virus (GAV), a serious disease of *P. monodon* in aquaculture in Queensland.

GLOSSARY OF ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
ADF	Aquaculture Development Fund
AIMWTF	Abrolhos Islands and Mid West Trawl Managed Fishery
AQIS	Australian Quarantine and Inspection Service
BRD	bycatch reduction device
BTAP	Broome Tropical Aquaculture Park
CAES	catch and effort statistics
CALM	Conservation and Land Management, Department of
CPUE	catch per unit effort
CW	carapace width
DEPM	daily egg production method
EA	Environment Australia
EEZ	exclusive economic zone
ENA	extended nursery area
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation (Act)
ERLF	Esperance Rock Lobster Managed Fishery
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
GIS	geographic information system
GPS	global positioning system
GSMH	Great Southern Marine Hatcheries
GVP	gross value of production
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
JTMAC	Joint Trawl Management Advisory Committee
KAAC	Kimberley Aboriginal Aquaculture Corporation
KARP	Kimberley Aboriginal Research Project
KSRP	Kimberley Sustainable Regions Program
MAC	management advisory committee
MOU	Memorandum of Understanding
MOP	mother-of-pearl
MSC	Marine Stewardship Council
NBPF	Nickol Bay Prawn Managed Fishery
NCP	National Competition Policy
NDSF	Northern Demersal Scalefish Managed Fishery
NHT	Natural Heritage Trust
NPF	Northern Prawn Fishery
PFRC	Pemberton Freshwater Research Centre
PFTF	Pilbara Fish Trawl (Interim) Managed Fishery
PIAC	Pearling Industry Advisory Committee
RLIAC	Rock Lobster Industry Advisory Committee
RPA	reef protected area
SCEF	South Coast Estuarine (Interim) Managed Fishery
SFD	standard fishing day
SOI	Southern Oscillation Index
SRR	spawning stock–recruitment relationship
SWTF	South West Trawl Managed Fishery
TAC	Total allowable catch
TPSA	tiger prawn spawning area
TSC	Total sustainable catch
VFAS	Voluntary Fisheries Adjustment Scheme
VFLO	Voluntary Fisheries Liaison Officer
VMS	Vessel Monitoring System
WAFJA	WA Fisheries Joint Authority
WANCSF	WA North Coast Shark Fishery
WASQAP	WA Shellfish Quality Assurance Program
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
WCRLMF	West Coast Rock Lobster Managed Fishery