State of the Fisheries Report

2001/2002

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 WA for the financial year ending 30 June 2002.

Peter P Rogers

Edited by Dr J. W. Penn

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

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GLOSSARY OF ACRONYMS

ADF	Aquaculture Development Fund
AIMWTMF	Abrolhos Islands and Mid West Trawl Managed Fishery
AQIS	Australian Quarantine and Inspection Service
BRD	bycatch reduction device
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
DOLA	Department of Land Administration
EA	Environment Australia
EGPMAC	Exmouth Gulf Prawn Management Advisory Committee
ENA	extended nursery area
ENSO	El Niño/Southern Oscillation
EPA	Environmental Protection Authority
ERLMF	Esperance Rock Lobster Managed Fishery
ESD	ecologically sustainable development
FHPA	fish habitat protection area
FRDC	Fisheries Research and Development Corporation
GAB	Great Australian Bight
GIS	geographic information system
GPS	global positioning system
GVP	gross value of production
IFM	Integrated Fisheries Management
IMP	interim management plan
IQF	individually quick frozen
ITE	individually transferable effort
ITQ	individually transferable quota
IUCN	International Union for the Conservation of Nature and Natural Resources
JANSF	Joint Authority Northern Shark Fishery
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
MAC	management advisory committee
MOU	Memorandum of Understanding
MOP	mother-of-pearl
MSC	Marine Stewardship Council
NBPMF	Nickol Bay Prawn Managed Fishery
NCP	National Competition Policy
NDSMF	Northern Demersal Scalefish Managed Fishery
NHT	Natural Heritage Trust
NPF	Northern Prawn Fishery
PIAC	Pearling Industry Advisory Committee
RLIAC	Rock Lobster Industry Advisory Committee
RPA	reef protected area
SBPMAC	Shark Bay Prawn Management Advisory Committee
SBSMAC	Shark Bay Scallop Management Advisory Committee
SCEF	South Coast Estuarine Fishery
SRR	spawning stock–recruitment relationship
SWFRAC	South West Freshwater Research and Aquaculture Centre
SWTMF	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
WAMTC	WA Maritime Training Centre
WANCSF	WA North Coast Shark Fishery
WASQAP	WA Shellfish Quality Assurance Program
WCDGDLIMF	West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery
WCRLMF	West Coast Rock Lobster Managed Fishery

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EXECUTIVE DIRECTOR'S OVERVIEW

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 *State of the Fisheries Report* has continued in the format established in 2000/01, reflecting the Department's commitment to apply the principles of ecologically sustainable development (ESD) to the management of Western Australian fisheries. The individual fishery status reports are now providing an annual 'report card' on ESD performance for all of the State's major commercial fisheries and some recreational fisheries.

These reports indicate that the majority of the State's fish stocks are in a healthy condition and are being exploited at sustainable levels. The southern pilchard stocks, which were severely depleted as a result of an exotic virus attack in 1999 and of concern last year, are now showing signs of a good recovery. The remaining commercial fishery of serious management concern is the southern and west coast demersal gillnet and longline fishery for shark, which is responding to the Department's management, but is also being impacted by other offshore fisheries not under Western Australian jurisdiction. Negotiations are continuing to address these management concerns.

Although the reports reflect the success of the Department's historical efforts in managing the major commercial fisheries and specialised recreational fishing, continuing population growth and improvements in fishing technology are increasing the pressures on our fish stocks. These emerging management issues are being addressed through the current initiatives to develop arrangements for integrated fisheries management (IFM) and guidelines for resource sharing between the fisheries sectors. Resolution of these issues will however require an ongoing commitment to gathering accurate data on the catch and fishing activities by each sector each year.

To this end, the status reports are now providing, wherever possible, first estimates of recreational and commercial catch shares to identify priority areas for IFM. Similarly, the bioregional overviews for commercial and recreational fishing this year are for the first time providing detailed statistics on Departmental activities in relation to ensuring fishers' compliance with the management arrangements for each fishery.

I would like to take this opportunity to acknowledge the dedication and professionalism demonstrated by all Divisions of the Department in ensuring that the important data recorded in this volume were collected and utilised to maintain our fisheries. Both commercial and recreational fishers are also to be commended for their high degree of support for the Department of Fisheries management programs which conserve the State's fisheries resources.

Peter P. Rogers
EXECUTIVE DIRECTOR

EDITOR'S OVERVIEW

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.

To enable this comprehensive report on the management status of the State's fisheries to be compiled each year, a high degree of collaboration is necessary between the users of the fish resources and the Department's Divisions of Fisheries Research and Fisheries Management Services. I am pleased to report that the level of cooperation and collaboration continued to be excellent in 2001/02 and is the major factor which enables sustainable harvest levels from our fish stocks to be assessed each year. All commercial vessels provide valuable monthly records of catches and fishing activities, enhanced by the voluntary contribution of more detailed data through research logbook programs and access to vessels by researchers for catch monitoring purposes. Similarly, the recreational fishing community characteristically responds positively to the regular surveys of its fishing activities, and actively contributes to the success of management and research, particularly through the Voluntary Fisheries Liaison Officer program. Aquaculture research and development information reported in *State of the Fisheries* also relies heavily on collaboration with aquaculturists who provide access to farms and facilities for experimental projects. Data from all of these sources, together with the fishery-independent research projects which are used to validate and enhance fishery data, provide the scientific basis for management and aquaculture development of the State's fish resources.

For this 2001/02 edition of *State of the Fisheries*, the report is again arranged to reflect each sector's fishing activities within each of the State's six bioregions (Overview Figure 1). For each fishery, the status reports are structured to provide an annual ecologically sustainable development (ESD) assessment for each fishery under the following headings:

- Fishery description
- Retained species
- Non-retained species
- Ecosystem effects
- Social effects
- Economic effects
- Fishery governance
- External factors.

These ESD assessments indicate that the majority of the State's fish stocks are being harvested at sustainable levels and that few fisheries are at risk of significantly impacting on the marine environment. This assessment reflects the high level of management control historically applied to the State's major commercial fisheries and the positive support by industry for sustainable management initiatives.

These *State of the Fisheries* assessments are now being linked to comprehensive ESD and risk assessment reports being generated for the major export fisheries in response to the requirements of the Federal *Environment Protection and Biodiversity Act 1999*. During 2001/02, the Department has begun the process of submitting detailed reports to Environment Australia on all the major commercial fisheries, and anticipates that most export fisheries will be assessed by the end of 2003. The annual *State of the Fisheries* documentation has proved invaluable to this Environment Australia process and provides the ongoing assessments needed to underpin the Department's annual performance reporting commitments to the Western Australian Parliament.

While *State of the Fisheries* helps meet these statutory requirements, the volume also provides a ready reference document for interested fishers and members of the public

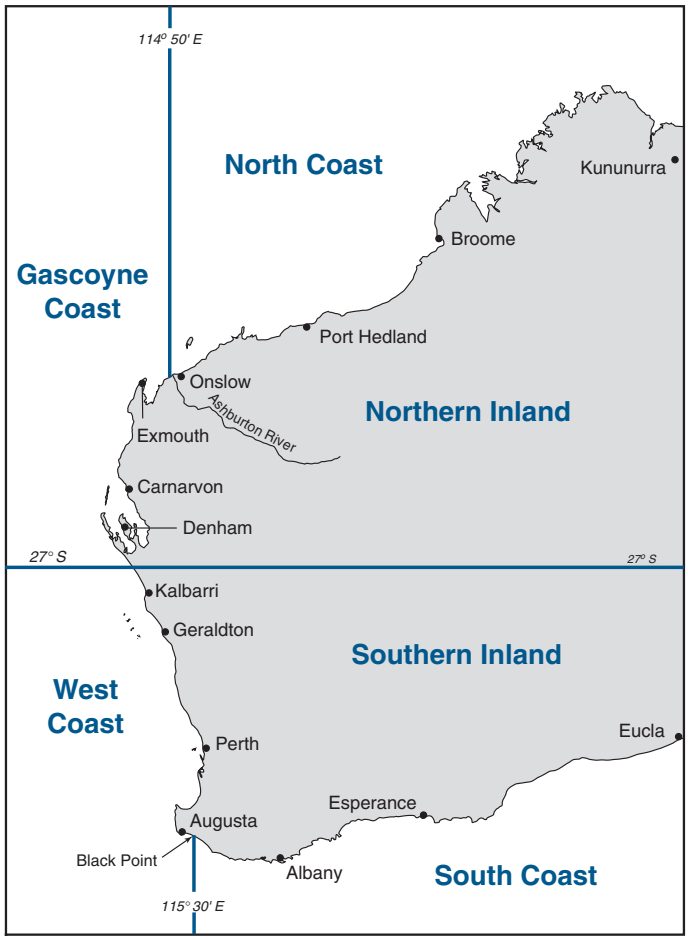
EDITOR'S OVERVIEW (cont.)

wishing to better understand the performance of our fisheries over time. The document is also available on the Department of Fisheries website at http://www.fish.wa.gov.au/res/index.html.

In using this volume, readers should note that the individual status reports relate to the last full year of production from the relevant fishery and aquaculture sectors. Owing to the time required for the process of data gathering, validation and analysis, this period is the 2000/01 financial year or the 2001 calendar year. Similarly, the statistics on compliance and educational activities by Fisheries Officers are also for 2000/01, following the introduction that year of a new, more comprehensive system for collection of regional activity data. In contrast, the information relevant to the Department's management planning activities relates to the most recent year (2001/02) and provides an indication of actions flowing from the assessments of the state of the stocks in the previous year.

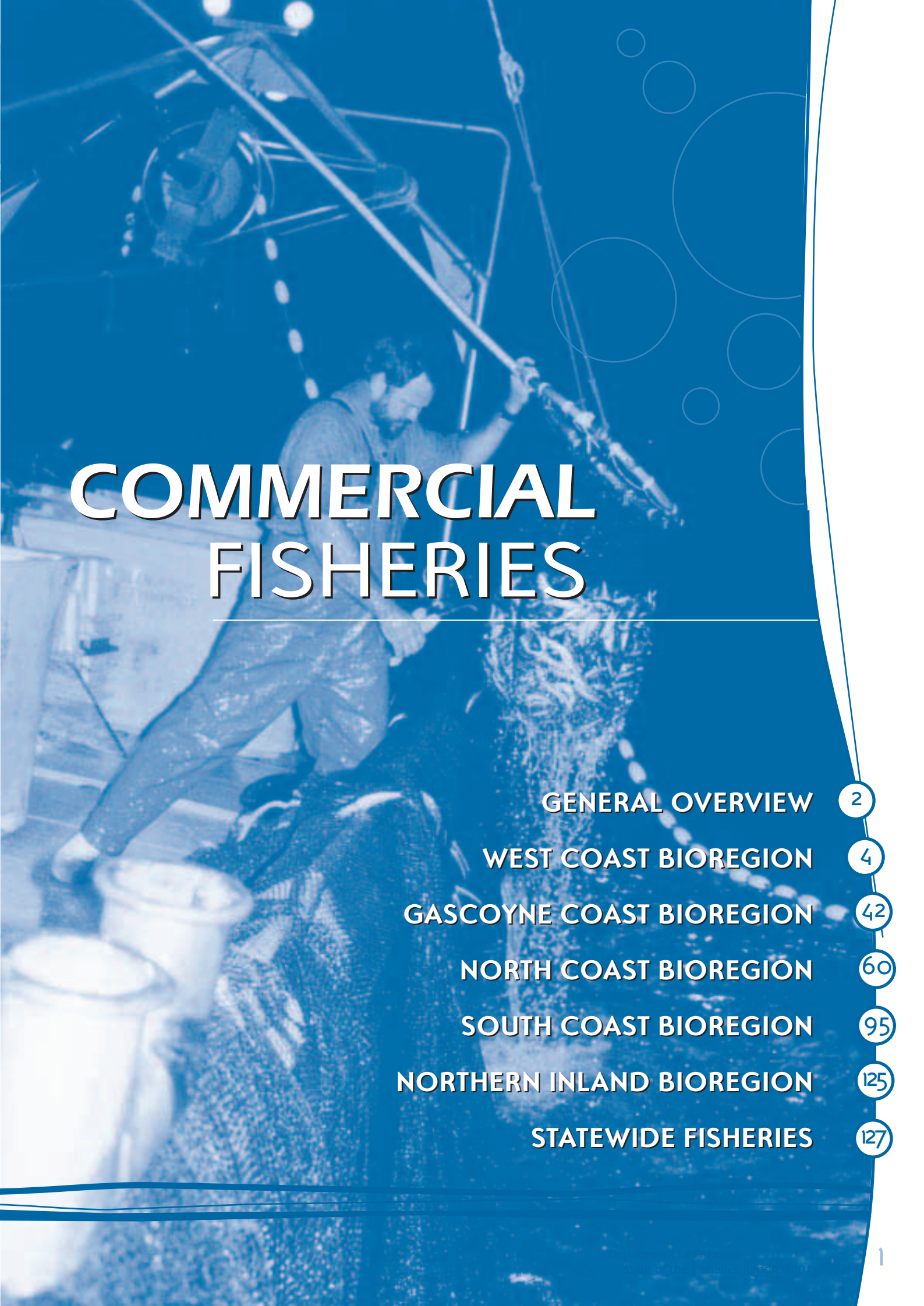
Preparation and validation of the extensive array of information contained within this report is a significant task to which many Department of Fisheries staff contribute through each year. I would like to take this opportunity to thank my colleagues in the Fisheries Management Services and Fisheries Research Divisions for their extensive contributions. Special thanks are also due to my editorial assistant, Ms Fran Head, who has carried out the task of compilation and copy-editing, and my publications officer, Mrs Sandy Clarke, who has undertaken the layout and production of the volume.

Dr J.W. Penn
DIRECTOR – FISHERIES RESEARCH



OVERVIEW FIGURE 1

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



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 achieved 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 1.75% of their gross value of production (GVP) in 2001/02. All fisheries also contributed to the Development and Better Interest Fund at a rate of 0.65% of their GVP.

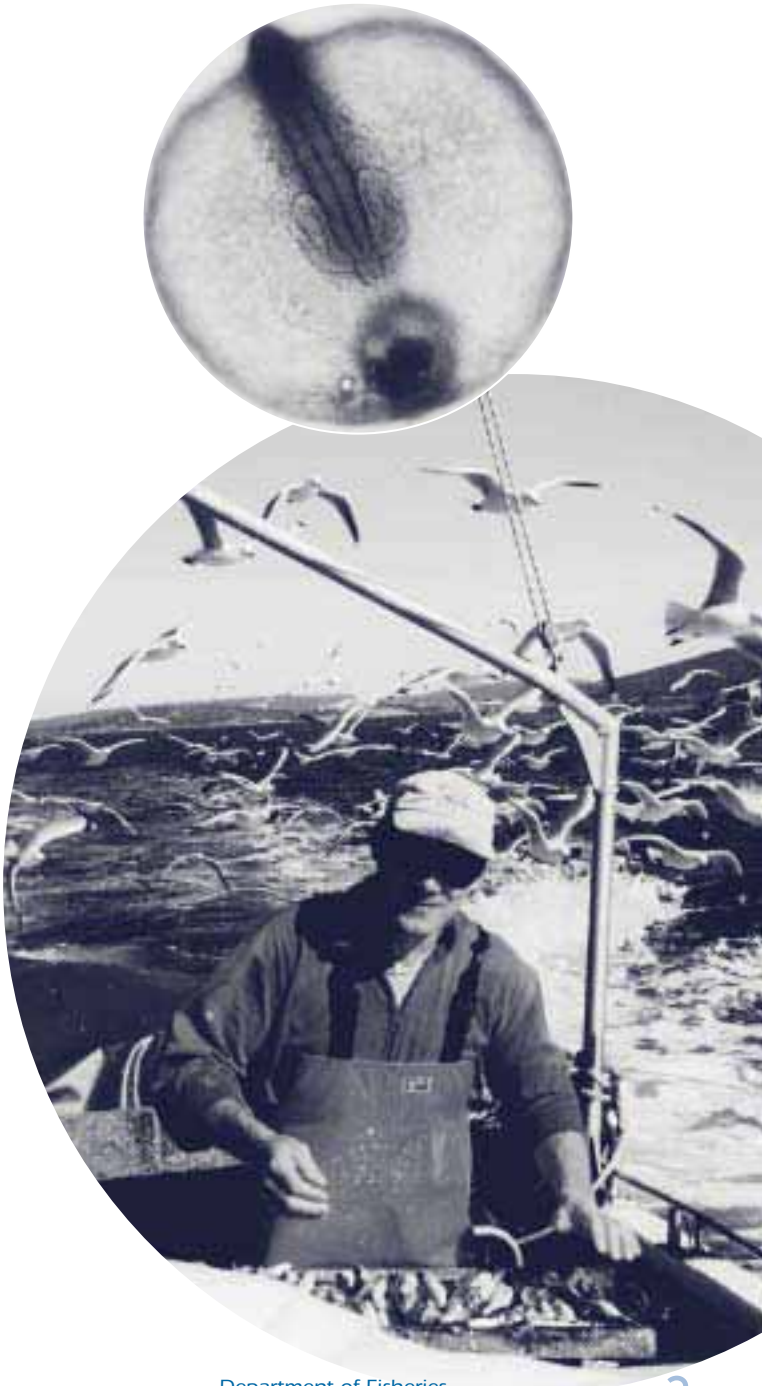
A key achievement during 2001/02 has been the production of ecological sustainability reports to Environment Australia (EA) for continued listing of species taken in various export fisheries under section 303 DB of the *Environment Protection and Biodiversity Conservation Act 1999*. Reports were produced and submitted for the West Coast Rock Lobster, Shark Bay Prawn and Exmouth Gulf Prawn Managed Fisheries, while production of reports for the Shark Bay Scallop, Shark Bay Snapper and Abalone Managed Fisheries was substantially completed.

Other key achievements during 2001/02 have included the implementation of unitisation in the West Coast Rock Lobster Managed Fishery, the continued implementation of bycatch reduction devices (BRDs) in the State's trawl fisheries, gazettal of a management plan for the South Coast Estuarine Fishery and implementation of the Vessel Monitoring System (VMS) in the Exmouth Gulf and Nickol Bay Prawn Managed Fisheries.

The outcomes of the Government's review of legislation with respect to National Competition Policy (NCP), which were announced in early 2002, will result in significant changes to the domestic rock lobster processing sector and to some of the key fishery rules. Some other significant NCP-related possible changes to rock lobster processing and fishery rules were also flagged for examination in the period up to 2006.

Not all commercial fishing in Western Australia is subject to specific management regulation at this stage. The 'unmanaged' portion, comprising a number of fishing activities undertaken under the authority of a fishing boat licence, is known collectively as 'wetline fishing'. Usual methods include handlining, droplining, trolling and hand-hauled netting, while less commonly used methods include drop netting, squid jigging and lift netting. In total 2,236 tonnes of fish were reported as wetline catch during 2000/01, comprising 1,297 tonnes (58%) from the west coast bioregion, 490 tonnes (22%) from the north coast, 296 tonnes (13%) from the Gascoyne and 153 tonnes (7%) from the south coast.

Rationalisation of the wetline fishery continues to be a major focus and substantial progress has been made on the development of management for the wetline sector, which will be a key element of giving effect to the principles of Integrated Fisheries Management. The Mackerel Independent Advisory Committee concluded its meetings and provided its advice to the Executive Director of Fisheries on future management options for the mackerel fishery. Planning for the development of management arrangements for the general wetline sector has set the stage for substantial progress in this area during 2002/03. Meanwhile, gazettal of legislation to give effect to mutually agreed catch sharing arrangements in the barramundi fishery in the Kimberley region is a sign of the continued progress which is being achieved in the resource-sharing area.



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. There were also some significant events in the fishery over the year. These included unitisation of the entitlement (from pots to units), the announcement of the outcomes of the National Competition Policy review – which will see major changes to the rules for processing and changes to some of the key management rules for the fishery – and submission of the ecological sustainability report on the fishery to Environment Australia. There was also a continued focus on meeting the ongoing requirements of the Marine Stewardship Council (MSC)'s chain of custody certification process. Notably, the 2001/02 season catch of just under 9000 tonnes was well below expectations, primarily as a result of poor climatic conditions during the 'whites' phase.

Considerable progress was made during the year on management arrangements for the west coast estuaries, and on the development of a Mandurah–Bunbury trap-based crab fishery. Both of these areas should see significant changes implemented in 2002/03.

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

- Demersal line fishing
- Mackerel (primarily by trolling)
- 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. Mackerel are also taken by both groups; however, the operation of the mackerel fishery has been examined by an independent review committee which has reported to the Minister on future management options. There is also a take of fish by beach seining and near-shore gillnetting using hand-hauled nets.

The activities of the wetline fishery are expected to come under review during 2002/03 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 offices located in Geraldton, Dongara, Jurien, Lancelin, Hillarys, Fremantle, Mandurah, Bunbury and Busselton. 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.

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. 7–8. In addition, a number of other fisheries are serviced which target abalone, blue swimmer crabs, pilchards, scallops, 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 area, and this increases the need for rigorous compliance monitoring in some areas. Fisheries Officers also conduct gear inspections on the many north-west trawlers that are seasonally outfitted in the region.

Inshore at-sea compliance is generally conducted using patrol vessels less than 8 m, while two dedicated large patrol vessels (> 20 m) are based in Fremantle and Geraldton respectively and deployed to other regions as seasonal programmed duties are undertaken. In addition to duties conducted by district-based Fisheries Officers, the Serious Offences Unit conducts investigations into serious fishery offences on a needs basis.

Activities during 2000/01

During 2000/01, Regional Services personnel undertook 34,987 hours of service in compliance work in commercial fisheries in the west coast bioregion (West Coast Commercial Compliance Table 1), excluding aquaculture and duties concerned with fish habitat protection. 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.

Between January and June 2001, Fisheries Officers recorded 3,348 field contacts with commercial fishing operations and 1,823 office contacts with commercial fishers. A percentage of these contacts results 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. During the year, 388 infringement warnings and 76 infringement notices were issued, and a further 30 cases resulted in prosecution of commercial fishers.

There were concerns over interference with commercial fishing gear in the Cockburn Sound (Crab) Managed Fishery during peak periods, and similar reports continued to be received from the Peel/Harvey Estuarine Fishery despite increased levels of surveillance, including joint patrols with police. Industry was advised to take a more active role in providing accurate information to assist investigations.

Unverified reports continued to be received of trawling within closed waters in Zone D (Comet Bay) of the South West Trawl Managed Fishery, and there was one incident reported in the purse seine fishery.

Compliance monitoring continued within the estuarine, purse seine, shark and wetline fisheries, with no significant issues arising. Overall, the level of compliance in 2000/01 for the minor commercial fisheries was good.

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 2000/01 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion*	34,987
Fisher field contacts by Fisheries Officers (6 months)*	3,348
District Office contacts by Fisheries Officers (6 months)*	1,823
Fishwatch reports **	696
OFFENCES DETECTED	**NUMBER**
Infringement warnings	388
Infringement notices	76
Prosecutions	30

* These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

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

Further north, the Mid West Regional Office conducted a pre-season briefing for operators in the Abrolhos trawl fishery. There were no significant compliance issues during the 2001 Abrolhos scallop season, although one operator was detected allegedly fishing outside the fishery in closed waters. The Vessel Monitoring System was introduced at the opening of the season and all vessels were fitted with VMS units. The introduction of this technology ran smoothly and is seen as a major tool in efficiently managing compliance within the environmentally sensitive Abrolhos Islands reserve. A dedicated two-man field operations team was established during 2000/01 to enhance regional services delivery to the Abrolhos Islands.

Initiatives in 2001/02

During 2001/02 the Regional Services Branch extended its use of risk assessment processes, both internally and in conjunction with the client base, to determine priority areas of concern in commercial fisheries. The identified major risks in both minor commercial and cost-recovered commercial fisheries were the black market and wholesale–retail sector, where avenues for the sale of illegally taken product could occur, and interference with commercial fishing gear.

One of the initiatives for 2001/02 was to focus on illegal sales of fish within the individual regions and across regions in targeted joint operations. A number of significant results were achieved in relation to illegal sales of rock lobster, abalone, finfish and squid. Some apprehensions were also achieved in connection with interference with fishing gear in the Peel/Harvey Estuary.

This joint industry/Departmental approach to risk assessments continues to provide a focus for relevant compliance operations.

In addition to these enforcement-centred initiatives, staff in the Mid West region conducted a number of public information displays and seminars targeting commercial and recreational rock lobster fishers. Material presented focused on new regulations and some of the identified problem areas around the possession of setose rock lobsters and rock lobster tails.

REGIONAL RESEARCH OVERVIEW OF WETLINE FISHING

The catch and effort statistics (CAES) database indicates that over half (58%) of the wetline catch in 2000/01 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)* 210 tonnes, West Australian dhufish *(Glaucosoma hebraicum)* 191 tonnes, whitebait *(Hyperlophus vittatus)* 144 tonnes, Australian herring *(Arripis geogianus)* 117 tonnes, sweetlip emperor *(Lethrinus miniatus)* 64 tonnes, samson fish *(Seriola hippos)* 61 tonnes, sea mullet *(Mugil cephalus)* 57 tonnes, spangled emperor *(Lethrinus nebulosus)* 52 tonnes, redfish *(Centroberyx affinis)* 35 tonnes and baldchin groper *(Choerodon rubescens)* 33 tonnes. Catches of dhufish, pink snapper, emperor, and baldchin are the main product of the demersal scalefish operations reported on pp. 37–41, noting that catches of emperors are mostly from the Abrolhos Islands. Whitebait, Australian herring and sea mullet comprise most of the catch of the beach bait fishers who operate between Tim's Thicket and Augusta (see pp. 32–34).

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 Augusta using baited traps or 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 tonnes 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, 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 (effectively a subset of Zone B) for those fishing the Abrolhos Islands between March and June.

Following on from record catches of between 13,000 and 14,000 tonnes in the 1998/99 and 1999/2000 seasons, the 11,300 tonne catch in the 2000/01 season was equal to the 10-year moving average. However, in 2001/02, the catch of the fishery declined to approximately 9,000 tonnes. Variations in catch of this magnitude are not abnormal, and largely reflect the level of puerulus settlement four years

earlier, which is in turn dependent upon environmental factors such as the Leeuwin Current.

The 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 highly valuable to fisheries managers because arrangements and options can be assessed against the established objectives in the context of predicted catch trends. This said, the 2001/02 season's catch was below the range predicted by the Department of Fisheries' Research Division, but this is most likely to have been as a result of poor climatic conditions for catching lobster throughout the normally productive 'whites' phase. 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 and maturation rates of the lobsters.

With the exception of the maximum size restrictions, the above elements of this management package have been maintained because they continue to be relevant by ensuring that the stock does not fall below the established biological reference point. The maximum size rule was removed for the 2001/02 season following detailed scientific advice and consultation with stakeholders. This action was taken to increase the value of the catch in 2001/02 without increasing costs or presenting an unacceptable risk to sustainability. The maximum size restrictions will be automatically reinstated for the 2002/03 season.

At the commencement of the 2001/02 season a major amendment to the West Coast Rock Lobster Managed Fishery Management Plan 1993 came into effect, resulting in 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 quantity of gear that the individual licensee can use. This change makes the nature of the commercial fishing right clearer and provides a more explicit link to the overall (and adjustable) capacity or total allowable effort permitted in the fishery, as described in the management plan.

The Department is currently working on an extension of the unitisation process designed to recognise investment in units of entitlement through a register.

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 process, an environmental risk assessment has been completed, and the four moderate risks identified have been the subject of additional assessment and reporting during 2001/02.

The process of addressing the MSC requirements both complements and is complemented by work being done to satisfy the new Commonwealth Government environmental legislation being administered by Environment Australia. The Department submitted its ecological sustainability report to EA in October 2001 and has responded to the public comments received through that body.

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 2002/03, 2003/04 and 2004/05 seasons, in particular:

- new directions for the fishery's management program in response the National Competition Policy;
- a review of the composition of, and process for appointing members to, the Rock Lobster Industry Advisory Committee (RLIAC);
- the development of an explicit harvest strategy in the form of fisheries management decision rules; and
- an assessment of the relative efficiencies of the current management system to determine where gains can be made by commercial operators.

These strategic management issues, along with other matters that affect the management of the State's rock lobster fisheries, are considered by RLIAC. 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 2001/02 the committee met four times, held four stakeholder open forum meetings and conducted a coastal tour visiting Fremantle, Dongara and Geraldton.

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
Quarterly 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 that participants and community members understand, accept and adhere to the management rules. The Regional Services Branch provides many of the services aimed at achieving these objectives.

The Branch provides a range of at-sea and land-based compliance services within the west coast bioregion. These services are provided by Fisheries and Management Officers stationed in Denham, Geraldton, Dongara, Jurien, Lancelin, Fremantle, Mandurah, Bunbury and Busselton, and by Fisheries Officers aboard the patrol vessels *Baudin*, *McLaughlin* and *Walcott*.

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

Services provided by land-based officers include processing, landing and gear inspections, licensing checks, wholesale/retail checks and inshore sea-based patrols utilising vessels ranging in size from 5 to 12 m. They also provide support to 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.

Larger patrol vessels ensure that fishers adhere to zone and closed-water requirements, gear restrictions, and seasonal closures.

Activities during 2000/01

In 2000/01 the approach to management in partnership with industry continued, with the first 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. All participants agreed that it produced clear results and has established a participative model for further development. Major risks identified included illegal sale into the restaurant trade, interference with commercial fishing gear, and over-potting. It is envisaged that this process will occur on a yearly basis, and will lead to more effective and efficient compliance monitoring.

As part of the move toward a more focused and planned compliance model, a Compliance Coordinator was appointed to enhance in-field contact with fishers and coordinate across-region operations. The Coordinator attends rock lobster association meetings to educate fishers on rule changes and to obtain information on local compliance issues that can then be incorporated into the compliance planning process. Additionally, mobile factory patrols were established late in the season to complement increased time spent in the field by district-based Fisheries Officers. The patrols, based in Fremantle and Geraldton, travel at random throughout the fishery area 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 2000/01. 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 2.5–3.2% of the entire landed catch consigned to processing factories (West Coast Rock Lobster Table 2).

Regional Services officers in the west coast bioregion delivered 28,182 hours to the West Coast Rock Lobster Managed Fishery in 2000/01. While compliance in the fishery was generally good, 366 infringement warnings and 66 infringement notices were issued, and 22 prosecutions were initiated or conducted (West Coast Rock Lobster Table 1).

Fisheries Officers reported 3,111 field-based contacts and 1,244 contacts in District Offices with commercial fishers during the second half of 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 2000/01 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in fishery	28,182
Fisher field contacts by Fisheries Officers (6 months)*	3,111
District Office contacts by Fisheries Officers (6 months)*	1,244
OFFENCES DETECTED	**NUMBER**
Infringement warnings	366
Infringement notices	66
Prosecutions	22

* These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

WEST COAST ROCK LOBSTER TABLE 2

Summary statistics of factory inspections of commercially captured western rock lobster in the 2000/01 fishing season.

STATISTIC	VALUE
Number of unique vessels checked	Entire fleet at least once
Average number of inspections per vessel	7.1
Average number of baskets checked per vessel*	19.95
Proportion of total commercial catch inspected	2.5%–3.2%
Non-compliance rate (per-animal basis)**	0.0014–0.0015
Total consigned commercial catch ('000 kg)	11,273
Estimated total illegal catch consigned ('000 kg)	16.3–16.9

* 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. Minor infringement notices and warnings continued to be issued, some for setose rock lobster but the majority for over-size animals. Closed-water offences detected within the waters of Rottnest Island were again an issue during the season. There was a significant increase in reports of the illegal pulling of fishing gear.

In the Mid West Region (principally Zones A and B), the majority of complaints received were about unauthorised pulling of pots. Complaints related to early pulling and recreational fishers interfering with fishing gear were also high. District operations included roadside checkpoints and aerial surveillance. Aerial checks covered fishing at Big Bank, A Zone vessels fishing in less than 20 fathoms after 1 March, and the southern and south-eastern portion of A Zone prior to that area opening on 14 March. Operations were also conducted to ascertain whether vessels were pulling pots belonging to other vessels, to check fishermen departing vessels for possession of totally protected fish, to carry out formal pot counts, and to monitor for the return of protected fish to the water.

Throughout the season, patrol vessel operations continued to target areas of complaint, these being mainly under-size/over-size/setose rock lobster, zone boundary offences, gear interference and over-potting. In the Gascoyne Region, one licensee was prosecuted for fishing in waters closed to the taking of western rock lobster. In the Southern Region, increased activity in the latter part of the season saw up to 50 boats fishing out of the Bunbury area.

Initiatives in 2001/02

Following the successful introduction of the mobile rock lobster patrols in the latter part of 2000/01, industry agreed to the full-time implementation of the patrols for the 2001/02 season. Compliance staff working with the Rock Lobster Coordinator also planned and implemented a number of joint regional initiatives targeted at areas identified through the risk assessment process. Additionally, priority was given to developing and testing new techniques and technology aimed at more effective compliance initiatives and outcomes.

The delivery of a new patrol vessel, the PV *Hamelin*, which is to replace the PV *Baudin*, will also enhance the seagoing capabilities of the Departmental patrol vessel fleet.

Research Summary

During the year, research activities continued to focus on forecasting future catch levels, monitoring levels of puerulus settlement on a lunar-monthly cycle, monitoring of breeding stock levels, monitoring of catches through both fishers' and processors' returns, and modelling and stock assessment. Research advice was provided to the Rock Lobster Industry Advisory Committee, Western Rock Lobster Development Association, WA Fishing Industry Council, various fishermen's associations and the general public. A Master's thesis entitled 'Time series modelling of the environmental factors affecting the daily catch rates of western rock lobster' also was completed at Edith Cowan University using data from the voluntary research logbook program and guidance from the Fisheries Research Division. Such projects add significantly to the knowledge base for the rock lobster fishery and demonstrate how good collaborative research can be undertaken by the Department of Fisheries and the Western Australian universities. In addition, a focus was placed on gathering quantitative data to be used in the assessment of the impacts of rock lobster fishing in the context of ESD issues arising from Commonwealth legislation 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 2000/01):
11,266 tonnes

Landings

Trends in the annual catches from the West Coast Rock Lobster Managed Fishery (WCRLMF) 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 2000/01 catch in the WCRLMF was forecast from puerulus settlement to be 11,200–12,400 tonnes. Processors' figures show that the catch from the WCRLMF for the 2000/01 season was 11,266 tonnes, 4.1% greater than the long-term average catch of 10,820 tonnes and 22.4% less than the previous season's record of 14,523 tonnes. In 2000/01, the catches in A Zone, B Zone and C Zone were 1,673 tonnes, 3,504 tonnes and 6,089 tonnes respectively, with A Zone 4.3% lower, B Zone 23% lower and C Zone 26% lower than the record previous season.

In 2000/01, a survey of recreational rock lobster fishers estimated that they caught approximately 560 tonnes, which was a 25.3% decrease on the catch estimate for 1999/2000 of 750 tonnes. The decrease reflected the reduced recruitment of lobsters.

The total catch of western rock lobster from this fishery (commercial and recreational) was approximately 11,830 tonnes, 22.5% lower than the previous season's record catch of 15,270 tonnes.

Octopus may be caught in rock lobster pots, generally in shallow water (0–20 fathoms or 0–37 m), and a catch rate of about 0.035 octopus per pot lift was recorded in the 2000/01 voluntary research logbook data. This was 20.7% above the average of 0.029 per pot lift over the period 1985/86 to 1999/2000. This translates to an estimated 366,000 octopus caught in the fishery during 2000/01. Octopus catches in B Zone generally are twice those of the other two zones.

Fishing effort

The nominal fishing effort for 2000/01 was 10.46 million pot lifts, 2.4% lower than the 10.72 million pot lifts for 1999/2000 (West Coast Rock Lobster Figure 1). The nominal effort for the A, B and C Zones of the WCRLMF was 1.22 million, 3.78 million and 5.46 million pot lifts respectively, which was 6.1% more, 3.1% less and 3.7% less than the previous season's 1.15, 3.90 and 5.67 million pot lifts.

Effort equivalent to 0.52 million commercial pot lifts was used by the recreational fishery to land its catches. This was 5.5% lower than the 0.55 million pot lifts used in 1999/2000.

The total effort used in the WCRLMF during 2000/01 was 10.98 million pot lifts, 2.3% lower than the 11.24 million pot lifts made in 1999/2000.

The reduced level of pot usage maintained since 1993/94 has had the secondary effect of 'encouraging' a reduction in fleet size as vessels purchased additional pot entitlements to improve their economic efficiency. Over 1999/2000 and 2000/01 vessel numbers remained stable with a fleet of 594 licensed boats, indicating that the restructuring has slowed. Under new legislation introduced in 2000/01, new WCRLMF 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, 146, 147 and 291 vessels actually fished for lobster in 2000/01 in A, B and C Zones respectively, with two A Zone, four B Zone and four C Zone licences dormant.

Catch rate

A decline in the abundance of rock lobsters from the record 1998/99 and 1999/2000 seasons was forecast for 2000/01. Trends in catch rates show a 'cyclical' pattern due to environmental effects on levels of puerulus settlement (Rock Lobster Figure 2) which are reflected in catches three and four years later. Accordingly, catch per unit of fishing effort in 2000/01 decreased substantially (20.6%) compared to the rate in the record catch season of 1999/2000 (1.08 and 1.36 kg/pot lift respectively) (West Coast Rock Lobster Figure 2).

Recreational component: **5% (approx.)**

See information in 'Landings' and 'Fishing effort' above, and the Recreational Western Rock Lobster Fishery Status Report (pp. 136–138).

Stock assessment completed: **Yes**

The stock remains fully exploited but under the current management arrangements, introduced in 1993/94, the breeding stock has been rebuilt and remains at or above the target levels of the late 1970s and early 1980s (West Coast Rock Lobster Figures 3–5).

Pot reductions continue to be an effective tool with which to manage fishing effort in the WCRLMF. Whilst some effort increase was evident between 1993/94 and 1998/99, nominal effort levels remained stable from 1998/99 to 1999/2000 and even declined slightly in 2000/01. The 18% temporary pot reduction has maintained an 18% reduction in nominal fishing effort when data from 1991/92 and 2000/01 are compared. The maintenance of these lower effort levels has ensured that the exploitation rate of the stock remains lower than prior to the introduction of the management package in 1993/94, as evidenced by 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 will be factored into stock assessments and future management advice.

Post-larval recruitment to the fishery is monitored and fluctuates in response to environmental conditions such as strength of the Leeuwin Current and westerly winds. Annual indices of puerulus settlement for 2000/01 were average to above average but within the historical range of values (West Coast Rock Lobster Figure 6). 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.

Stock assessment is undertaken using existing models but a new approach using depletion estimates currently is being investigated.

Exploitation status: **Fully exploited**

Breeding stock levels: ***Adequate***

The north and south coastal fishery-dependent spawning

stock indices, which are based on commercial monitoring data, are presented in West Coast Rock Lobster Figure 3. The coastal and Abrolhos Islands indices from the fishery-independent survey of the breeding stock are presented in West Coast Rock Lobster Figures 4 and 5 respectively.

Both sets of indices show a considerable decline in 2001 in the coastal breeding stock measures used to assess levels of egg production. Whilst the declines appear dramatic, similar declines in water temperatures appear to have had an effect on the catchability of lobsters leading to lower catch rates during the independent breeding stock survey. The coastal indices have returned to levels equivalent to those in 1997 and 1998. Research advice always has been that, following the introduction in 1993/94 of the current management arrangements, an improvement followed by a stabilising of egg production should occur. This might suggest that the coastal indices in 1999 and 2000 (West Coast Rock Lobster Figure 5) were artificially high due to environmental influences on the survey catch rates. These issues are being examined, and a three-year moving average (smoothing) of the breeding stock indices is being considered. This would show the underlying trends in the breeding stock, rather than highlighting individual data points which can vary significantly as a result of unrelated environmental effects.

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 in the early 1990s (West Coast Rock Lobster Figure 3).

These facts notwithstanding, the levels of egg production still are 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, and will act as a calibration for indices derived from fishery data. The breeding stock survey will be expanded in 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 have been sampled for the previous four seasons.

Projected catch next season (2001/02):
9,550–10,350 tonnes

Total catch predictions for the WCRLMF 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 6). Catch estimates for C Zone also are forecast from combined puerulus settlement figures from a number of C Zone puerulus collection sites. These additional forecasts, for the most part, are not dissimilar to the predictions based on Alkimos settlement alone, but appear to be a little more accurate at this stage. Seasons 2001/02 and 2002/03 are expected to produce commercial catches of around 9,550–10,350 tonnes and 10,750–11,950 tonnes respectively, resulting from the lower puerulus settlements in 1997/98 and 1998/99 (West Coast Rock Lobster Figure 6). Forecast recreational catches indicate that total rock lobster landings (commercial and recreational) will be in the range of 10,030–10,830 tonnes in 2001/02.

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**

The WCRLMF interacts with the Australian sea-lion, *Neophoca cinerea* (status based on IUCN (1994) criteria: lower risk, near threatened), in two ways. The first is due to the discard at sea of the plastic bands around boxes of bait and the subsequent snaring of the bands around the sea-lion's neck or body. This is not common, and an industry code of practice and education have significantly reduced the at-sea discard rate of the bands. The second interaction is the 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 are reported to occur only where pots are set adjacent to the few islands on which this species breeds. 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. However, 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. This rate varied between 7% and 24%, depending upon whether pupping occurred in summer or winter (Shaughnessy 1999). Significant non-fishery factors responsible for the high mortality rate of young sea-lions are attacks on pups by territorial bulls and adverse environmental conditions (Shaughnessy 1999).

Anecdotal information and some preliminary research data suggest that turtles can occasionally become entangled in the ropes of rock lobster pots, most being released alive and unharmed. Turtle deaths are 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 environmental risk assessment and data are being collected through as many sources as possible to establish the level of mortality caused by rock lobster fishing. It is understood that leatherback populations are in decline worldwide. Recent research by Spotila et al. (1996, 2000) suggests Indian Ocean and western Pacific populations cannot withstand even moderate levels of adult mortality and that the current level of indigenous harvest and incidental mortality in commercial fisheries will lead to the extinction of these populations if they continue. The indigenous harvest of leatherbacks in south-east Asian countries and elsewhere, the wholesale poaching of eggs from nests in these regions and the loss of suitable habitat for nesting due to tourism-related developments are significant causes of mortality for

this critically endangered species. By comparison, 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.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The fishery is unlikely to cause significant 'food web' changes, 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.

Habitat effects: **Low**

The legislated design of rock lobster pots, the materials they are made from and the strict control of replacement pots prevent 'ghost fishing' problems arising. A study of human impacts (including rock lobster fishing) on the marine environments of the Abrolhos Islands, funded by the Fisheries Research and Development Corporation (FRDC), estimated that potting might impact on between 0.1% and 0.3% of the surface area of fragile habitat (corals) at the Abrolhos. 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.

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 584 vessels and 1,647 people were engaged directly in fishing for rock lobster in 2000/01. This equates to one skipper and an average of about 1.82 deckhands per vessel. During the year, 11 processing establishments engaged between 150 employees in the closed season and 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 (2000/01): $300 million

The price fishermen received for the western rock lobster in 2000/01 was an estimated average of $27/kg in A and B Zones of the fishery and $26.50/kg in C Zone. This was similar to the $27/kg paid throughout the fishery in 1999/2000. These prices have been 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 WCRLMF in 2000/01 was approximately $300 million, with approximately 95% of product being exported to Japan, Taiwan, Hong Kong/China, the United States and Europe. Foreign exchange earnings from the fishery exceed this value by a considerable amount.

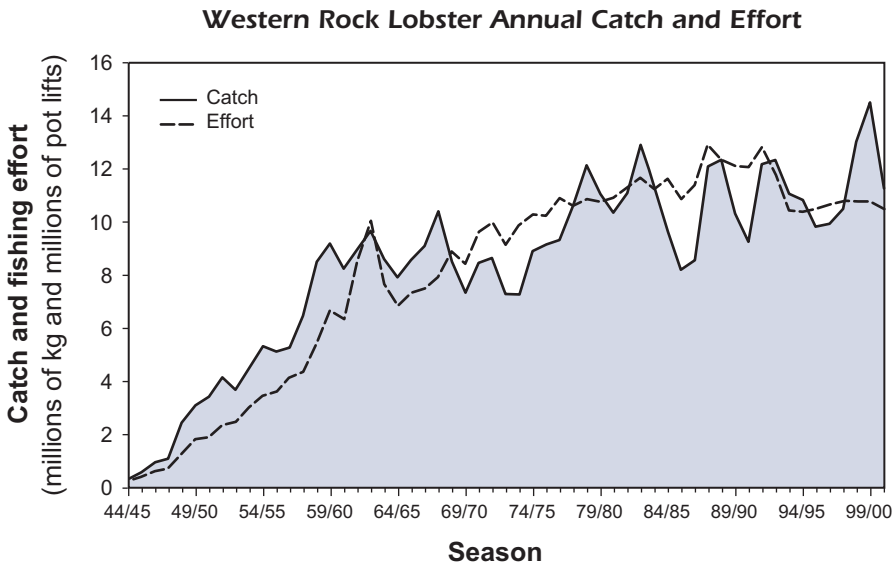
FISHERY GOVERNANCE

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 tonnes in 1985/86 to 14,523 tonnes in 1999/2000. The average catch was 10,820 ± 587 tonnes (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.

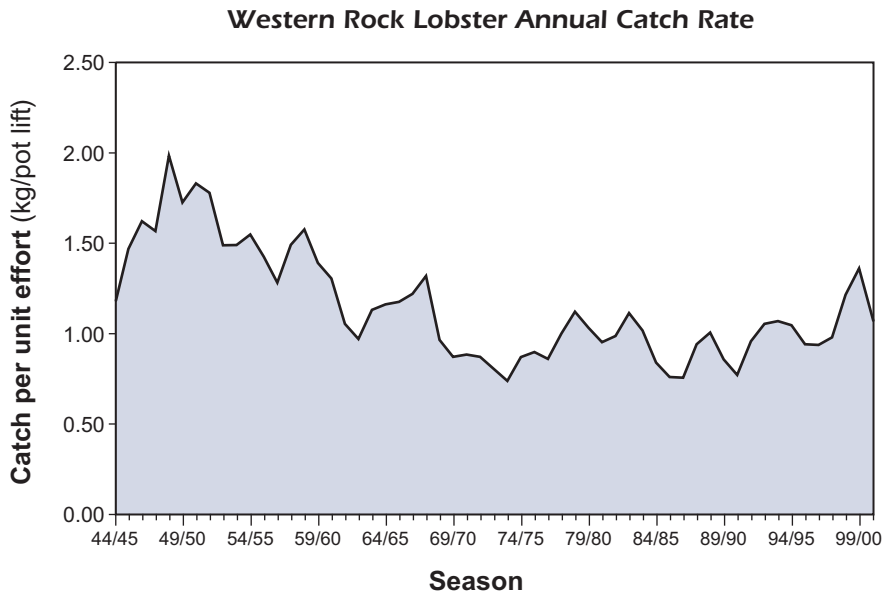
EXTERNAL FACTORS

Catches peaked in 1999/2000, with the second successive season of record landings, and declined to slightly above average levels in 2001/02 as expected. A further decline will occur in 2001/02 before average to very good catches forecast for two seasons following. The forecast reductions are a result of lower puerulus settlements 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. 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. The recreational catch decreased in 2000/01 due to the reduced densities of lobsters in the shallower waters, but numbers of recreational licences remain high and are expected to increase in future years. Both the Department of Fisheries and the rock lobster industry have been addressing issues raised by the Marine Stewardship Council to maintain the world's first MSC certification, and those arising from Commonwealth legislative requirements to ensure an ecologically sustainable fishery.



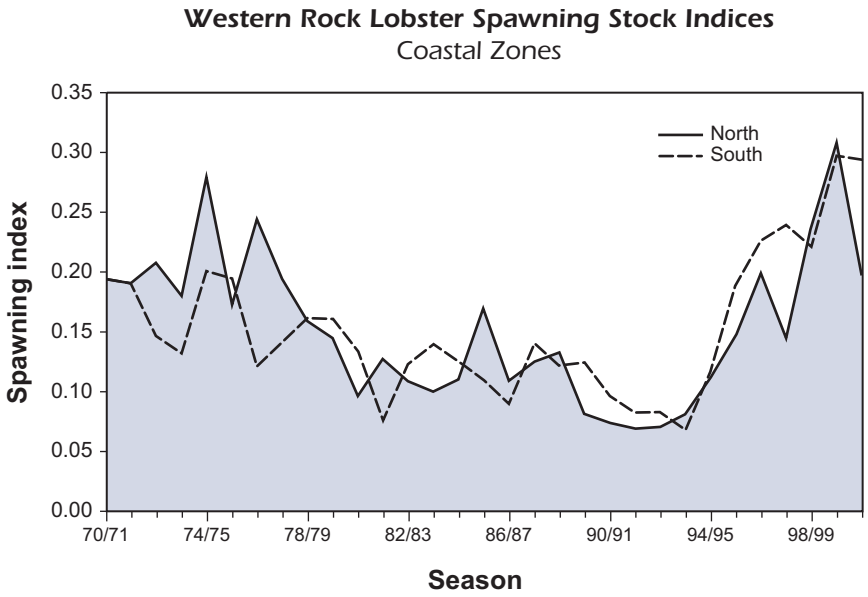
WEST COAST ROCK LOBSTER FIGURE 1

Annual catch and nominal fishing effort from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2000/01.



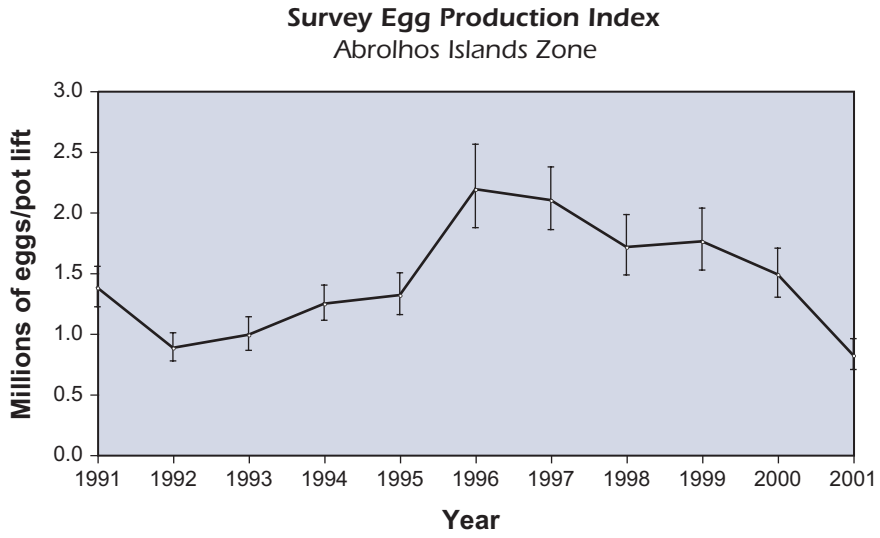
WEST COAST ROCK LOBSTER FIGURE 2

Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2000/01.



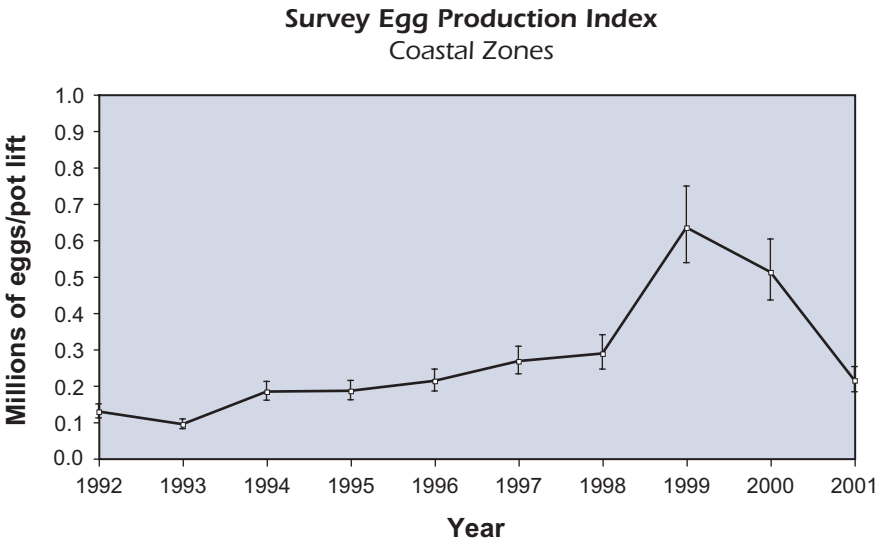
WEST COAST ROCK LOBSTER FIGURE 3

Time series of monitoring spawning stock index (an index of numbers of eggs/pot lift integrated over the whole season) for the north (Jurien and Dongara) and south (Fremantle and Lancelin) coastal regions.



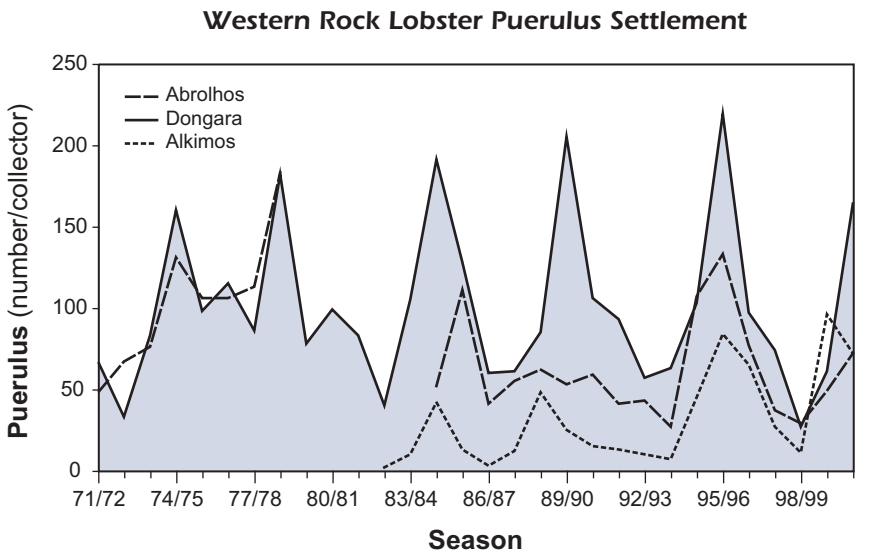
WEST COAST ROCK LOBSTER FIGURE 4

Egg production indices as measured by the independent breeding stock survey at the Abrolhos Islands.



WEST COAST ROCK LOBSTER FIGURE 5

Egg production indices as measured by the independent breeding stock survey at the coastal sampling sites.



WEST COAST ROCK LOBSTER FIGURE 6

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

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 (AIMWTMF), the South West Trawl Managed Fishery (SWTMF) and the trawl fishery off the south coast east of Esperance. 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 2001/02 to allow for transferability of Zone A and D licences. The plan was also amended to allow for the unitisation of fishing gear, which will take effect on 1 October 2002.

Bycatch reduction devices were introduced to the AIMWTMF as a licence condition for the 2002 Abrolhos Islands season. For the 2002 season, licensees were required to have a BRD fitted to one net. In 2003, all nets will be required to be fitted with BRDs.

The Vessel Monitoring System, a satellite tracking system used to monitor the movement of vessels within the waters of a fishery, was introduced into management arrangements for the AIMWTMF in April 2001 and will be introduced into the SWTMF in 2003.

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)
Condition 73 and/or 79 on a Fishing Boat Licence

Consultation Process

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 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 27°51' south latitude and 29°03' south latitude on the landward side of the 200 m isobath'*.

The permitted fishing area opened on 3 April and closed on 31 May 2001. In this fishery, the fishing gear (net size) is unitised, with one headrope unit converting to 4 fathoms. For the 2001 season, the entire entitlement of 46 headrope units, or 184 fathoms, was utilised by the 16 boats which operated in the fishery.

The Port Gregory trawl fishery operates as part of the AIMWTMF. The permitted fishing area opened on 1 March for prawns and 3 April for scallops, and was closed on 31 October 2001.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2001):
1,182 tonnes whole weight

Landings

The total landings for the 2001 season were 1,182 tonnes whole weight of scallops compared to 429 tonnes whole weight in 2000 (Abrolhos Islands Scallop Figure 1). This was higher than the projected catch based on pre-season survey as approximately 300 tonnes came from an area not surveyed. The catch exceeded the defined acceptable catch range as a result of above-average recruitment. It was, however, less than the peak catches of the early 1990s when very strong recruitment occurred, and is therefore not of management concern. No prawns were caught in the Port Gregory area.

Fishing effort

A total of 4,773 trawl hours (nominal effort) were recorded for the 2001 season. This is equivalent to 3,998 standardised trawl hours (standardised to 14 fathoms headrope length), which is much higher than the 1,134 standardised trawl hours in 2000. This effort level represents a fishing season of 21 days' duration in 2001, compared to 7 days in 2000.

Catch rate

The catch rate in 2001 was 296 kg/hr (whole weight, standardised effort), compared with 378 kg/hr for 2000 achieved with lower effort.

Recreational component: **Nil**

Stock assessment complete: **Not assessed**

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 four years of surveys (1997–2000). 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 (2002):
200–300 tonnes whole weight

Using the November 2001 survey data, the projected catch range for 2002 is likely to be 200–300 tonnes whole weight for the surveyed areas, which is lower than the 2001 catch. During the survey, only one area showed reasonable levels of recruitment, with all other surveyed areas showing low 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 relatively bare sand habitat associated with this species. 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**

Turtles occur in the Abrolhos Islands but are rarely taken during the short trawling season. Interaction with turtles is minimal and few other protected species occur in this area.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Due to the high natural variability of this scallop stock it is unlikely that any predators are fully dependent on this species.

Habitat effects: **Low**

The trawl 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.

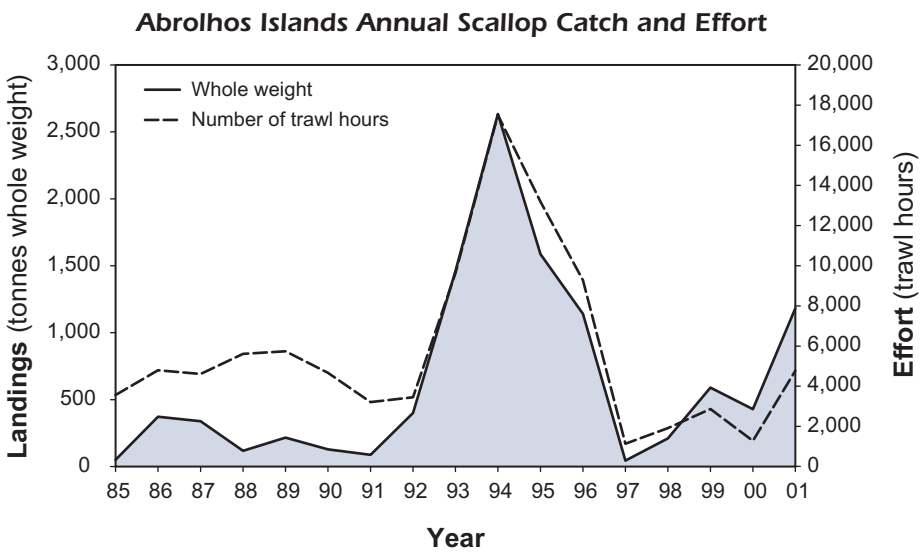
SOCIAL EFFECTS

This scallop fishery utilises large numbers of crew (up to 13 per vessel) to carry out on-board processing during the short annual season. The estimated employment for the year 2001 was 200 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2001:
$4.8 million

The estimated value of the catch has been based on the average wholesale price per kilogram obtained in the Shark Bay fishery, that is $4.10/kg whole weight or $20.50/kg meat weight. Meat weight is approximately 20% of the whole weight.



ABROLHOS ISLANDS SCALLOP FIGURE 1

Annual scallop landings for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985–2001.

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 is expected to be in the range of 50–600 tonnes whole weight at the current level of permitted effort.

EXTERNAL FACTORS

This fishery is highly variable, being dependent on sporadic recruitment that is apparently strongly influenced by environmental conditions such as the Leeuwin Current. As more years of pre-season survey and catch/effort data become available, the relationship between environmental factors and recruitment will be further evaluated.

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. Seven boats operated in the fishery during 2001.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2001): Prawns 10 tonnes
Scallops 23 tonnes whole weight

Landings

The total landings for the season were 10 tonnes of western king prawns (*Penaeus latisulcatus*) and 23 tonnes whole weight of scallops. The catch of king prawns was down on the good catch of 32 tonnes in the previous season. The fishery also lands a mixture of by-product species, of which the most abundant species recorded were 11 tonnes of sand whiting (*Sillago* spp.), 4 tonnes of blue swimmer crabs (*Portunus pelagicus*), and 1 tonne each of sole, squid, flounder and mixed skates and rays.

Fishing effort

Not assessed.

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 2001 was 28 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2001:
Prawns $150,000
Scallops $100,000

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 $14.05/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 $4.10/kg whole weight or $20.50/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 2001):
239 tonnes whole weight

Landings

The scallop catch of 239 tonnes whole weight was substantially lower than the very high catch of 2,722 tonnes seen in 2000, but still relatively high compared to the previous highest catch of 138 tonnes whole weight recorded in 1995. The south coast trawl fishery is principally a scallop fishery, though two licence holders reported landings of mixed finfish, of which leatherjacket, redfish and queen snapper were the main species recorded.

Fishing effort

The annual effort expended in this scallop fishery is an outcome of initial fishing surveys used by operators to estimate stock abundance and likely benefits of continued fishing. As a consequence, the level of effort utilised each year closely follows stock abundance and catch levels.

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 2001 was 16 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001):
$1 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. The scallop catches in 2001 were higher than those seen in the fishery in general over the last 10 years (except the very high catch seen in 2000), indicating continued fishing down of the stock which was still available 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 proportion of the State's inshore crab catches. They may be targeted by a variety of fishing gear. The primary methods used by commercial fishers targeting crabs are crab traps or drop nets. Crabs are also taken by trawl gear in several prawn and scallop trawl fisheries.

Commercial access to oceanic areas with abundant blue swimmer crab stocks is controlled under a series of separate management arrangements. In Cockburn and Warnbro Sounds, commercial access is managed under the provisions of the Cockburn Sound and Warnbro Sound (Crab) Management Plans.

The use of crab traps in the waters of Comet Bay (Mandurah), Shark Bay and Geographe Bay (Busselton) is controlled under a variety of arrangements provided by way of subsidiary legislation under the *Fish Resources Management Act 1994*. While the sustainability of the 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.

In the lower west coast estuaries set nets are still used. However, commercial crab fishing no longer occurs in the Leschenault Inlet, as this estuary was closed to all commercial fishing after a Voluntary Fisheries Adjustment Scheme (VFAS) removed all commercial operators. In the Mandurah Estuarine Fishery, crab traps are now the principal method used.

The total annual commercial catch of crabs is monitored through information provided by fishermen on their monthly catch and effort returns. Fishermen also provide more detailed information via a voluntary daily research logbook program.

Following a statewide review of the inshore crab fishery in the years 1997 to 1999, recommendations for the future of the fishery were developed. The Minister has now approved the directions for future management arrangements, with a view to managing the State's crab stocks on a statewide zonal arrangement.

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 the expanding 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 a high level of participation by recreational fishers, additional research became necessary to address key biological parameters and collect fishery information required for stock assessments in the future. A number of new research projects were instigated during 1997/98, with funding from FRDC, under the umbrella of the national collaborative blue swimmer crab research initiative. This research on 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 sequel three-year project to enable the development of stock allocation and assessment techniques in the State's 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

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 the Peel/Harvey Estuary in the south and Shark Bay 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. One licence holder has access to the Warnbro Sound managed fishery, while access to the Cockburn Sound managed fishery is by 11 licence holders.

Licence holders in the Exmouth Gulf Beach Seine Fishery, Shark Bay Beach Seine and Mesh Net Managed Fishery, and estuarine fisheries south of latitude 32° S, are permitted to take blue swimmer crabs by drop net or set net. 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 2002.

Two commercial fishers are permitted to take crabs by traps (80 traps each) in the waters of Comet Bay. The Carnarvon Experimental Crab Trap Fishery is also continuing, with two fishers permitted to take crabs using 200 traps each. Exemptions to fish in the Carnarvon Experimental Crab Trap Fishery are granted on an annual basis. One Shark Bay beach seine fisher and one Cockburn Sound fisher are also permitted to take crabs using up to 200 traps each in Shark Bay. These two fishers have a long-standing and continuing history of targeting crabs in these waters.

Recreational fishers also take significant quantities of crabs, particularly in the south-west of the State. Surveys to estimate the recreational take have been undertaken for some regions during the past five years.

Main fishing method

Purpose-designed crab traps.

RETAINED SPECIES

Commercial production (season 2000/01): 736 tonnes

Landings

A commercial catch of 736 tonnes of blue swimmer crab was taken in 2000/01, 9% up on the 673 tonnes caught in the 1999/2000 season. Commercial catches in Cockburn Sound contributed 212 tonnes (31% decrease), while other areas making a substantial contribution to total landings were the Peel/Harvey Estuary (70 tonnes, 14% increase) and Shark Bay (301 tonnes, 40% increase) (see Blue Swimmer Crab Figure 1).

Fishing effort

The commercial crab catch is made using a large variety of fishing methods (see Blue Swimmer Crab Figure 2). In the past year, traps took 81% of the commercial catch, while the balance of the catch was taken mostly by trawling (10%), gillnetting (6.9%) and drop netting (1.3%). Fishing effort overall 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.

Catch rate

Because of the variety of fishing methods in use and areas being 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 catch rate using traps in Cockburn Sound (0.95 kg/trap lift) decreased by 26% compared with the previous season. In the Peel/Harvey Estuary (1.41 kg/trap lift), catch rates for traps increased by 16% but gillnet catches dropped to zero. In Shark Bay (1.77 kg/trap lift), trap catch rates increased by 30%.

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. With the lower commercial catches in the south and higher Shark Bay catches in 2000/01 it is likely that the recreational share of the overall catch has decreased in the current year.

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. Trap catches in Shark Bay (Blue Swimmer Crab Figure 3) show almost a five-fold increase since the commencement of the Shark Bay Experimental Crab Fishery in 1998, while effort and catch per unit effort (CPUE) have only increased three and 0.5 times respectively. These increases are due to more efficient fishing of blue swimmer stocks as the fishers' knowledge of the fishery has increased over time. Following the change from gillnets to purpose-designed pots in 1994/95, trap catches in Cockburn Sound increased until reaching a peak of 333 tonnes in 1997/98 (Blue Swimmer Crab Figure 4), after which the catches declined. Similarly, effort peaked in 1997/98 and has subsequently declined due to industry buy-backs and latent effort in the fishery. However, on an annual basis the catch, effort and CPUE in Cockburn Sound display significant variation. Blue swimmer catches in Peel/Harvey (Blue Swimmer Crab Figure 5) have maintained fairly consistent levels in terms of catch, effort and CPUE since the implementation of pots in 1995/96, with a moderate increase in catch and CPUE evident in 2000/01.

Yield-per-recruit analysis has indicated that yields in the fishery 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 catch in the fishery by reducing size (age) at first capture is not economically viable, as market demands mean that premium prices are paid for animals > 130 mm CW. Similarly, catching smaller crabs with lower meat yields is unlikely to be satisfying to recreational fishers.

Exploitation status: Not assessed

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: Low

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.

SOCIAL EFFECTS

Approximately 43 people are 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 Shark Bay in the north. Additional employment is also being created in the Gascoyne region where post-harvest processing of the crab catch is occurring.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000/01): $3.1 million

The catch was valued at approximately $3.1 million in 2000/01, with most of the product going to local and interstate markets.

FISHERY GOVERNANCE

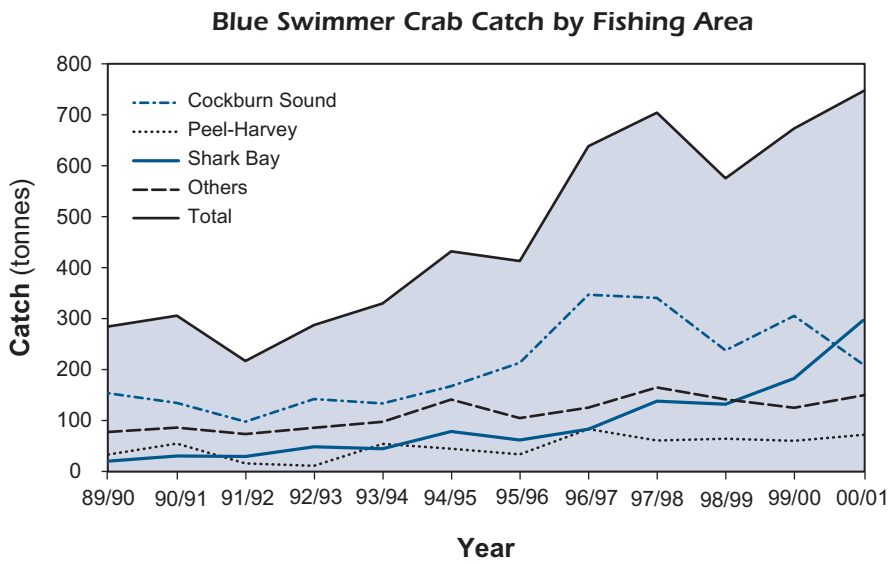
Acceptable catch range: **600–800 tonnes**

Commercial catches are expected to be in the range 600–800 tonnes, based on catches in the years 1997/98 to 1999/2000. For the managed fishery in Cockburn Sound the commercially acceptable range for the current management regime is approximately 200–350 tonnes, based on catches in the five-year period from 1995/96 to 1999/2000, since the fishing effort was converted to trapping and effort stabilised.

There is also interest in expanding the blue swimmer crab fishery 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.

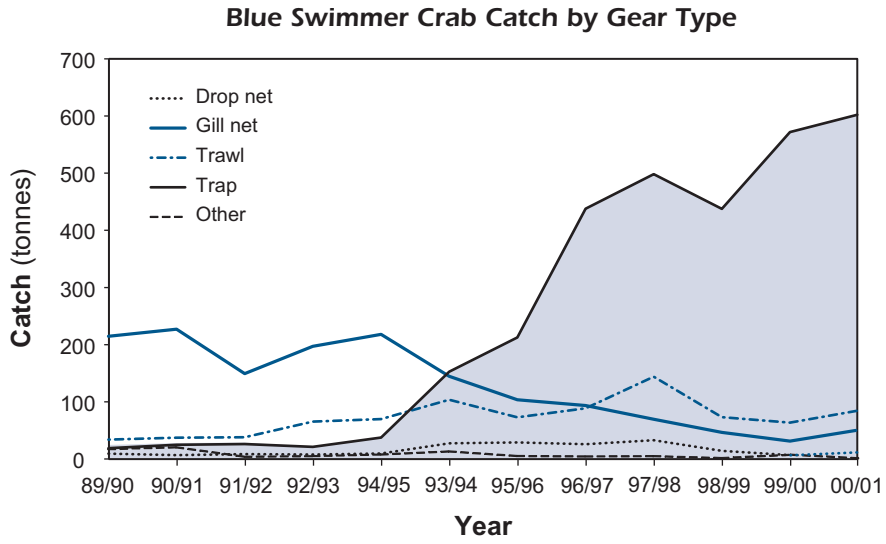
EXTERNAL FACTORS

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 is 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 this 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.



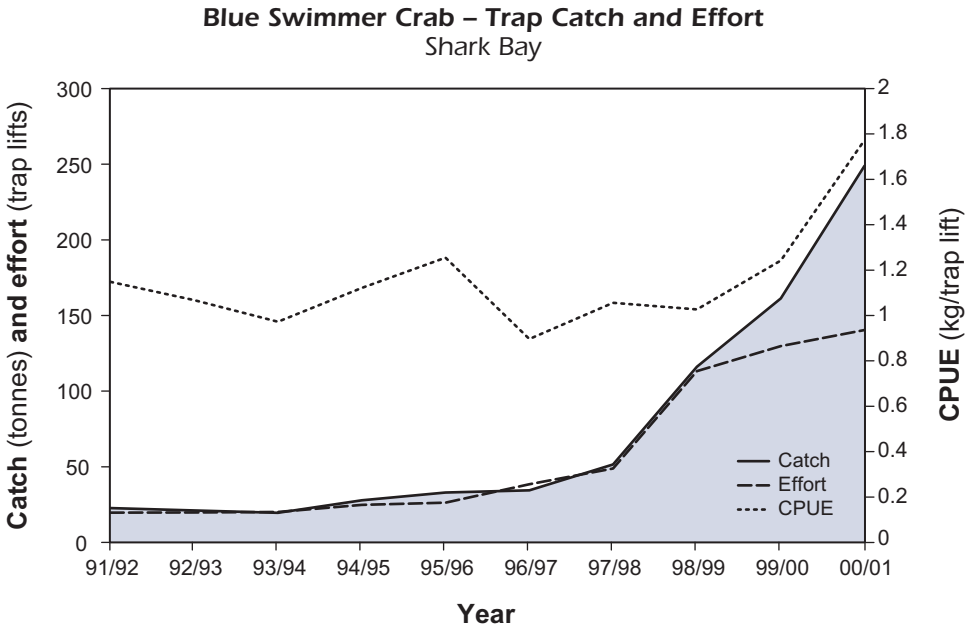
BLUE SWIMMER CRAB FIGURE 1

Commercial catch history for the blue swimmer crab (*Portunus pelagicus*) in Western Australia between 1989/90 and 2000/01, indicating main regions of commercial catches.



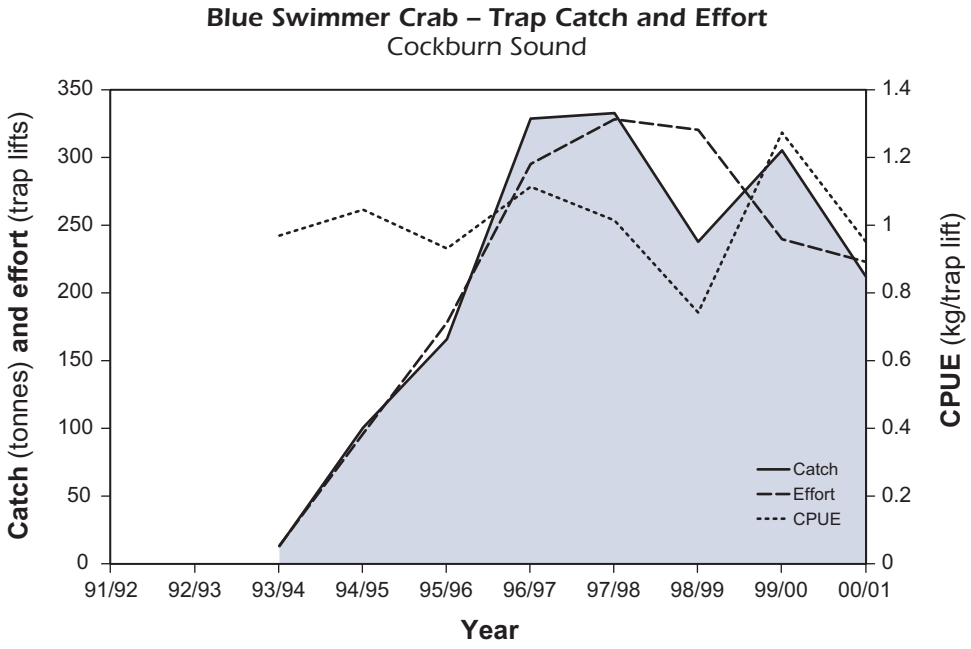
BLUE SWIMMER CRAB FIGURE 2

Blue swimmer crab catch taken by different gear types in Western Australia during the period 1989/90 to 2000/01.



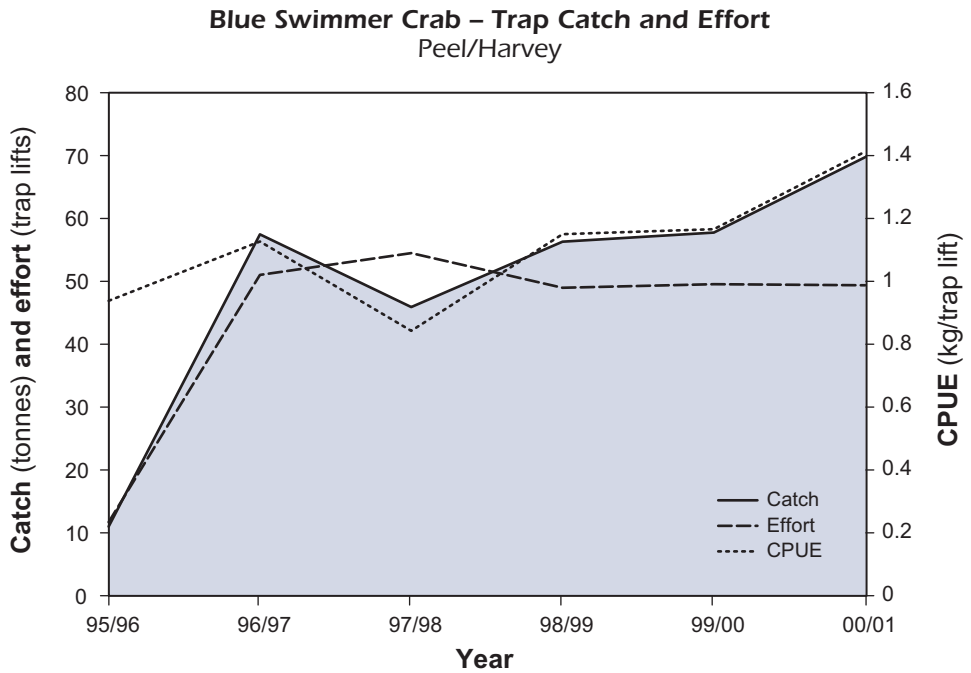
BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (kg), effort (trap lifts) and catch per unit effort (kg/trap lift) in Shark Bay during the period 1991/92 to 2000/01 using traps.



BLUE SWIMMER CRAB FIGURE 4

Blue swimmer crab catch (kg), effort (trap lifts) and catch per unit effort (kg/trap lift) in Cockburn Sound during the period 1991/92 to 2000/01 using traps.



BLUE SWIMMER CRAB FIGURE 5

Blue swimmer crab catch (kg), effort (trap lifts) and catch per unit effort (kg/trap lift) in the Peel/Harvey Estuary during the period 1995/96 to 2000/01 using traps.

WEST COAST DEEP-SEA CRAB FISHERY

Management Summary

The West Coast Deep-Sea Crab Fishery is presently a developmental fishery. Fishers target giant (king) crabs (*Pseudocarcinus gigas*), snow crabs (*Chaceon bicolor*) and champagne crabs (*Hypothalassia acerba*). Stocks are currently accessed via a condition on a WA fishing boat licence. There are seven boats currently authorised to participate within this fishery. Given the vulnerability of deep-sea crab stocks to over-exploitation, the Department has concerns about the ability of the fishery to continue to support all licensees, and will be giving consideration to ways of equitably sharing reduced access to the resource.

There have been several submissions to Environment Australia in 2001/02 regarding the sustainability of this fishery. Part of EA's requirements is that a formal management plan be in place by December 2002. The Department intends to implement an interim management plan for this fishery shortly, the details of which have been discussed with industry and other interested parties over the past 12 months.

Governing Legislation/Fishing Authority
Condition 106 on a Fishing Boat Licence

Consultation Process
Department–industry meetings

Research Summary

Research in this sector involves assessing the current status of the West Coast Deep-Sea Crab Fishery based on commercial catch returns and logbook information. Information from these sources is reflected in the following status report.

WEST COAST DEEP-SEA CRAB STATUS REPORT

Prepared by R. Melville-Smith

FISHERY DESCRIPTION

Boundaries and access

The developmental West Coast Deep-Sea Crab Fishery 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, with each licence holder permitted to use 700 small moulded plastic pots. Current access arrangements result from a voluntary agreement among the fishers. To limit the level of exploitation, but still obtain a sufficient spread of fishing effort across the fishery for stock assessment purposes, three fishers have been allocated 'full-time' access (9–12 months) and four 'part-time' access (0–3 months). Fishers are required to nominate one of five areas in which they will fish. The maximum fishing effort in any one area is 18 fisher months (e.g. one full-time fisher = 12 fisher months plus two part-time fishers at 3 months each = 6 fisher months).

In 2006, all licensees are expected to be granted equal access to whatever portion of the deep-sea crab stocks is made available by the Department of Fisheries for commercial harvesting. The allocation may be in the form of time access, effort or catch quota units.

Main fishing method

Moulded plastic pots operated in longline formation.

RETAINED SPECIES

Commercial production (season 2000/01): 213 tonnes

Landings

A catch of 213 tonnes of snow crabs was taken in the fishery in 2001, an increase of 49% on the catch taken in the 2000 season (143 tonnes). Champagne crabs decreased from the 12.4 tonne landings reported by five licence holders in 2000 to a negligible catch reported in 2001. Small volumes of giant crabs were landed by vessels in the southern region of the fishery in 2000, but no catch was reported in 2001.

Fishing effort

Effort increased by 74% from an estimated 51,000 pot lifts in the 2000 season to 88,750 pot lifts in the 2001 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 14%, from 2.8 kg/pot lift in 2000 to 2.4 kg/pot lift in 2001. 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: No

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.

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, therefore offer protection for the female portion of the populations. Furthermore, preliminary evidence shows that size at maturity for males and females of both snow and champagne crabs is well below the minimum size in both species (Kim Smith, Murdoch University, unpub. data) and that therefore the broodstock is protected to some extent.

Much more 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 both species 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 (2001): $2.8 million

The beach value of the fishery was about $2.8 million in 2001, based on an average beach price of $13/kg for snow, $9.5/kg for champagne and $25/kg for giant crabs.

FISHERY GOVERNANCE

Acceptable catch range: **Not assessed**

The effort in this developing fishery is 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.

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

Management arrangements 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.

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. This included the total removal of commercial fishing units in the Leschenault Estuarine Fishery.

A discussion paper on alternative management options for a proposed West Coast Estuarine Fishery incorporating the three existing estuarine fisheries was released for comment in December 2001. It is anticipated that the changes to the management arrangements for these fisheries will be finalised in 2002/03.

Governing Legislation/Fishing Authority

Condition 19 on a Fishing Boat Licence
Condition 17 on a Commercial Fishing
Various orders under Section 43 of the *Fish Resources Management Act 1994* (closed waters and permitted gear)
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 2001. Unit holders in the three west coast estuaries are endorsed to fish a single west coast estuary system only. During 2000/01, all six of the licence holders in the Leschenault Estuary accepted an offer from the Government's buy-back scheme with the result that commercial fishing no longer occurs in that estuary.

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

Main fishing method

Gillnet/haul net.

RETAINED SPECIES

Commercial production (season 2001): 264 tonnes

Landings

The total landings of 264 tonnes from west coast estuaries include the following catches of key target species:

Blue swimmer crabs	*Portunus pelagicus*	93.0 tonnes
Sea mullet	*Mugil cephalus*	69.4 tonnes
Yellow-eye mullet	*Aldrichetta forsteri*	51.4 tonnes
Western sand whiting	*Sillago schomburgkii*	16.4 tonnes
Tailor	*Pomatomus saltatrix*	6.2 tonnes
Australian herring	*Arripis georgianus*	4.9 tonnes
Other species		22.4 tonnes

Swan/Canning: The 2001 catch level showed a small increase over 2000 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 2001 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, a dramatic decline occurred between 1998 and 2000. However, the total catch for 2001 of 196.5 tonnes was similar to the 2000 catch figure. Approximately 54% of the finfish catch comprised sea mullet and yellow-eye mullet during 2001, with approximately 37% of the total 2001 catch consisting of blue swimmer crabs.

Hardy Inlet: The 2001 catch remained similar to that of the previous year (actual figure not available as there were fewer than five operators). The majority of the catch was composed of western sand whiting, with small quantities of sea mullet and yellow-eye mullet. There were no reported catches of blue swimmer crabs in 2000.

Key indicator species

Black bream: Catches of black bream were reported from the Swan/Canning Estuary and the Hardy Inlet during 2001. The reported catches from these estuaries showed a minor increase from the 2000 catches.

Cobbler: Minor catches of cobbler were reported from the Swan/Canning Estuary and Peel/Harvey Estuary during 2001. The reported catches of cobbler in the Swan/Canning Estuary have been declining from the late 1980s, with 2001 being the lowest on record. The 2001 catch in the Peel/Harvey Estuary is also at an historically low level. There was no catch reported from the Hardy Inlet for 2001.

King George whiting: King George whiting catches for 2001 were reported from the Peel/Harvey Estuary only. Total annual catches from these west coast estuaries have declined considerably since the high catch values in 1998 and 1999, noting that high catches in the late 1990s appear to have resulted from an above-average recruitment into these estuaries.

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 applying 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 2001.

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.

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 2001.

Catch rate

Swan/Canning: While the annual values of the catch per unit effort for the finfish fishery in the Swan/Canning Estuary have varied over the past 15 years, the overall catch rate trend generally has been stable, as a result of reduced effort and corresponding reductions in catch. While targeted fishing effort cannot be determined for individual stocks, the general stability of the overall CPUE suggests the abundance of the suite of species which 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 since 1997. While targeted fishing effort cannot be determined, the general stability of the overall CPUE over this period suggests the abundance of the suite of species which 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 2001 CPUE has decreased slightly from the 2000 value.

Recreational component:
Overall percentage not assessed

The most recent recreational catch survey data, for the year 1998/99, were reported in the *State of the Fisheries Report 2000/01*.

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 targeted species (black bream, cobbler and King George whiting). Annual monitoring assessment of stock trends is undertaken using catch and effort indicators.

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 2000/01, the catch data for the Swan River stock indicate a slight increase in the catch associated with a further 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 of this once important species in 2000/01 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 several 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 2001 appear to be due to lower recruitment generally and the maturing and offshore movement of the fish previously recruited.

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*. As the size at maturity is less than the legal minimum length, breeding stock levels are believed to be adequate. 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 and low fishing effort in offshore waters appear to afford sufficient 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 2001, 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 (2001):
$730,000

FISHERY GOVERNANCE

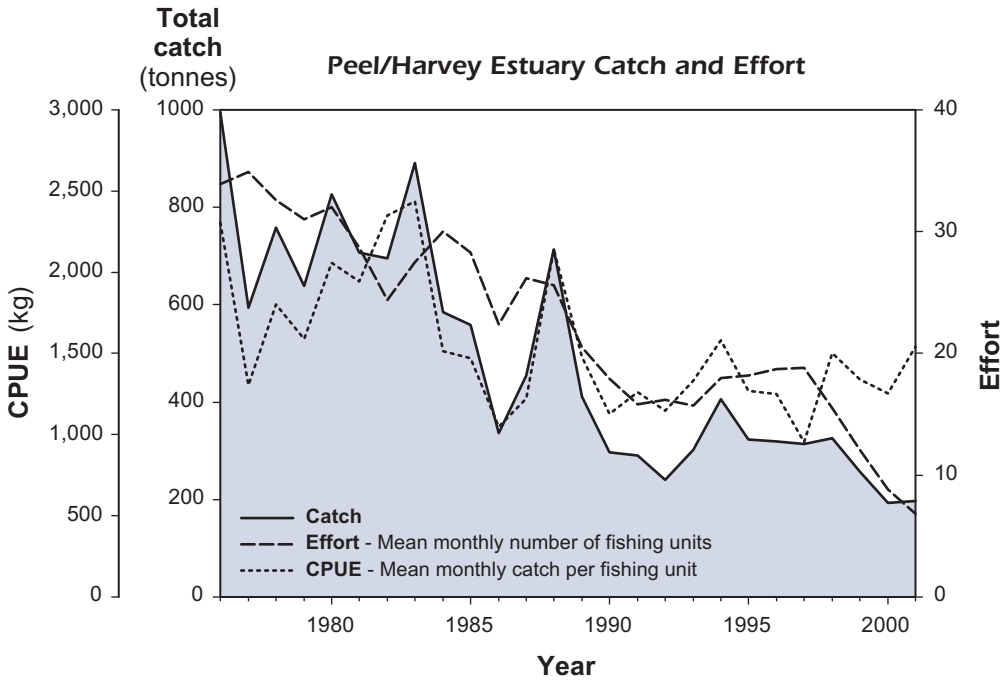
Acceptable catch range: **Not available**

The appropriate ranges cannot be assessed at this time owing to the limited data available from the decreasing number of commercial fishers.

EXTERNAL FACTORS

The estuarine catches for 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 1976–2001.

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 (Fish Net) Managed Fishery: The fishery primarily targets small pelagic fish by the beach seine method within the coastal waters between the mouth of the Moore River, north of Perth, and Tim's Thicket, south of Mandurah.

Continued beach access remains the main management issue relevant to this fishery, particularly where coastal developments restrict vehicle access. The fishery has been approved for a Voluntary Fisheries Adjustment Scheme, which will be implemented in 2002/03.

Management of south-west beach seine fishing is being reviewed in association with the South West Coast Salmon and West Coast Purse Seine Managed Fisheries. Increased development, tourism and marine recreational activities in the area mean there is increasing resource-sharing pressure on these fisheries. There is also a need to introduce more formal management for these fisheries, which are currently managed through a number of gear and species prohibitions. A VFAS is also planned to help address some of the resource-sharing issues.

The major target species for the beach seine fisheries is whitebait, *Hyperlophus vittatus,* 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, 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. 19.

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 (*Hyporhamphus melanochir*) and Australian herring (*Arripis georgianus*). 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 important recreational species. The fishery has been approved for a VFAS.

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

Cockburn Sound (Line and Pot) Managed Fishery: There are currently 24 licensed fishers in this fishery, although not all licensees exercise their fishing entitlement. Reductions in the number of licensees have come about, in part, through the Fisheries Adjustment Scheme for the Cockburn Sound (Crab) Managed Fishery, where all licences associated with fishing units exiting through that scheme were surrendered. This would be expected to continue with the implementation of VFASs for the West Coast (Beach Bait) and Cockburn Sound (Fish Net) Managed Fisheries.

The fishing methods employed include handline, longline and squid jigging; the pots used are unbaited octopus pots. Many of the species targeted by this fishery are also targeted by recreational fishers, e.g. shark, pink snapper (*Pagrus auratus*), garfish and Australian herring.

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
Relevant Managed Fishery Licence

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 (Fish Net) 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 2001 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. 32–23, 34–36, 170 and 19–23 respectively).

Main fishing method

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

RETAINED SPECIES

Commercial production (season 2000): 46.2 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 (Fish Net) and the West Coast Purse Seine Managed Fisheries, which conduct part of their respective operations within Cockburn Sound.

From the early 1990s the finfish catches increased to a peak catch in 1992 and then declined to 60.1 tonnes in 1998. This rose sharply to 90.9 tonnes in 1999. However the current 2001 catch represents a decline to 46.2 tonnes (Cockburn Sound Figure 1). The composition of the 2001 catch included over 20 finfish and elasmobranch species. Over 90% of the total catch consisted of sea garfish (*Hyporhamphus melanochir*), Australian herring (*Arripis georgianus*) (20 tonnes), pink snapper (*Pagrus auratus*), yellow-eye mullet (*Aldrichetta forsteri*) (1.6 tonnes) and sea mullet (*Mugil cephalus*) (1.3 tonnes).

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

Australian herring catches showed a steady increase from 1980, reaching a peak in 1994 (around 50 tonnes). Since that time, catches have declined significantly. The catch for 2001 was 20 tonnes (Cockburn Sound Figure 2).

Fishing effort

The 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 (Cockburn Sound Figure 1). This provides only an indication of the overall usage of the area by the commercial sector, which is composed of a number of different fisheries and various fishing methods.

The fishing effort peaked during the early 1990s at 1,400–1,600 boat days. It declined to 882 boat days in 1997, rose to 1,562 boat days for 1999 and has continued to decline to 943 boat days for 2001.

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 101.8 kg/boat day in 1992 and the lowest reported catch rate was 43.4 kg/boat day in 1990. The 2001 catch rate was 49 kg/boat day. The 2001 catch rate for Australian herring was 21.2 kg/boat day (Cockburn Sound Figure 2).

Recreational component: **45% (approx.)**

The most recent recreational survey data, relating to 1996/97, was reported in the *State of the Fisheries Report 2000/01*. In summary, the recreational finfish catch for that year was estimated to be about 45% of the combined recreational and commercial catch, and the recreational catch of blue swimmer crabs about 5% of the total.

Stock assessment completed: **Not assessed**

For an assessment of Australian herring stocks, see pp. 113–115.

Exploitation status: **Not assessed**

For an assessment of Australian herring stocks, see pp. 113–115.

Breeding stock levels: **Not assessed**

For an assessment of Australian herring stocks, see pp. 113–115.

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 2001, 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 21. Production supplies restaurant and retail sectors in the metropolitan area.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001): **$103,000**

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

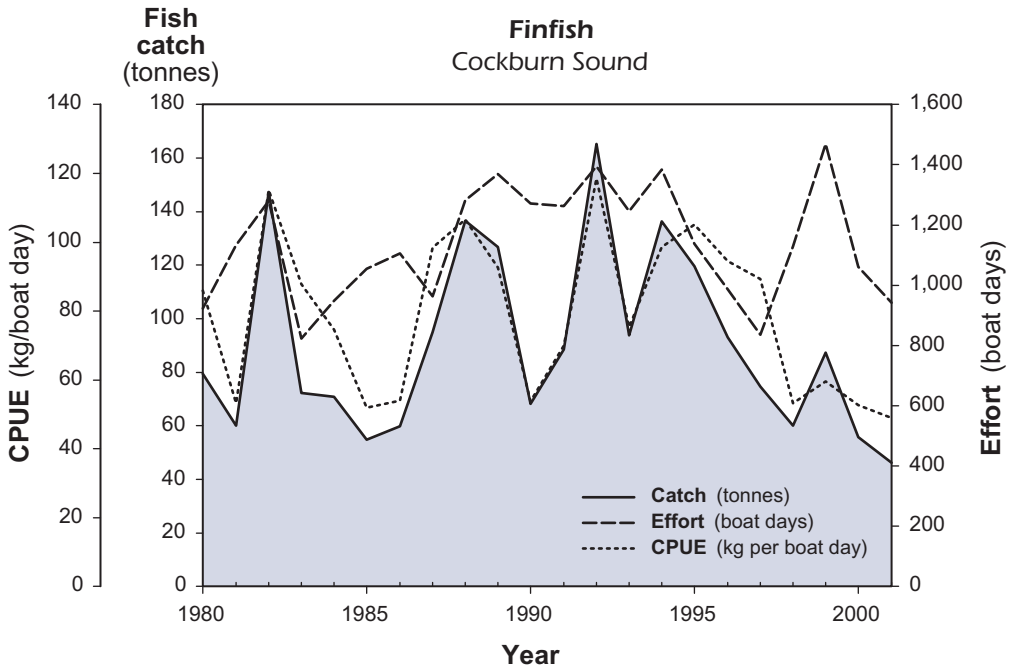
FISHERY GOVERNANCE

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

The expected catch range under the current management regime is 40–95 tonnes 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 is still at the lower end of the acceptable catch range, apparently as a result of the significant downward trend in effort over recent years.

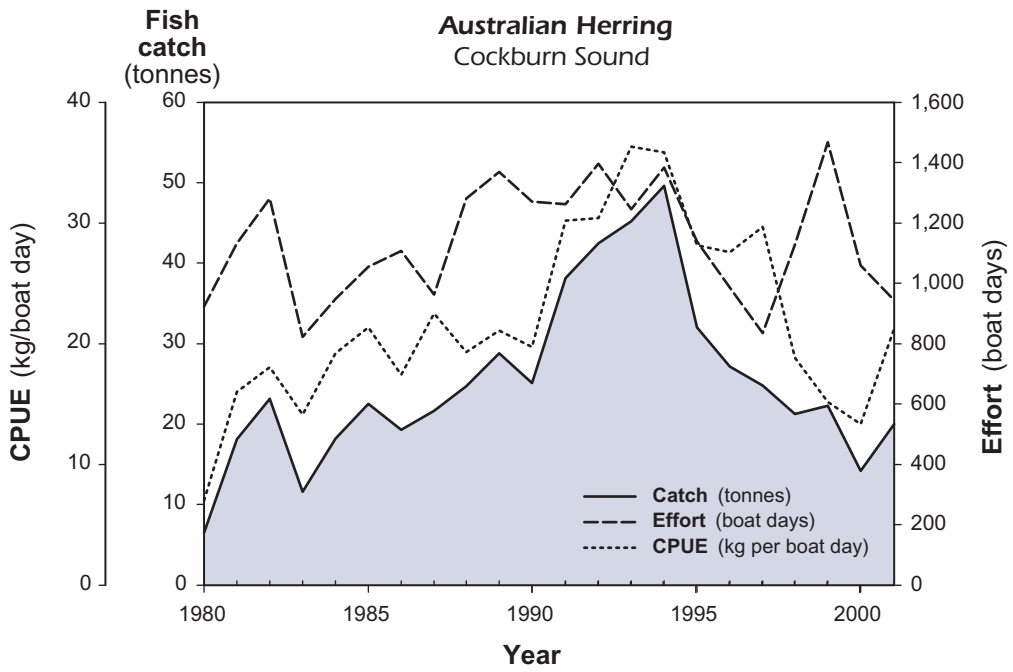
EXTERNAL FACTORS

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 1980–2001.



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 1980–2001.

WEST COAST BEACH BAIT (FISH NET) MANAGED FISHERY STATUS REPORT

Prepared by R. Mitchell, G. Baudains and D. Gaughan

FISHERY DESCRIPTION

Boundaries and access

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

The West Coast Beach Bait (Fish Net) Managed Fishery extends from the mouth of the Moore River, north of Perth, to Tim's Thicket in the south, with access currently via limited entry licence. The south-west beach seine fishing activities, also targeting 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 'southern whitebait 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 2001):

All species 344 tonnes
Whitebait 240 tonnes

Landings

The main target species in this fishery is whitebait, of which 240 tonnes were caught in the 2001season. The catches of all other species landed in this fishery, which amounted to 104 tonnes, are shown in West Coast Beach Bait Tables 1 and 2. Sea mullet, blue sprat, yellow-eye mullet and western sand whiting dominated the remainder of the catch.

Catches of whitebait are discussed here according to the region in which they were landed. Metropolitan and Mandurah landings form part of the managed fishery, while Bunbury landings are from the south-west beach seine fishing.

Metropolitan: The catch of whitebait for the metropolitan region during 2001 was 11 tonnes, a major decrease from the average of 24.8 tonnes over the previous three years (West Coast Beach Bait Figure 1).

Mandurah: The whitebait catch at Mandurah was 32.1 tonnes, very similar to that in 2000.

Bunbury: The Bunbury catch increased again, from 175 tonnes in 2000 to 197 tonnes in 2001 (West Coast Beach Bait Figure 1).

Fishing effort

Given the schooling behaviour of whitebait and most of the other retained species, and the targeting of schools by fishermen, the catch and effort data from this fishery do not provide a reliable measure of abundance.

Catch rate

See 'Fishing effort' above.

Recreational component: **Not assessed**

There is no recreational fishery for whitebait. While some of the other retained species are also fished recreationally, there is no assessment for these recreational catches.

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 the dominant Bunbury sector in 2001 was higher than in the previous year, while in the metropolitan and Mandurah sectors it was lower.

The 2001 catch of 240 tonnes was considerably less than the catch range of 272–375 tonnes predicted by the Leeuwin Current/whitebait model, which utilises the previously observed positive relationship between the Fremantle sea level (Leeuwin Current) and subsequent catch. These results indicate that further refinement of the model is needed, and this will be undertaken as more data becomes available in future years. The average monthly Leeuwin Current in 2001 was again stronger than average. The Leeuwin Current/whitebait model suggests that the 2002 catch should be at the higher end of the range.

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 tonnes for the entire west coast. The cyclical nature of the fishery, whereby very good catches continue to be 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, and 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 this 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, but the impact of any such interaction is not yet understood. Overall, therefore, the ecological impact of the fishery is considered to be low.

Habitat effects: **Low**

All fishing occurs over sandy substrate and the impact of the relatively light fishing gear is minimal.

SOCIAL EFFECTS

Approximately 28 fishing units involving about 59 fishermen and crew worked in the whitebait industry in 2001.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001): **$430,000**

The price for whitebait was similar to that obtained in 2000, at an average of $1.80/kg. Total catch value was about $430,000.

FISHERY GOVERNANCE

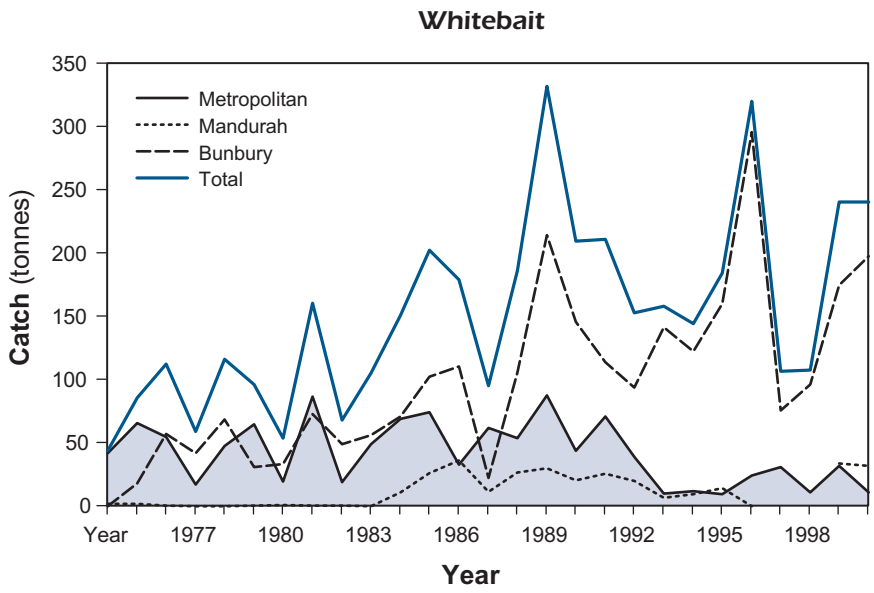
Acceptable catch range: **Whitebait 106–331 tonnes**

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 FIGURE 1

Total annual catch of whitebait for each sector from 1975 to 2001.

WEST COAST BEACH BAIT TABLE 1

Catches in 2001 of retained species other than whitebait from the West Coast Beach Bait (Fish Net) Managed Fishery. Numbers in brackets indicate that part of the catch taken from Cockburn Sound.

SPECIES		CATCH (tonnes)
Mullet, sea	*Mugil cephalus*	2.8 (1.2)
Mullet, yellow-eye	*Aldrichetta forsteri*	1.6 (1.6)
Pilchard	*Sardinops sagax*	1.0 (1.0)
Sprat, blue	*Spratelloides robustus*	2.6 (2.6)
Whiting, western sand	*Sillago schomburgkii*	1.7 (0.1)
Others		1.4 (1.0)
Total		**11.1 (7.5)**

WEST COAST BEACH BAIT TABLE 2

Catches in 2001 of retained species other than whitebait from the south-west beach seining sector.

SPECIES		CATCH (tonnes)
Mullet, sea	*Mugil cephalus*	34.2
Mullet, yellow-eye	*Aldrichetta forsteri*	5.8
Tailor	*Pomatomus saltatrix*	1.3
Sprat, blue	*Spratelloides robustus*	12.3
Garfish, sea	*Hyporhamphus melanochir*	2.4
Whiting, western sand	*Sillago schomburgkii*	33.1
Others		4.1
Total		**93.2**

WEST COAST PURSE SEINE MANAGED FISHERY

Management Summary

This fishery is based primarily on the capture of pilchards (*Sardinops sagax*) and scaly mackerel (*Sardinella lemuru*) by purse seine nets 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 food and pet food. The recreational angling bait sector is currently the main market.

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. 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. The possibility of a further outbreak represents a real threat to the industry.

The fishing season runs from 1 April to 31 May. The pilchard catch allocation (cap) for the 2001/02 licensing period was set at 720 tonnes, a significant increase over the previous year when the take was set at 260 tonnes due to the severely depressed state of pilchard stocks following the Herpesvirus outbreak.

The determination of a pilchard catch cap and the process for allocation among licensees are considered to be temporary measures in response to the mass pilchard mortality events. Management arrangements are currently based on limited entry 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 is being developed in consultation with stakeholders but is yet to be finalised. The proposed arrangements could also see the development of a zoned fishery in which the northern and southern development zone endorsement holders would be incorporated into the West Coast Purse Seine Managed Fishery Management Plan.

Governing Legislation/Fishing Authority
West Coast Purse Seine Management Plan 1989
West Coast Purse Seine Managed Fishery Licence

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 survey of spawning biomass was undertaken in July–August of 2000. 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. Another egg survey is scheduled for August 2002.

The need to introduce a new management approach, following the post-mass mortality period when the fishery was essentially closed in some regions, has been presented to the Purse Seine MAC during 2001. 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.

WEST COAST PURSE SEINE MANAGED FISHERY STATUS REPORT

Prepared by R. Mitchell, T. Leary and D. Gaughan

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 the tropical sardine *Sardinella lemuru* (previously called scaly mackerel, hereafter referred to as sardinella) also important in some years. In addition, smaller quantities of maray are commonly caught, while small catches of anchovies and yellowtail scad also occur periodically.

Commercial production (season 2001): **879 tonnes**

Landings

The combined catch of pilchards, sardinella and maray for the managed fishery area and the developmental zone increased to 879 tonnes in 2001; however, 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 14 tonnes in 2000 to over 148 tonnes in 2001. The sardinella catch decreased slightly from 610 tonnes in 2000 to 596 tonnes in 2001. In addition, a substantial catch of 135 tonnes of maray (traditionally a minor retained species) was landed for the year. No anchovy were landed in 2001. 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 participated in the fishery in 2001 compared to 2000. Together they fished a total of 738 days compared to 367 days in 2000, an effort increase of greater than 100%. The recent significant changes in the stocks (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 1,202 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 2000 provided evidence that the stock was recovering strongly after the 1998/99 mass mortality event. The age structure of the west coast pilchard catches is dominated by 3- and 4-year-olds, which is indicative of a healthy stock, and there was again a good level of recruitment. However, assuming there has been strong recovery, as has been the case at Albany and Bremer Bay, availability to the fleet has remained very low.

If the west coast stock were gradually being displaced (offshore, to deeper water or southwards) by high water temperatures – as seen with a number of tropical species, including mud crabs which have been discovered in several lower west coast estuarine systems in recent times – then low catches might still continue even though the stock had recovered. However, the issue of stock size and stock availability has yet to be adequately resolved.

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, 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, but there is currently no evidence to indicate any interaction between these and the purse seine industry in this region.

ECOSYSTEM EFFECTS

Food chain effects: **Medium**

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 WA, 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. It is anticipated that this concept will be adopted by the Purse Seine MAC during 2002.

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, many licence holders and their crew have had to obtain income from elsewhere. Including vessel crews, the industry provided direct employment for 16 people during 2001.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001): **$660,000**

The relatively small quantities of pilchards and maray were sold as individually quick frozen bait, while the majority of the sardinella were processed for human consumption. Average price of sardinella ranged between $620/tonne and $750/tonne.

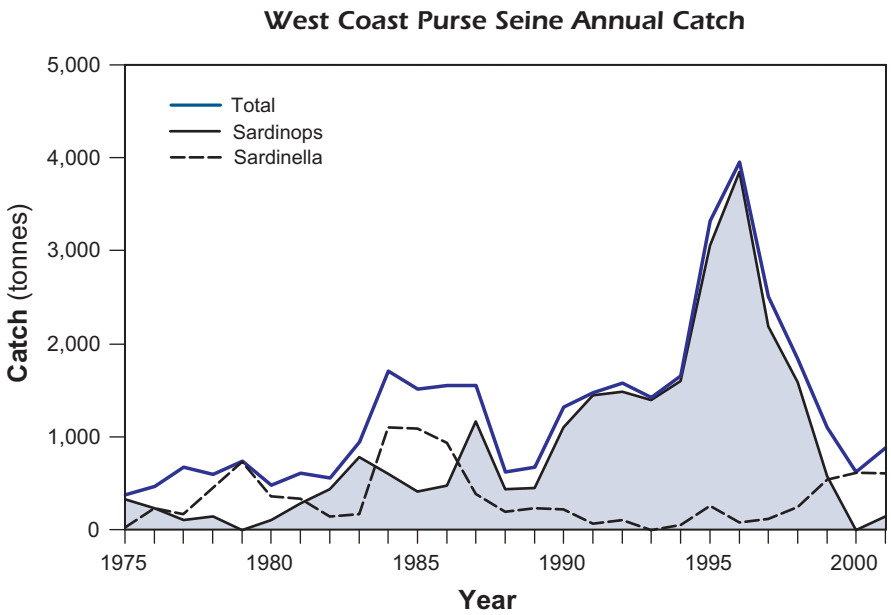
FISHERY GOVERNANCE

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, 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.

Common community concern over the unrestricted access of the wetline fishery 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.

Two-thirds of the wetline fleet, or 442 vessels, took dhufish between June 1991 and 1998. Most catches of the 'wetline only' fleet (97 boats) were small, with only 27 boats landing more than one tonne a year for more than three years. A variety of licensed fishing boats from other fisheries, including 178 rock lobster boats, reported taking dhufish by wetlining. Dhufish are caught mostly from waters deeper than 20 m extending from Kalbarri to near Esperance. Few dhufish are taken on the south coast, while the reported catch in the Abrolhos Islands has increased substantially over the study period. Dhufish are essentially managed by using a legal minimum length of 500 mm, which until recently has created a 'buffer' for the stocks, as it is estimated that male dhufish mature at 250–300 mm (three years of age) and females at 300–350 mm (three to four years of age).

Around 466 boats of the wetline fleet took pink snapper between June 1992 and 1998, but only 45 boats recorded landing more than one tonne a year in three of the six years. Of the boats catching pink snapper, 103 were 'wetline only' and 165 were rock lobster boats. The major wetline catches of pink snapper are from the Abrolhos Islands area, with the highest catches being in August, March and April. The legal minimum length for pink snapper is 410 mm.

Altogether 291 boats of the wetline fleet landed baldchin groper, including 86 'wetline only' and 116 rock lobster boats. Six 'wetline only' boats and one other recorded landing more than one tonne a year in three of the six years. Although baldchin groper is caught between the Perth metropolitan area and Ningaloo, 46% of the catch comes from the Abrolhos Islands. The catch has little seasonal variation. The legal minimum length for baldchin groper is 400 mm.

There was significant progress on the development of a process to implement formal management arrangements for the wetline fishery. The process will commence during 2002/03 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

Previous research was presented in the *State of Fisheries Report 2000/01*.

The current FRDC-funded project on short-term release mortality of under-size dhufish and snapper has been completed; however, longer-term mortality will continue to be examined until June 2005 through a tagging program. The research indicates that in the short term, the release mortality of under-size dhufish and snapper after capture by line is affected more by depth of capture than by hook type or release method (i.e. venting). For dhufish caught at depths greater than 40 m, preliminary analysis suggests that more than half will not survive more than three days after release.

While there has been a series of discrete research projects on dhufish in the west coast bioregion in recent years, and a large amount of research on pink snapper in the Gascoyne bioregion over the last two decades, there are significant gaps in our knowledge of dhufish and pink snapper in the west coast bioregion. Information on the basic biology of pink snapper south of Shark Bay is lacking and preliminary data indicate that biological parameters, such as growth rates and reproductive cycles, vary strongly with latitude. Also, age structures of pink snapper populations in this region are not available, but are required to assess stock status. Stock assessments will be vital to the upcoming integrated management of this bioregion to provide estimates of sustainable catch levels. A proposal for funding was submitted to FRDC to study the stock structure of dhufish and pink snapper populations along the west coast to determine the appropriate geographical scale for management, as well as to gain information on the biological parameters for pink snapper. This application was unsuccessful in 2001/02, but is being resubmitted in 2002/03.

Research into the biology of pink snapper on the lower west coast has commenced this year with an Honours student at Curtin University studying reproductive biology. Preliminary information on the biology of the demersal breaksea cod *(Epinephelides armatus)* is also available in an Honours thesis jointly supervised by Curtin University and the Department of Fisheries.

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 primarily CAES data.

WEST COAST DEMERSAL SCALEFISH STOCKS STATUS REPORT

Prepared by J. St John

FISHERY DESCRIPTION

Boundaries and access

Wetlining for west coast demersal scalefish is not yet subject to a specific management plan. The fishing activities are assessed within the boundaries of the west coast bioregion, i.e. in the waters of the Indian Ocean south of latitude 27° S and west of longitude 115°30' E. During 2000/01 a total of 59 'wetline only' vessels, and another 158 vessels that were licensed in other fisheries, operated within this bioregion using handline and dropline to target demersal species.

Main fishing method

Handline and dropline.

RETAINED SPECIES

Commercial production (season 2000/01): 896 tonnes

Landings

During 2000/01, 204 of the 216 boats in the west coast bioregion wetlined for demersal finfish. Of these, 197 boats reported catching West Australian dhufish, 184 boats caught pink snapper and 127 caught baldchin groper. Landings of pink snapper were highest at 210 tonnes, followed by dhufish (191 tonnes); baldchin groper was also in the top four with 33 tonnes. Major species in the catch from the northern area of the west coast included two lethrinid species, *Lethrinus nebulosus* and *Lethrinus miniatus* (variously reported as spangled emperor, sweetlip emperor, sweetlips and nor-west snapper), with 126 tonnes caught by 72 boats, and coral trout (*Plectropomus maculatus*), with 15 tonnes caught by 50 boats. These six major demersal species represented 64% of the total catch of all species caught by handline and dropline in the fishery. The remaining 36% comprised approximately 100 other species.

The above demersal scalefish catches do not include catches taken under other managed fishery licences. For example, in 2000/01 the West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery (WCDGDLIMF) landed 69 tonnes of scalefish, including 16 tonnes of dhufish and 7 tonnes of pink snapper (see demersal gillnet and longline fisheries status report on pp. 119–124). 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: Over the last 10 years the reported total catches of dhufish along the west coast reflect general trends in fishing effort (West Coast Demersal Scalefish Figure 1). At 191 tonnes, the 2000/01 catch was well above the 10-year average of 155 tonnes, and second only to the peak catch of 197 tonnes in 1997/98. It also fell outside the acceptable range of 125–179 tonnes calculated last year. Monthly catches were over 20 tonnes in January and April 2001. The increase over the 1999/2000 catch was 17.3 tonnes, with most of this (13.4 tonnes) taken by wetliners without specific managed fishery licences. The previous catch peak in 1997/98 appeared to be due to a high abundance of dhufish that year, as dhufish catch rates were high in both the demersal gillnet fishery and in the top 10 boats of the line fishery off Fremantle.

Pink snapper: For the first time in four years, the pink snapper catch was above the 10-year average of 204 tonnes (West Coast Demersal Scalefish Figure 2), with landings of 210 tonnes in 2000/01 representing an increase of 51.9 tonnes over the previous year. In contrast to other demersal species, catches of snapper are highly variable, reflecting large natural annual fluctuations in recruitment to the stock, particularly in the north of the bioregion. The monthly catches for the current year were highest (greater than 20 tonnes) from February to May 2001.

Baldchin groper: Both catch and catch rates for baldchin groper have remained relatively consistent over the last 10 years (West Coast Demersal Scalefish Figure 3). The catch of baldchin groper in 2000/01 was 33 tonnes, similar to last year's catch and close to the 10-year average of 31.8 tonnes. Monthly catches ranged from 1.6 tonnes to 3.9 tonnes, with catches greater than 3 tonnes reported in four months of the year.

Fishing effort

Throughout 2000/01, 216 boats fished a total of 9,318 days in the west coast demersal scalefish fishery. Compared to the previous year, the number of active boats in the fishery was down by 26 and effort was reduced by 383 days. When the latent effort in the sector is considered, small annual changes in effort, such as this 5% reduction in total effort for the fishery, are unimportant.

Catch rate

In this multi-species fishery, the overall catch rates calculated for individual species are not a reliable measure of their abundance owing to the targeting behaviour of the fishers. To examine the catch rates of individual species caught throughout the bioregion, catch and fishing effort from boats that targeted these species was examined in two areas expected to differ in fishing pressure, namely Geraldton and Fremantle. It should be noted that the method for calculating catch rates was revised this year. Previously, catch rates depicted the changes in catch rates of the same boats over 10 years. This year, annual catch rates were calculated using the top 10 boats with reliable data for each year, thus allowing for the frequent changes in boat ownership or skippers that are common in the wetline sector. Catch rates were calculated for dhufish and snapper in both regions and for baldchin groper in the Geraldton region only (West Coast Demersal Scalefish Figures 1, 2 and 3). Catch rates were averaged and standard errors were calculated to depict variability of catch rates among boats.

In addition, catch rates for dhufish have been adjusted to allow for increases in fishing efficiency due to technological improvements. (The introduction of GPS on boats in the early 1990s impacted primarily on dhufish, which is a sedentary species.) Therefore, to account for this increase in fishing efficiency, the nominal effort of each boat used to calculate dhufish CPUE has been increased by 5% for 1992/93, by 10% for 1993/94 and by 15% from 1994/95 to the present. These nominal increases are best estimates that were based on discussions with expert fishers and will need to be validated in the future.

Recreational component: **30% (approx.)**

The recreational catch of the west coast was last estimated from boat ramp surveys in 1996/97 (Sumner and Williamson 1999) and was reported in detail in the *State of Fisheries Report 2000/01*. Of the total catch in 1996/97, the recreational sector took approximately 46% of the dhufish, 10% of the snapper and 44% of the baldchin groper, with an overall catch share of around 30%. Results of the national telephone survey of recreational fishing conducted from May 2000 to April 2001 will provide an update of the recreational catch for the bioregion. In addition, since September 2001 the catch from charter boats has been monitored through compulsory returns, and figures for their catch of demersal finfish in this bioregion will become available next year.

Stock assessment completed: **Yes**

A preliminary stock assessment has been carried out for dhufish, the main species in the west coast demersal scalefish fishery, but more precise information on age structure of populations will be required to complete a comprehensive stock assessment (see *State of the Fisheries Report 2000/01*). To assess trends in the major demersal stocks targeted in this fishery, standardised catch rate and overall catch and effort data are monitored.

Dhufish: Adjusted catch rates of dhufish around Fremantle have declined in the last four years from the exceptionally high rates in 1997/98 (West Coast Demersal Scalefish Figure 1). Over this period, the catch rates have halved from 58 kg/day in 1997/98 to 29 kg/day in 2000/01. Current catch rates are lower than the 10-year average of 37 kg/day. This recent decrease in the catch rates of the top boats in Fremantle indicates a localised decline in dhufish stocks, despite the high catch in the bioregion in the current year. In contrast to the Fremantle area, adjusted catch rates of dhufish in Geraldton have remained consistent throughout the decade, with the highest catch rate of 38 kg/day occurring in 1991/92, 1999/2000 and 2000/01. Thus current catch rates in Geraldton are higher than the 10-year average of 32 kg/day. Although Geraldton catch rates during 2000/01 were about 10 kg/day higher than in Fremantle, they vary widely among boats in each region.

Pink snapper: In contrast to dhufish, the average catch rate of pink snapper for the top 10 boats differed significantly between the two regions. Over the decade, average catch rates were relatively low and stable in Fremantle, ranging from 15 kg/day to 32 kg/day, compared to Geraldton where average catch rates varied annually from 67 kg/day to 174 kg/day (West Coast Demersal Scalefish Figure 2). Catch rates were more variable among boats in Geraldton than in Fremantle. Furthermore, over the past decade catch rates of pink snapper in Geraldton have been two to seven times higher than catch rates in Fremantle (West Coast Demersal Scalefish Figure 2). The snapper fishery is renowned for its high variability in catch due to natural annual fluctuations in recruitment to the stock. The CPUE in Geraldton has followed annual trends in the total catch of snapper for the bioregion, because most pink snapper is caught in the north of the bioregion. Fluctuations in recruitment of pink snapper in the north may be related to spawning events of the oceanic stocks of pink snapper in Shark Bay, with eggs and larvae transported southward on the Leeuwin Current. In contrast, the CPUE in Fremantle over the decade did not follow this trend, and average catch rates of pink snapper in that area have remained very low and steady. These 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 not influenced by recruitment events occurring in the Geraldton region.

Baldchin groper: The average CPUE for baldchin groper by the top 10 boats at Geraldton has remained steady around 15 kg/day over the last decade (West Coast Demersal Scalefish Figure 3). After the introduction of GPS in some boats in 1992/93, the variability of catch rates increased among the top 10 boats, but overall catch rates of baldchin groper did not increase. Catch and catch rates of baldchin groper are the least variable of the major species in the west coast demersal scalefish fishery.

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

At present the adjusted catch rate for the three main target species, which provides an indication of spawning biomass, does not suggest that breeding stock levels are affecting recruitment. Direct measurements of breeding stock, however, are needed to confirm this assessment.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Line fishing is a highly selective fishing method that targets demersal fishes using baited lines. Bycatch therefore comprises only a small proportion of the 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**

Fishing methods used in the wetline fishery, targeting demersal fishes with baited lines, have little physical impact on the benthic environment.

SOCIAL EFFECTS

Employment in this fishery is difficult to assess as the majority of boats (157) in the wetline fleet are associated with other licensed fisheries. Only 59 boats in the wetline fleet hold no other licences and thus are ‘wetline only’. These vessels employed around 150 skippers and crew to take demersal finfish during 2000/01.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000/01): **$4.74 million**

The estimated value of the fishery in 2000/01 includes all species caught by handlines and droplines on the west coast of Western Australia. More than 97 species or groups of seafood were recorded as catch and sold for an estimated $4.74 million. The highest-valued catch was dhufish at 38% of the total value, followed by pink snapper (23%), the lethrinids (12%), baldchin groper (5%) and coral trout in descending order of value. Catch of all other species

represented less than 20% of the value of this fishery. In 2000/01 dhufish, pink snapper and baldchin groper sold on average for $9.41/kg, $5.24/kg and $6.72/kg respectively. Compared to last year, the prices for dhufish, pink snapper and baldchin groper increased by 4%, 14% and 11% respectively. Of all species in the fishery, coral trout commanded the highest average price of $10.54/kg.

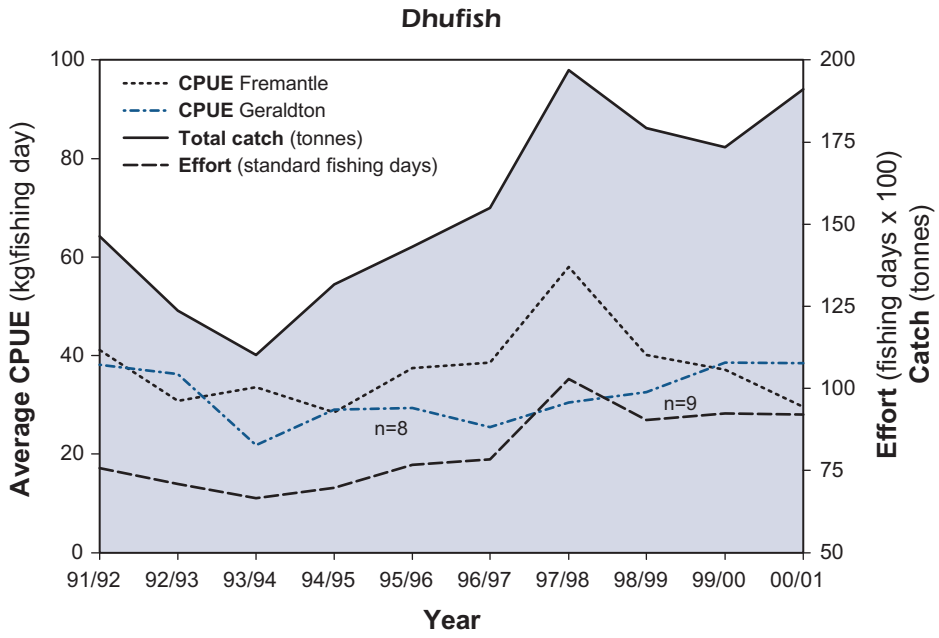
FISHERY GOVERNANCE

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, the acceptable catch ranges are 125–179 tonnes for dhufish, 153–254 tonnes for pink snapper and 27.5–35.5 tonnes for baldchin groper.

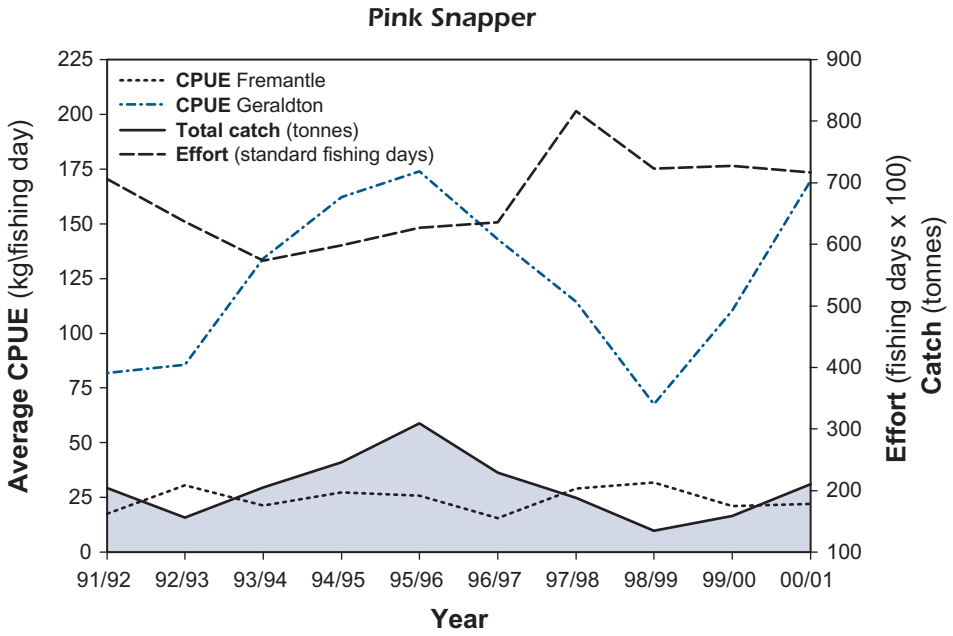
In 2000/01, the catches of pink snapper and baldchin groper were both within the acceptable range based on 1990s catches. The catch of dhufish, the major target of the fleet, at 191 tonnes was above the acceptable range, indicating a greater focus on this species and possibly increasing rates of exploitation.

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.



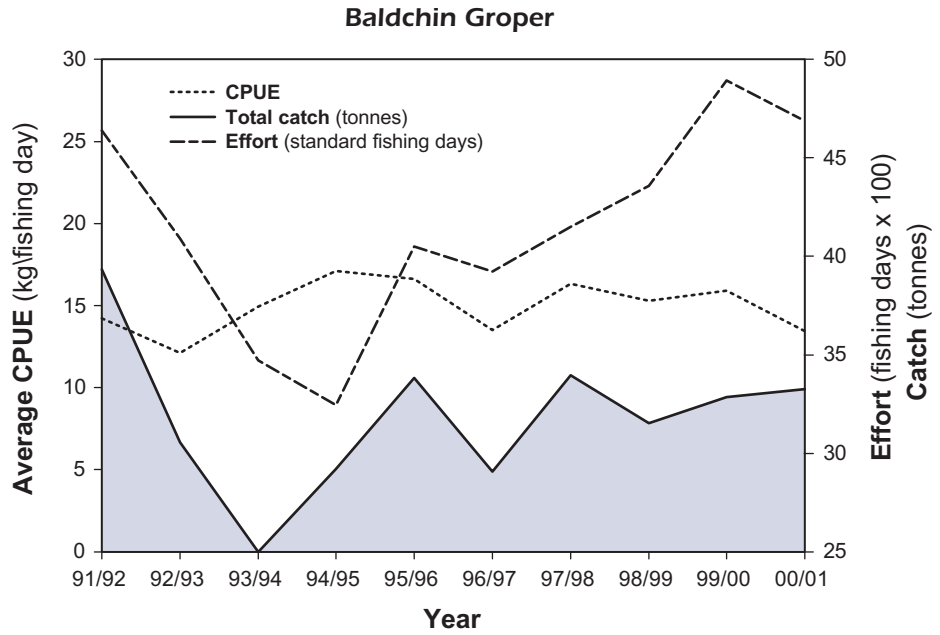
WEST COAST DEMERSAL SCALE FISHERY FIGURE 1

Annual catch and adjusted effort for dhufish in the west coast demersal scalefish fishery over the decade from 1991/92 to 2000/01. 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 SCALE FISHERY FIGURE 2

Annual catch and effort for pink snapper in the west coast demersal scalefish fishery over the decade from 1991/92 to 2000/01. 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 SCALE FISHERY FIGURE 3

Annual catch and effort for baldchin groper in the west coast demersal scalefish fishery over the decade from 1991/92 to 2000/01. 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.

The major changes in the Gascoyne bioregion over the past 12 months have included:

- Formal introduction of Vessel Monitoring System and bycatch reduction device requirements into the management arrangements for the Exmouth Gulf Prawn Managed Fishery.
- Development and implementation of a Memorandum of Understanding between the Department of Fisheries and industry for the Exmouth Gulf Prawn Managed Fishery, allowing greater flexibility to industry in relation to their specific fishing arrangements, for the purposes of adding value to their catch/product.
- Introduction of further requirements regarding the use of BRDs in the Shark Bay Prawn and Shark Bay Scallop Managed Fisheries, whereby they are now formally required to fish with a BRD in each of their nets (prawn) or in one net (scallops – but moving to two nets in 2003).

Additionally, management effort has been focused on:

- Preparation of reports addressing the principles of ecological sustainability (in line with the requirements of the *Environment Protection and Biodiversity Conservation Act 1999*) for the Exmouth Gulf Prawn, Shark Bay Prawn, Shark Bay Scallop and Shark Bay Snapper Managed Fisheries.
- Commencement of the development of a draft plan of management for the experimental inshore crab fishery in Shark Bay.

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);
- Beach seining and near-shore gillnetting.

The demersal line fishery takes a range of demersal fish species, including emperors and baldchin groper/tuskfish, 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). 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.

There is also a take of fish by beach seining and near-shore gillnetting 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 working out of 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 VMS 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 patrol vessels for more extensive at-sea operations.

Activities during 2000/01

During 2000/01, Department of Fisheries Regional Services personnel delivered 6,051 hours to compliance activities for Gascoyne coast bioregion commercial fisheries (Gascoyne Commercial Compliance Table 1). This figure excludes any time spent working on compliance issues for the Australian Fisheries Management Authority (Commonwealth and/or jointly managed fisheries), aquaculture compliance, or duties concerned with fish habitat protection. The major percentage of these hours comprised duties performed in relation to trawl fishery compliance activities.

During the period 1 January through to 30 June 2001, Fisheries Officers recorded 103 field contacts with commercial fishing operations and 124 office contacts with commercial fishers. Over the full year (1 July 2000 through to 30 June 2001), 3 infringement warnings and 8 infringement notices were issued, while a further 7 cases were progressed as prosecution actions against commercial fishers.

The majority of investigations resulting in prosecution action during 2000/01 were related to the Shark Bay Prawn and Scallop Managed Fisheries. These were largely offences detected by the VMS. However, during the year a number of other commercial fisheries in the bioregion, including the Exmouth Gulf Prawn and Shark Bay Snapper Managed Fisheries and the 'wetline' fishery, continued to require a high level of compliance monitoring/service delivery.

While compliance within the various 'wetline' fisheries continued to be generally good, complaints were received regarding a small number of fishers using unauthorised, recreational fishers as crew and/or incorporating the catches of recreational fishers in their consignments.

GASCOYNE COMMERCIAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in commercial fisheries within the Gascoyne coast bioregion during the 2000/01 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	6,051
Fisher field contacts by Fisheries Officers (6 months)*	103
District Office contacts by Fisheries Officers (6 months)*	124
Fishwatch reports **	85
OFFENCES DETECTED	**NUMBER**
Infringement warnings	3
Infringement notices	8
Prosecutions	7

* These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

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

2000/01 also saw greater numbers of offences being detected in the Shark Bay Snapper Managed Fishery, in line with the stricter and more comprehensive management arrangements introduced by major amendment in late 2000. These offences related mainly to non-compliance with quotas or failure to complete correct catch and disposal records.

Compliance with the regulations remained high in the Shark Bay Beach Seine and Mesh Net Managed Fishery.

Initiatives in 2001/02

During 2001/02, the Gascoyne bioregion's management staff commenced a series of workshops and meetings with industry – in particular the Exmouth Gulf Prawn Managed Fishery participants – to work through issues associated with levels of compliance funding and servicing. At the time of reporting, these discussions were ongoing. However, it is expected that, by incorporating industry in the development of risk assessment processes, both the Department and industry will gain a better understanding of one another's priorities, obligations and expectations, and that this increased awareness will facilitate the formulation and delivery of appropriate compliance projects.

With the Shark Bay prawn and scallop trawl fisheries having trialled the use of VMS as a compliance tool over the past two years, and the Exmouth Gulf prawn fishery coming 'on line' with VMS this year, the Department has been working to review the most appropriate strategy to deal with any 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 producing benefits for those handling these matters. In addition, the introduction of VMS into the Exmouth Gulf prawn fishery management arrangements necessitated extra training in VMS requirements for staff working at the Exmouth District Office.

During 2001/02, the Shark Bay Beach Seine and Mesh Net Managed Fishery has been undergoing review in relation to the identified need for more contemporary management arrangements. This is likely to include analysis of the current and ongoing compliance program for the fishery.

REGIONAL RESEARCH OVERVIEW OF WETLINE FISHING

The CAES database indicates that around 13% of the State's wetline catch was reported from the Gascoyne coast bioregion during 2000/01. The top ten species comprised Spanish mackerel (*Scomberomorus commerson*) 63 tonnes, goldband snapper (*Pristipomoides multidens*) 26 tonnes, pink snapper (*Pagrus auratus*) caught outside of the Shark Bay Snapper Managed Fishery 25 tonnes, other mackerel 16 tonnes, red emperor (*Lutjanus sebae*) 15 tonnes, sea mullet (*Mugil cephalus*) 15 tonnes, nor-west snapper (Lethrinidae) 14 tonnes, spangled emperor (*Lethrinus nebulosus*) 11 tonnes, sweetlip emperor (*Lethrinus miniatus*) 10 tonnes and mulloway (*Argyrosomus hololepidotus*) 8 tonnes.

An interim management plan for the troll fishery for mackerel, details of which are reported under the north coast bioregion (pp. 86–91), is currently in review. 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. 57–59). The majority of the mullet and whiting 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 27 boats in the fishery also catch 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 granted to licensees prior to the start of the 2002 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 currently being discussed with industry. Another exemption has also been granted to allow one licence holder to trial 'bison' otterboards (as opposed to standard flat wooden otterboards) in the 2002 season.

Bycatch reduction devices (specifically grids) were fully implemented in the 2002 season. Vessels operating in the fishery are required to fish with a grid in each net by way of a condition on the managed fishery licence. Trials of secondary bycatch reduction devices (for example, square mesh panels) are expected to occur later in the season.

The 2002 fishing season commenced on 6 March and is scheduled to close on 21 October. 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 five 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 are soft-shelled and therefore less marketable. Permanent nursery area closures within the fishery prevent the fishing of small prawns while two spatio-temporal closures are to protect tiger prawn breeding stocks

The Shark Bay Prawn Management Advisory Committee (SBPMAC) provides advice to the Minister on the management of the fishery. The MAC 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. During 2002, the Minister approved an amalgamation of the SBPMAC with the Shark Bay Scallop and Exmouth Gulf Prawn MACs, which should see the amalgamated MAC better positioned to focus on broad issues while detailed fishery management matters will be dealt with directly between the Department and licensees.

An ecological sustainability report was prepared in consultation with the various stakeholders and submitted to Environment Australia for continued listing of the fishery products under the *Environment Protection and Biodiversity Conservation Act 1999.*

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

Consultation Process
Shark Bay Prawn 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 new project to determine biodiversity of bycatch in trawled and untrawled areas will commence in 2002.

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

SHARK BAY PRAWN MANAGED FISHERY STATUS REPORT

Prepared by M. Kangas and E. Sporer

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 2001 season, which opened on 14 March and closed on 28 October.

Recruitment surveys in March and April within the closed area south of the Carnarvon/Peron Line and extended nursery area (ENA) were used to determine the extent of the ENA to be opened. The ENA was partially opened (to 25°20'24" S) together with the Carnarvon/Peron Line on 16 April. Owing to small prawn size along the latitude 25°20'24" S, the ENA closure line was raised 1.6 nautical miles (to 25°18' S) on 20 April. The closed portion of the ENA opened on 15 May. The entire ENA closed to fishing on 1 August to protect juvenile king prawns.

Denham Sound opened on 14 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 (28 October).

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2001): 1,696 tonnes

Landings

The total landings of major penaeids for the 2001 season were 1,696 tonnes, comprising 1,322 tonnes of king prawns, 371 tonnes of tiger prawns and 3 tonnes of endeavour prawns. There were also 165 tonnes of minor penaeids (coral prawns) landed.

King prawn landings for 2001 were 11% lower than the five-year average (Shark Bay Prawn Figure 2). Tiger prawn landings (371 tonnes) were 41% lower than the five-year

average and below the expected catch range (400–700 tonnes) for this species. It was noted that during the 2000 season both the Wooramel and the Gascoyne rivers flooded, which may have triggered early tiger prawn migration into the trawl grounds. This may have led to higher catches of tiger prawns earlier within the season. Because most of the tiger prawn catch was taken early during the 2000 season (31.5 kg/hr in March, compared to an average of 14.6 kg/hr in 1996–1999), it may have reduced the spawning biomass during that season, thus reducing the tiger prawn recruitment for the 2001 season. Two further factors restricted the tiger prawn catch in 2001. The southern tiger prawn spawning area was extended, and a threshold catch rate cut-off level of 10 kg/hr was implemented. These factors would have reduced the take of tiger prawns to maintain optimum spawning stock levels.

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 2001 totalled 78 tonnes whole weight. All Shark Bay Prawn Managed Fishery boats have Shark Bay Scallop Managed Fishery Class B licences.

By-product landings were 89 tonnes of blue swimmer crab (*Portunus pelagicus*), 26 tonnes of squid, 18 tonnes of cuttlefish, 10 tonnes of tuna (wetlining), 5 tonnes of mulloway (*Argyrosomus hololepidotus*) and a small quantity of other miscellaneous finfish species.

Fishing effort

Effort recorded in the 2001 daily logbooks for the fleet showed nominal effort as 50,422 hours, which was a reduction of 5,652 hours when compared with the last five years' average effort (56,074 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.

Catch rate

A catch rate of 26.2 kg/hr for king prawns was observed, which was similar to average catch rates seen in the fishery over the last five years and was relatively high compared to the catch rate of 24.7 kg/hr observed in the period of high catches from 1980 to 1988. The 2001 tiger prawn catch rate of 7.4 kg/hr was lower compared to that of the years 1991–2000 (mean 10.4 kg/hr). However, comparison with the catch rates for the period 1980–1989 (mean 4.2 kg/hr) indicates that the 2001 catch rate was better than during this period of low recruitment. The 2001 season catch rates have also been affected by extended full moon closures aimed at increasing economic efficiency and reducing 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 are being examined to improve understanding of the SRR for the king prawn stock, and we continue to employ an examination of catch trends to support our evaluations. 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 tonnes respectively.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Owing to the multi-species nature of this fishery, levels of exploitation of both king and tiger prawn stocks are being carefully monitored with the aim of achieving maximum sustainable catches simultaneously. Current stock and recruitment studies indicate that the king prawn stock remains at a point where recruitment is not affected by spawning stock levels. At the current level of exploitation, fluctuation in annual king prawn harvest is likely to result from effort levels and environmental effects on recruitment, and not from abundance of spawning stock.

In contrast, the recruitment levels of tiger prawns during the 1980s were affected by reduced spawning stock biomass. Management practices have now been employed to increase the survival of these spawning stocks. Because lower tiger prawn catch was anticipated for the 2001 season from pre-season surveys, the spatial extent and location of the tiger prawn spawning area (TPSA) was re-examined. Since the inception of the TPSA in 1996, the spawning area had been defined as one area and closed by an arbitrary date (generally mid-July). In 2001, it was divided into two parts, the southern and northern areas (Shark Bay Prawn Figure 1). 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. Standardised research surveys (to confirm commercial catch rates derived from logbook information) were carried out to obtain the catch rate of tiger prawns, which provided the basis for closure of the southern spawning area on 19 June. The southern boundary was also moved further south than previously to effectively close off areas where large female tiger prawns actively spawn. The northern spawning area, which is aligned with the northern portion of the original 1996 TPSA, was closed from 24 July for the remainder of the season. This survey and closure regime will continue for a minimum of three years to allow an analysis of its usefulness in protection of spawning stock.

A reduction in the fleet size from 35 to 27 boats through the buy-back scheme introduced in 1990, together with the new area closures introduced in that year, appear to have benefited tiger prawn stocks. However, 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 moving the stock on to the fishing grounds from inshore areas early, thereby allowing the fishery to deplete the spawning stock well before the spawning season starts in August.

NON-RETAINED SPECIES

Bycatch species impact: **Medium**

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. Trialling and implementation of secondary bycatch reduction devices will 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. Loggerhead turtles are occasionally taken, but 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 the turtles too can be returned to the sea alive. The implementation of bycatch reduction devices (grids) into the fishery during 2002 will eliminate the occasional capture of turtles in trawl nets.

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. These factors indicate that the removal of these volumes of prawns is unlikely to impact on higher-order predators which are also likely to utilise the finfish discards.

Habitat effects: **Low**

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. Trawling occurs over approximately 40% of the habitat occupied by adult prawns, but less than 20% of inner Shark Bay as a whole, 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). In terms of the overall licensed area of the fishery, the fleet is operating over less than 10%.

This fact, combined with the hard sand habitats and very low levels of benthic fauna characteristic of the Shark Bay trawl grounds, means that the typical impact of the trawls is minimal.

SOCIAL EFFECTS

The estimated employment for the year 2001 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 (2001): **$25.2 million**

Wholesale prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, the value of prawns was lower than in 2000 and average ex-boat prices were as follows:

King prawns	$14.05/kg
Tiger prawns	$16.16/kg
Endeavour prawns	$10.49/kg
Coral prawns	$3.68/kg

FISHERY GOVERNANCE

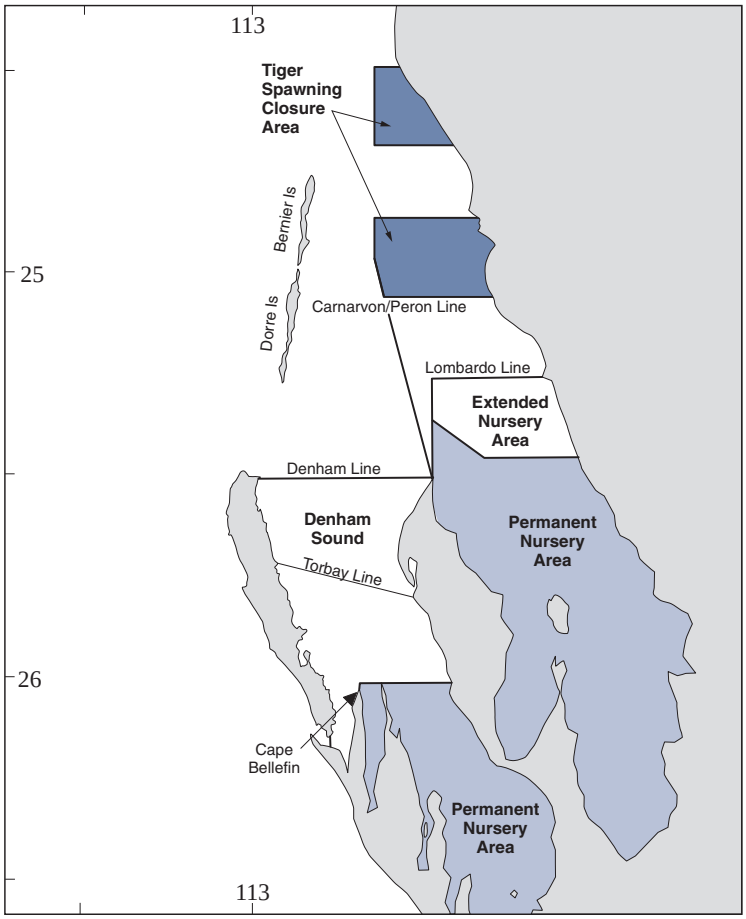
Acceptable catch range: **1,501–2,330 tonnes**

Under current effort levels and normal environmental conditions, and based on the 10-year range of catches since the restructuring of the fishery to 27 licences (1990), the acceptable catch range for major penaeids is 1,501–2,330 tonnes. Acceptable catch ranges for individual species are king prawns 1,100–1,600 tonnes, tiger prawns 400–700 tonnes and endeavour prawns 1–30 tonnes. While total prawn catches during 2001 were within the overall range set, the low tiger prawn catch fell outside the acceptable range for that species. This low tiger prawn catch had the effect of triggering the collaborative initiative with industry to strengthen the TPSA closure system.

EXTERNAL FACTORS

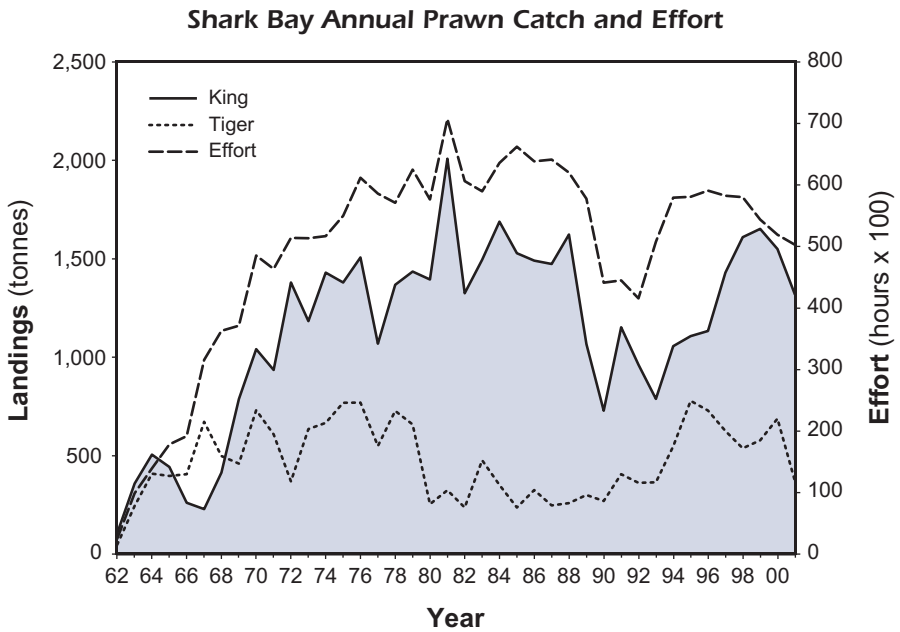
The catches of prawns in Shark Bay are particularly stable compared with other penaeid fisheries. The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment. A relationship between current strength (as measured by Fremantle sea level) and king prawn catches has been identified and may be used to indicate catch trends. An ENSO (El Niño/Southern Oscillation) event is developing in 2002 that may result in a weaker Leeuwin Current and cause king prawn catches to be at the lower end of the range for the 2002 season.

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.



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, 1962–2001.

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 2002 fishing season commenced on 6 April and is scheduled to close on 20 November. More flexible fishing arrangements are being trialled in the 2002 season in order to provide industry with the flexibility to maximise tiger prawn size (and hence market value) while maintaining the existing monitoring and tiger prawn breeding stock catch threshold protocols. A Memorandum of Understanding (MOU) between industry and the Department has been developed to ensure accountability over the trial period. The MOU provides a maximum of 199 fishing nights between the legislated opening and closing dates, with industry declaring closures based on prawn size/marketability and nominating non-fished nights as a replacement for legislated moon closures.

Management controls also include limited entry and gear restrictions as well as controls on vessel size and power. Licensees in the fishery have been granted an exemption to permit trials with quad gear (four smaller nets). Depending on the results of these trials, the Exmouth Gulf Prawn Management Plan 1989 may be amended to allow for more flexible gear configurations (without altering the total headrope in the fishery).

The Vessel Monitoring System was formally introduced to the fishery in the 2002 season by way of an amendment to the Exmouth Gulf Prawn Management Plan 1989. The VMS is being used to monitor both the legislated and MOU-based temporal and spatial closures.

Bycatch reduction devices (specifically grids) were also formally introduced to the fishery at the start of the 2002 season by way of a condition on the managed fishery licence. Vessels are required to tow a grid in half the number of nets being used (that is, one grid for two standard nets and two grids if using quad gear). Full implementation of grids is expected to occur in 2003. Similarly, it is expected that secondary bycatch reduction devices (for example, square mesh panels) will be trialled in the 2003 season.

The Exmouth Gulf Prawn Management Advisory Committee (EGPMAC) provides advice to the Minister on the management of the fishery. The MAC 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. During 2002, the Minister approved an amalgamation of the EGPMAC with the two Shark Bay trawl MACs, which should see the amalgamated MAC better positioned to focus on broad issues while detailed fishery management matters will be dealt with directly between the Department and licensees.

An ecological sustainability report was prepared in consultation with the various stakeholders and submitted to Environment Australia for continued listing of the fishery products under the *Environment Protection and Biodiversity Conservation Act 1999.*

Governing Legislation/Fishing Authority
Exmouth Gulf Prawn Management Plan 1989
Exmouth Gulf Prawn Managed Fishery Licence

Consultation Process
Exmouth Gulf Prawn Management Advisory Committee
Department–industry meetings

Research Summary

Research activities focused on stock assessment and surveys to monitor both annual recruitment of tiger prawns and spawning stocks. 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 some of the king prawn stocks was also undertaken in collaboration with industry to assist with harvesting strategies.

During the past year, collaborative research has continued with industry on assessing devices to reduce unwanted bycatch. Work is also being undertaken with industry and CSIRO on assessing the possibility for stock enhancement of the tiger prawn population and monitoring of juvenile tiger prawn habitats.

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

EXMOUTH GULF PRAWN MANAGED FISHERY STATUS REPORT

Prepared by M. Kangas and E. Sporer

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 2001 season. All boats towed 4.5 fathom quad gear (four nets).

The fleet commenced fishing on 10 April in Area A (predominantly king prawn grounds), but moved to Area B (predominantly tiger prawn grounds) on 15 April due to the small size of the king prawns. Areas B and C were then fished until 1 August. However, there were a series of industry surveys carried out in these areas in collaboration

with the Department of Fisheries' Research Division to determine specific areas where small-sized tiger prawns were located and these areas were avoided through voluntary closures. Area D opened on 28 May and remained open until the closure of the season. Fishing ceased in all areas on 17 November. The season officially closed at 8.00 a.m. on 23 November.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2001): 670 tonnes

Landings

The total prawn landings from Exmouth Gulf for the 2001 season were 670 tonnes, an increase on last year's combined landings of 565 tonnes. Lower than average catches were achieved for all major prawn species, with 330 tonnes of king prawns, 208 tonnes of tiger prawns and 131 tonnes of endeavour prawns landed (Exmouth Gulf Prawn Figure 2). One tonne of banana prawns was also taken. Although the king and tiger prawn catches were still low (below the acceptable range), there was an increase in the catch of both species compared to 2000 when catches were negatively affected by the impact of Cyclone Vance on the prawn habitat. The improvement in tiger prawn catch is considered to reflect the improvement in nursery seagrass habitat (discussed later).

Recorded landings of by-product were 43 tonnes of coral prawns, 10 tonnes of blue swimmer crab, 7 tonnes of squid, 6 tonnes of cuttlefish, 3 tonnes of shark, 2 tonnes of bugs and octopus and less than one tonne of mixed finfish species.

Fishing effort

Total nominal effort for the 2001 season was 27,043 hours. Two boats were removed from the fishery in 2000 to compensate for the full introduction of quad gear (4 x 4.5 fathom nets), with 6 fathoms less of overall headrope towed in the fishery during 2000 and 2001 compared to the period when 16 boats fished using twin gear (2 x 7.5 fathom nets). The comparable effort in twin-gear terms was 33,284 hours, which was slightly lower than in 2000 (33,741 hours).

Catch rate

The catch rates in twin-gear terms, after adjusting for changes in configuration from twin to quad gear, were 9.9 kg/hr for king prawns, 6.3 kg/hr for tiger prawns and 3.9 kg/hr for endeavour prawns. These catch rates were above those in 2000 but still below average.

Recreational component: Nil

Stock assessment complete: Yes

The king and tiger prawn stocks are 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 variably exploited depending on the abundance of the more valuable tiger prawns.

The king prawn catch in 2001 was just below the normal range for the second year, apparently due to flow-on negative effects from the severe Cyclone Vance in March 1999.

The tiger prawn stock during 2001 was also below the normal range, but is recovering from the cyclone-induced low of 2000. The damaging impacts of Cyclone Vance on nursery seagrass habitats severely affected recruitment in 2000, but some of the structured habitats inshore have since recovered, resulting in improved recruitment in 2001. Length-frequency distributions have also returned to a normal pattern, showing a higher proportion of recruits than residual prawns. The catch in 2001 was achieved while maintaining a significant biomass of spawning stock (approximately 100 tonnes) during the spring period (August to October).

The endeavour prawn stock was lightly fished in 2001, as much of its distribution overlaps that of the tiger prawns, on which the fishing effort for the season was low.

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 spawner biomass above the historically determined biological reference point, utilises a cut-off threshold catch rate of 16 kg/hr (standard twin gear). During 2001, tiger prawn catch rates were closely monitored from May to July 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 23 kg/hr, i.e. well above the threshold level. After consultation with industry, the tiger prawn area was reopened for three nights fishing (24–26 October) to allow excess breeding stock to be harvested.

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 breeding stock each year. Endeavour prawns are also considered to be resilient to fishing pressure due to their smaller size and similar low catchability to king prawns.

Projected catch next season (2002): 330–430 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 to November of the same year). For 2002, the projected tiger prawn catch is 330–430 tonnes.

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. 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.

Protected species interaction: **Low**

While protected species including dugongs, turtles and sea snakes are 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. Trialling of grids and secondary bycatch reduction devices continued in 2001 to improve the quality of the prawn catch by minimising the capture of large animals and reducing the volume of overall bycatch species retained in the trawls.

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**

The trawling effort is focused in the deeper central and north-western sectors of Exmouth Gulf and occurs over about 35% of the licensed fishery area and about 30% of the target species habitat. 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 2001 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 2001: **$9.5 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	$14.05/kg
Tiger prawns	$16.16/kg
Endeavour prawns	$10.49/kg
Coral prawns	$2.12/kg

FISHERY GOVERNANCE

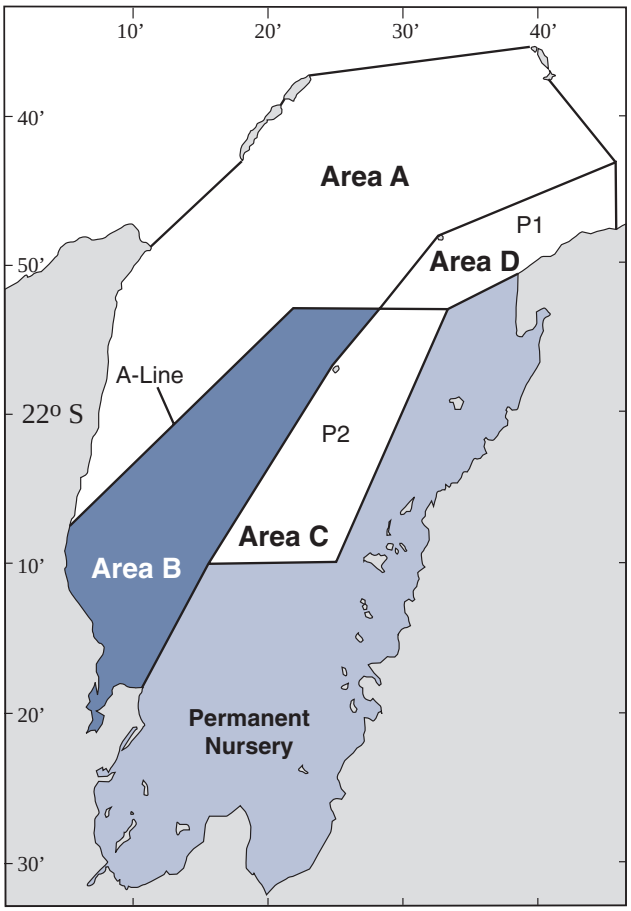
Acceptable catch range: **771–1,276 tonnes**

Under current fishing effort levels, the acceptable catch range for major penaeids is that of the late 1990s (771–1, 276 tonnes). Acceptable catch ranges for individual species are king prawns 350–500 tonnes, tiger prawns 250–550 tonnes and endeavour prawns 120–300 tonnes (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

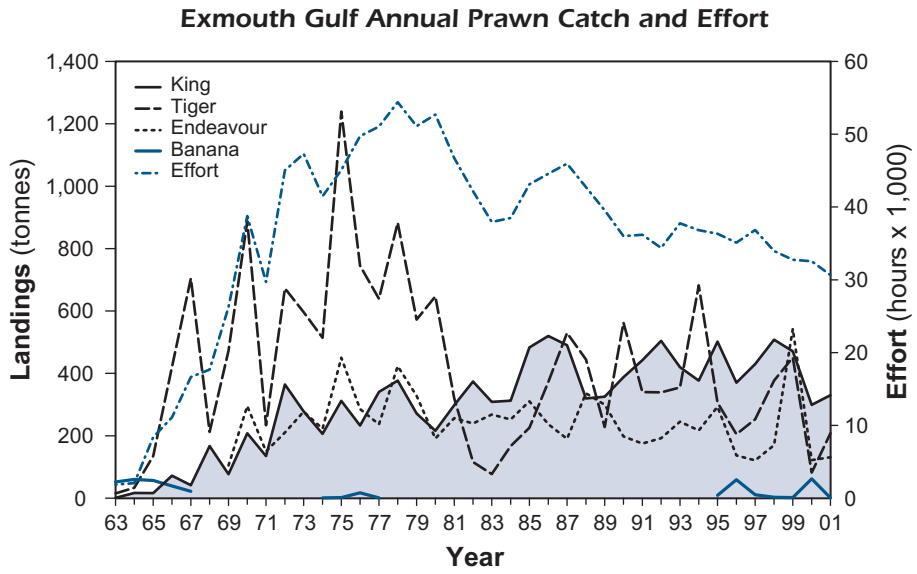
Changes to the nursery seagrass habitat in the eastern area of Exmouth Gulf following Cyclone Vance in 1999 appear to have had a significant effect on the productivity of the Gulf. Surveys of the juvenile tiger prawn habitat have been undertaken each spring since 1999 and are again planned for November/December 2002 to monitor the recovery of the habitat. The results of these CSIRO surveys between 1999 and 2001 indicate an increasing trend in seagrass biomass of 1.2% in 1999, 10.3% in 2000 and over 40% in 2001.

Thirteen boats continued to fish using quad trawl gear in 2001 under an exemption. This continues to be a trial to ascertain the most efficient net configuration, and will be reflected in amended management arrangements for the fishery, which may be based on unitisation of the trawl headrope length. These changes will be monitored carefully to ensure that tiger prawn spawning stocks are maintained above historically set targets.



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, 1963–2001.

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 typically 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 2002 scallop fishing season commenced on 6 May and is scheduled to close on 21 October (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. Other management measures include limited entry, area closures, gear controls and crew limits.

Bycatch reduction devices (specifically grids) were formally introduced to the fishery at the start of the 2002 season by way of a condition on the managed fishery licence. Vessels are required to tow a grid in one of the two nets being used. Full implementation of grids is expected to occur in 2003.

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 (SBSMAC) provides advice to the Minister on the management of the fishery. The MAC 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. During 2002, the Minister approved an amalgamation of the SBSMAC with the Shark Bay Prawn and Exmouth Gulf Prawn MACs, which should see the amalgamated MAC better positioned to focus on broad issues while detailed fishery management matters will be dealt with directly between the Department and licensees.

An ecological sustainability report to Environment Australia was prepared in consultation with the various stakeholders for continued listing of the fishery products under the *Environment Protection and Biodiversity Conservation Act 1999*.

Governing Legislation/Fishing Authority
Shark Bay Scallop Management Plan 1994
Shark Bay Scallop Managed Fishery Licence

Consultation Process
Shark Bay Scallop 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 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 new project to determine biodiversity of bycatch in trawled and untrawled areas will commence in 2002.

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

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 2001 scallop season commenced on 28 April in Denham Sound, which was open for trawling for three days. Fishing for scallops then commenced on the main fishing grounds in Shark Bay on 1 May. Trawling for scallops by Class A boats had ceased by the end of June because of low catch rates. The Shark Bay scallop season officially closed on 28 October.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2001):
1,082 tonnes whole weight

Landings

The total scallop catch for this fishery was 1,082 tonnes whole weight, of which 60 tonnes were taken from Denham Sound during the three days of fishing in late April. This overall catch was lower than the acceptable range set but within the projected range based on the pre-season survey. The Class A fleet (all 14 boats fished in 2001) caught 694 tonnes whole weight or 64% of the total catch, with the Class B fleet taking 388 tonnes whole weight (Shark Bay Scallop Figure 1). Low quantities of by-product (4 tonnes of blue swimmer crabs and less than one tonne of bugs) were recorded for the Class A fleet during 2001.

Fishing effort

The total effort recorded by the Class A boats in 2001 was 8,645 hours, the lowest recorded since 1991.

Catch rate

A mean catch per unit effort of 80.5 kg/hr (whole weight) was recorded for the Class A fleet. This efficient catch rate was maintained as a result of the decision to cease fishing in 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 2000 scallop survey. This low recruitment, apparently due to environmental conditions, resulted in a 2001 catch that was slightly below the acceptable range set. This follows a strong Leeuwin Current in 1999 and 2000, a feature which has previously been correlated with low catch rates and is therefore not considered to reflect the impact of fishing. The survey design and analysis of the data are also being refined to provide separate catch forecasts for the Shark Bay and Denham Sound areas. This will allow separate opening dates to be determined for each area to optimise scallop catches each season. No fishing took place in Denham Sound between 1996 and 2000 due to low recruitment levels. More settlement of scallops was observed during the 2000 and 2001 surveys, hence the need for an assessment of scallop stocks in the entire Shark Bay scallop fishery.

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 2001 as a result of the low recruitment, it is considered adequate to provide recruitment in the normal range for 2002.

Projected catch next season (2002):
1,250–1,950 tonnes whole weight

The catch projection for the 2002 season is based on the November 2001 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 1,150–1,700 tonnes whole weight. Higher recruitment was observed in the Denham Sound area, giving a predicted catch range of 100–250 tonnes whole weight. The catch projection for the fishery as a whole is therefore in the range 1,250–1,950 tonnes whole weight.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Owing to the legislated design of the nets (100 mm mesh), fish bycatch is minimal.

Protected species interaction: **Low**

Protected species, occasionally captured, are released alive due to the relatively short duration of trawls. During 2001, grid trials to minimise the capture of large animals were continued on Class A scallop boats, and full implementation is planned to take place in 2003.

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 (estimated 30%) of the typically bare sand habitat associated with concentrations of this species. As a result of the small area impacted and the short-term impact of the gear on sand habitats, the overall effect of fishing is low.

SOCIAL EFFECTS

The estimated employment for the year 2001 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 2001:
$4.4 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 $4.10/kg whole weight or $20.50/kg meat weight. Meat weight is 20% of whole weight.

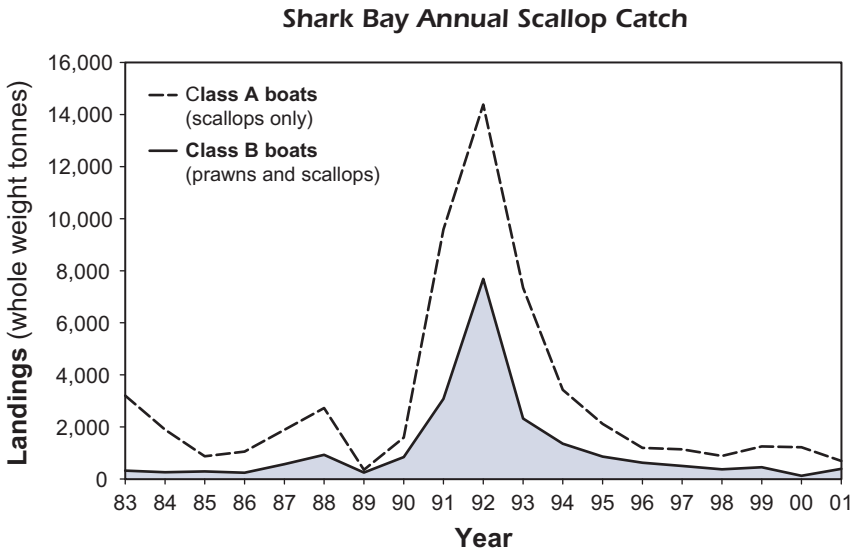
FISHERY GOVERNANCE

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

The acceptable catch range is approximately 1,250–3,000 tonnes 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 lower end of this acceptable catch range. The 2001 catch of 1,082 tonnes was marginally below the acceptable range, but resulted from poor environmental conditions rather than the effects of fishing and is therefore not of concern to management.

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 1999–2001 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. An ENSO event is developing in 2002 that may result in a weaker Leeuwin Current and improved scallop catches in 2003.



SHARK BAY SCALLOP FIGURE 1

Annual scallop landings by fleet for the Shark Bay Scallop Managed Fishery, 1983–2001.

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 currently takes a mixed catch of whiting (Sillaginidae), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and yellowfin bream (*Acanthopagrus latus*). Entry to the fishery is limited, with restricted, family-only transfers and gear/effort 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 local fish processing factory in Denham. Effort is primarily driven by market needs as opposed to fish availability, with catches conforming to commercially acceptable size limits, which are frequently above the legal minimum size for species concerned.

Governing Legislation/Fishing Authority

Shark Bay Beach Seine and Mesh Net Management Plan 1992

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 the 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 (whiting) being fished at sustainable levels. The fishery, although relatively small-scale, makes a significant contribution to the Denham economy and community. 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 April 2001, 11 unit-fishing boat 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 2001):
All finfish 259 tonnes
Whiting 115.3 tonnes

Landings

Whiting is the main target species in Shark Bay, although the overall catch consists primarily of two species of whiting (*Sillago schomburgkii* and *S. analis*), sea mullet, tailor and bream. Thus assessments of the fishery have been based historically on the total whiting catch and effort data (Shark Bay Beach Seine Figure 1). Landings during 2001 were 115.3 tonnes of whiting. The 2001 total catch for the Shark Bay beach seine and haul net fishery of 259 tonnes has decreased from the 2000 reported catch (Shark Bay Beach Seine Figure 2). Among the landings of other species from this fishery, mullet (90.8 tonnes) ranked second to whiting, followed by tailor (26.1 tonnes) and bream (7.7 tonnes). There were 19 tonnes of fish of other species.

Fishing effort

During 2001, there was an average of seven boats fishing per month, expending a total of 1,241 days of fishing effort (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 2001.

Catch rate

The CPUE (based on nominal effort) for the whiting fishery has shown a rising trend over the past decade, although the catch rate declined slightly in 2001, to 93 kg/boat day. The CPUE for the overall Shark Bay beach seine and haul net fishery increased steadily between 1989 and 1995. Following the 1995 peak there has been a slight downward trend in the CPUE values. The current season catch rate was 208.7 kg/boat day (all species) (Shark Bay Beach Seine Figure 2).

Recreational component: **< 5%**

An estimate of the recreational component of the beach seine fishery based on the 1998/99 survey (Sumner et al. 2002) was provided in the *State of the Fisheries Report 2000/01*. This survey indicated that at that time the recreational share of the catch was less than 5% of the total catch. As another recreational survey has recently been completed, an update will be provided in next year's report.

Stock assessment completed: **Yes**

A preliminary yield-per-recruit stock assessment has been conducted for the western sand whiting (*Sillago schomburgkii)* stock in Shark Bay. Biological data were incorporated from research by Lenanton (1970). Ongoing monitoring of the whiting catches to 2001 shows a general increasing trend in CPUE resulting from the reduced effort levels during the early 1990s. This indicates that the stock is being fished within its productive capacity at the current levels of effort.

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 catches of whiting over recent years provide a good indication that the breeding stock is being maintained.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The fishery operates throughout its licence area but with a very low level of effort as it specifically targets schools of fish. As a result of the gear type used and the method of operation, there are no bycatch issues or physical habitat impacts associated with this fishery. Overall the fishery has minimal effect on the Shark Bay ecosystem.

Protected species interaction: **Low**

As nets are actively set and hauled, if any protected species are caught they are immediately released.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

Nets are set and hauled over shallow sand banks and have no lasting effect on the habitat.

SOCIAL EFFECTS

During 2001, the average number of fishers in the Shark Bay Beach Seine and Mesh Net Fishery was 17. Fishing and associated local processing is one of the major sources of employment for the Denham community.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001):

All finfish $750,000

Whiting $414 ,000

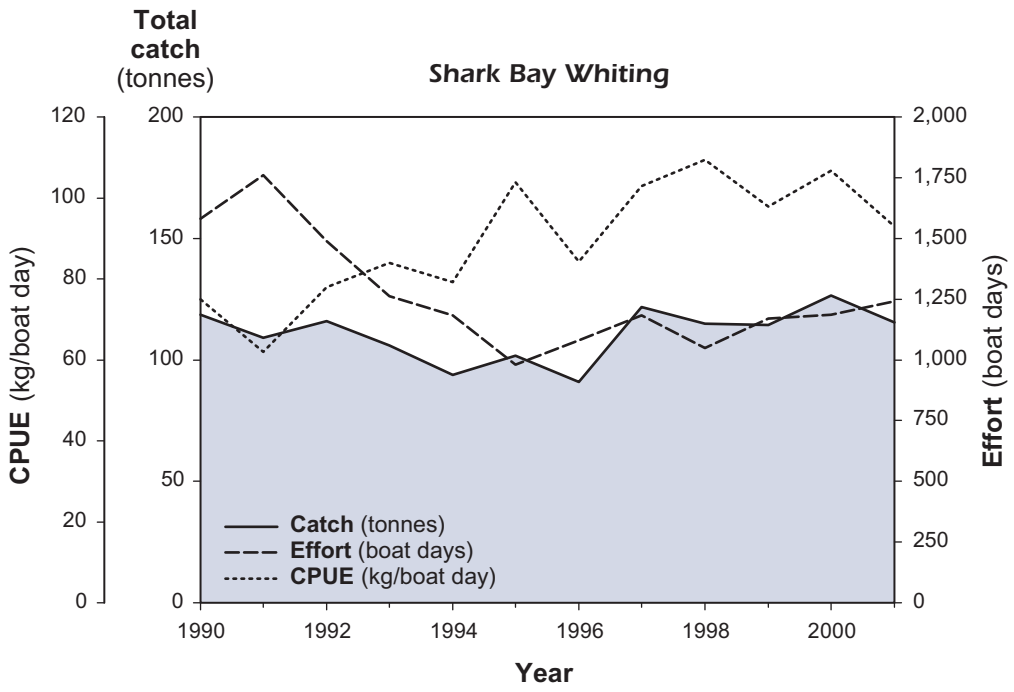
FISHERY GOVERNANCE

Acceptable catch range: **Whiting 95–140 tonnes**

The acceptable catch range under the current management regime is 95–140 tonnes of Shark Bay whiting. The projection is 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%. Future annual catch values which fall outside of this range will be investigated. Where consecutive catches occur outside of the range, changes to the management arrangements may need to be considered.

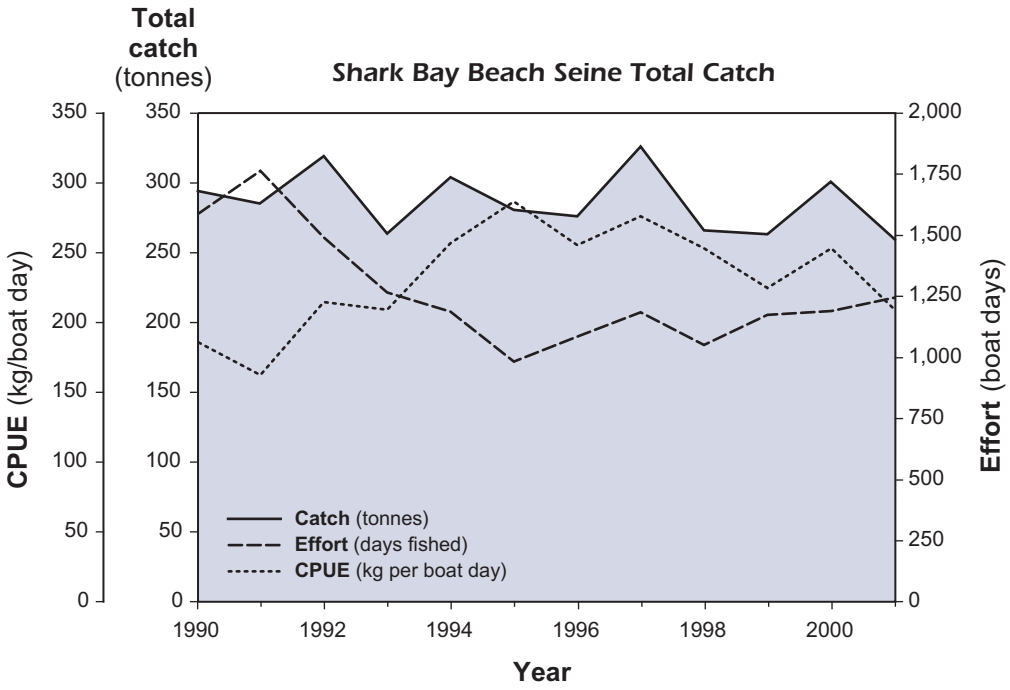
EXTERNAL FACTORS

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



SHARK BAY BEACH SEINE FIGURE 1

The annual catch (tonnes), effort (boat days) and catch per unit effort (CPUE, kg/boat day) for whiting from Shark Bay over the period 1990–2001.



SHARK BAY BEACH SEINE FIGURE 2

The annual catch (tonnes), effort (boat days) and catch per unit effort (CPUE, kg/boat day) for the total finfish fishery of Shark Bay over the period 1990–2001.

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.

In 2001, new management arrangements were introduced under the provisions of the Shark Bay Snapper Fishery Management Plan Amendment 2000. The fishery is now quota-managed on a year-round basis, and a minimum holding of 100 quota units applies. Units are transferable, although a number of governing policies and principles exist. The annual (1 September to 31 August) total allowable catch of pink snapper (*Pagrus auratus*) is currently set at 563,750 kg. There are 5,125 units in the fishery and the current value of each unit is 110 kg.

The amendment to the management plan simplified the complex management and administrative arrangements previously in place while providing more flexibility for both industry and the Department. However, a number of minor 'teething problems' with the new arrangements have occurred on both sides. In response, a working group comprising Departmental and industry personnel has been established to resolve the issues.

An ecological sustainability report was prepared in consultation with the various stakeholders for continued listing of the fishery products under the *Environment Protection and Biodiversity Conservation Act 1999.*

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 will utilise data collected since the 1980s to assess the potential for increased yields from this oceanic snapper stock. Until the results from this research become available, monitoring of the fishery will continue to be undertaken annually using CAES data.

The monitoring data is used to provide the status report.

SHARK BAY SNAPPER MANAGED FISHERY STATUS REPORT

Prepared by D. Gaughan

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. There are 48 licences, but some boats have several managed fishery licences aggregated on one fishing boat licence. This total includes Shark Bay prawn and scallop trawlers, which are also permitted to catch up to one tonne of snapper per year. 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. Commencing in 2001, the whole year's catch is now subject to a single TAC and individually transferable quotas. The snapper quota for 2001 was set at 550 tonnes.

Main fishing method

Mechanised handline.

RETAINED SPECIES

Commercial production (season 2001):
Snapper 467 tonnes
Other speciess 105 tonnes

Landings

The managed snapper fishery operates on the ocean stock of snapper which is distinct from the inner Shark Bay stocks. Catches of snapper from the ocean stock in 2001 were slightly lower than the previous year, at 467 tonnes compared with 488 tonnes in 2000. The fact that the catch achieved was below the TAC was due to limited market capacity rather than availability of fish. The snapper fishery also took 105 tonnes of other finfish species in 2001, which is very similar to the catch in 2000. The catch of other species is detailed in Shark Bay Snapper Table 1.

Fishing effort

The effectiveness of fishing effort varies markedly on a seasonal basis. Fishing effort in 2001 was 894 standard May–August line boat days, compared with 851 days in 2000 and 712 days in 1999.

Catch rate

Catch per line boat day of the managed fishery licensed boats for the peak months (May–August) was 418 kg in 2001, approximately 30% lower than the average for the 1990s of 593 kg/boat day (Shark Bay Snapper Figure 1).

Recreational component: **4% (approx.)**

The Gascoyne Recreational Fishing Survey, conducted between April 1998 and March 1999 (Sumner et al. 2002), has estimated the recreational catch from the offshore stock at 14 tonnes, approximately 2.5% of the commercial catch. In addition, there is a recreational catch of offshore pink snapper from charter boats, reported to be about 6 tonnes.

For the genetically distinct inner bay stocks (not covered by this status report), most of the catch is recreational and is now subject to separate management arrangements. Research for management of these stocks is reported in the recreational fisheries section on pp. 147–150.

Stock assessment completed: **Yes**

The pink snapper stock is close to fully exploited. A stock production model assessment in the mid-1980s estimated maximum sustainable yield at around 600 tonnes, whereas the average annual commercial catch for the 1990s was 503 tonnes. The FRDC-funded project commenced in July 2000 will assess the potential for increased yields from this oceanic pink snapper stock.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Snapper breeding stock level for the ocean stock is not measured directly; however, there are no indications of insufficient breeding stock from the catch rates, locations fished or size frequency. This is in contrast to the inner Shark Bay stocks, where the breeding stock level has been seriously impacted by recreational fishing.

SHARK BAY SNAPPER TABLE 1

Catches in the year 2001 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. 86–91).

SPECIES		TONNES
Spangled emperor	*Lethrinus nebulosus*	20.4
Mulloway	*Argyrosomus hololepidotus*	15.9
Sweetlip emperor	*Lethrinus miniatus*	10.7
Red emperor	*Lutjanus sebae*	9.1
Trevally, various		8.1
Cod, various		7.0
Goldband snapper	*Pristipomoides multidens*	5.1
Rankin cod	*Epinephelus multinotatus*	4.3
Dhufish	*Glaucosoma hebraicum*	3.7
Pearl perch	*Glaucosoma buergeri*	2.5
Cobia	*Rachycentron canadum*	2.1
Tuna, various		1.8
Sea perch, various		1.5
Amberjack	*Seriola dumeridae*	1.4
Flagfish	*Lutjanus vitta*	1.4
Shark, various		0.6
Scalefish, other		9.4
Total		**105.0**

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

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

Protected species interaction: **Negligible**

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

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Food chain effects are negligible because the quota system restricts catches to a small percentage of the total biomass of snapper.

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 (2001): **$2.6 million**

The value of the pink snapper taken in the fishery was $2.15 million, while other finfish species added a further $450,000.

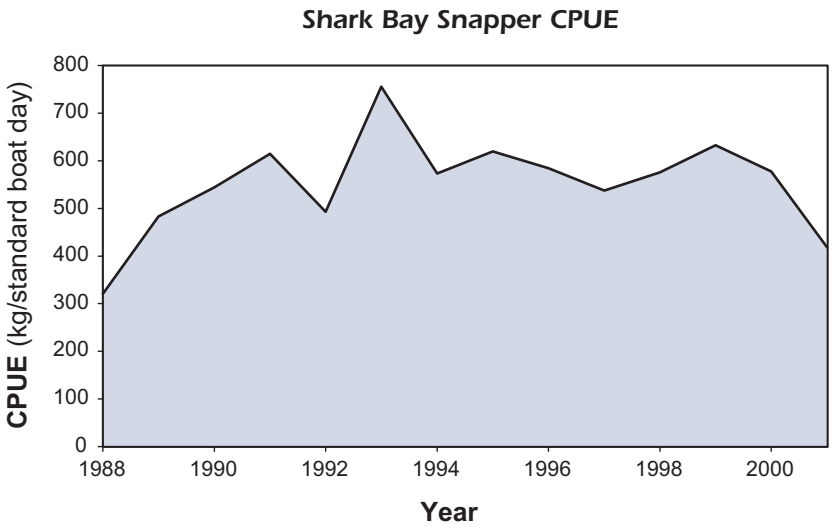
FISHERY GOVERNANCE

Acceptable effort range: **820–950 days**

The total allowable commercial catch under the new year-round quota system is 550 tonnes. Effort is likely to be around 820–950 standard May–August line boat days. It is expected that the new management arrangements may encourage the Shark Bay prawn and scallop trawler fleet to utilise their share of the TAC (41 tonnes).

EXTERNAL FACTORS

Demand for snapper has been low in recent years and efforts are being made to develop overseas and Eastern States markets.



SHARK BAY SNAPPER FIGURE 1

Catch per unit effort by year from 1988 to 2001 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 from May to August, the CPUE for line fishing from May to August is used as the index of abundance.

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 more 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 as the provider of the majority of the State's demersal fishfish. 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.

There was further expansion of the VMS to include the Kimberley and Nickol Bay Prawn Managed Fisheries, with the Onslow Prawn Managed Fishery expected to come under VMS later in 2002. In these fisheries the VMS is used primarily for the management of closed waters (nursery areas).

A resource management agreement (the 'Barramundi Accord'), which was developed for the barramundi resources of the Kimberley, was given effect through a number of changes to management arrangements for the Kimberley Gillnet and Barramundi Managed Fishery and to recreational fishery controls. The management arrangements provided for under the Accord will allow for sustainable management of the stock and reduce conflict between user groups. These arrangements will be further developed over the next few years following the anticipated reviews of recreational and customary fishing in the Kimberley and Pilbara. The activities of netting operators on the Eighty Mile Beach and in the Pilbara will also come under further focus at that time.

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;
- Demersal line fishing (Pilbara line fishery).

Owing to concerns from both industry and Government about increased catches of mackerel and preliminary assessments that indicate that the species could be over-fished, an independent review committee has examined the fishery and reported to the Minister on future management options.

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 are expected to come under review in the near future to prepare 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. As management arrangements require vessels to operate with a Vessel Monitoring System on board, officers also oversee the location of vessels and the time each vessel spends within the waters of specific 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.

Activities during 2000/01

During 2000/01, Department of Fisheries Regional Services personnel undertook 2,515 hours of compliance work in commercial fisheries in the north coast bioregion (North Coast Commercial Compliance Table 1). A large proportion of these hours were spent responding to reports through the VMS of vessels operating outside the provisions of the Pilbara Trawl and Northern Demersal Scalefish Management Plans. The remainder of the services delivered were to a wide range of compliance activities across the remaining fisheries in the bioregion.

Between January and June 2001, Fisheries Officers recorded 13 field contacts with commercial fishing operations and 94 office contacts with commercial fishers. During the year, 4 infringement notices were 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.

Some concerns have also been expressed over continued conflict between commercial gillnet fishers and the recreational sector, especially in waters adjacent to Broome and the Eighty Mile Beach north of Port Hedland.

Initiatives in 2001/02

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 historically available funds have declined. Discussions have commenced 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.

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 2000/01 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	2,515
Fisher field contacts by Fisheries Officers (6 months)*	13
District Office contacts by Fisheries Officers (6 months)*	94
Fishwatch reports **	25
OFFENCES DETECTED	**NUMBER**
Infringement warnings	0
Infringement notices	4
Prosecutions	10

* These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

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

REGIONAL RESEARCH OVERVIEW OF WETLINE FISHING

This assessment, which utilised the CAES database, indicates that around a quarter (22%) of the State's wetline catch during 2000/01 was reported from this bioregion, which includes waters off both the Kimberley and Pilbara coasts. The top ten species comprised Spanish mackerel (*Scomberomorus commerson*) 242 tonnes, threadfins (Polynemidae) 72 tonnes, goldband snapper (*Pristipomoides multidens*) 28 tonnes, other mackerel 27 tonnes, unspecified shark 15 tonnes, grey mackerel (*Scomberomorus semifasciatus*) 14 tonnes, blacktip shark (*Carcharhinus* spp.) 8 tonnes, scarlet sea perch (*Lutjanus malabaricus*) 7 tonnes, nor-west snapper (Lethrinidae) 6 tonnes and red snapper (*Lutjanus erythropterus*) 6 tonnes. An interim management plan for the troll fishery for mackerel, details of which are reported on pp. 86–91, is currently in review. 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*). The opening and closing dates for the fishery vary from year to year and are based on advice from the Research Division. The 2002 fishing season commenced on 1 March and will end on 15 November, which generally aligns with season dates for the adjacent Exmouth Gulf Prawn Fishery. However, different areas within the fishery have different season dates which allows access to target species, usually tiger and banana prawns, at appropriate times.

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 first steps to introducing bycatch reduction devices into the fishery were taken this year with vessels required to have half their gear fitted with BRDs. The management plan for the fishery was amended in September 2001 to remove the non-transferability provisions on C and D class licences. However, holders of these licences need to hold an Exmouth Gulf Prawn or Nickol Bay Prawn Managed Fishery Licence for the Onslow licence to be effective.

There was also an amendment to the management plan to implement the Vessel Monitoring System within the fishery. The VMS requirements will come into force on 1 October 2002.

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 interviews with boat skippers. Annual meetings are held with boat operators to consider the status of the stocks and recommend changes to fishing operations.

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

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 2001 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 2001 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 2001): **63 tonnes**

Landings

The total landings of major penaeids for the 2001 season were 63 tonnes, including 15 tonnes of king prawns, 28 tonnes of tiger prawns, 7 tonnes of endeavour prawns and 13 tonnes 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 to 130 tonnes. The season catch of 63 tonnes is at the lower end of the catch range for this fishery. Recorded landings of by-product species included 8 tonnes of coral prawns, 12 tonnes of bugs, 2 tonnes of squid and blue swimmer crabs and less than one tonne each of black tiger prawns, cuttlefish, shark and mixed finfish species.

Fishing effort

Not assessed.

Catch rate

Not assessed.

Recreational component: **Nil**

Stock assessment complete: **Not assessed**

The catches during 2001 continued to be below average for king prawns, middle of the range for tiger prawns and in the lower end of the range for endeavour prawns. Banana prawn catches were within the acceptable range in 2001, although low compared to 2000 which was above average for the fishery. This decline in banana prawn catch occurred in spite of moderate rainfall; however, the rain was not associated with any cyclones, which increase water turbidity and reduce predation. 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: **Not assessed**

Breeding stock levels: **Not assessed**

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.

Protected species interaction: **Low**

The Onslow prawn fishery can at times catch turtles and sea snakes, but the overall low effort level and targeted coverage of the fishery suggest that such interaction would not be significant. Bycatch reduction devices (grids) will be used in the fishery in 2002/03.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Because of the limited spatial coverage of this fishery and its low levels of catch of the target species, 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). Consistent effort occurs mostly between the Ashburton River and Onslow for banana and king prawns, and in the Mangrove Passage area for tiger prawns. Trawling occurs over a very small proportion (< 5%) of the king prawn habitat, as densities in most areas are too low for economically viable trawling. In contrast, fishing covers a high proportion (50%) of the discrete banana prawn habitats associated with river estuaries.

The fishery is restricted to clean sand and mud bottoms, where trawling has minimal physical impact.

SOCIAL EFFECTS

Estimated employment for the year 2001 was 12–15 skippers and crew, with up to 10 people involved in local processing.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2001: **$900,000**

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices received by vessels fishing along the northern coast in 2001 were as follows:

King prawns	$14.05/kg
Tiger prawns	$16.16/kg
Endeavour prawns	$10.49/kg
Banana prawns	$11.55/kg
Coral prawns	$2.12/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:

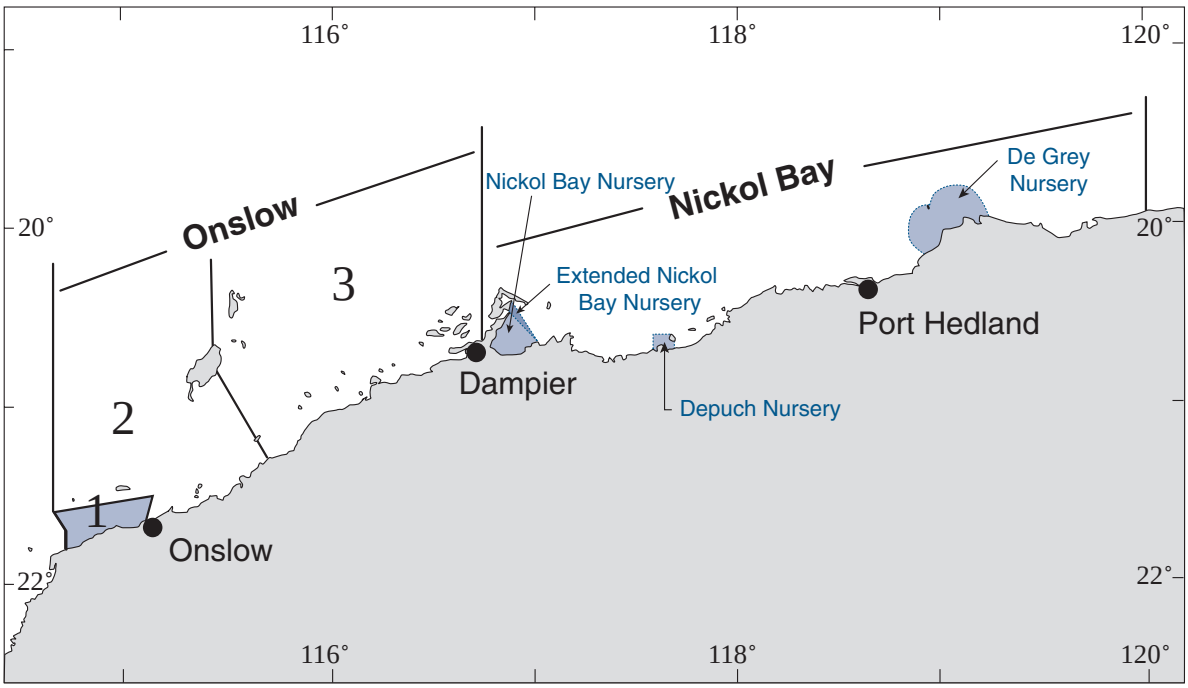
King prawns	10–55 tonnes
Tiger prawns	5–40 tonnes
Endeavour prawns	5–20 tonnes
Banana prawns	2–90 tonnes

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

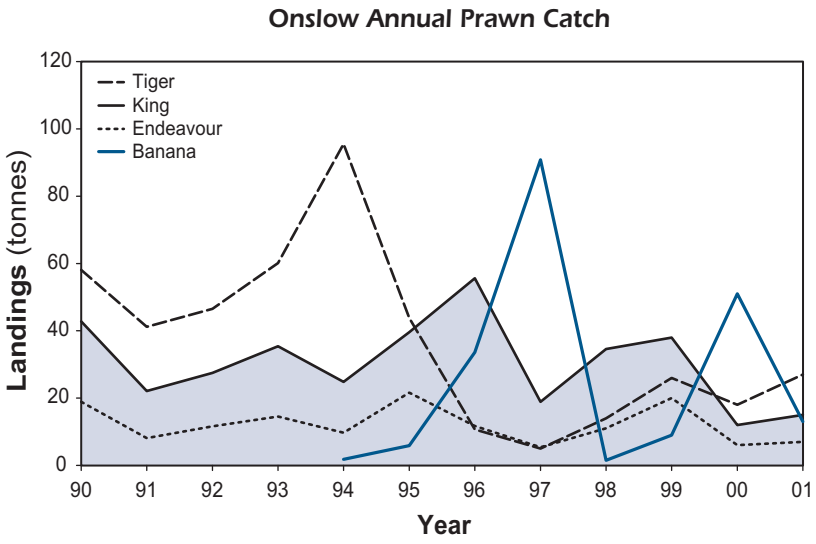
The catches taken are from a number of separate nursery areas and are highly variable from year to year. This is particularly the case for the rainfall-dependent banana prawn.

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 Onslow and Nickol Bay Prawn Managed Fisheries.



ONSLOW PRAWN FIGURE 2

Annual landings for the Onslow Prawn Managed Fishery, 1990–2001.

NICKOL BAY PRAWN MANAGED FISHERY

Management Summary

The Nickol Bay Prawn Managed Fishery (NBPMF) targets banana prawns (*Penaeus merguiensis*), western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*) and endeavour prawns (*Metapenaeus* spp.), with most prawn fishing activity using otter trawl gear and occurring in inshore areas.

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. The first steps to introducing bycatch reduction devices into the fishery were taken this season with vessels required to have half their gear fitted with BRDs. In addition, the Vessel Monitoring System was implemented in the fishery in 2002.

There was also an amendment to the Pilbara Fish Trawl Interim Managed Fishery Management Plan which removed the linkages between that fishery and the NBPMF.

Different areas within the fishery have different season dates. The main fishing ground for the 2002 fishing season opened on 1 May and will close 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.

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.

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

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 2001 season the major fishing areas were open during the following periods:

Nickol Bay Nursery	1 May–1 August
Extended Nickol Bay Nursery	1 May–15 November
Depuch Nursery	1 May–1 August
De Grey Nursery	1 May–15 November
Onslow Area 3	1 March–11 November

There were 14 boats licensed to trawl for prawns in Nickol Bay during 2001.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2001): **22 tonnes**

Landings

The total landings of major penaeids for the 2001 season were 22 tonnes, comprising 11 tonnes of banana prawns, 8 tonnes of king prawns, 2 tonnes of tiger prawns and 1 tonne of endeavour prawns (Nickol Bay Prawn Figure 2).

The catch forecast of banana prawns (80–190 tonnes), projected on the basis of rainfall over the period December to March, was not realised. Fishers noted a lack of water turbidity that may have contributed to high predation.

Recorded by-product species for 2001 were 13 tonnes of coral prawns, 4 tonnes of bugs, 3 tonnes of shark, and less than one tonne each of black tiger prawns, blue swimmer crab, squid, cuttlefish, scallops and mixed finfish species.

Fishing effort

During 2001, 289 days of fishing was recorded by boats licensed to fish in the Nickol Bay prawn fishery. This was approximately 60% down on the average number of fishing days recorded in the last four years, as the fleet left early to go to alternative fisheries in response to the very low abundance of banana prawns.

Catch rate

Not assessed.

Recreational component: **Nil**

Stock assessment complete: **Not assessed**

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 catches in 2001 did not fit the relationship, with only 11 tonnes taken rather than the 80–190 tonnes forecast. A possible explanation is that although the rainfall recorded was moderate, it was not associated with any cyclone event that would increase water turbidity. The absence of turbidity may have increased predation rates.

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

Projected catch next season (2002):
Banana prawns 1–40 tonnes

The catch projection for banana prawns, based on the 7 mm of rain during the 2001/02 summer period, is between 1 and 40 tonnes.

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.

Protected species interaction: **Low**

The Nickol Bay prawn fishery can at times catch turtles and sea snakes, but the overall low effort level and targeted coverage of the fishery suggest that such interaction would not be significant. Bycatch reduction devices (grids) will be implemented in the fishery during 2002/03.

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 less than 5% of the coastal habitat within the fishery. Habitat types on the trawl areas associated with banana and king prawns are mud and sand respectively, and not impacted significantly by trawl gear.

SOCIAL EFFECTS

Estimated employment for year 2001 was 40–50 skippers and crew, with up to 20 people involved in onshore processing in the region.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2001:
$300,000

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 northern coast in 2001 were as follows:

Banana prawns	$11.55/kg
King prawns	$14.05/kg
Tiger prawns	$16.16/kg
Endeavour prawns	$10.49/kg
Coral prawns	$2.12/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:

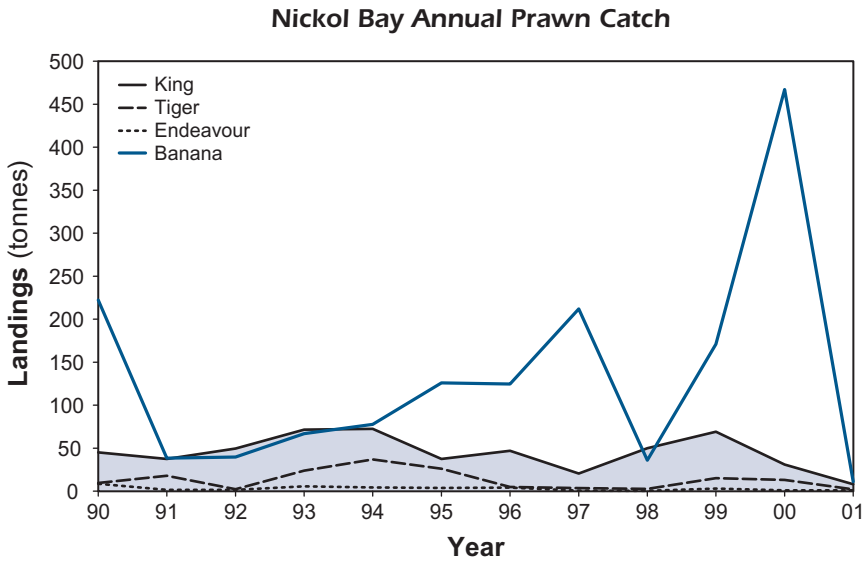
Banana prawns	40–220 tonnes
King prawns	20–70 tonnes
Tiger prawns	2–40 tonnes
Endeavour prawns	1–10 tonnes

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. It should also be noted that the banana prawn catch has exceeded 400 tonnes following extreme cyclonic rainfall on three occasions over the past 30 years.

EXTERNAL FACTORS

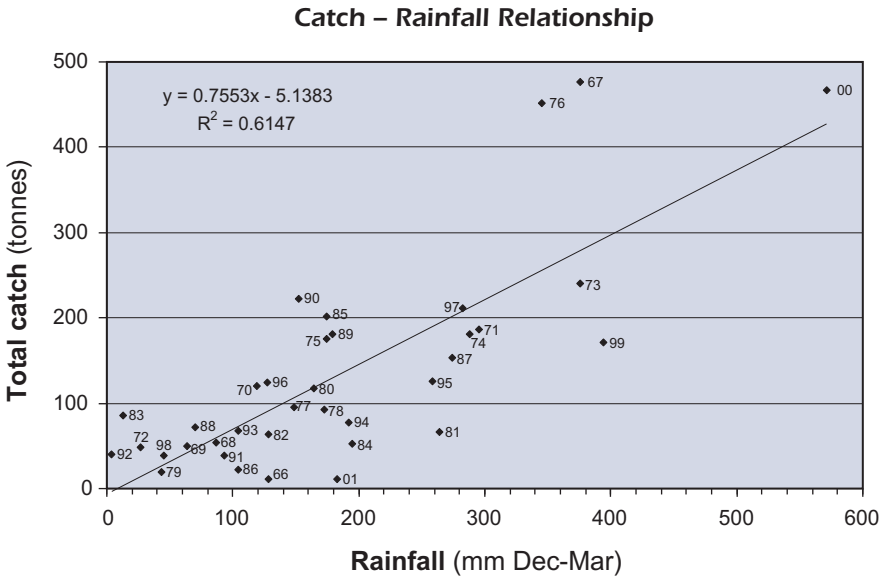
Banana prawns usually dominate the catch from Nickol Bay. The catch of this species is positively correlated with rainfall in the months December to March. With only 7 mm of rainfall recorded for this period during 2001/02 and the low catches observed in 2001, very low landings (1–40 tonnes) of banana prawns are forecast for 2002. The king prawn catches were also below the acceptable range for this species in 2001 and may reflect lower recruitment levels due to less favourable environmental conditions. It is anticipated that the king prawn catches should return to the acceptable catch range in 2002 as low rainfall has again been experienced.

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 (PFTIMF). 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 dependent on management measures in place elsewhere, and on 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 PFTIMF 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 NBPMF and other fisheries for which they have licences. These vessels, however, are not economically viable in the NBPMF in low banana prawn years 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, 1990–2001.



NICKOL BAY PRAWN FIGURE 3

Relationship between banana prawn landings and rainfall between December and March for the years 1966–2001.

BROOME PRAWN MANAGED FISHERY

Management Summary

The Broome Prawn Managed Fishery is a small fishery which operates from June to August in a designated trawl zone off Broome and generally coincides with the seasonal closures for the Northern and Kimberley prawn fisheries. The dominant species caught are western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species). Licensees were required to install bycatch reduction devices in this fishery from the commencement of the 2002 fishing season.

Governing Legislation/Fishing Authority
Broome Prawn Fishery Management Plan 1999
Broome Prawn 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. The relationship between catch and moon phase was investigated during 1997/98, which resulted in some modifications to the annual management arrangements to optimise fishing times.

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

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 2001 fishing season on 1 June and closed on 31 July, allowing for a total of 60 nights fishing. Fishing actually ceased at 8.00 a.m. on 24 July after a total of 54 nights fishing.

Five Western Australian-based Northern Prawn Fishery (Gulf of Carpentaria) boats are licensed to operate in this fishery.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2001): **142 tonnes**

Landings

The total landings for the 2001 season were 142 tonnes, including 62 tonnes of king prawns and 80 tonnes of coral prawns (Broome Prawn Figure 1) for 54 days fished. King prawn landings for 2001 were 38% lower than the five-year average (86 tonnes) whereas the catch of coral prawns was above average.

Fishing effort

Nominal effort recorded in the daily research logbooks for the fleet was 2,785 hours.

Catch rate

Average catch rates of 22.4 kg/hr for king prawns and 28.8 kg/hr for coral prawns were recorded. Although the catch rate for king prawns remained relatively stable for the duration of the fishery, declining from an average of 24 kg/hr in June to 20.2. kg/hr in July, it was low compared to previous seasons. This may be because the fishery commenced close to the full moon, when catch rates of king prawns are lowest, and only fished through one new moon period during the season. As this fishery is aligned to the mid-season closure of the Northern Prawn Fishery, the timing is not always optimal with respect to the recruitment of king prawns on to the trawl grounds. Additionally, the short duration of fishing does not always allow for the full exploitation of stocks during higher catch rate periods over the new moon.

Recreational component: **Nil**

Stock assessment complete: **Yes**

A Delury depletion analysis incorporating lunar effects was carried out on the 2001 logbook data to quantify the standing stock of king prawns in the Broome fishery. From this analysis, a standing stock of approximately 166 tonnes was estimated. This indicates that for the 2001 season approximately 38% of the stock was taken by fishing, utilising the 2,785 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.

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 2001 season. This stock would contribute to the spawning stock for 2002 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 very short duration of this fishery and the small number of boats involved, the impact on bycatch species is considered to be minimal.

Protected species interaction: **Low**

The fishery operates in relatively deep water, and this fact, combined with the short season, restricted small size trawl area and the small number of boats involved, means that interaction with protected species is minimal.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The short duration and limited spatial coverage of this fishery, and the small number of boats involved, indicate that food chain effects will be insignificant.

Habitat effects: **Low**

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 2001 was 20 skippers and crew over the two-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 2001: **$1 million**

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, prices received by boats for 2001 were as follows:

King prawns	$14.05/kg
Coral prawns	$2.12/kg

FISHERY GOVERNANCE

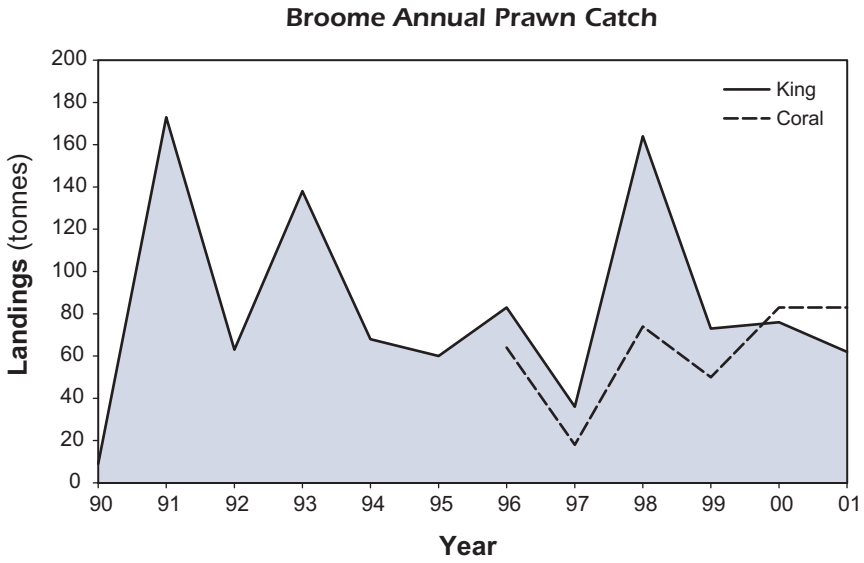
Acceptable catch range: **King prawns 35–170 tonnes**

Under current effort levels and previous environmental conditions, the acceptable range for the king prawn catch, based on the catches of the 1990s, is 35–170 tonnes. The 62 tonnes of king prawns taken in 2001 are at the low end of the acceptable range due to low effort.

EXTERNAL FACTORS

Catches of king prawns in the Broome Prawn Managed Fishery have fluctuated between 36 and 173 tonnes since 1991. Before that time this fishing area was used on a casual basis by boats transiting to the Northern Prawn Fishery (NPF) 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 as was seen 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, 1990–2001.

KIMBERLEY PRAWN MANAGED FISHERY

Management Summary

The Kimberley Prawn Managed Fishery, which targets banana prawns (*Penaeus merguiensis*), operates off the north of the State between Koolan Island and Cape Londonderry and abuts the western boundary of the Commonwealth Northern Prawn Fishery. A significant number of vessels hold authorisations to operate in both fisheries, 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. The Vessel Monitoring System was introduced into the fishery during 2001. Bycatch reduction devices were also required to be installed by the licensees in this fishery from the second half of the 2002 season. A review of the management arrangements for this fishery, primarily to deal with the very high levels of effort, was commenced in 2002.

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.

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

KIMBERLEY PRAWN MANAGED FISHERY STATUS REPORT

Prepared by M. Kangas and E. Sporer

FISHERY DESCRIIPTION

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 2001 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 133 boats had access to the Kimberley Prawn Managed Fishery under various licensing arrangements, only 20 boats operated in the fishery during the 2001 season.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2001): 303 tonnes

Landings

The total landings for the 2001 season were 303 tonnes, comprising 238 tonnes of banana prawns, 47 tonnes of tiger prawns *(Penaeus esculentus)*, and 18 tonnes of endeavour prawns (*Metapenaeus* spp.) (Kimberley Prawn Figure 1).

The banana prawn catch was within the projected catch range (200–350 tonnes) using the preliminary relationship between summer rainfall and catches. The tiger prawn catch was within the acceptable catch range for this species (15–60 tonnes), as was the endeavour prawn catch (7–80 tonnes).

Recorded by-products were 13 tonnes of squid, 3 tonnes of bugs and less than one tonne of scallops.

Fishing effort

During the 2001 season, 20 vessels operated in the fishery for a total of 1,159 fishing days.

Catch rate

Not assessed.

Recreational component: Nil

Stock assessment complete: Not assessed

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.

Further investigations have shown a more promising relationship between early season rainfall (January and February) and the subsequent catch of banana prawns. Rainfall during the period January–February 2002 was 567 mm at Derby and 625 mm at Kalumburu, which indicates that banana prawn catches for 2002 should be in the range of 200–380 tonnes. Investigations on refining rainfall–catch relationships are continuing.

Exploitation status: Not assessed

Breeding stock levels: Not assessed

Projected catch next season (2002):
Banana prawns 200–380 tonnes

The projected catch for 2002 based on the rainfall-catch relationship is 200–380 tonnes for banana prawns.

NON-RETAINED SPECIES

Bycatch species impact: Low

The majority of the catch in this fishery comprises banana prawns which form schools that are specifically targeted, meaning that bycatch is minimal. In the Kimberley, however, banana prawns may also be generally trawled when they are

dispersed due to local tidal conditions. Overall, the fishery is likely to have a low impact on bycatch species.

Protected species interaction: **Low**

Turtle exclusion devices are used by the NPF boats. Trials of bycatch reduction devices (on one side) will commence in the Kimberley Prawn Managed Fishery during 2002.

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 2001 was 80 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2001: **$3.7 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 boats fishing along the northern coast in 2001 were as follows:

Banana prawns	$11.55/kg
Tiger prawns	$16.16/kg
Endeavour prawns	$10.49/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:

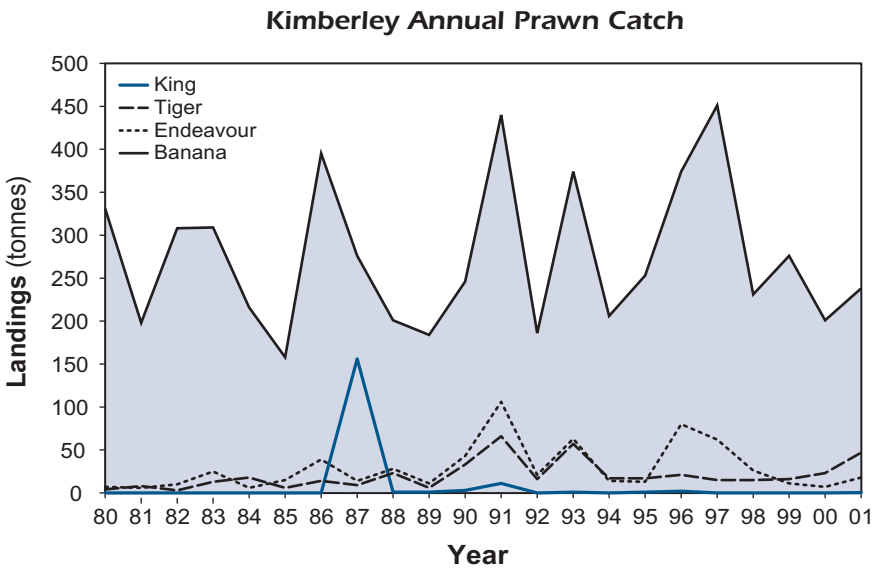
Banana prawns	200–450 tonnes
Tiger prawns	15–60 tonnes
Endeavour prawns	7–80 tonnes

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.

This fishery is used by relatively few stand-alone, Kimberley-only boats for the complete fishing season. Boats from Nickol Bay and elsewhere in Western Australia use it 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 use this fishery for periods each year, and in fact the Kimberley fishing season is set to mirror dates used in the NPF, to prevent the small Kimberley fishery from attracting too much fishing effort from its large 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, 1980–2001.

KIMBERLEY GILLNET AND BARRAMUNDI MANAGED FISHERY

Management Summary

The Kimberley Gillnet and Barramundi Managed Fishery (KGBMF) 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 (*Eleutheronema tetradactylum*). The main areas of the fishery are the river systems of the northern Kimberley, King Sound, Roebuck Bay and the top end of Eighty Mile Beach.

There are currently seven licences in the fishery, reduced from a historical level of 10 through a Voluntary Fisheries Adjustment Scheme in 1999. The licences are currently only transferable between family members, but it is proposed that they become fully transferable after 1 January 2003.

Following the development in 2000 of the 'Barramundi Accord', arrangements have now been put into place to achieve cohesive management of commercial and recreational fishing for 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 Fishery Management Plan 1989
Kimberley Gillnet and Barramundi Managed Fishery Licence

Consultation Process
Department–industry meeting

Research Summary

The data used 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.

KIMBERLEY GILLNET AND BARRAMUNDI MANAGED FISHERY STATUS REPORT

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

The boundaries of this limited entry fishery are *'all Western Australian waters lying north of 19° south latitude and west of 129° east longitude and within three nautical miles seawards of the low water mark of the mainland of Western Australia and the waters of King Sound of 16°21'38" south latitude'*. Access to the fishery was by seven vessels during 2000/01. (Note: The distribution of barramundi catches in Western Australia extends further south to the Ashburton River near Onslow. These catches are outside of the boundaries of the managed fishery and are not included in this status report).

Main fishing method

Gillnet.

RETAINED SPECIES

Commercial production (season 2000/01):
All species 99.6 tonnes
Barramundi 43.9 tonnes

Landings

Each of five principal fishing areas is considered separately because of differing histories of development, effort application, recreational interest and unit stock considerations: Cambridge Gulf/Ord River, Kimberley coast (six river systems), King Sound/Fitzroy River, Broome coast, and Pilbara coast to the Ashburton River, the last of which is south of the prescribed restricted entry fishery (below latitude 19° S). Landings from the Pilbara coast are not included in the total catch figure. Total landings of barramundi for all four prescribed fishing areas within the fishery were 43.9 tonnes for 2000/01 (Kimberley Gillnet Figure 1). This catch of barramundi was approximately the same as in 1999/2000.

The 2000/01 landings of threadfin salmon, at 46.9 tonnes, were similar to those of barramundi (Kimberley Gillnet Figure 2). The catch for this species peaked between 1997/98 and 1999/2000 and has declined by approximately 50% since that time to the present catch. It is not known why the catches have fallen so dramatically. These two main species comprised 91% of the total catch. There were reported landings of 14 other species, including 3 tonnes of elasmobranchs (sharks and rays).

Fishing effort

The fishing effort in this gillnet fishery is calculated as the total annual number of fishing days by all boats multiplied by the average daily total of 100 m lengths of gillnet used per boat. During 2000/01, the total effort across the four prescribed fishing areas was 1,285 units. This total effort is slightly lower than last year (Kimberley Gillnet Figure 1).

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 current CPUE is up slightly from last year (Kimberley Gillnet Figure 1).

The catch and CPUE for threadfin peaked during 1998/99 and since that time has declined to the current low value (Kimberley Gillnet Figure 2), suggesting a switch in targeting from threadfin back to barramundi in the past two seasons.

Recreational component: **Not assessed**

Stock assessment completed: **Yes**

The last detailed stock assessment, utilising the 1999 commercial catch data and 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 sector the breeding biomass was declining. Trends in catch and effort since that time indicate that the Broome sector experienced a peak catch and effort in 1999/2000 followed by a decline in 2000/01. The Cambridge Gulf sector had the highest catch for five years in 1999/2000, followed by a slight decline in 2000/01; however, the present fishing effort is at an historical low level. There has been a trend for increasing catch and fishing effort during the past three years in the Kimberley coast sector of the fishery. This is in contrast to the lower catches and effort recorded in the King Sound sector during the past three years.

Reported catches of threadfin salmon, the other target species, have declined in the past three years, which may be a function of declining abundance of threadfin or specific targeting of barramundi. This will be more closely monitored in future years.

Exploitation status: **Fully exploited**

Barramundi on average are fully exploited.

Breeding stock levels: **Adequate**

Assessment of the barramundi stocks indicates that breeding stocks in most areas are adequate.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The fishery operates at a relatively low intensity over a wide area of the Kimberley, specifically targeting barramundi and threadfin salmon. The fishing gear, with large mesh sizes, does not generate a significant bycatch of species important to other sectors, but does take some sharks and rays. Because of the low effort levels, these impacts are unlikely to be significant to the stocks involved. Overall, this fishery is likely to have little effect on the Kimberley ecosystem as a whole.

Protected species interaction: **Low**

The fishing gear used for this fishery does take some crocodiles. 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 which is subject to extreme tidal currents and associated changes.

SOCIAL EFFECTS

The Kimberley Gillnet and Barramundi Managed Fishery involved an average of about 15 fishers in 2000/01. There was additional employment through local processors and distribution networks. The fishery provides local fresh fish for the tourist trade throughout the Kimberley region.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000/01):
All species $605,000
Barramundi $368,000

FISHERY GOVERNANCE

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

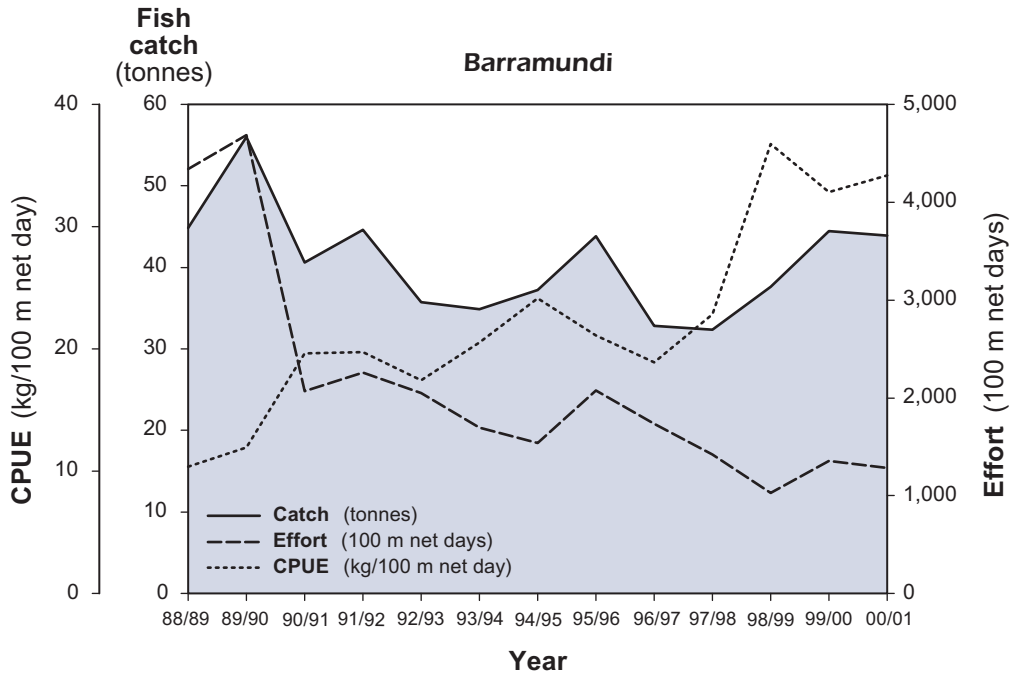
This projection is derived by double exponential, smoothed forecasting of the annual catches up to 1998/99 and the variation of observations around the predictions. The confidence intervals are set at 80%. The current catch is beginning to exceed the range set due to increasing abundance flowing from substantial decreases in effort over the past decade and is therefore not of concern.

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 Pilbara desert coastline are likely to suffer 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 specific management arrangements in the future.

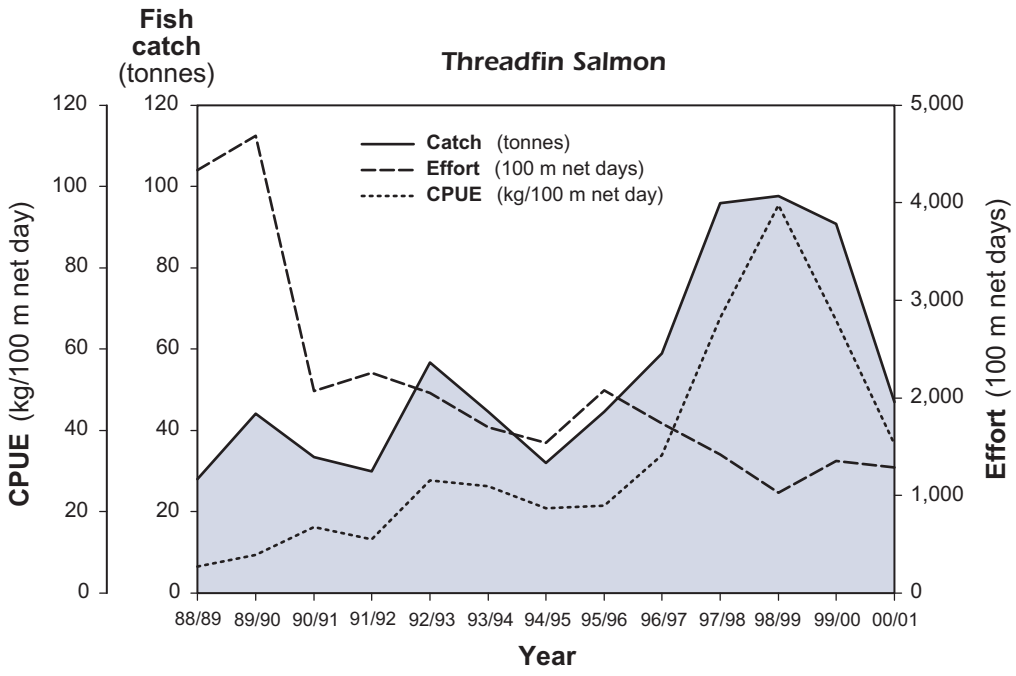
Resource sharing between commercial and recreational fishers on the Ord River has been an issue of debate. However, recent and anticipated levels of commercial fishing by existing operators are not considered to pose a threat to the viability of the resource. At current levels of commercial fishing it is unlikely that the abundance of barramundi is being significantly impacted across the Kimberley region.

Since 1995/96 the catch of threadfin salmon has been considerable, making it the major focus of this fishery in recent years (Kimberley Gillnet Figure 2). Murdoch University currently has a three year FRDC-funded project to study the biology of threadfin salmon in the Kimberley region.



KIMBERLEY GILLNET FIGURE 1

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for barramundi from the Kimberley Gillnet and Barramundi Managed Fishery over the period 1988/89 to 2000/01.



KIMBERLEY GILLNET FIGURE 2

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for threadfin salmon from the Kimberley Gillnet and Barramundi Managed Fishery over the period 1988/89 to 2000/01.

NORTHERN DEMERSAL SCALEFISH MANAGED FISHERY

Management Summary

The Northern Demersal Scalefish Managed Fishery (NDSMF) 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 the tropical snapper (Lutjanidae), which include red emperor *(Lutjanus sebae)*; the emperors or nor-west snappers (Lethrinidae), which include goldband snapper (*Pristipomoides multidens* and related *Pristipomoides* species); and the cods or gropers (Serranidae).

The Northern Demersal Scalefish Fishery Management Plan 2000 commenced on 1 January 2001, superseding the Northern Demersal Scalefish Fishery Interim Management Plan 1997.

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 2001, the nominal TSC was 800 tonnes of demersal scalefish and the total effort allocation was 1,760 days.

A number of amendments were made to the management plan in 2001. These included an increase in the total number of units in Area 2 of the fishery and the insertion of a provision in the management plan which afforded natural justice to the sole remaining objector pending from the old interim management plan. The unit consumption monitoring mechanism was also altered to increase flexibility to the Area 2 licensees, and provisions were inserted that allow Area 2 licensees to pay their fees by instalments.

Governing Legislation/Fishing Authority
Northern Demersal Scalefish Fishery Management Plan 2000
Northern Demersal Scalefish 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 to assess the status of the fish stocks that contribute to this fishery, principally red emperor and goldband snapper. This research work was undertaken in an FRDC-funded research project from 1997 to 2000. This information is now being incorporated into age-based stock assessment models to assess the long-term sustainable yield of the fishery, in particular the two key stocks. Ongoing monitoring of this fishery is being undertaken using both CAES data and VMS records.

The appropriateness of the present TSC is under review in order to provide a long-term sustainable catch level for Area 2 of the NDSMF.

The third largest component of the NDSMF catch is the cod group. Little information is currently available on the species composition and their relative abundance. A number of cod species which occur in the NDSMF are Indian Ocean endemics about which little is known. This gap in the knowledge of the NDSMF 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 NDSMF may also involve the stocks from waters greater than 200 m depth. 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 low production potential of deeper-slope reef fish, the sustainable catch from this zone is likely to be quite low.

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

NORTHERN DEMERSAL SCALEFISH FISHERY STATUS REPORT

Prepared by S.J. Newman

FISHERY DESCRIPTION

Boundaries and access

The waters of the NDSMF 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 area. Fishing access to the research area can be facilitated through 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 NDSMF 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 2001, 6 vessels (5 trap vessels and one line vessel) 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 2001): 504 tonnes

Landings

The reported catch in the NDSMF 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 four years since the implementation of management controls, the reported catch in the NDSMF has ranged between 470 and 580 tonnes, reflecting an annual average in this four-year period of approximately 523 tonnes. The catch of demersal scalefish in the NDSMF in 2001 increased from the low levels of the previous year as the result of an increase in the trap catch (Northern Demersal Scalefish Table 1, Northern Demersal Scalefish Figure 2). The trap and line fishery in the NDSMF principally targets red emperor and goldband snapper, with many species of snappers, emperors and cods comprising a large component of the landed by-product. A breakdown of the landed catch in the NDSMF in 2001 is provided in Northern Demersal Scalefish Table 2. The species composition of the landed catch is similar to that reported in 2000. There has been an increase in the landed catch of the key target species, with red emperor up from 89 tonnes to 95 tonnes and goldband snapper up from 185 tonnes to 204 tonnes. A number of operators within the NDSMF are also involved in other fishing activities in the region, such as trolling for Spanish mackerel *(Scomberomorus commerson)*. The catches of pelagic fishes such as the mackerels are not included in the demersal scalefish catch. The catch of Spanish mackerel and other mackerels is reported on pp. 86–91.

Fishing effort

The five fish trap vessels that fished in the NDSMF in 2001 reported using between 20 and 40 fish traps per day. The line vessel that fished in the NDSMF in 2001 reported using 5 lines per day. The effort allocated in 2001 was 152 fishing boat days per licence, or a total of 1,672 standard fishing days. A standard fishing day is defined as using up to 20 traps or 5 lines per day. The number of days fished reported in the statutory monthly returns was a total of 828 boat days, including 701 boat days for trap vessels and 127 days for line vessels. The number of standard fishing days (SFDs) reported using data from the VMS database was 1,064 SFDs (928 SFDs for trap vessels and 136 SFDs for line vessels), indicating that 608 SFDs remained unutilised in the fishery at the end of the 2001 fishing season. 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 NDSMF.

The fish trap effort (in boat days fished) within the NDSMF has on average been decreasing since 1992. The fish trap effort in 2001 was marginally higher than that recorded in 2000 (Northern Demersal Scalefish Table 1). 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. The line effort recorded in 2001 was down on that recorded in 2000 (Northern Demersal Scalefish Table 1).

Catch rate

The introduction of management controls in 1998 resulted in an increase in catch per unit effort (CPUE) for trap vessels in the NDSMF. 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 450–490 kg/day, which is similar to the range prior to the introduction of direct management. The CPUE for line vessels in recent years has been variable depending on the effort levels.

The trap CPUE averaged during 2001 was 480.3 kg per standard trap fishing day (20 traps x 24.02 kg/trap/day) compared to the forecast of 481.4 kg per standard trap fishing day (24.1 kg/trap/day) used in the effort allocation process. This CPUE was closer to the forecast than expected given the lower level of effort recorded in the fishery.

That is, artificially created effort anomalies were evident in 2001, following introduction of the VMS rules, as fishers chose to travel for as long as possible outside the boundary of the fishery to avoid the use of effort allocations in transit. Thus very little transit time is now logged as effort, whereas historically it was. The effect of this change in fishing fleet behaviour has been to inflate the current CPUE 5–10% above the 2000 level.

Recreational component: Not assessed

At present there is little recreational fishing effort directed towards the deeper-water fish species in Area 2, which are the key species targeted by commercial fishers in the NDSMF. 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. A creel survey of the Pilbara coast conducted recently included the West Kimberley (Broome) area, and these data are currently being analysed. The magnitude of this recreational fishing effort and the catch taken are expected to be small relative to the overall commercial catch.

Stock assessment completed: Not assessed

The introduction of formal management procedures has restricted the number of vessels permitted to fish in the waters of the NDSMF. A target TSC of 800 tonnes was initially adopted in order to constrain harvest rates. The control mechanism implemented to maintain a catch level of approximately 800 tonnes was a restriction on the number of trap or line days fished by each vessel exploiting the NDSMF 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 catch to be achieved within each year. The outcome from this effort determination process for the 2002 fishing season is noted in the 'Acceptable catch range' section below. However, it should be noted that the level of catch in the NDSMF over the past four years since effort controls were implemented appears to have stabilised in the range of 500–600 tonnes due to the decision by vessel operators to not fully utilise the allocated effort each year.

A summary of the key results arising from a major FRDC-funded research project completed in 2000 was given in the

State of the Fisheries Report 2000/2001. This project provided detailed biological information on the two key demersal finfish species in the NDSMF, red emperor and goldband snapper. The results indicated that the stocks of the two major target species were fully exploited and that a TAC of 800 tonnes, if achieved, would have the fishery operating above optimum levels if the catch of these species increased. This project has provided the foundation for detailed age-structured stock assessment models to be developed for the two key species. It should be noted that the assessment information now provided is different to that reported last year which was based on the preliminary outputs of the age-structured stock assessment models.

The current stock assessment analyses indicate that the maximum sustainable yield of the two target species can be obtained at current effort levels. It should 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 NDSMF has been estimated by the stock assessment model and assessed in relation to accepted international reference points for these types of species.

The assessment information now provided differs from previous reports because it is now based on the outputs of the age-structured stock assessment models. The stock assessment work indicates that the current level of breeding stock for 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 level of 30–40% 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 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.

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

Six vessels fished in the 2001 fishing season with an average crew level of 3 people per vessel, indicating that 18 people were directly employed in the NDSMF.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001): **$2.76 million**

The NDSMF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery landed a total of 504 tonnes of demersal scalefish in 2001, for a catch value of over $2.76 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. This value is higher than that reported in 2000 owing to the increase in catch levels in the fishery. Further, the increase in value of the fishery is also a reflection of improved prices in the 2001-fishing season.

FISHERY GOVERNANCE

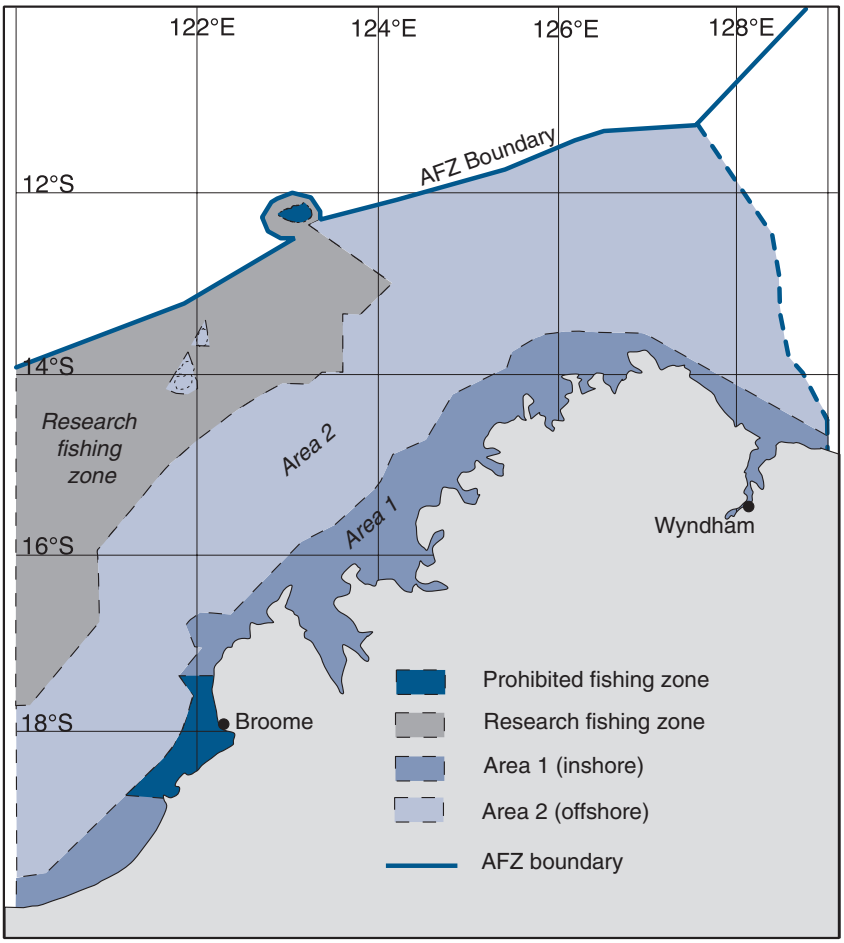
Acceptable catch (or effort) range: **600–1,000 tonnes**

For the calendar year 2002, 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 tonnes.

However, the long-term sustainable catch level for Area 2 of the NDSMF is currently being assessed, which may result in refinement of the current TSC. In the four years since the introduction of management controls (1998–2001), the fleet has been unable to achieve the 800 tonne TSC. In each of these years a large amount of unutilised effort has remained at the end of the fishing year. Results from the recently completed FRDC-funded study assessing the key species in the NDSMF indicate that catch levels of the two key species should not exceed the present levels. The trigger points for management action are likely to be the TSC ± 20% after consultation with industry.

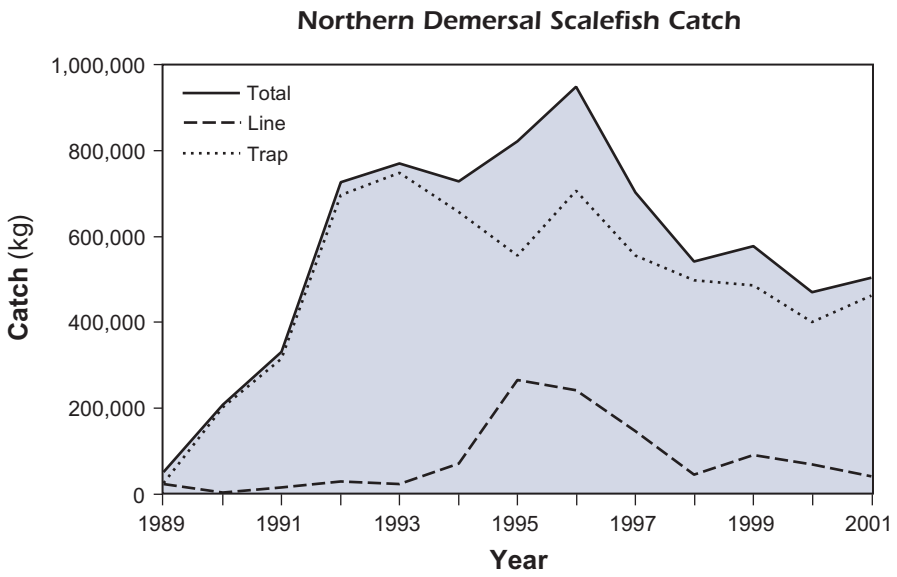
EXTERNAL FACTORS

The impacts of environmental variation on the fishery are not large. There are no data to indicate either significant variation in recruitment amongst years or changes to catchability of the two key species amongst years.



NORTHERN DEMERSAL SCALEFISH FIGURE 1

Boundaries and access areas of the Northern Demersal Scalefish Managed Fishery.



NORTHERN DEMERSAL SCALEFISH FIGURE 2

Catches of demersal finfish in the NDSMF by line and trap, 1989–2001.

NORTHERN DEMERSAL SCALEFISH TABLE 1

Catches of demersal finfish by line and trap in the NDSMF, 1989–2001. Note that the NDSMF came under full management in 1998 and effort levels have been limited in each year since.

YEAR	TOTAL ALLOWABLE EFFORT (days)	LINE CATCH (kg)	LINE EFFORT* (block days)**	FISH TRAP CATCH (kg)	FISH TRAP EFFORT (block days)**	TOTAL CATCH (kg)
1989		23,979	267	26,649	81	50,628
1990		4,638	91	202,783	395	207,421
1991		16,031	255	316,228	750	332,259
1992		29,607	433	695,954	1,776	725,561
1993		23,507	283	747,215	1,713	770,722
1994		71,763	453	656,937	1,349	728,700
1995		265,798	1,204	555,162	1,200	820,960
1996		242,590	1,319	706,063	1,412	948,653
1997		146,548	788	555,172	1,293	701,720
1998	1,684	44,863	78	497,154	916#	542,017
1999	1,716	91,045	228	485,918	992#	576,963
2000	1,562	68,543	155	401,487	890#	470,080
2001	**1,672**	**41,822**	**136**	**462,498**	**928#**	**504,320**

* Line methods that have been selected for the calculation of effort include handline, dropline and longline only.

** Block days are defined as the number of days on which fishing occurred in a particular block by a particular vessel (that is, block boat days).

\# Trap fishing effort from 1998 onwards has been converted to standard trap fishing days for comparison with previous years.

NORTHERN DEMERSAL SCALEFISH TABLE 2

Demersal finfish catch in tonnes and the percentage composition of each of the major species taken by trap and line fishers in the NDSMF in 2001.

SPECIES GROUP		LINE tonnes	LINE %	FISH TRAP tonnes	FISH TRAP %	TOTAL CATCH tonnes
Red emperor	*Lutjanus sebae*	1.3	0.3	93.7	18.6	95.0
Goldband snapper	*Pristipomoides multidens*	33.5	6.6	170.8	33.9	204.3
Cod species	Serranidae	2.0	0.4	81.8	16.2	83.8
Spangled emperor	*Lethrinus nebulosus*	--	--	34.4	6.8	34.4
Scarlet perch	*Lutjanus malabaricus*	2.3	0.4	36.0	7.1	38.3
Red snapper	*Lutjanus erythropterus*	0.5	0.1	2.2	0.4	2.7
Other species		2.3	0.5	43.7	8.7	45.9
All demersal finfish		**41.8**	**8.3**	**462.5**	**91.7**	**504.0**

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 operate under individually transferable effort regimes monitored by the satellite-based Vessel Monitoring System.

The Pilbara Fish Trawl Interim Managed Fishery commenced in 1998 when a number of fishing boats with conditions authorising fish trawling were brought under a management plan. The fishery is controlled through a combination of area closures, gear restrictions and total and area-specific effort limitations. Since coming into a formal management framework, 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 Pilbara Trap Managed 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 tonne limit. However, the ability of the fishery to target red emperor may require species limits in the future.

Some demersal scalefish are also taken by 'wetline only' vessels which are not part of the two managed fisheries.

Governing Legislation/Fishing Authority
Pilbara Fish Trawl Interim Managed Fishery 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 further study into bycatch from the Pilbara trawl fishery, funded by the Natural Heritage Trust (NHT) and the Department of Fisheries, will be completed in 2002/03.

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. This has been a managed fishery since 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 (Pilbara Figure 1) 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. 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.

Pilbara Figure 1 is a general diagram showing areas where specific fishing activities are permitted within this fishery. The exact latitudes and longitudes delineating the sectors of the Pilbara fishery are listed in the Pilbara Trap Management Plan 1992 and the Pilbara Fish Trawl Interim Managed Fishery Management Plan 1997.

Main fishing method

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

RETAINED SPECIES

Commercial production (season 2001):

Trawl 2,221 tonnes
Trap 266 tonnes
Line 99 tonnes

Landings

Catch of the major species for 2001 are shown in Pilbara Table 1. The catches by different fishing methods for the years 1985 to 2001 are shown in Pilbara Table 2 and illustrated in Pilbara Figure 2.

Demersal scalefish catch by trawl, trap and line was 2,221 tonnes, 266 tonnes, and 99 tonnes respectively.

The 2001 trawl fishery demersal scalefish catch had a similar species composition to that in 2000, though with decreased catches of blue spot emperor and Rankin cod and increased catches of red snapper and scarlet perch. The

major target species landed (2000 catch in brackets) were red snapper *(Lutjanus erythropterus)* 365 tonnes (252 tonnes), blue spot emperor *(Lethrinus hutchinsi)* 318 tonnes (401 tonnes), threadfin bream (Nemipteridae) 228 tonnes (187 tonnes), flagfish *(Lutjanus vitta)* 171 tonnes (166 tonnes), goldband snapper *(Pristipomoides multidens)* 122 tonnes (75 tonnes), scarlet perch *(Lutjanus malabaricus)* 88 tonnes (65 tonnes), red emperor *(Lutjanus sebae)* 74 tonnes (68 tonnes), spangled emperor *(Lethrinus nebulosus)* 24 tonnes (27 tonnes) and Rankin cod *(Epinephelus multinotatus)* 19 tonnes (25 tonnes). Retained by-product totalled 150 tonnes, including shark 73 tonnes, bugs 7 tonnes and cuttlefish 67 tonnes.

The trap fishery catch increased slightly, from 257 tonnes in 2000 to 266 tonnes in 2001. Major species taken by the trap fishery in 2001 (2000 figures in brackets) were blue spot emperor 43 tonnes (39 tonnes), red snapper 35 tonnes (27 tonnes), red emperor 30 tonnes (40 tonnes), goldband snapper 26 tonnes (30 tonnes) and Rankin cod 21 tonnes (27 tonnes). There is no by-product in this fishery.

Demersal scalefish catches by line fishing were higher in 2001 at 99 tonnes (59 tonnes in 2000), mainly due to greatly increased catches of goldband snapper. The catches in 2001 (2000 figures in brackets) were mainly goldband snapper 38 tonnes (6 tonnes), spangled emperor 8 tonnes (18 tonnes), Rankin cod 4 tonnes (5 tonnes) and red emperor 4 tonnes (7 tonnes). In addition, the line vessels covered in this report recorded catches of 190 tonnes (187 tonnes) of sharks and rays (which includes the North Coast Shark Fishery catch) and 103 tonnes (130 tonnes) of mackerel in the Pilbara.

The Pilbara shark catch is reported in more detail in the North Coast Shark Fisheries Status Report (pp. 92–94), and the mackerel catch in the Spanish Mackerel Stock Status Report (pp. 87–91).

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 2001 is also recorded as the net bottom time (hours) taken from skippers' logbook data.

In the trawl fleet there are the equivalent of seven 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, and the percentage of the allocation used in 1998 to 2001 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 2001 of 8% in Area 2 and 3% in Area 4 (compared with 17% and 10% in 2000). There was no trawling in Area 3 or Area 6 in 2001.

Three trap boats were allocated 5,867 trap units in 2001 (days multiplied by number of traps) and the number of units used, calculated from VMS, was 5,380. This number of units used equates to 414 days fished with an average of 13.7 traps per day, an increase from the average of 11.6 traps used per day in 2000. The number of days allocated, the number of days used and the percentage of the allocation used in 2000 and 2001 are shown in Pilbara Table 5. The comparable number of days reported in CAES returns in 2001 was 446 (compared with 518 days in 2000).

In 2001, line fishers reported operating for 401 days, compared with 500 days in 2000. This effort does not include trolling, which is reported in the Spanish Mackerel Stock Status Report (pp. 87–91), nor the dropline effort in the North Coast Shark Fishery (pp. 92–94). Plans for future management of line fishing in the Pilbara will be considered during the statewide 'wetline' fishing review.

Catch rate

The catch rates (based on nominal effort) for red emperor have decreased in the recently developed Areas 4 and 5 of the trawl fishery, and have stabilised at a low level in Area 1. The red emperor catch rate has been stable in Area 2. Blue spot emperor catch rates have decreased in Areas 1, 2, and 5 of the trawl fishery. Rankin cod catch rates have been reduced to a very low level in Area 1, and have decreased in Areas 4 and 5 but appear to be stable in Area 2. Flagfish and threadfin bream catch rates are stable. 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 rate for the trap fishery (based on the reported number of days fished) was considerably higher in 2001 than 2000, apparently due to efficiency gain flowing from the consolidation of the fleet. The line catch rate in 2001 was more that twice that in 2000 due to the large goldband snapper catches.

Recreational component: **Not assessed**

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.

The apparent local depletion of these indicator species in 2000 and 2001 led to a suggestion by the Department of Fisheries that effort reduction should occur in Areas 1 and 5 in 2002. After management consultation with industry, it was agreed to postpone any change in the total effort allocation and instead reduce the effort in Area 1 and increase effort in Areas 2 and 4.

Trawl and trap fishery: In 2001, the effort adjustment in the trawl fishery appears to have resulted in slow rebuilding of the spawning biomass of red emperor in Area 1 with continued increases in spawning biomass in Areas 2 and 4. In Area 1, Rankin cod and blue spot emperor catch rates continued to decline. In Area 5, the catch rates of red emperor, blue spot emperor and Rankin cod all continued to decrease, indicating that the fish stocks in this area are smaller than expected.

Anticipated increases in efficiency, especially as a result of the consolidation of the trap and trawl fleet, are likely to exacerbate the local over-exploitation of the indicator species.

Line fishing: The line catch was the highest recorded since 1997, mainly due to greatly increased goldband snapper catches.

The near-doubling of the goldband snapper catch between 2000 and 2001 in the trawl, trap and line sectors is cause for concern as this deeper-water species matures at a relatively large size and is long-lived, making it 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, which has management implications, as stock depletion in one fishery may reduce recruitment in adjacent fisheries.

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 in the fishing area overall. Catch rates of blue spot emperor continue to decline in Areas 1 and 5 of the trawl fishery, but it is likely that an adequate breeding stock exists outside the trawl 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 possibly in Area 5 of the trawl fishery.

The increased focus on goldband snapper in 2001 by both the trawl and line vessels suggests the breeding stocks of these species are likely to be reduced and need to be monitored more closely in future.

To ensure breeding stock levels of red emperor and Rankin cod are maintained at satisfactory levels, overall effort reduction in the trap and trawl fishery should be considered in the future.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Owing to the relatively large mesh size used by the fish trawl fishery, there is only a small bycatch of under-size and unmarketable scalefish. An NHT-funded project on bycatch in the trawl fishery will be completed in 2002/03. For the trap and line fisheries, bycatch is minimal.

Protected species interaction: **Medium**

The trawl fishery involves the occasional capture of dolphins which are apparently attracted to the trawl while it is operating. The significance of these accidental captures, relative to the population size and natural mortality of the North West Shelf dolphin population, will be assessed as part of the bycatch project. Sea snakes and turtles are occasionally captured in the fish trawl nets but are returned alive to the sea in most cases. The frequency of capture of these species will also be investigated during the bycatch project. There is no indication of interaction between protected species and the trap or line sectors.

ECOSYSTEM EFFECTS

Food chain effects: **Medium**

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 have a moderate impact.

Habitat effects: **Medium**

Impacts to the habitat are restricted to those of the trawl fishery, which in turn is restricted to a relatively low 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. Effective impact is further lessened by the concentration of effort in the west of the fishery where the habitat is already most disturbed, with low effort in the east where habitat is least disturbed.

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. It is not known whether this exceeds the rate of regrowth.

SOCIAL EFFECTS

It is estimated that 20 fishers (using 11 licences) were employed during 2001 on Pilbara trawl fishing vessels, and 5 fishers (using 6 licences) in the trap fishery. The level of employment in line fishing is not assessed.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001): **$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 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 2001 was $7.4 million, with a retained by-product valued at $300,000. 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 approximately $1.1 million (trap) and $500,000 (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 North Coast Shark Fisheries Status Report (pp. 92–94) and the Spanish Mackerel Stocks Status Report (pp. 87–91) respectively.

The catches from these 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 1999. In the trawl fishery, due to effort reduction, there have been decreases in catch over the last four years, and the acceptable catch range has been determined from the relationship between more recent catches and fishing effort. The effort allocation in the trawl and trap fisheries for 2001 indicates a catch range of 1,900–2,200 tonnes for trawl and 150–300 tonnes for trap. The trawl catch in 2001 is slightly above the upper limit of the defined range, apparently as a result of of fleet consolidation which has seen the more efficient vessels forming a larger proportion of the total.

Following this consolidation of the trap and trawl fisheries into a smaller number of dedicated operators in 2001, it would be beneficial to set an effort level which could be left unadjusted for several years. If this were to occur, there would first need to be appropriate downward adjustment to the allocated effort in the trawl and trap sectors. The increased line catch of goldband snapper is also a cause for concern, noting that the line sector does not have a set effort allocation.

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 in tonnes (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 2001.

		FISH TRAWL CATCH		TRAP CATCH		LINE CATCH		TOTAL CATCH
		tonnes	%	tonnes	%	tonnes	%	tonnes
Red snapper	*Lutjanus erythropterus*	365	89%	35	9%	9	2%	409
Blue spot emperor	*Lethrinus hutchinsi*	318	88%	43	12%	-	-	361
Threadfin bream	Nemipteridae	228	100%	-	-	-	-	228
Goldband snapper	*Pristipomoides multidens*	122	66%	26	14%	38	20%	186
Flagfish	*Lutjanus vitta*	171	98%	4	2%	-	-	175
Scarlet perch	*Lutjanus malabaricus*	88	74%	21	18%	9	8%	118
Red emperor	*Lutjanus sebae*	74	69%	30	28%	4	3%	108
Spangled emperor	*Lethrinus nebulosus*	24	36%	34	52%	8	12%	66
Rankin cod	*Epinephelus multinotatus*	19	43%	21	48%	4	9%	44
Frypan snapper	*Argyrops spinifer*	42	98%	1	2%	-	-	43
Other demersal scalefish		711	90%	51	6%	27	4%	788
All demersal scalefish		**2,221**	**86%**	**266**	**10%**	**99**	**4%**	**2,586**
Shark and ray		73	38%	0		117*	62%	190
Other byproduct		77	100%	0		0		78

* Includes the North Coast Shark Fishery catch.

PILBARA TABLE 2

Summary of reported commercial catches (tonnes) of demersal scalefish by line, trap and trawl in the Pilbara fishery, as well as by-product from the fish trawl fishery.

YEAR	DEMERSAL SCALEFISH				BY-PRODUCT*
	Line	Trap	Trawl	Total	Trawl
1985	180	168	-	348	-
1986	65	113	-	178	-
1987	67	192	3	262	-
1988	136	243	3	382	-
1989	104	457	124	685	-
1990	157	407	421	985	4
1991	107	119	754	980	14
1992	63	148	1,413	1,624	21
1993	67	178	1,724	1,969	42
1994	79	207	2,506	2,792	102
1995	95	222	2,821	3,138	77
1996	136	302	3,201	3,639	102
1997	109	234	2,630	2,973	133
1998	78	250	2,512	2,840	119
1999	50	371	2,136	2,419	69
2000	59	257	1,995	2,314	80
2001	**99**	**266**	**2,221**	**2,592**	**150**

* 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**

PILBARA TABLE 4

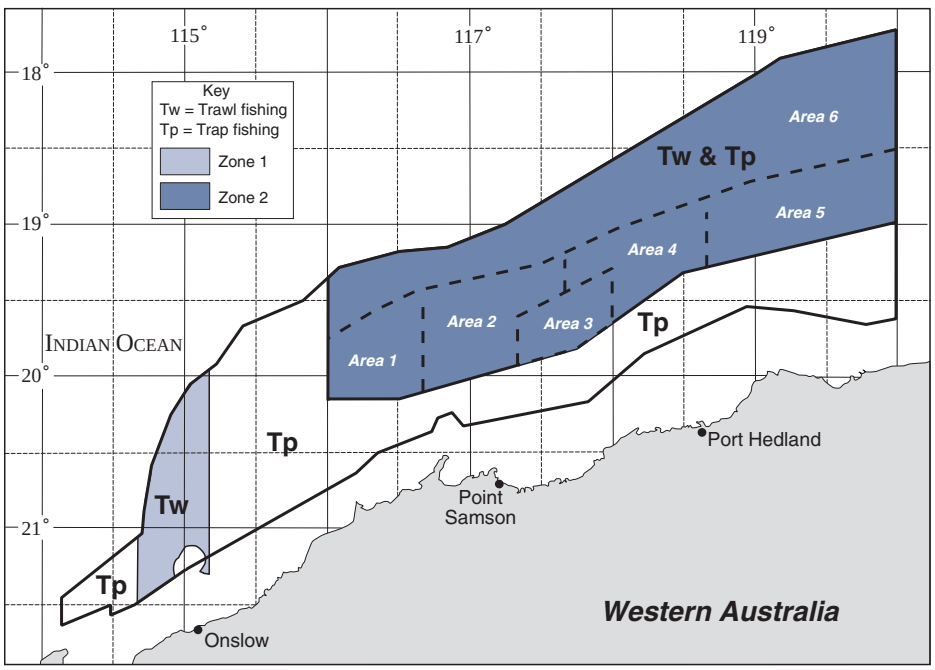
The number of hours allocated, the number of hours used and the percentage of the allocation used in each area of the Pilbara trawl fishery.

		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	5,198	23,096
TRAWL	time used	9,438	3,928	0	3,358	4,476	21,199
	% of time used	82%	117%	-	110%	86%	92%
2001	**time allocation**	**10,624**	**3,797**	**0**	**3,528**	**5141**	**23,090**
TRAWL	**time used**	**10,428**	**4,091**	**0**	**3,644**	**4819**	**23,000**
	% of time used	**98%**	**108%**	**-**	**103%**	**94%**	**100%**

PILBARA TABLE 5

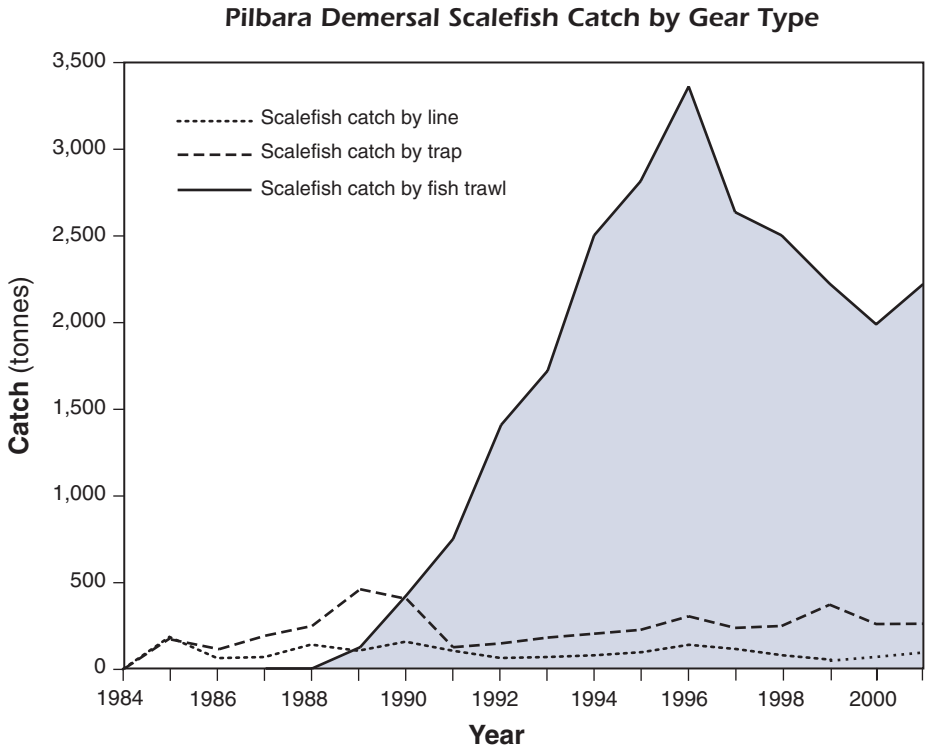
The number of days allocated, the number of days used and the percentage of the allocation used in the Pilbara trap fishery.

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



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

Catches of demersal scalefish (tonnes) in the Pilbara fishery by trap, line and trawl.

MACKEREL FISHERY

Management Summary

Fishing for Spanish mackerel, under the general wetline access available to all Western Australian licensed commercial fishing boats, was reported by 72 boats during 2001. Although most of these catches were made opportunistically by boats operating within other fisheries, there were about 10 boats which specifically targeted mackerel. Owing to concerns over increased catches and evidence to suggest that the species may be in danger of over-fishing, an interim management plan (IMP) was examined by a Mackerel Independent Advisory Panel, which has made recommendations to the Executive Director on criteria for access to and management arrangements for the mackerel fishery. It is expected that management arrangements will be put in place during 2002/03.

Currently, the capture of Spanish mackerel by commercial and recreational fishers is subject to a minimum legal size of 900 mm total length.

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

Research Summary

The narrow-barred Spanish mackerel, *Scomberomorus commerson*, is the main target species in the Western Australian mackerel fishery and has been the focus of two recent research projects. Results from these studies, which include a joint WA/NT/Qld FRDC-funded project to determine the stock structure of Spanish mackerel in northern Australia and a stock assessment of Spanish mackerel in Western Australia, should be available by the end of 2002. The stock assessment project involves the gathering of biological information and analysis of catch and effort data for the commercial fishery. With the aid of fisheries models these data will be used to determine the status of mackerel stocks in Western Australian waters and 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, based primarily on data for Spanish mackerel.

SPANISH MACKEREL STOCK STATUS REPORT

Prepared by M. Mackie

FISHERY DESCRIPTION

Boundaries and access

Spanish mackerel are widespread throughout the Indo-West Pacific. In Western Australia, they are fished commercially from Geraldton north to the Northern Territory border. 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. Fishers have also reported mackerel 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. It is also likely that Spanish mackerel migrate along the coast, although preliminary results from the stock structure project indicate that these movements are not extensive.

Based on methods used in the fishery and likely boundaries of the interim management plan, the mackerel fishery is reported in four sectors,

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 2001):
Spanish mackerel 389.9 tonnes
Other mackerel 56.0 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 (*Scomberomorus semifasciatus*) is the dominant by-product, particularly in the Gascoyne and west coast sectors where it is sometimes captured in large numbers. However, because fishing methods need to be modified in order to catch this species in quantity, it is essentially a separate fishery. Other by-products of Spanish mackerel fishing include school mackerel (*Scomberomorus queenslandicus*), 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 similar species are also netted by some fishers for use as bait in their mackerel fishing operations.

The reported catch of 389.9 tonnes of Spanish mackerel in 2001 comprised 179.3 tonnes from the Kimberley sector, 107 tonnes from the Pilbara sector, 70.5 tonnes from the Gascoyne sector and 33 tonnes 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*. Discussion with fishers indicates that the relatively low 2000 catch in the Kimberley region was mainly due to environmental effects on the seasonal abundance of mackerel. Reported catches in the west coast sector are usually minor, although a historic high of 33 tonnes was recorded in 2001. 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).

Annual catches of other species of mackerel, including grey, school, spotted and shark mackerel, are shown in Spanish Mackerel Table 1. Grey mackerel are sometimes captured in large numbers but are usually present in the fishery for only one or two months each year. This species, which makes up approximately 80% of the 'other mackerel' catch, is preferred over Spanish mackerel on the export market and is now caught in significant numbers in the Gascoyne sector. The large catches of other mackerel from 1988 to 1992 indicate that grey mackerel are also present in large numbers at times within the west coast sector. It has also become more targeted in the Pilbara sector although at present little is known about the distribution and abundance of this species in the north of the State. Annual fluctuations in the catch of other mackerel are thus mainly due to variability in the capture of grey mackerel, with catches of school and shark mackerel species making up approximately 7% each of this category. Catches of other mackerel in the Kimberley and Pilbara show significant year-to-year variability and, in contrast to catches of Spanish mackerel, were lower in 2001 than in 2000. This was also the case in the Gascoyne sector, whereas in the west coast sector catches of other mackerel increased substantially, from 4 tonnes in 2000 to 11.5 tonnes in 2001.

Fishing effort

The commercial fishing effort recorded in the CAES database for the 2001 season, by sector, was as follows:

Kimberley sector	9 boats	573 days
Pilbara sector	17 boats	475 days
Gascoyne sector	32 boats	1,200 days
West coast sector	29 boats	835 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 39 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. This data does not therefore provide a true indication of the effectiveness of fishing effort, as it contains considerable latent effort. Initiation of a fishery-specific logbook once the fishery becomes more structured under the IMP will provide more reliable data on real mackerel fishing effort.

Monthly patterns of fishing effort are similar to those for catches; 83% of the annual fishing effort by all vessels within the Kimberley sector for the period 1990–2001 (data pooled) occurred between June and October, with a peak of 21% in August. In the Pilbara sector for the same period, 65% of the fishing effort occurred from July to August (peak of 21% in August); in the Gascoyne sector 85% of effort occurred from May to August (peak of 31% in July), and in the west coast sector 71% of effort occurred from March to June (peak of 21% in May). These data highlight the strong seasonality of mackerel catches, with the decreased peak in the Pilbara sector reflecting a more prolonged mackerel fishing season than in other sectors. The data also show that peak catches occur earlier in the south than in the north of the State.

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. In addition, these data have been standardised to allow for changes in fisher experience, for the introduction of dories, GPS and faster vessels, and for change in catchability of mackerel with the use of lighter lines. The data provided here and in Spanish Mackerel Figure 2 may therefore differ from data provided in previous years. Because of restricted boat numbers, the data for the Gascoyne and west coast sectors have also been pooled.

There is little data for reliably assessing catch rates in the Kimberley sector until 1985. Since this time catch rates have varied between 124 kg/day and 196 kg/day (average 152 kg/day), and generally exhibit a slight rising trend with 169 kg/day captured in 2001. Prior to 1990 catch rates in the Pilbara sector fluctuated significantly, reaching a low in 1988 of 43 kg/day. Since 1990 catch rates in this sector have continued to rise, particularly after 1996, with 217 kg/day recorded in 2001 (Spanish Mackerel Figure 2). Catch rates in the combined west coast/Gascoyne sector are lower than in the northern sectors and exhibit more of a cyclic pattern, with the highest catch rate recorded in 1979 (126 kg/day) and the lowest in 1992 (20 kg/day). In 2001 the catch rate was 85 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 for the Broome area obtained during the Pilbara survey also provide an estimate of recreational catches for that part of the Kimberley sector. In the west coast sector during 1996/97 12.9 tonnes of Spanish mackerel (45% of the total recreational/commercial catch) and 0.4 tonnes of other mackerel (12% of the total catch) were taken, whilst in the Gascoyne region during 1998/99 51 tonnes of Spanish mackerel (45% of the total catch) and 8.1 tonnes of other mackerel (25% of the total catch) were captured. Recreational catches in the Pilbara sector during 1999/2000 comprised 20.5 tonnes of Spanish mackerel and 10.2 tonnes of other mackerel (16% and 37% of the total catch respectively), whereas in the Kimberley sector during the same survey 2.7 tonnes of Spanish mackerel and 0.4 tonnes of other mackerel were captured (2% of the total catch for each of the mackerel categories). Note that these recreational catch data are spatially comparable with commercial catch data presented in this report and include data for mackerel that were taken by sharks before being landed. The data do not include fish that were caught and released (up to 50% of captures), although mortality of these fish may be high because mackerel do not recover well from capture.

Reported catches of Spanish mackerel by recreational charter vessels have been relatively minor since 1990, ranging between 0.8 and 3.1 tonnes per year (mean = 1.8 tonnes), with 0.9 tonnes recorded during 2001. Most (80–100%) of the charter catch was taken in the Gascoyne and Pilbara sectors.

Stock assessment completed: **Yes**

Initial assessment of Spanish mackerel stocks has been made using catch and effort data, biological information, and biomass dynamics and yield-per-recruit modelling. Biological attributes of fast growth and young age at sexual maturity (< 2 years) indicate resilience to fishing pressure by Spanish mackerel. However, because individuals also become susceptible to fishing at an early age, are likely to be more site-attached than previously thought, and form aggregations that can be targeted by fishers, the species should be managed in a conservative manner. Aggregating behaviour also causes bias in the catch rate data used as an index of abundance, further necessitating a cautious approach to management.

Biomass dynamics modelling was only appropriate for the southern region (combined west coast and Gascoyne sectors) as there was insufficient contrast in the catch and effort data for the other sectors. The estimated carrying capacity (K) for Spanish mackerel in the southern region is estimated to be 1,115 tonnes (95% CI = 757–2,116 tonnes) whilst the estimated biomass in 2001 was 913 tonnes (95%

CI = 580.5–1,417 tonnes). The combined recreational and commercial catch for the southern region during 2001 was approximately 20% of the 2001 biomass estimate. Yield-per-recruit analyses indicate that the appropriate fishing mortality for this species ($F_{0.2}$ at maximum YPR) is approximately 0.2 in the Pilbara and Gascoyne sectors, and 0.3 in the Kimberley sector, suggesting the need for conservative management in the Pilbara and Gascoyne sectors. Current fishing mortality is likely to be similar to or slightly above these target levels. The information available to date therefore indicates that stocks of Spanish mackerel in Western Australia are healthy, although a cautious approach is needed. Insufficient data is 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 was 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 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: **Not assessed**

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects **Negligible**

The fishing methods used in this fishery have minimal impact on the habitat.

SOCIAL EFFECTS

Approximately 72 people were employed catching Spanish mackerel during the 2001 mackerel fishing season. This estimate is based on those boats recording significant catches of Spanish mackerel (> 500 kg in the Gascoyne, > 1000 kg in the Pilbara and Kimberley). The average number of crew on each boat (2 per boat in the Gascoyne and Pilbara, 4 per boat in the Kimberley) was then pooled to determine overall employment. This estimate does not consider employment of fishers in the west coast sector or of fishers catching minor amounts of mackerel in other sectors, as they are considered employees of other fisheries. For many of the fishers included as employees of the mackerel fishery, the duration of employment is only about six months each year.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001):
Spanish mackerel $2.2 million
Other mackerel $300,000

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: **249–358 tonnes**

Acceptable catch ranges for the individual sectors are Kimberley 110–165 tonnes, Pilbara 80–110 tonnes, Gascoyne 50–70 tonnes and west coast 9–13 tonnes. These acceptable catch ranges are based on historic catch trends and may be changed when the interim management plan is introduced or when the processes controlling recruitment variability in Spanish mackerel are better understood.

Reported catches during 2001 in the west coast sector were well above the acceptable catch range for this region. However, as these catches appear due to high recruitment rather than significant increases in fishing effort, they are not considered a threat to the ongoing sustainability of the resource. Catches within the other sectors were either within (Pilbara) or slightly above (Kimberley and Gascoyne) the respective acceptable catch ranges. Catches outside the acceptable catch range in the Gascoyne and Kimberley sectors are not of immediate concern given the variability of catch and effort, which are yet to be controlled under a management framework.

EXTERNAL FACTORS

Spanish mackerel and associated species are important commercial and recreational species, and implementation of the interim management plan will provide timely regulation of the commercial fishery that is needed for the long-term conservation of these fish. This is agreed in principle by industry, although there is considerable debate about the type of management that is needed. As a consequence there have been delays to implementation of the IMP and it is unlikely to be operational during the 2002 season. Ongoing cooperation between Department of Fisheries research staff and mackerel fishers will be essential under the IMP to ensure information needed to monitor the status of the fishery is obtained.

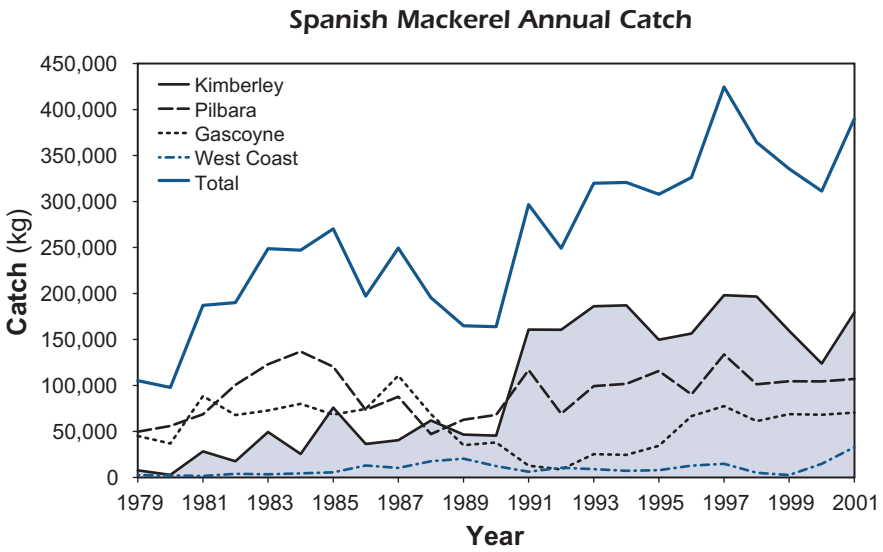
The recreational fishery for Spanish mackerel also requires assessment as this is a growing sector which takes a significant proportion of the mackerel catch. Such an assessment will need to examine the usefulness of current minimum size limits and bag limits, since research fishing and tagging experience suggests that the survival of released fish is low.

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.

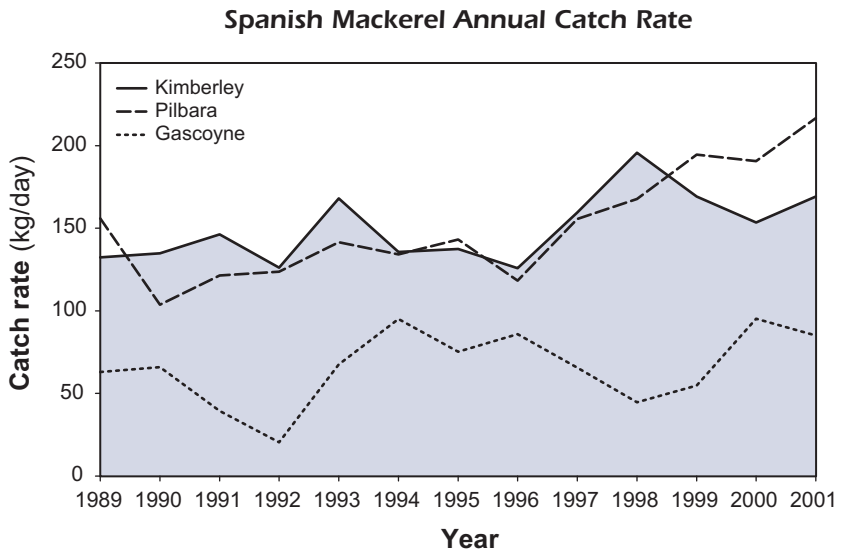
YEAR	SPANISH MACKEREL (tonnes)					OTHER MACKEREL (tonnes)				
	Kimberley*	Pilbara	Gascoyne	WC	Total	Kimberley	Pilbara	Gascoyne	WC	Total
1980	2.8	56.0	36.9	2.2	97.9	0.0	8.6	2.1	0.0	10.8
1981	28.3	68.7	88.5	1.7	187.2	1.9	0.4	0.1	0.1	2.5
1982	17.6	100.7	67.8	4.0	190.1	3.3	3.6	11.8	1.2	19.9
1983	49.5	123.0	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**

* Catches by Taiwanese gillnet fishers of approximately 5–90 tonnes per year (mean approx. 50 tonnes) between 1980 and 1986 (Stevens and Davenport 1987) 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.

NORTH COAST SHARK FISHERIES

Management Summary

Joint Authority Northern Shark Fishery (JANSF): The taking of shark between 123°45' E (Koolan Island) and the WA/NT border (and to the limit of the Australian Fishing Zone) is controlled by a joint authority arrangement between the Commonwealth and the State of Western Australia under State law. In this arrangement the State is given control of the JANSF on behalf of the Joint Authority.

The Offshore Constitutional Settlement arrangement set down in February 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) are to be managed by the Joint Authority in the JANSF. The Department is currently reviewing the JANSF with the view to updating the management arrangements.

WA North Coast Shark Fishery (WANCSF): The Western Australian-controlled sector of the northern shark fishery is managed by orders under section 43 of the *Fish Resources Management Act 1994*. The orders were first gazetted in May 1993 and cover the taking of shark in all waters off the north coast, from longitude 114°06' E (North West Cape) to 123°45' E with shark longlines and shark droplines using powered hauling gear. Those permitted to fish in the WANCSF with shark gear do so under a fishing boat licence condition and are permitted to use longlines and droplines with metal traces.

The State's shark fisheries are currently undergoing the ecological sustainability assessment process. An initial risk assessment workshop was held in April 2002 and a draft report will be available for comment from Environment Australia in early 2003.

In January 2002 the WA Demersal Gillnet and Demersal Longline Fisheries Management Advisory Committee, which formerly advised only on the management of the southern shark fisheries, was restructured to include a representative of the northern fisheries, and renamed the WA Demersal Net and Hook Fisheries Management Advisory Committee.

There is a lack of knowledge regarding the dynamics of the large number of target shark species in these fisheries, largely as a result of low fishing activity. The paucity of knowledge on northern shark species is not a problem unique to Western Australia, and to address this concern the Department of Fisheries is part of a collaborative shark research project involving a number of agencies across northern Australia, including CSIRO and the Northern Territory and Queensland fisheries agencies.

Governing Legislation/Fishing Authority
Fisheries Notice no. 476 (Section 43 order)
Fisheries Notice no. 602 (Section 43 order)
Fisheries Notice no. 601 (Section 43 order)
Condition 127 on a Fishing Boat Licence

Consultation Process
WA Demersal Net and Hook Fisheries Management Advisory Committee
Department–industry meeting

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 has been prepared based on CAES data from industry and a knowledge of tropical shark stocks from preliminary research data and the scientific literature.

NORTH COAST SHARK FISHERIES STATUS REPORT

Prepared by R. McAuley and R. Lenanton

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 2000/01, two vessels reported using gillnets in the JANSF.

RETAINED SPECIES

Commercial production (season 2000/01): 272 tonnes

Landings

This total shark catch of 272 tonnes included 79 tonnes of sandbar sharks. In 2000/01, the northern shark fisheries also retained 10 tonnes of finfish species. For a more detailed breakdown of catch species composition, see North Coast Shark Table 1. Annual catches since 1994/95 are shown in North Coast Shark Figure 1.

In addition to the catch by the two dedicated fisheries, sharks are also caught by other user groups. During 2000/01, 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 totalling 83 tonnes. A further 'wetline' catch of 19 tonnes of shark and ray was taken by vessels without access to managed fisheries.

Fishing effort

Effort has not been reported in previous years, as the accuracy of CAES data from the northern shark fisheries was uncertain. Since August 2000, Department of Fisheries research staff have been working closely with the full-time operators in the northern shark fisheries and the standard of catch and effort reporting is now considered to be good. The standardised effort measure used (hook hours) is the number of longline hooks multiplied by the number of fishing hours.

In 2000/01, the total fishing effort was 1,210,606 hook hours expended by 9 vessels, which represents an increase of 12.9% over the previous year (North Coast Shark Figure 2). The majority of effort was concentrated in the region between North West Cape and Broome. Given the continued high value of shark fins and the introduction of additional full-time vessels, effort in this fishery is likely to rise further in coming years.

Catch rate

The catch rate data (North Coast Shark Figure 2) indicate that there is no overall trend in abundance in the tropical shark stocks over the period since 1994/95.

Recreational component: **Not assessed**

Stock assessment completed: **Not assessed**

A preliminary stock assessment of the fisheries' main target species, the sandbar shark, *Carcharhinus plumbeus*, should be completed next year.

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

NON-RETAINED SPECIES

Bycatch species impact: **Low**

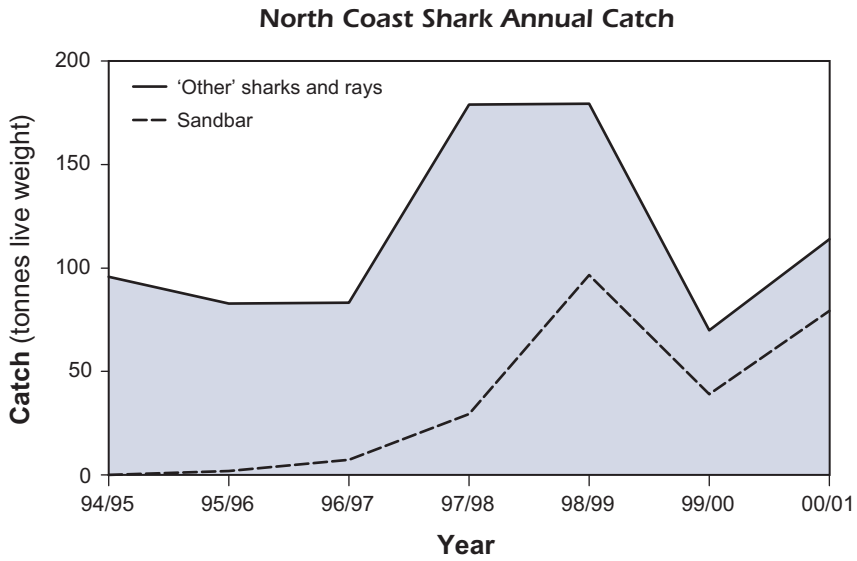
The fisheries have some scalefish catch which is generally retained for sale. There is some discarded bycatch of unsaleable species of sharks, stingrays and scalefish which preliminary ESD assessment has rated as a low to negligible risk to those stocks.

Protected species interaction: **Low**

The longline and dropline methods used in the northern shark fisheries have been rated as having a generally low risk of interacting with protected species. Given the current low level of pelagic gillnet effort in the fisheries (see 'Main fishing methods'), the risk of interaction with protected species such as dolphins by this method is also considered to be low.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**



NORTH COAST SHARK FIGURE 1

Annual landings for the north coast shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2000/01.

Habitat effects: **Negligible**

The principal types of fishing gear (dropline and longline) are set so that they are only in intermittent contact with the seabed, and their physical impact on the seabed is minimal.

SOCIAL EFFECTS

Estimated employment in the northern shark fleet during 2000/01 was approximately 25 fishers.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000/01): $900,000

The combined value of the catch from the two managed sectors was approximately $900,000 (including the estimated value of shark fins). During the 2000/01 season, shark fins maintained their value of between $25 and $120/kg, depending on fin size and species. 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 conservatively estimated using a price of $60/kg (the high value reflecting the generally larger sharks caught in this fishery). Categories of shark which do not have saleable fins were excluded from fin valuation.

FISHERY GOVERNANCE

Acceptable catch range: **Not assessed**

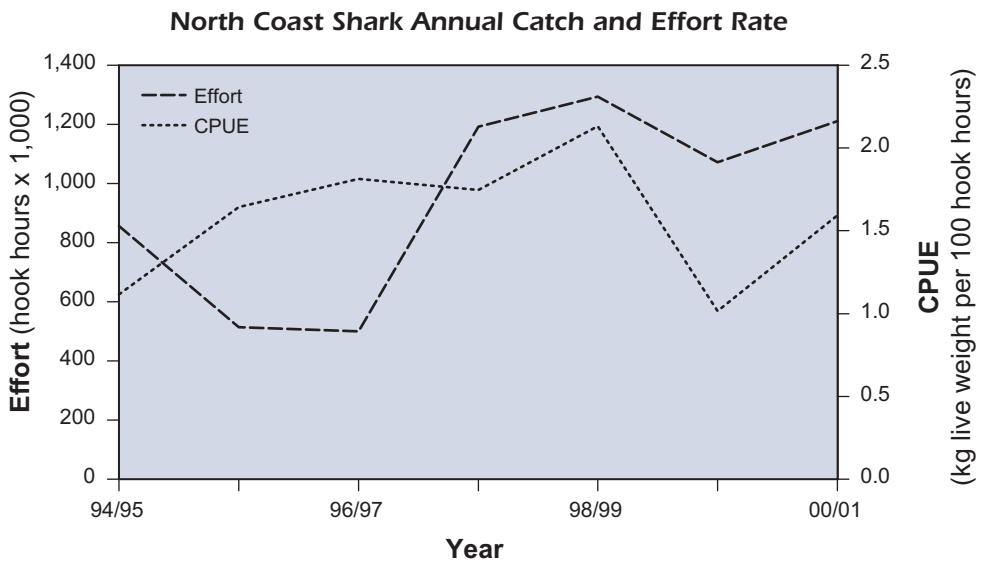
EXTERNAL FACTORS

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 difficult, particularly for the minor species in the catch.

NORTH COAST SHARK TABLE 1

Catch species composition for the north coast shark fisheries (WANCSF and JANSF), 2000/01.

SPECIES		CATCH (tonnes)
Elasmobranchs		
Sandbar (thickskin) shark	*Carcharinhus plumbeus*	79
Blacktip shark	*Carcharinhus* spp.	47
Tiger shark	*Galeocerdo cuvier*	34
Pigeye shark	*Carcharinhus amboinensis*	29
Hammerhead shark	Sphyrnidae	23
Lemon shark	*Negaprion acutidens*	15
Bronze whaler shark	*Carcharinhus obscurus*	9
Grey reef shark	*Carcharinhus amblyrhynchos*	7
Skates and rays		4
Shovelnose rays		3
Other sharks		22
Scalefish		
Red emperor	*Lutjanus sebae*	3
Rankin cod	*Epinephelus multinotatus*	2
Mackerel (unspecified)		1
Other scalefish		4



NORTH COAST SHARK FIGURE 2

Annual catch and effort rates for the north coast shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2000/01.

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 deep-water crabs, as well as western rock lobsters in the Augusta area. There is also a commercial fishery operating in the various estuaries of the south coast. A trawl fishery for scallops has been active in recent years, but activity was at a lower level in 2001/02.

A key management step in 2001/02 was the introduction of new management arrangements for the South Coast Estuarine Fishery. The South Coast Estuarine (Interim) Management Plan 2001 was gazetted in January and will come into force on 1 July 2002. This interim management plan is the result of extensive consultation amongst all user groups and recognises the interests of all stakeholders whilst ensuring a viable sustainable fishery on the south coast waterways. The invitational period of the Voluntary Fisheries Adjustment Scheme for this fishery closed on 17 May 2002.

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. An ecological sustainability report to Environment Australia is being developed for submission early in 2003 and a risk assessment workshop was conducted as part of that process.

There was an increase in vessels targeting deep-sea crabs on the south coast and the Department is considering formalising management arrangements for this area. One option being considered is combining all of the arrangements for the rock lobster and deep-sea crab fisheries into a 'South Coast Crustacean Managed Fishery'. This would essentially manage rock lobster and deep-sea crab stocks along the south coast in a number of zones, which will closely match current managed fishery boundaries and use the number of rock lobster pot entitlements as the basis for unitising the deep-sea crab fishery.

The 'wetline' fishery in the south coast bioregion is the smallest of the regional wetline fisheries. The primary activities are inshore gillnetting and beach seining.

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 licences, catch and fishing gear, and land-based inspections of catch, fish processing factories, retail outlets and catch consignment deliveries. 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 6.5 m patrol vessel to conduct inshore at-sea inspections, while a dedicated large patrol vessel (> 20 m) is deployed from other regions to carry out offshore work. In addition to work conducted by District-based staff, a Serious Offences Unit conducts investigations into serious fishery offences on a needs basis.

Activities during 2000/01

During 2000/01, Department of Fisheries Regional Services personnel undertook 5,044 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, aquaculture compliance, and duties concerned with fish habitat protection. Around 40% of these hours comprised duties performed in commercial abalone compliance, with the remainder worked in the wide range of minor commercial fisheries operating in the bioregion. Minor fisheries of particular focus included the fishery for Australian salmon and the estuarine fishery.

Between January and June 2001, Fisheries Officers recorded 225 field contacts with commercial fishing operations and 454 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, 3 infringement warnings and 5 infringement notices were issued, and a further 5 cases resulted in prosecution of commercial fishers.

Turning to specific fisheries, the abalone fishery on the south coast continued to require a high level of compliance monitoring. Breaches of regulations detected in 2000/01 related to non-compliance with rules covering annual quota management, non-completion of catch and disposal records, and the unlicensed take and sale of abalone. Poaching activity by unlicensed operators conducting illegal commercial operations continued to be a significant issue within this fishery.

The Serious Offences Unit was again used during the year to target illegal abalone sales. Two major prosecutions of unlicensed commercial-level operators occurred, and investigations into other suspected offenders are continuing. The media attention given to the high fines and penalties imposed for these offences ensures that the general public is aware of the activities of fish thieves, and serves as a deterrent to other thieves. In addition to the cases of unlicensed operators reported above, three prosecutions were initiated for commercial abalone offences during 2000/01, and one other matter is currently under consideration.

There was a high level of compliance activity in the seasonal Western Australian salmon and herring fisheries, including beach inspections for block nets, checking commercial licences, and compliance by the public with regard to activities within the designated fishing zone boundaries.

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 2000/01 financial year.

CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	5,044
Fisher field contacts by Fisheries Officers (6 months)*	225
District Office contacts by Fisheries Officers (6 months)*	454
Fishwatch reports **	34
OFFENCES DETECTED	
Infringement warnings	3
Infringement notices	5
Prosecutions	5

* These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

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

Recreational/commercial conflict in relation to beach-based activities continued to be an issue for the salmon fishery, particularly with respect to the designated fishing zones. Fisheries Officers continued to conduct a public education program during the salmon season.

Compliance within the South Coast Estuarine Fishery was generally good, although some complaints were received regarding fishers continuing to operate nets beyond the daytime set net closure times. These instances sometimes occur because of breakdowns or larger than expected fish catches that result in a delay in clearing fish from the nets. Fisheries Officers monitor licences, gear restrictions, closed-water areas, fish size limits and setting and retrieval limits in this fishery.

Compliance monitoring activities undertaken in the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery include monitoring the use of time/gear units and net lengths. Some commercial/recreational/general community conflict continued in certain areas of the fishery, but liaison by Fisheries Officers with community and industry has assisted each sector to develop a better understanding of the other sectors' concerns and needs.

In the South Coast Purse Seine Managed Fishery, the closures and associated regional effects resulting from the pilchard mortality events required more time to be spent on liaison with fishers, processors and the general community, rather than on specific monitoring and enforcement work, though the small research quota introduced in May and June 2001 required some oversight.

Overall, the main area of concern within the bioregion relates to illegal sale of fish by unlicensed individuals or organised groups, primarily in the abalone fishery, although the problem is also known to occur in the rock lobster, crab and finfish fisheries and at certain times of the year with squid and octopus.

Some concerns have also been reported from the commercial rock lobster and deep-sea crab fisheries regarding potential over-potting and the maintenance of zone boundary restrictions. Unfortunately, resources do not permit a high degree of at-sea monitoring of these fisheries.

Initiatives in 2001/02

Funding of the compliance program for the commercial abalone fishery has historically proved a difficult management issue, with differences in viewpoint between industry and the Department on required levels of compliance activity to adequately police the fishery. Discussions with industry undertaken in January 2002 regarding future funding have led to mutually agreed arrangements for the next two years. With careful planning, these arrangements will ensure adequate compliance coverage for this valuable resource and provide a consistent deterrent effect for those wishing to break fishery rules.

In response to concerns regarding compliance with gear restrictions in the Southern Demersal Gillnet and Demersal Longline Managed Fishery, a compliance program involving on-board inspections of fishing equipment has been initiated in 2001/02. Most of the commercial vessels inspected were found to be compliant with the fishery regulations, although some individuals were found to be using nets in excess of their allocated length.

Finally, a new management plan for the South Coast Estuarine Fishery will come into effect in July 2002, and Fisheries Officers are planning an education campaign to inform stakeholder groups about important changes to the regulations.

REGIONAL RESEARCH OVERVIEW OF WETLINE FISHING

The CAES database indicates that a small proportion (7%) of the wetline catch in 2000/01 was reported from the south coast bioregion. The top ten species comprised hapuku (*Polyprion oxygeneios*) 21 tonnes, redfish (*Centroberyx affinis*) 20 tonnes, pink snapper (*Pagrus auratus*) 19 tonnes, gummy shark (*Mustelus antarcticus*) 14 tonnes, samson fish (*Seriola hippos*) 12 tonnes, trevalla (*Hyperglyphe antarctica*) 11 tonnes, Australian herring (*Arripis georgianus*) 10 tonnes, cod (Serranidae) 64 tonnes, queen snapper (*Nemadactylus valenciennesi*) 6 tonnes and squid (4 tonnes). Fisheries along the south coast are concentrated around Albany, Bremer Bay and Esperance. Hapuku and redfish are targeted in deeper waters off 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. A maximum pot entitlement of 10 pots per metre applies to any boat and there is a restriction of 90 pots on the overall pot entitlement on any licence. 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 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'.

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

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 (ERLMF) 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 2000/01, 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 2000/01, 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 2000/01): 79 tonnes

Landings

A catch of 40 tonnes of southern rock lobsters was taken in the ERLMF in 2000/01, an increase of 7% on the catch taken in the 1999/2000 season (38 tonnes). The combined catch for the GAB and Albany southern rock lobster fishery zones in 2000/01 was 39 tonnes, an increase of 25% on the 1999/2000 figure (31 tonnes). Catches in the Albany zone decreased from 8 to 7 tonnes, but in the GAB zone of the fishery catches increased from 23 to 32 tonnes. As a by-product of the rock lobster fishery, 5 tonnes of giant crabs (*Pseudocarcinus gigas*) (an increase of 70%) and 14 tonnes of champagne crabs (*Hypothalassia acerba*) (unchanged from 1999/2000) were landed in the Albany zone, while 5 tonnes of giant crabs (an increase of 150% over the 1999/2000 figure) were landed in the ERLMF.

Fishing effort

The ERLMF experienced a 61% increase in nominal fishing effort levels, from 42,000 pot lifts in 1999/2000 to 67,000 pot lifts in 2000/01. Total effort for the Albany and GAB zones in the 2000/01 season was 115,000 pot lifts, an increase of 25,000 pot lifts (27%) on the previous season's 90,500 pot lifts. Fishing effort increased in the Albany zone from 33,700 pot lifts in 1999/2000 to 45,300 pot lifts in 2000/01, and in the GAB zone from 57,000 pot lifts in 1999/2000 to 70,000 pot lifts in 2000/01. Effort figures are confounded in the Albany zone, because an unknown amount of the effort recorded there may have targeted deep-water crabs rather than lobsters.

Catch rate

The catch per unit of fishing effort for the 2000/01 season in the ERLMF decreased by 33%, from 0.9 kg/pot lift in 1999/2000 to 0.6 kg/pot lift in 2000/01. The combined catch per unit of fishing effort for the GAB and Albany zones in the 2000/01 season was 0.34 kg/pot lift, similar to the 2000/01 season. Catch rates decreased from the 1999/2000 value in the Albany zone by 35%, from 0.23 to 0.15 kg/pot lift, and increased in the GAB by 10%, from 0.41 to 0.45 kg/pot lift.

Recreational component: **< 12%**

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 tonnes per year.

Stock assessment completed: **Yes**

Indications from a biomass dynamics model of the Western Australian portion of the southern rock lobster resource, and from a postal survey in which commercial fishers were asked to quantify the amount of available ground colonised by lobsters, suggest that the Albany and GAB zones are not suited to southern lobster colonisation. The survey of fishers showed that the Albany and GAB zones only have about 10% of the amount of ground available for lobster colonisation compared with what can be found in the optimal fishing areas inside the ERLMF. The Esperance area has a long history of sustained exploitation (South Coast Rock Lobster Figure 1) and model results, though inconclusive, would suggest that the virgin biomass for this part of the fishery was substantial (of the order of 400–1,000 tonnes) and in the face of exploitation remains reasonably solid (at around 350 tonnes). Model outputs show that the ERLMF fishery is stable at current annual catch levels of around 40 tonnes, as achieved in 2000/01, but not at the 60 tonne levels that were experienced in the early to late 1990s. There has been a substantial increase in effort in the recent season, for only a minimal increase in catch. One explanation for this may be that there is localised depletion occurring. However, an alternative explanation may lie in a change to the management arrangements. In the 2000/01 season, following a request from the majority of licence holders in this fishery, 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.

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 appears to have stabilised at around 7 tonnes, but effort has increased over this period of stabilisation. While superficially this suggests that the lobster stock in the Albany zone is being steadily depleted, the other possible explanation is that more effort is being directed at deep-water crab fishing in this multi-species crustacean fishery. 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 tonnes annually.

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 Western Australian 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. As 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 (2000/01): $2.8 million

The beach value of the southern rock lobster fishery was about $2.4 million in 2000/01, 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.

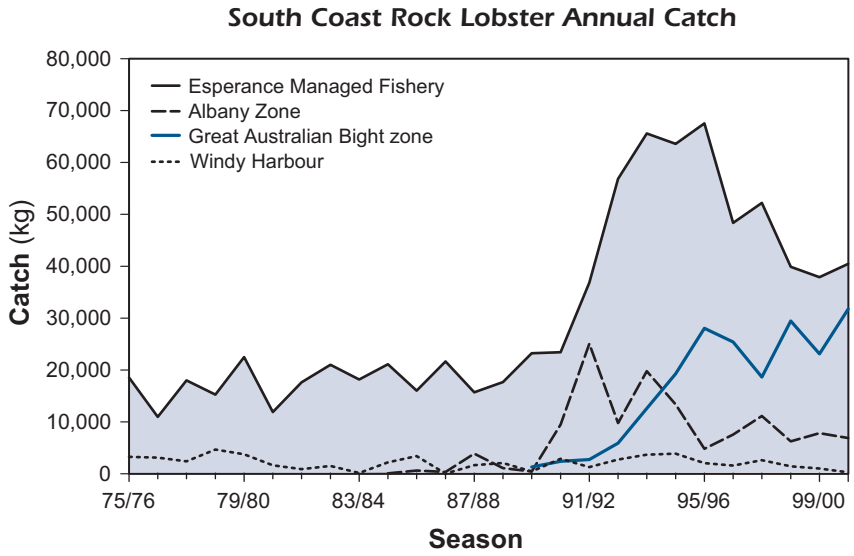
FISHERY GOVERNANCE

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 ERLMF 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 2000/01.

ABALONE MANAGED FISHERY

Management Summary

The Abalone Managed Fishery harvests three abalone species: greenlip abalone (*Haliotis laevigata*), brownlip abalone (*Haliotis conicopora*) and Roe's abalone (*Haliotis roei*). The large greenlip and brownlip abalone are confined to the lower south-west and south coasts of the State, while the smaller Roe's abalone are found in commercial quantities from the South Australian border to Shark Bay, although they are not uniformly distributed throughout this range.

The commercial abalone 'season' operates from 1 April each year to 31 March the following year. The fishery is divided into eight areas so that the spatial nature of the abalone stocks can be better managed. Total allowable catches are determined for each area in the fishery on an annual basis and units for an area are assigned a unit value based on the number of units in that area and the TAC. Every fishery licence is endorsed with a certain number of tradeable units of entitlement to a specific area or areas. Multiplying the number of area units on a licence by the unit value for that area indicates the weight of abalone that can be taken in that area by the holder of that licence (or their nominated operator). During 2001/02, the management plan was amended to allow the Executive Director to increase or decrease area TACs during the fishing season under certain circumstances.

Since a major management plan change in March of 1999, each licence in the fishery must be permanently endorsed with a minimum of 800 units for Roe's abalone and 450 units for greenlip/brownlip abalone. There are a number of licences, however, that are permitted to exist below the minimum unit holding level because these licences continue to be fished as they had been prior to the major management plan change.

Currently there are 42 current abalone licences, with 15 authorised to take greenlip/brownlip abalone and the remainder to take Roe's abalone. There is a total of 13,800 greenlip units, 2,300 brownlip units and 25,180 Roe's abalone units in the fishery. During 2001/02, fishermen were entitled to catch nearly 108 tonnes whole weight of Roe's abalone, 195 tonnes whole weight of greenlip abalone and 35 tonnes whole weight of brownlip abalone.

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.

Governing Legislation/Fishing Authority
Abalone Management Plan 1992
Ministerial Policy Guideline no. 10
Abalone Managed Fishery Licence

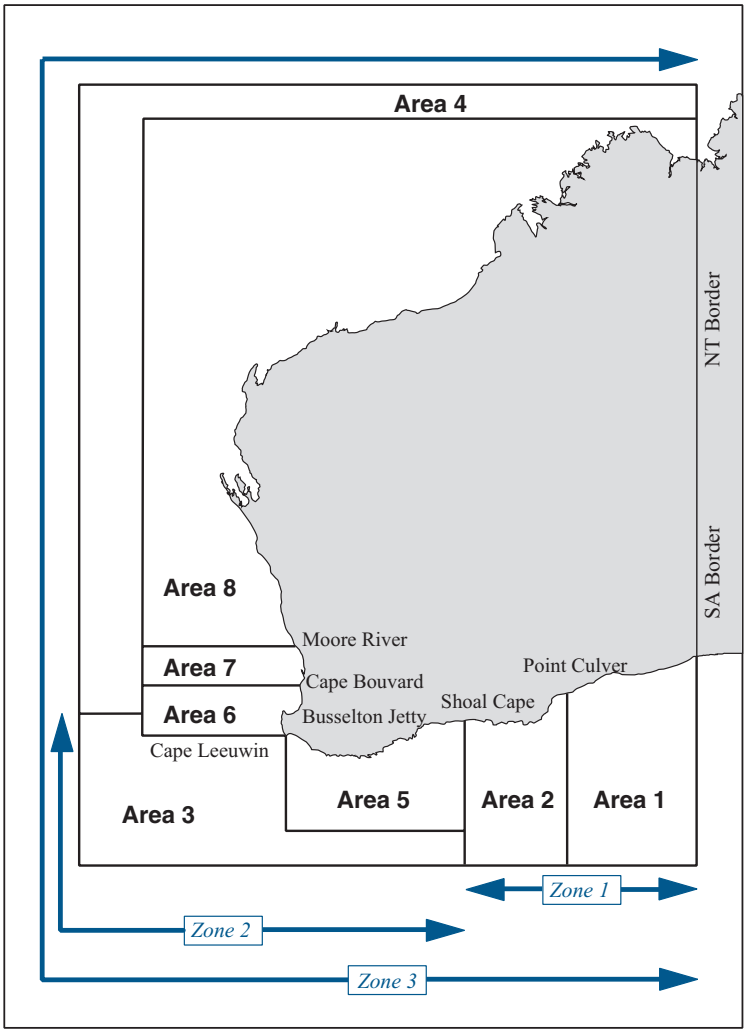
Consultation Process
Abalone Management Advisory Committee
Department–industry meetings

Research Summary

The 2001 quota period represents the third full season of abalone fishing under current management arrangements. Prior to 1999 the Abalone Managed Fishery was divided into three zones. Since 1999 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). The quota period for all areas of the Abalone Managed Fishery since 1999 has been 1 April to 31 March in the following year. (For simplicity, data is reported against the quota period for the year in which it began. For example, for the 2001/02 quota period, data will be reported as taken in the 2001 season.) Although the TAC in each area remains similar to what was previously taken when the fishery was divided into three zones, in some cases it is difficult to compare the current fishery information with historical data.

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, the mean size of abalone taken is monitored by examining the number of abalone caught for each consignment. For the Roe's abalone fishery, where the number of individual abalone is not recorded by divers, a similar measure is being developed using information from the abalone processors.

In addition to monitoring the stocks using industry data, the Department's research involves collaborative activities with divers to develop protocols to optimise production from stunted stocks occurring across the fishery. A collaborative project, due to start in the near future with funding support from FRDC, will involve research and industry divers using underwater video to collect data on density and size structure of abalone stocks.



ABALONE FIGURE 1

General map showing old zonal arrangements and new area management regime of the commercial abalone fisheries of Western Australia.

GREENLIP AND BROWNLIP ABALONE STATUS REPORT

Prepared by C. Skepper, B. Hancock, C. Syers 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.

Please note that, 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 2001 to 31 March 2002.

Main fishing method

Diving. Abalone divers operate from small fishing vessels (generally < 9 m).

RETAINED SPECIES

Commercial production (season 2001):

Greenlip 187.46 tonnes whole weight
Brownlip 31.09 tonnes whole weight

Landings

Catches are currently controlled by quotas, which during the 2001 season were 194.67 tonnes whole weight (73 tonnes meat weight) for greenlip abalone and 34.87 tonnes whole weight (14 tonnes meat weight) for brownlip abalone. The greenlip catch was estimated to be 187.46 tonnes whole

weight (70.3 tonnes meat weight) and the estimated brownlip catch was 31.09 tonnes whole weight (12.4 tonnes meat weight) for the 2001 season (Abalone Table 1). The combined catch was 2% lower than in 2000 and 5% below the quota as a result of catches below quota from Areas 1 and 2. Fishing conditions are particularly difficult in Area 1 (the Nullarbor fishery) and, historically, the full quota is not taken. The brownlip quota in Area 2 was under-fished by 3.7 tonnes whole weight (1.48 tonnes meat weight) owing to a voluntary reduction in the quota agreed on by the Area 2 licence holders.

Fishing effort

Total effort for 2001 was 1,259 days fished for greenlip and brownlip abalone, including 'fishdowns' (see 'Stock assessment' section below). This was greater than the effort in 2000 (1,173 days) but within the acceptable effort range of 1,110–1,520 days when adjusted to accommodate the reduced catch.

Catch rate

In 2001 the catch rate was 173.6 kg whole weight (65.7 kg meat weight) per diver day, or 169.6 kg whole weight (64.3 kg meat weight) per diver day excluding the fishdown catch and effort.

Recreational component (2001): **20–25% (approx.)**

Based on recreational telephone surveys, recreational fishing accounted for an estimated 23% of the combined commercial and recreational catch of greenlip and brownlip abalone in 2001. See Recreational Abalone Fishery Status Report, pp. 139–143.

Stock assessment completed: **Yes**

Presently greenlip and brownlip abalone stocks are assessed by analysing industry data from daily catch records, information from processors, fishers' monthly returns 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 (known as 'fishdowns'). This allows licence holders, under specific management conditions, to access stocks of under-size but mature abalone which have ceased to grow through limitations on food. This harvesting process allows improved growth of recruiting abalone, and has the flow-on effect of temporarily reducing fishing pressure on more heavily targeted, faster growing abalone stocks. Stunted populations are expected to be fished every three to five years, depending on the status of the stocks.

In Area 1 there are extensive, isolated populations of stunted greenlip abalone. The generally small size of these abalone (surveyed in 1974, 1994 and 2000) has limited catches from this part of the fishery, with less than 530 kg whole weight (200 kg meat weight) fished annually from 1994 to 1999. In 2000, exploratory fishing at Twilight Cove revealed that less than 5% of stocks were of legal size (140+ mm) and that stocks reaching legal size were localised to small areas. Fishing activity during the 2001 season was limited to a controlled fishdown which took place to the east of Twilight Cove at Scorpion Bight, resulting in 1.04 tonnes whole weight (0.39 tonnes meat weight) being landed.

In Area 2 there was a slight increase in the average meat weight recorded for non-stunted greenlip stocks in 2001 (179 g compared to 177 g in 2000). The Area 2 catch rate for non-stunted greenlip abalone stocks was 49.7 kg meat weight per day in 2001, decreasing from 54.6 kg meat weight per day in 2000. Catch rates fell despite a total of 12.8 tonnes whole weight (4.8 tonnes meat weight) of greenlip abalone being landed during a fishdown of stunted stock at Point Malcolm, which relieved fishing pressure (and effort) on traditionally fished stocks by reducing the catch from these areas by 12%. The effect of the 2001 season fishdown was somewhat offset by the fact that fishers voluntarily 'rested' traditional fishing grounds in the western sector of Area 2. As this region traditionally produces an average of around 12.5 tonnes whole weight (4.7 tonnes meat weight) of greenlip abalone and 2.5 tonnes whole weight (1 tonne meat weight) of brownlip abalone meat weight each season (1995–2000), the fishing pressure on areas outside the fishdown and the western sector effectively remained at normal levels. With fishdowns in Area 2 likely to be on a smaller scale after the 2001 season, the use of this option to relieve pressure on traditional stocks in the near future will be lessened. The average meat weight of brownlip abalone fell noticeably by 10 g to 249 g during the 2001 season, continuing a general declining trend since 1999 (when average meat weight peaked at 268 g). This occurred despite fishers voluntarily reducing the 2001 brownlip quota by 3.75 tonnes whole weight (1.5 tonnes meat weight) in response to concerns regarding falling average meat weights.

Area 3 has utilised a combination of temporary quota reductions and closures of the most productive locations in the recent past as a means of redirecting effort. In addition, raising minimum size limits (by industry agreement) has increased the average meat weight of greenlip abalone substantially since 1997. In 2001, the average meat weight for non-stunted greenlip abalone taken in Area 3 was 226 g. This was a slight decrease from the 231 g recorded in 2000, which was the highest average observed during the past decade. During the season the catch of greenlip from traditionally fished grounds was decreased 7.5% by fishing 8 tonnes whole weight (3 tonnes meat weight) of 'stunted stock' during a fishdown east of Hopetoun. Information on brownlip abalone stocks in this area is limited, as divers have in the past primarily targeted greenlip abalone. The quota for brownlip abalone in Area 3 was increased by 5 tonnes whole weight (2 tonnes meat weight) prior to the 2000 season to allow divers to target new areas for brownlip abalone. This increase was retained for the 2001 season, and average meat weights and diver catch records indicate that this approach has been effective. The average meat weight for brownlip abalone taken in 2001 was 274 g, similar to the 274.5 g recorded in 2000, which was the highest since 1995.

Exploitation status: **Fully exploited**

Breeding stock levels: ***Adequate***

Previous research has shown that greenlip abalone mature at between 70 and 90 mm shell length, and brownlip abalone mature at between 90 and 130 mm shell length, which are both well below the minimum size limits set across the fishery. 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, whereas within fast-growing portions of Area 3, fishers only take abalone exceeding 153 mm shell length. In addition, as maturity is age-related, many of the stunted stocks are making a contribution to the breeding stock at smaller sizes than indicated by the typical size at maturity.

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 (2001):
$11.7 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 $11.7 million. These prices were significantly lower than last year's values of $163/kg meat weight for greenlip and $132.50/kg meat weight for brownlip abalone.

FISHERY GOVERNANCE

Acceptable catch and effort range:
1,110–1,520 diver days for 229.54 tonnes whole weight

To be fished at a historically sustainable level, the 2002 quotas for greenlip abalone (194.67 tonnes whole weight, 73 tonnes meat weight) and brownlip abalone (34.87 tonnes whole weight, 14 tonnes meat weight) should be taken within the five-year range (1994–1998) of 1,110–1,520 diver days. The effort recorded in 2001 (1,259 days) was within this range. The mean (± SD) catch rate (based on total annual catch divided by days dived that year) within the five-year range was 154 ± 20 kg whole weight per day for greenlip/brownlip abalone (meat to whole weight conversion rate for greenlip abalone = 2.667). Although effort in number of days fished may vary due to variations in total catch in the more remote parts of the fishery and the use of fishdowns, the season's mean kg/day catch rates should not fall significantly below the average presented.

The Area 2 greenlip quota will remain at 80 tonnes whole weight (30 tonnes meat weight) in 2002, with a maximum of 64 tonnes whole weight (24 tonnes meat weight) of greenlip to be taken from traditional non-stunted stocks, and up to a maximum of 16 tonnes whole weight (6 tonnes meat weight) from stunted stocks. The Area 2 brownlip quota has been voluntarily reduced from 19.8 to 18 tonnes whole weight (7.92 to 7.2 tonnes meat weight) in response to the recent downward trends in meat weights. Fishing in Area 2 in 2002 (including the western sector) will operate under a Memorandum of Understanding between the Department of Fisheries and industry, which will provide for a series of in-season evaluations of sector performance in terms of average meat weight results for both abalone species against pre-determined historical means. These evaluations will take place as each sector reaches a defined level of catch, with fishing activity resuming after the evaluation if average meat weight criteria are met as specified in the MOU.

EXTERNAL FACTORS

In the last few years there has been a change in the normal operating procedure of the fishery, away from owner-operators to lease divers. This change has resulted in divers spending longer in the water for a day's fishing in an attempt to minimise fishing costs. This shift impacts on the assessment of effort in the fishery. In some locations in the abalone fishery there has also been an increase in the prevalence of divers targeting deeper-water stocks (> 30 m) that historically have contributed little to general catch. At present fishing depth is not recorded on the daily catch record. During 2000 a new industry catch reporting system, which is on a finer scale than previous systems, was initiated by the Department of Fisheries for all greenlip/brownlip abalone fishing areas. The data from this initiative permits more effective assessment of these increasingly valuable stocks, and will improve the reliability of management in the future.

Further assessment and supervised fishing of stunted stocks are planned for 2002 in Areas 1, 2 and 3. In addition, the Department of Fisheries in collaboration with the industry is continuing to develop new techniques for greenlip and brownlip abalone stock surveys using underwater digital video camera equipment.

ABALONE TABLE 1

Greenlip and brownlip abalone catch and effort by quota period.

QUOTA PERIOD	GREENLIP TAC kg whole weight	BROWNLIP TAC kg whole weight	GREENLIP CAUGHT kg whole weight	BROWNLIP CAUGHT kg whole weight	COMBINED CATCH kg whole weight	DIVER DAYS
1990	126,500	-	114,414	18,768	133,182	809
1991	148,500	-	131,266	14,660	145,926	1,145
1992	192,500	-	175,054	30,285	205,339	1,284
1993	197,450	-	178,794	31,155	209,949	1,347
1994	200,750	-	177,166	32,223	209,389	1,522
1995	187,264	-	151,863	27,263	179,126	1,327
1996	189,750	-	176,668	21,933	198,601	1,113
1997	207,350	-	187,993	26,298	214,291	1,259
1998	200,750	-	187,644	22,198	209,842	1,246
1999	189,750	28,000	180,620	27,673	208,293	1,121
2000	194,669	34,875	189,846	33,531	223,377	1,173
2001	**194,669**	**34,875**	**187,459**	**31,089**	**218,548**	**1,259**

Notes

1. Data source: quota returns.
2. Standard conversion factors for meat weight to whole weight for greenlip abalone were 2.75 prior to 2000 and 2.667 for 2000 and 2001. Brownlip abalone conversion factor for meat weight to whole weight was 2.5.
3. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.
4. 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.

ROE'S ABALONE STATUS REPORT

Prepared by B. Hancock, C. Syers and C. Skepper

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. Abalone divers generally operate from small fishing vessels (generally < 9 m), although on occasion they can approach stocks from the shore.

RETAINED SPECIES

Commercial production (season 2001):
99.2 tonnes whole weight

Landings

Catches are currently controlled by quotas, with the TAC for the 2001 quota year being 107.9 tonnes whole weight for Roe's abalone. The catch of 99.2 tonnes whole weight for the 2001 season (Abalone Table 2) was lower than the TAC as some stock in remote locations (primarily Area 1) remained unfished, and there was a voluntary catch reduction in Area 8 from 12 to 10 tonnes, initiated by industry due to concerns over the low abundance of legal-sized abalone.

Fishing effort

Total effort in 2001 was 719 diver days, which was less than the minimum defined in the acceptable effort range of 725–929 days for 107.9 tonnes TAC. It should be noted that the full quota was not taken, and that there were further voluntary reductions in Area 8, resulting in a lower effort requirement.

Catch rate

The Roe's abalone catch rate in 2001 was 137.93 kg whole weight per diver day.

Recreational component: **40–45% (approx.)**

The recreational catch estimates for 2001 were in the range 40–45% of the total Roe's abalone catch. See Recreational Abalone Fishery Status Report, pp. 139–143.

Stock assessment completed: **Yes**

Presently stocks of Roe's abalone are assessed by analysing industry data from the daily catch records, information from processors, fishers' monthly returns and data collected during specific research projects. Unlike greenlip and brownlip abalone, Roe's abalone are not counted by divers, so there are no data for assessing trends in the average meat weights within this fishery.

The assessment of Roe's abalone stocks uses daily catch records to review catch per unit effort and movement of catch and effort across the 10 x 10 mile grid reporting

system. These catch statistics indicate that the overall abundance has not changed substantially as the catch was fished in fewer days than was the case last year, at less than the acceptable effort range projected last season. Comparative assessments of changes in catches from particular locations beyond gross catch weight figures, for example by assessing changes in average meat weight, are needed to be able to monitor fluctuations in catches prior to any critical change in stock health. This information can be extracted from the details provided to abalone processors. The Fisheries Research Division is providing advice to industry and assisting with analysis of mean weight data collected during the 2002 season to assess the usefulness of this data set.

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, observations from divers suggested that the quota remained too high despite previous reductions. Recruitment in this area at the extreme end of the species range is not as consistent as in the central part of the fishery. The abundance of legal-sized Roe's abalone in this area has declined due to localised depletion of abalone exacerbated by inappropriate distribution of fishing effort by less experienced fishers, together with environmental factors outside of the control of the commercial fishery such as hot weather coinciding with extremely low tides. Since 1998 the quota for Area 8 has been reduced from 30 tonnes to 24 tonnes in 1999, 20 tonnes in 2000 and 12 tonnes in 2001. Voluntary agreement by industry extended the reductions to 16 tonnes in 2000 and 10 tonnes in 2001. Industry operators have traded quota units to ensure that only divers experienced in fishing these remote sections are able to operate in the north of Area 8.

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.

ABALONE TABLE 2

Roe's abalone catch and effort by quota period.

QUOTA PERIOD	ROE'S TAC kg whole weight	ROE'S CAUGHT kg whole weight	DIVER DAYSΔ
1990	105,000	117,558	1,114
1991	101,000	110,334	1,005
1992	105,000	112,275	942
1993	128,000	116,390	1,058
1994	125,960	119,849	1,146
1995	125,960	115,218	1,206
1996	125,960	122,065	1,176
1997	126,790	119,080	970
1998	93,960*	86,530	799
1999	119,900+	108,278	757
2000	115,900+	107,683	755
2001	**107,900+**	**99,173**	**719**

Δ Diver days from dedicated Roe's abalone divers only.

* Reduced quota for a six-month season.

+ Industry-instigated voluntary 6 tonne reduction in quota for 1999 and voluntary 4 tonne reduction in 2000 and a 2 tonne reduction in 2001 in response to concerns over the low abundance of legal-sized abalone in Area 8.

Notes

1. Data source: quota returns.
2. Standard conversion factors for meat weight to whole weight for Roe's abalone were 2.5 prior to 2000 and 3.0 from 2000.
3. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar year.

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 (2001): $4.1 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 $4.1 million. The price of Roe's abalone was significantly higher last year at $55/kg whole weight.

FISHERY GOVERNANCE

Acceptable catch and effort range: 725–929 diver days for 107.9 tonnes whole weight

For the 2001 season catch rate projections were designed to take account of changes in the management arrangements for Area 7, such as the removal of the daily bag limit. With the inclusion of this variation in catch rate for Area 7, the full quota for the Roe's abalone fishery in 2002 (107.9 tonnes whole weight) should be achieved in 725–929 days of fishing, the same projection as for the 2001 season.

SOUTH COAST ESTUARINE FISHERY

Management Summary

The South Coast Estuarine (Interim) Management Plan 2001 was published in the Government Gazette on 22 January 2002. The new management arrangements will come into force on 1 July 2002 and expire on 30 June 2005. The interim plan will supersede several licence conditions and other subsidiary legislation such as Prohibition Notices.

The new arrangements will not result in dramatic changes to the fishery, but will better define permitted fishing methods and times. They will also provide for transferability of authorisations when the number of units in the fishery has been reduced to the optimum level of 15. The invitational period for the Voluntary Fisheries Adjustment Scheme for this fishery closed on 17 May 2002, with the negotiation phase to be completed by 28 June 2002. Prior to the recent VFAS there were 26 licensed units, and it is unlikely that the latest scheme alone will reduce the number of units to the target number.

Governing Legislation/Fishing Authority
Condition 19 on a Fishing Boat Licence
Condition 17 on a Commercial Fishing Licence
Various orders under Section 43 of the *Fish Resources Management Act 1994* (closed waters and permitted gear)

Consultation Process
Department–industry meetings

Research Summary

Research monitoring of fish stocks in the 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 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 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 Fishery (SCEF): Oyster Harbour, Wilson Inlet, Irwin Inlet, Broke Inlet, Princess Royal Harbour, Parry Inlet, Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Culham Inlet, Oldfield Inlet, Torradup Inlet, Stokes Inlet and Jerdacuttup Lakes. The level of access stood at 29 fishing units in May 2001, a reduction from 31 fishers in 2000 as a result of the Voluntary Fisheries Adjustment Scheme. A further two units were relinquished to the VFAS in late 2001.

South coast licensees have access to each of the individual south coast estuaries, except Beaufort Inlet where only three licensees a year are granted entry. The South Coast Estuarine Fishery 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 2001): 274 tonnes

Landings

The total reported landings of 274 tonnes from the south coast estuaries incorporate molluscs and crustaceans as well as finfish, and are composed of the following species:

Cobbler	*Cnidoglanis macrocephalus*	77.1 tonnes
Blue swimmer crabs	*Portunus pelagicus*	38.9 tonnes
Black bream	*Acanthopagrus butcheri*	27.4 tonnes
Sea mullet	*Mugil cephalus*	24.7 tonnes
Australian herring	*Arripis georgianus*	22.8 tonnes
Leatherjacket	Monocanthidae	17.5 tonnes
Silver bream	*Rhabdosargus sarba*	9.5 tonnes
Pink snapper	*Pagrus auratus*	9.3 tonnes
King George whiting	*Sillaginodes punctata*	9.1 tonnes
Flathead	Platycephalidae	9.1 tonnes
Other species		28.4 tonnes

The reported catch from south coast estuaries shows a stable history between 1993 and 2001, with a peak catch reported in 1998. The reported 2001 catch figure has increased from the 2000 levels (South Coast Estuarine Figure 1). In 2001, higher catches were reported from Princess Royal Harbour, Oyster Harbour, Irwin Inlet, Wilson Inlet, Stokes Inlet and Oldfield Inlet, which each showed an increase of more than 1 tonne over 2000 levels. Decreased catches compared to the previous year were recorded from Broke Inlet, Jerdacuttup Lakes, Culham Inlet and Gordon Inlet. The 2001 reported catches were similar to the 2000 catches for Beaufort Inlet. There was a low level of fishing in Parry Inlet during 2001. There was no fishing reported in Hamersley Inlet and Dempster Inlet.

While over 40 species of sharks, rays, finfish 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 2001, the reported catches of black bream in south coast estuaries decreased slightly from 2000 levels (South Coast Estuarine Figure 2).

Cobbler: During 2001, the catch was concentrated in three south coast embayments/estuaries, namely Wilson Inlet, Oyster Harbour and Princess Royal Harbour, with the highest catches (75%) 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 2001 catches from Wilson Inlet increased by 10 tonnes from the 2000 catch (South Coast Estuarine Figure 3).

King George whiting: During 2001, the majority of catches were reported from Wilson Inlet. The King George whiting catch from Wilson Inlet for 2001 continued to decline from the high 1998 level and at present is at the catch level 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 overall 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 2001 this trend continued due to the removal through the VFAS of an additional four fishing units (South Coast Estuarine Figure 1).

Catch rate

Catch per unit effort has closely followed the trend in catches overall in south coast estuaries. The catch rate reported for the south coast estuaries in 2001 was similar to 2000 levels.

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 overall trends in both catch and CPUE, the black bream stocks overall 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 the upper end of the historical range, and average catch per vessel operating, indicate that this valuable stock is trending to higher abundance over the past decade.

King George whiting: Approximately 70% 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. 113-115.

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 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 have historically 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 South Coast Estuarine Fishery involved an average of around 40 fishers during the 2001 fishing season, as well as generating additional regional employment. The catches from this fishery also provide fresh local fish to regional centres.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001): **$960,000**

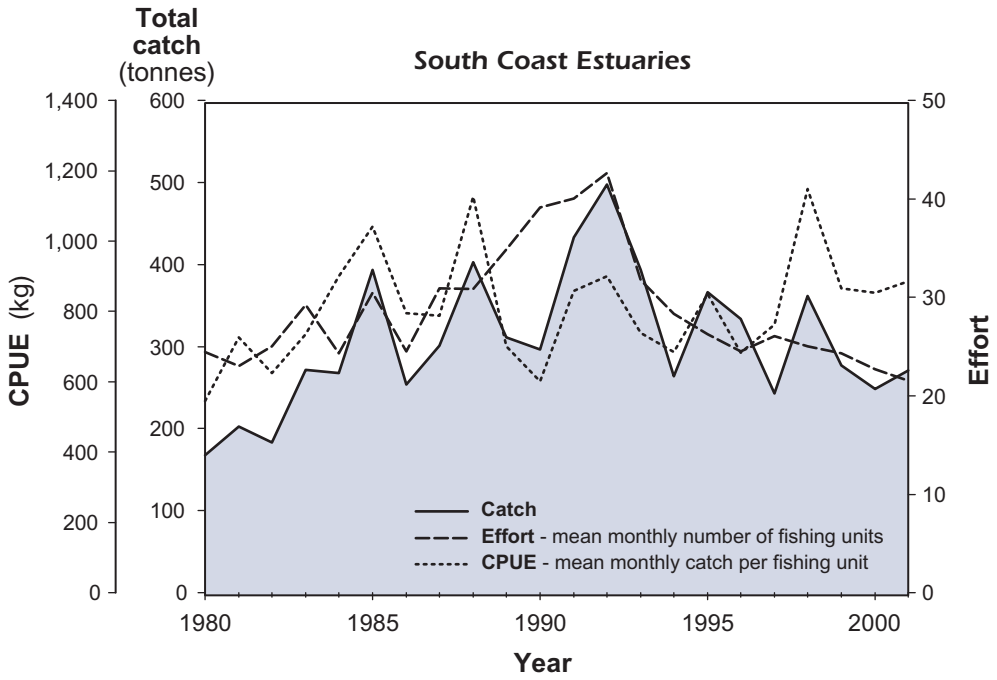
FISHERY GOVERNANCE

Acceptable catch range: **200–500 tonnes**

The acceptable catch range under current management arrangements is 200–500 tonnes (rounded to the nearest 50 tonnes). The acceptable catch range is derived by 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. The catch of 274 tonnes in 2001 was within the acceptable range.

EXTERNAL FACTORS

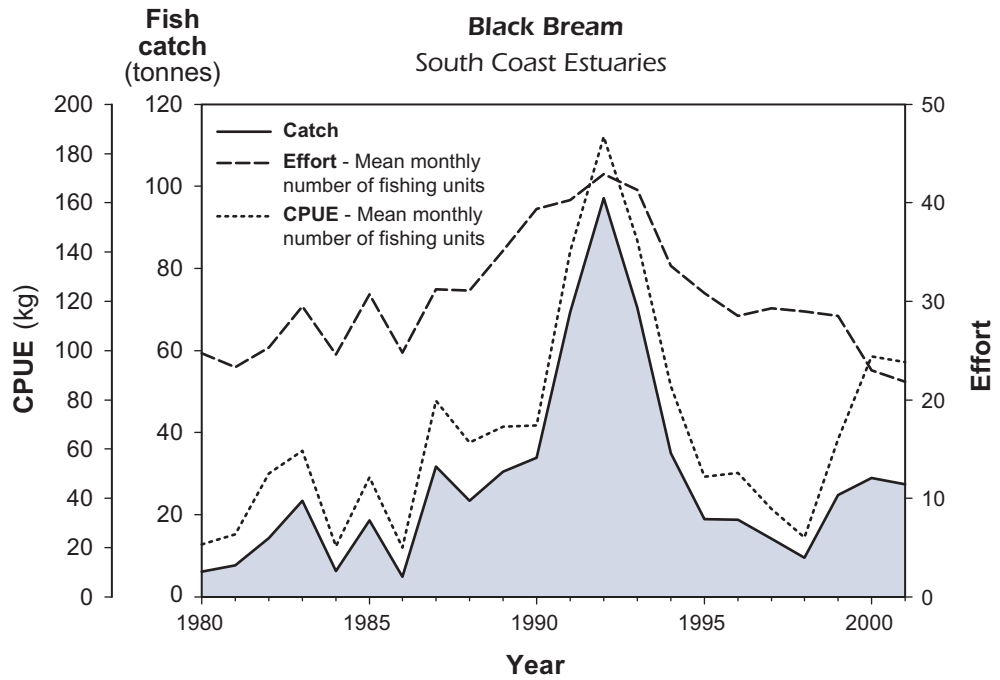
Variation in fish abundance in these south coast estuarine stocks is largely driven by environmental influences on recruitment. In the South Coast Estuarine Fishery this is further complicated by the natural closure of some estuaries and the need for human intervention to breach estuarine bars, mostly 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 catch and effort from year to year.



SOUTH COAST ESTUARINE FIGURE 1

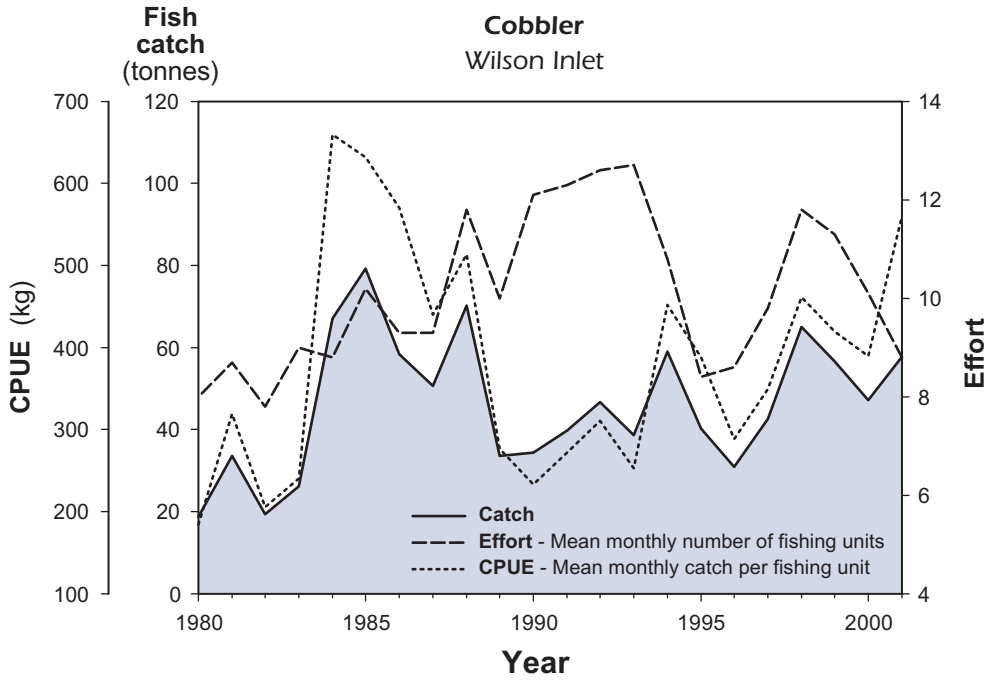
The annual catch, effort and catch per unit effort (CPUE) for the South Coast Estuarine Fishery over the period 1980–2001.

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.



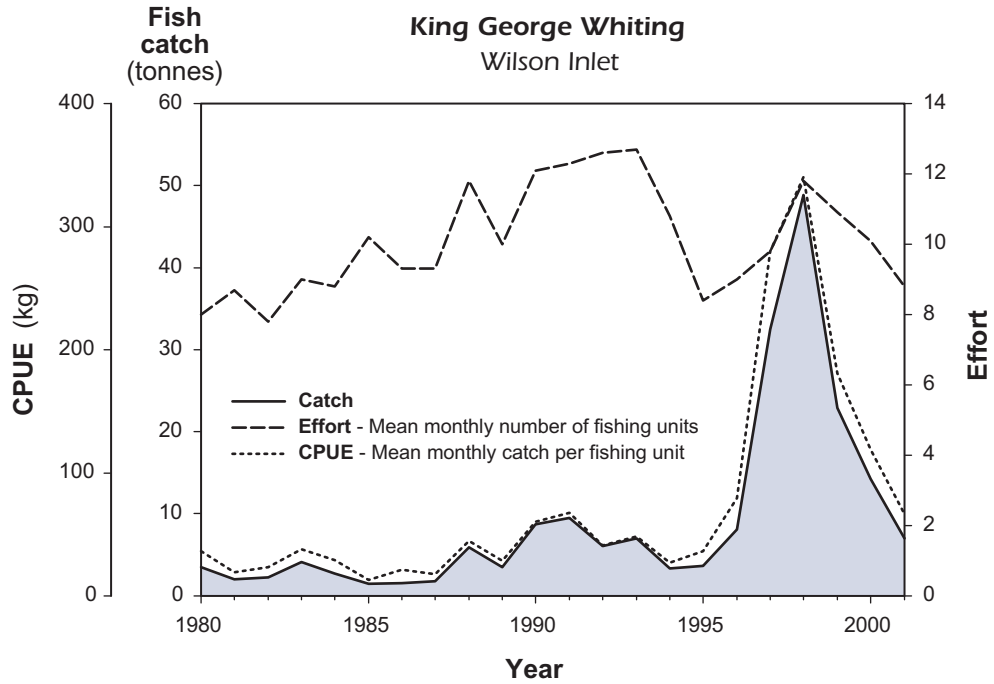
SOUTH COAST ESTUARINE FIGURE 2

The annual catch, effort and catch per unit effort (CPUE) for the black bream (*Acanthopagrus butcheri*) fishery in south coast estuaries over the period 1980–2001.



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 1980–2001.



SOUTH COAST ESTUARINE FIGURE 4

The annual catch, effort and catch per unit effort (CPUE) for the King George whiting (*Sillaginodes punctata*) fishery of Wilson Inlet over the period 1980–2001.

WESTERN AUSTRALIAN SALMON FISHERIES

Management Summary

Western Australian salmon (*Arripis truttaceus*) are taken primarily during their annual east-to-west migration, usually between March 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, comprising specific beaches that are shared by the authorisation holders.

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.

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 industry CAES data and historical biological research.

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 and the potential link to subsequent recruitment will be completed by late 2002. Time-series analysis of the historic Australian salmon catches to predict future catches is also being investigated through a separate FDRC-funded project also due to be completed by the end of 2002. These two projects will be using different methods to try to predict future commercial Australian salmon catches.

WESTERN AUSTRALIAN SALMON FISHERIES STATUS REPORT

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

As at May 2001, each of 18 licensed south coast teams has access to a nominated beach in this sector, 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 have access to beaches in the west coast sector, 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'*. Three licensees have access to the west coast sector north of Busselton Jetty. These licensed fishers are the only ones with authority to catch and sell Australian salmon from this sector.

Main fishing method

Beach seine.

RETAINED SPECIES

Commercial production (season 2001): 2,392 tonnes

Landings

The total State catch for the year was 2,392 tonnes, which was about 100 tonnes more than the previous year (Salmon Figure 1). The 2001 south coast commercial catch of Australian salmon was 2,066 tonnes. This catch was taken from the designated salmon beaches, with a minor catch component from the estuaries. Almost the entire south coast catch of salmon was taken between February and May 2001, the time of the spawning run along the south coast. There was a negligible 'back run' catch this year.

The highest proportion of the 2001 south coast catch (1,097 tonnes or 53.1%) was taken from the western sector of the fishery (west of Albany to Windy Harbour). A total of 822 tonnes (39.8%) was taken in the central region of the fishery (east of Albany to Cape Riche). Fewer fish (147 tonnes or 7.1%) were taken from the eastern sector of the fishery (from Cape Riche to the east).

The south-west and west coast catch for 2001 totalled 325 tonnes, a large increase on the almost zero catch of last year.

Fishing effort

There are 18 south coast and 15 south-west and west coast fishing teams (three with access only north of Busselton Jetty).

Catch rate

During 2001, the average catch per fishing team was 114.8 tonnes for the south coast and 21.7 tonnes for the west coast.

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 2001, there would have 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 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 spawning-run fish from the south coast to the west coast indicates a beneficial environmental effect rather than a higher stock level.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Current commercial catches indicate that the breeding stock is still 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 and the design of the gear used, the fishery involves minimal bycatch.

Protected species interaction: **Negligible**

This fishery has no interaction with protected species.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

As salmon are a top-end predator in the marine food chain of the lower west and south coasts, the fishery has the potential to reduce the mortality on salmon prey species. However, given the naturally occurring variability in Australian salmon biomass, the fishery effect is likely to be similar in magnitude to other factors contributing to the natural variation in 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 95 fishers and the south-west and west coast fishery involved an average of 39 fishers during the 2001 fishing season.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001): **$860,000**

The south coast catch in 2001 was received by four processors: Albany Bait Producers, Princess Royal Seafoods, Bevan's Fish Supplies and Bremer Bay Fish Processors.

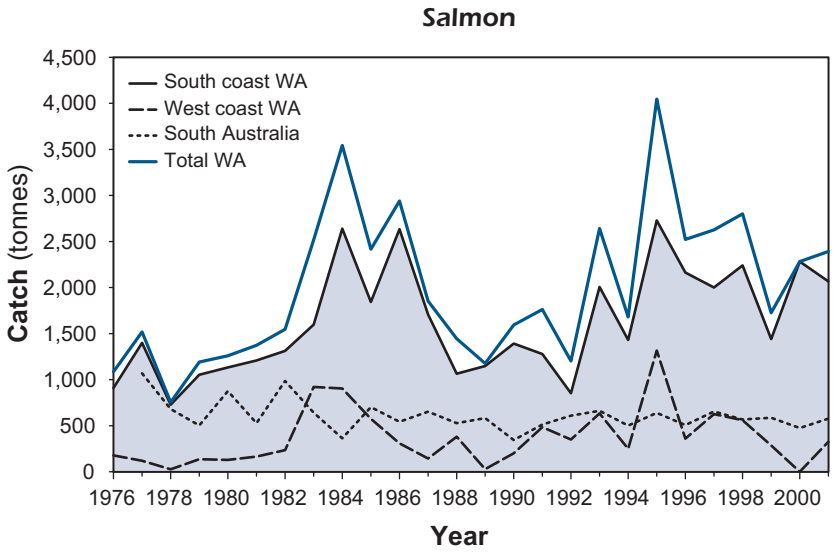
FISHERY GOVERNANCE

Acceptable catch range: **1,300–3,600 tonnes**

The expected catch range under the current management regime is 1,300–3,600 tonnes (rounded to the nearest 50 tonnes) of salmon. This projection is derived by double exponential smoothed forecasting of the past 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 2001 catch of 2,392 tonnes fell well within the catch range.

EXTERNAL FACTORS

The higher catches of Australian salmon along the west coast during 2001, compared to the previous year, 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 2001. 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 1976 to 2001. Catches prior to 1977 for South Australia are unavailable.

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 fishers are individually assigned to particular beaches and are specifically endorsed to use herring traps. There is a closed season (10 February to 25 March each year) which coincides with 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
Australian Salmon and Herring Advisory Committee
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.

Two FRDC-funded research projects are currently under way which will assist in the prediction of future catches. One is focused on the development of a juvenile index of recruitment for Australian herring, while the other is using time-series analysis of historic commercial catches. Both projects are due for completion by the end of 2002.

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

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 in the year 2001. This represents a reduction from 13 licences in 2000 as a result of Voluntary Fisheries Adjustment Schemes. On the west coast, the Cockburn Sound (Fish Net) Managed Fishery specifically fishes for herring. In addition, small quantities of herring are also taken by wetline vessels, and by some 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 2001): State 759 tonnes
South coast 616 tonnes

Landings

The total catch of Australian herring for the State in 2001 was 759 tonnes, a decrease of approximately 58 tonnes from the 2000 catch (Herring Figure 1). The south coast catch was 616 tonnes, which comprised 81% of the total State catch. The south coast landings included 589 tonnes from the ocean (579 tonnes from trap nets and 10 tonnes from other gear) and 27 tonnes from estuaries and embayments. The south coast catch to the end of May 2001 (traditionally the end of the trap net fishing season) was 599 tonnes, or 97% of the annual south coast catch. The west coast catch was 143 tonnes and included 46.5 tonnes from the ocean, 4.9 tonnes from estuaries and 91.4 tonnes 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 buy-back initiatives, with the most recent in 2000 when three units or 23% of the effort was removed.

Catch rate

The average catch per south coast trap net fishing team during 2001 was 57.9 tonnes, reflecting the expected increase due to the lower overall effort levels in this sector of the fishery. Although the most recent buy-back removed 23% of the effort, the average catch rate increased by only 12%.

Recreational component: Approx. 10% (south coast)

Recreational catch and effort figures are not available for 2001. 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

Two age-structured stock assessment models have been developed, one for the west coast of Western Australia and one for the southern coast of Australia, using historic information and data gathered during the three-year Australian herring research project. The results of the age-structured models suggest that the stock on the west coast of Western Australia is smaller than the stock 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 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 tonnes per trap net team with 19 teams to about 58 tonnes 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 about 100 tonnes 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 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. Further analyses are continuing to improve model estimates and to reduce uncertainty around some of the results of the model.

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

This fishery has no negative impact on protected species. However, some protected species such as fur seals and sea lions occasionally interact with the fishery.

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 47 fishers during 2001. Additional employment is created in the processing and distribution networks and retail fish sales sectors.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2001): $230,000

This estimate is for the south coast trap net fishery only.

FISHERY GOVERNANCE

Acceptable catch range: South coast 450–1,200 tonnes

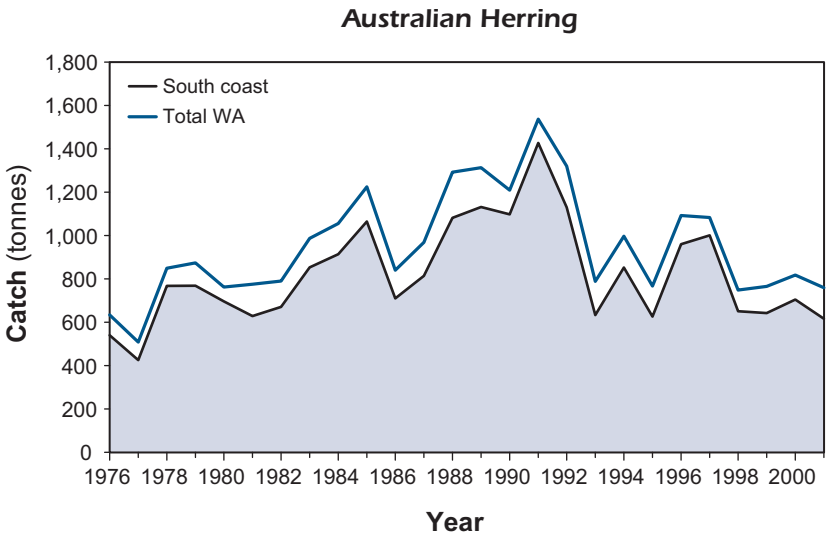
The acceptable catch range for the south coast Australian herring trap net fishery under the current management regime is 450–1,200 tonnes (rounded to the nearest

50 tonnes). 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 will need to be considered.

Using the above methods, the commercial west coast herring catch is expected to be between 60 and 125 tonnes. The current catch of 616 tonnes for the south coast fishery is within the range set, however as recent years have been towards the lower end of the range, catches and environmental factors will continue to be monitored closely.

EXTERNAL FACTORS

The catch trend to 1991 was towards increasing commercial catches of Australian herring. As is the case with Australian salmon, a proportion of the resource is recruited from South Australian nursery areas. However, it is thought that on a year-to-year basis, 'local' recruitment is far more important to the Western Australian fishery than recruitment from South Australia. This is likely to be particularly true for the west coast sector of the resource, where it is believed that protected marine habitats, such as Geographe Bay, are substantial nursery areas and can be a source of significant recruitment. Indeed, 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, which is consistent with the above view (correlation coefficient = 0.38; non-significant value).



HERRING FIGURE 1

Catches of Australian herring from the south coast and the total Western Australian catch for the period 1976 to 2001.

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 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. The total quota units currently allocated across each of the five zones in the fishery amount to 890.

With the exception of Zone 4 (Esperance region), TACs were kept at low levels for the 2001/02 season to allow continued rebuilding of the stock. The season for the South Coast Purse Seine Managed Fishery now runs from 1 July to 30 June each year.

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

Consultation Process

Purse Seine Management Advisory Committee
Agency–industry meetings

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 2002 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 catches has continued, and in the past year additional information has been collected through the research quota system. 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, has been presented to the Purse Seine MAC during 2001. 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.

In the *State of the Fisheries Report 2000/2001*, it was anticipated that in future editions the catches for this fishery would be reported in financial or quota years rather than in calendar years. Please note that this change has been delayed a year to permit a resumption of more normal catch and fishery activity levels.

SOUTH COAST PURSE SEINE MANAGED FISHERY STATUS REPORT

Prepared by R. Mitchell and D. Gaughan

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. The boundary between the latter two zones was formerly Point Charles, but was moved by agreement during 2001/02 for administrative reasons. 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): 981 tonnes

Landings

During 2001, the quotas for the Albany and Bremer Bay fishing zones were based on two six-month periods. In the Esperance zone a TAC of 1,060 tonnes was set for the year. Annual TACs for Albany and Bremer Bay were set at 0 tonnes from January to May 2001, however research quotas of 20 and 50 tonnes were set for the month of June to allow research fishing and sample collection of reported schools of pilchards. This recommendation followed

anecdotal evidence, which was subsequently verified by Department of Fisheries staff, of significant schools of pilchards moving into the Albany region during April and May of 2001. Following this, additional commercial quotas from July to December were set at 100 and 200 tonnes, bringing the total TACs for 2001 to 120 and 250 tonnes for Albany and Bremer Bay.

The catch of pilchards (*Sardinops sagax*) achieved in Albany, Bremer Bay and Esperance in 2001 was 104, 213 and 664 tonnes respectively (South Coast Purse Seine Fishery Figure 1). For Esperance the catch was 63% of the 1,060 tonne TAC, possibly due to movements of market-size pilchards out of the operating range of the fleet.

Fishing effort

Albany zone: The recorded number of CAES days in 2001 was 171.

Bremer Bay zone: The recorded number of CAES days in 2001 was 183.

Esperance zone: The recorded number of CAES days in 2001 was 450 which was very similar to the number of days fished in 2000 (453).

Catch rate

Albany zone: The 2001 catch rate for the Albany zone was 610 kg/day.

Bremer Bay zone: The 2001 catch rate for the Bremer Bay zone was 1,162 kg/day.

Esperance zone: The 2001 catch rate for the Esperance zone was 1,474 kg/day. This represents a decrease from the 2000 season (2,171 kg/day) of almost 32%. Estimates of fuel use, which would provide a more meaningful estimate of effort incorporating searching time, were not available.

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, some recruitment was recorded within each zone, with pilchards less than 4 years old dominating the catch.

Although the assessment model predicted that in 2001 there would be only a small increase in pilchard biomass at Albany and a small decrease at Bremer Bay, estimates of spawning biomass in 2001 using the daily egg production method (DEPM) have revealed a strong recovery in both regions. It has not been shown conclusively that a similarly strong increase occurred at Esperance because the most recent spawning biomass survey for this region was not undertaken until early 2002 and the results are not yet finalised. Although the preliminary estimate of the spawning area indicates that the Esperance pilchard stock has not undergone significant growth during 2001, a catch dominated by 1- and 2-year old fish indicates ongoing strong levels of recruitment in that region. The high abundance of young fish was accompanied by low availability of older fish. Spawning-aged pilchards were detected by the presence of their eggs in offshore waters, but not in the traditional Esperance purse seine grounds. If these somewhat contradictory results remain once the spawning biomass estimate is finalised, then further investigation will be required. Since exploitation rates are still being managed conservatively, risks of stock depletion are still considered to be minimal in the short term.

However, another factor that needs to be considered in assessing the overall south coast pilchard stock is the source of the apparent recovery in Albany and the possible link to this of the very low availability of adult pilchards to the Esperance fleet. Searches for fish between November 2000 and January/February 2001 in the Albany zone found little evidence of a large abundance of pilchards. Subsequently, the DEPM survey found a widespread distribution of spawning adults several months later in July of 2001. Instigation of a research quota allowed these fish to be sampled, which showed them to consist predominantly of 2- to 5-year olds. Given the very low levels of residual stock in Albany after the 1998/99 mass mortality and the recent appearance of several cohorts of spawning-age fish, it is apparent that these fish were entering the Albany region as migrants rather than being local recruits. This is in contrast to the spatial population dynamics during the 1990s when larger concentrations along much of the coast possibly negated any competitive advantage in migrating along the coast. Because migration is not a parameter in the current simulation model, the slow rate of recovery indicated by the model last year has been exceeded.

Exploitation status:
Overall south coast stock fully exploited

Breeding stock levels: **Adequate**

Estimates of vulnerable biomass (which closely reflects spawning biomass) at the end of 2002 were derived from the integrated model and are as follows: Albany 20,700 tonnes, Bremer Bay 19,800 tonnes, Esperance 26,900 tonnes. The total estimated spawning biomass across the south coast was 67,400 tonnes, which represents 87% of the previously estimated virgin biomass. This is a substantial increase from the previous year, indicating that the breeding stocks are returning to a healthy level. However, it is important to recognise that while the trends in spawning biomass provide a strong positive signal regarding the status of the stocks, the inherent difficulty in directly estimating the size of fish populations means there is always a certain level of uncertainty that cannot be resolved within normal financial constraints. Thus, while the trends can be considered to be very reliable, this is not the case with the actual magnitude of the increases. In recognition of the uncertainty around the biomass estimates and the fact that relatively little time has passed since the mass mortality event of 1998/99, pilchard catches should not be allowed to increase substantially over short periods.

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 in small quantities and released from the net or later discarded include yellowtail scad (*Trachurus novaezelandiae*) 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: **Medium**

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. As a result of the mortality event outside of the control of the fishery, the reduced biomass of pilchards is likely to have a significant impact on predatory species such as seabirds, mammals and tuna. 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. 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 WA, and (b) in which the dominant species can change in abundance inter-annually (e.g. due to environmental conditions). It is anticipated that this concept will be adopted by the Purse Seine MAC during 2002.

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 south coast purse seine industry has undergone a major decline over recent years, with many licence holders and their crew moving elsewhere. Likewise, processing factories have experienced significant declines in staff, and those which focused primarily on pilchards have been shut down for extended periods. These effects were felt mainly in the Albany and Bremer Bay regions. However, following the reopening of the pilchard fishery in these two regions there has been an increase in the number of people employed in this industry over the past 12 months. Currently there are 5 vessels fishing in Albany providing income for about 15 people. Likewise, 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 since November 2001, employing between 7 and 10 crew. The factories in Bremer Bay provide work for between 15 and 18 casual and full-time workers. The number of people employed in the pilchard fishery has increased steadily since the reopening of the Albany and Bremer Bay zones in July 2001 and is expected to increase further following the quota recommendations for 2002. In Esperance, where an economically significant TAC has remained, there were 4 vessels working in 2001, employing approximately 10 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): **$870,000**

The higher value angling blocks/trays and individually quick frozen (IQF) fish represented more than 95% of the total catch processed. The different product types for each zone are shown in South Coast Purse Seine Table 1. Total catch value for 2001 was $870,000 (981 tonnes at an average price of $887/tonne), marginally higher than last year's $840,000.

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. The effort level required to land the TAC in each region is not available.

The quotas for the remainder of the 2001/02 season (January–June 2002) are 300 tonnes for the Albany zone and 600 tonnes for the Bremer Bay zone.

EXTERNAL FACTORS

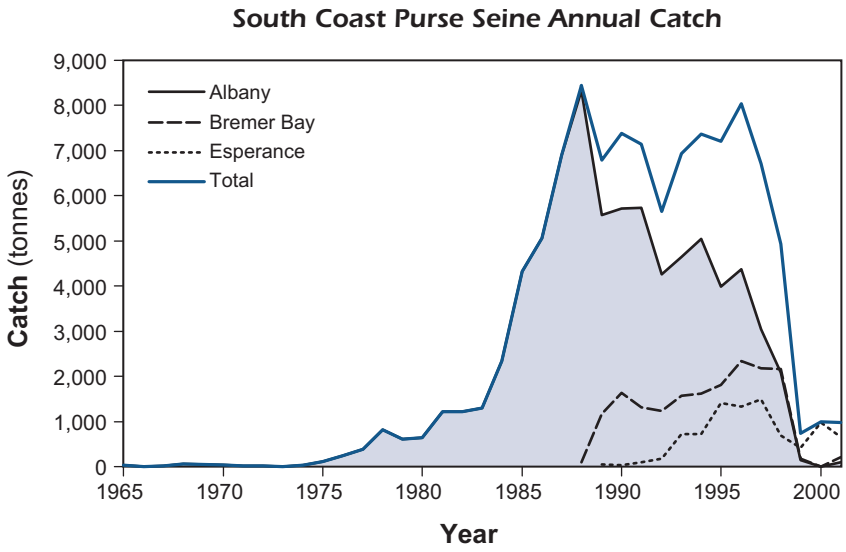
Following the loss of stock due to the mass mortality event of 1998/99, serious concerns about the survival of pilchard stocks in Western Australia were raised. However it appears the stocks are now showing positive signs of a recovery. Because there are still significant gaps in our knowledge of the 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* imported from overseas, which presents a degree of risk to the local pilchard stocks. Following the reopening of these zones in the second half of 2001, however, local pilchards are now being sold at a consistent rate to keep up with angler demand, which should reduce the requirement for imported bait and the associated risk.

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 (in tonnes) from Albany, Bremer Bay and Esperance for 2001.

PRODUCT	ALBANY	BREMER BAY	ESPERANCE	TOTAL SOUTH COAST
Trays	70.6	171.2	558.6	800.4 (81.6%)
IQF	32.8	39.9	50.2	122.9 (12.5%)
Pet food/Other	0.3	1.5	55.5	57.3 (5.8%)
Total	**103.7**	**212.6**	**664.3**	**980.6**



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 demersal finfish, including shark, by demersal gillnet and longline is controlled on the south coast and the west coast (below Shark Bay) through two complementary management plans. Both fisheries are managed using effort controls in the form of time/gear units, and both have traditionally targeted 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 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 the limit of the Australian Fishing Zone.

A five-year management package including phased effort reductions was introduced for this fishery in 1997/98 in response to an identified need to restore and maintain targeted shark stocks at 40% of their virgin biomass. The results of scientific monitoring indicate that the reductions made to date have not yet been effective in increasing the spawning biomass of the whiskery shark stock. A review of the current management package is expected to be completed during 2003/04.

West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery (WCDGDLIMF): 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 WCDGDLIMF 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 is currently managed under an interim management plan, which was recently amended to extend the interim managed fishery status to 31 May 2004. This will allow outstanding objections to be settled and facilitate the addressing of resource-user conflicts with the recreational sector and other commercial fishers regarding the catch of demersal scalefish and sharks.

The threat of over-exploitation and the potential for activation of latent effort remain important issues in both the southern and western fisheries. The ability of fishers outside these two managed fisheries to take sharks by other methods is also a matter of concern. Approval was given during 2001 to the drafting of legislation to prevent the use of hooks attached to rock lobster pots and similar unusual fishing methods to target sharks, and it is expected that this legislation will be introduced by November 2002. Further consultation will continue to focus on the issue of reducing the targeting of sharks by vessels operating in other commercial fisheries.

In 2001, the WA Demersal Gillnet and Demersal Longline Fisheries Management Advisory Committee agreed that an industry working group, together with Departmental representatives, would review current management arrangements for the demersal gillnet and longline fisheries. The working group meetmet on three occasions during 2001/02 and will continue to discuss the key issues facing the fisheries with a view to proposing alternative management arrangements to address those issues.

In January 2002, the MAC itself was renamed the WA Demersal Net and Hook Fisheries Management Advisory Committee, and restructured to include a representative from the northern shark fisheries.

The demersal gillnet and longline fisheries are currently undergoing the ecological sustainability assessment process. An initial risk assessment workshop was held in April 2002 and a draft report will be available for comment from Environment Australia in late 2002.

Governing Legislation/Fishing Authority

South Coast

Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992

Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery Licence

West Coast

West Coast Demersal Gillnet and Demersal Longline Interim Management Plan 1999

West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery Permit

Consultation Process

WA Demersal Net and Hook Fisheries Management Advisory Committee

Department–industry meetings (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. 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 R. Lenanton

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 2000/01 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 2000/01 was limited to 26 licences, which had powered-net drum endorsements.

Main fishing method

Demersal gillnet.

RETAINED SPECIES

Commercial production (season 2000/01):
All sharks 1,133 tonnes
Key species 862 tonnes

Landings

The total shark catch of 1,133 tonnes from these fisheries comprised 811 tonnes from the JASDGDLF and 322 tonnes from the WCDGDLIMF, made up as follows:

JASDGDLF:

Dusky whaler*	234 tonnes
Gummy shark*	233 tonnes
Whiskery shark*	137 tonnes
Sandbar shark†	22 tonnes
Other shark	185 tonnes
Total shark	**811 tonnes**

WCDGDLIMF:

Sandbar shark†	131 tonnes
Dusky whaler*	66 tonnes
Whiskery shark*	39 tonnes
Gummy shark*	5 tonnes
Other shark	81 tonnes
Total shark	**322 tonnes**

**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 2000/01, scalefish landings totalled 147 tonnes in the JASDGDLF and 69 tonnes in the WCDGDLIMF. 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, see North Coast Shark Fisheries 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 2000/01, 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 99.8 tonnes. A further 'wetline' catch of 20 tonnes of shark and ray was taken by vessels without access to managed fisheries.

Fishing effort

JASDGDLF: 148,713 kilometre gillnet hours

WCDGDLIMF: 95,921 kilometre gillnet hours

Effort is expressed as standardised kilometre gillnet hours to take into account the changes in net lengths used under the total allowable effort system (Demersal Gillnet and Longline Figure 2). Trading of effort entitlements has enabled some vessels to purchase additional effort units to become more cost effective, and this has reduced the number of active vessels. The effort expended by 29 vessels in the JASDGDLF in 2000/01 represented a 12% reduction on 1999/2000, while that expended by 13 vessels in the WCDGDLIMF was a 16% reduction on the previous season.

Catch rate

See 'Stock assessment' below.

Recreational component: **< 5%**

The estimated recreational catch between Augusta and Kalbarri, from a Department of Fisheries recreational trailered-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 and related 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 tonnes, 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 16.3% in 2000/01 to 176 tonnes, which was at the lower limit of the acceptable catch range set last year. Given the decreased effort in the temperate demersal gillnet and longline fisheries, this is not a cause for concern. Overall there was a 13.7% decrease in whiskery shark catch in the JASDGDLF and a 24.5% decrease in the WCDGDLF. Whiskery shark catches fell by 44.2% in Zone 2 of the JASDGDLF, probably as a result of decreased fishing effort in the western end of the zone, where whiskery sharks are more common. Despite a reduction in overall effort, the Zone 1 catch of whiskery sharks increased by 13.6%. Overall catch rates of whiskery sharks decreased substantially during the late 1970s and early 1980s, but since the late 1980s have declined only slowly and in recent years have remained relatively stable. The catch rate of this species declined slightly over the last 12 months but was still higher than it has been through most of the 1990s.

Dusky whaler: At 300 tonnes, the total catch of dusky whalers in 2000/01 was 10.6% less than that of the previous year and was at the lower limit of the acceptable catch range set last year. Whilst dusky shark catches in Zone 1 of the JASDGDLF increased by 6%, catches in Zone 2 and in the WCDGDLF declined by 24.1% and 22.6% respectively. Catch rates were calculated to have risen by 15.1% in Zone 1 and fallen by 10.6% in Zone 2 and 8.3% in the WCDGDLF. The declining catch rates in Zone 2 and the WCDGDLF may be related to fewer new recruits surviving to move from Zone 1 to these adjacent areas or fewer adult females pupping over a smaller geographic range.

Gummy shark: The total catch of gummy sharks in 2000/01 was 237 tonnes, 2.7% lower than in the previous year and slightly below the acceptable catch range set last year. However, given that the Zone 2 catch rate increased by 12.7% while effort in this zone, where more than 95% of

Western Australia's gummy sharks are caught, has decreased steadily over the last five years, last year's 'acceptable catch range' is considered too high and may need to be revised downward in the future to match the effort reduction. The generally stable catch rates 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: **Fully exploited**

Current effort levels in this multi-species fishery are considered to be fully exploiting the dusky whaler and gummy shark stocks and causing some over-exploitation of the whiskery shark stock. There is mounting evidence that exploitation of adult dusky whaler sharks by other State and Commonwealth managed sectors may be causing over-exploitation of the stock.

Breeding stock levels:

The 1998 assessment of whiskery sharks indicated that mature female biomass was only 16.8% of its unexploited level. However, nominal catch rate data suggests that the stock might have stabilised in recent years, although catch rates may now be confounded by current targeting practices. To clarify this, a full review of data validation processes is currently under way. Recent catch rates of neonate dusky whaler sharks suggest that the breeding stock 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. Species potentially affected include the great white (white pointer) shark (*Carcharodon carcharias)*, grey nurse shark (*Carcharias taurus*) and whale shark (*Rhincodon typus*), which are considered to be at low to negligible risk from the fishery.

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 2000/01 in the JASDGDLF was 50 skippers and crew, and in the WCDGDLIMF 20.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000/01): $4.8 million

JASDGDLF:	$2.7 million (shark and scalefish)
JASDGDLF:	$830,000 (shark fins)*
WCDGDLIMF:	$1 million (shark and scalefish)
WCDGDLIMF:	$310,000 (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. Declining shark catches in recent years have 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 tonnes
Dusky whaler	300–400 tonnes
Gummy shark	250–350 tonnes

Catches of key species 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 and will include sandbar sharks.

Because declining gummy shark catches have been accompanied by an upward trend in Zone 2 catch rate, the recent declines in catches are assumed to be a direct result of reductions in effort, not decreasing abundance. A similar situation is occurring with whiskery sharks, where catches and catch rates appear to have stabilised in response to effort reductions. Of more serious concern is the ongoing decline in dusky whaler shark catches and overall effort, which may be reflecting decreased adult numbers over a smaller geographic range.

EXTERNAL FACTORS

The level of demersal gillnet and demersal longline exploitation of dusky whaler sharks was assessed as sustainable in 1998 (using 1994/95 exploitation rates), provided the exploitation of mature animals did not exceed 4% annually. Continued evidence, both anecdotal and from unpublished catch records from Commonwealth-managed tuna longlining vessels and other WA-licensed vessels, suggests that significant numbers of large dusky whaler sharks may now be taken by other fishers. There is also an indication from regional catch rate data that recruitment has declined in recent years, which is supported by anecdotal evidence from gillnet fishers that they are catching a higher proportion of 1+ age classes of juvenile dusky whaler sharks. 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

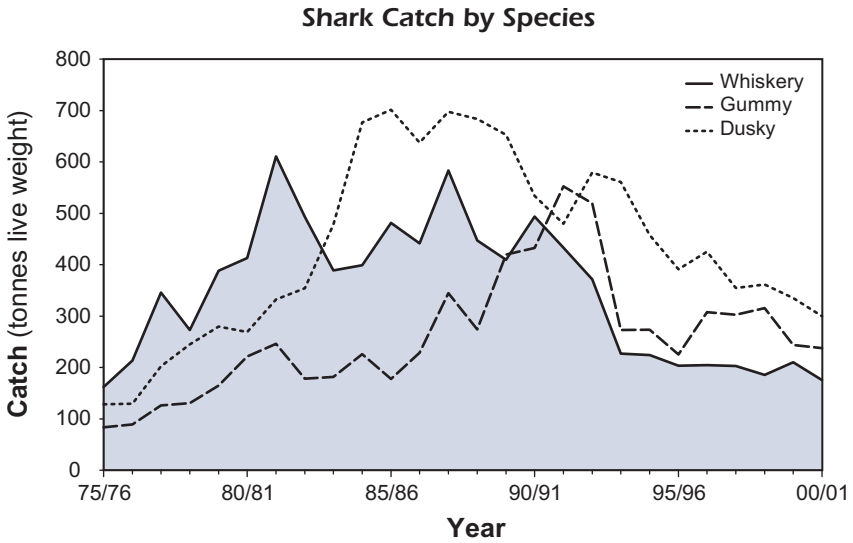
Shark catch species composition for the demersal gillnet and demersal longline fisheries (JASDGDLF and WCDGDLF), 2000/01.

SPECIES		CATCH (tonnes) JASDGDLF Zone 1	JASDGDLF Zone 2	JASDGDLF Total	WCDGDLF	TOTAL
Dusky	*Carcharinhus obscurus*	155	79	234	66	300
Gummy	*Mustelus antarcticus*	6	227	233	5	237
Whiskery	*Furgaleus macki*	95	42	137	39	176
Sandbar (thickskin)	*Carcharinhus plumbeus*	20	2	22	131	154
School	*Galeorhinus galeus*	0	52	52	0	52
Hammerhead	Sphyrnidae	8	15	22	18	40
Wobbegong	Orectolobidae	11	4	15	21	36
Blacktip	*Carcharinhus* spp.	3	2	6	22	28
Skates and rays		0	5	5	4	9
Copper	*Carcharinhus brachyurus*	0	0	0	4	4
Shovelnose rays	Rhinobatidae, Rhyncobatidae	0	0	0	3	3
Pencil	*Hypogaleus hyugaensis*	< 1	1	1	0	1
Other sharks		59	25	85	11	96

DEMERSAL GILLNET AND LONGLINE TABLE 2

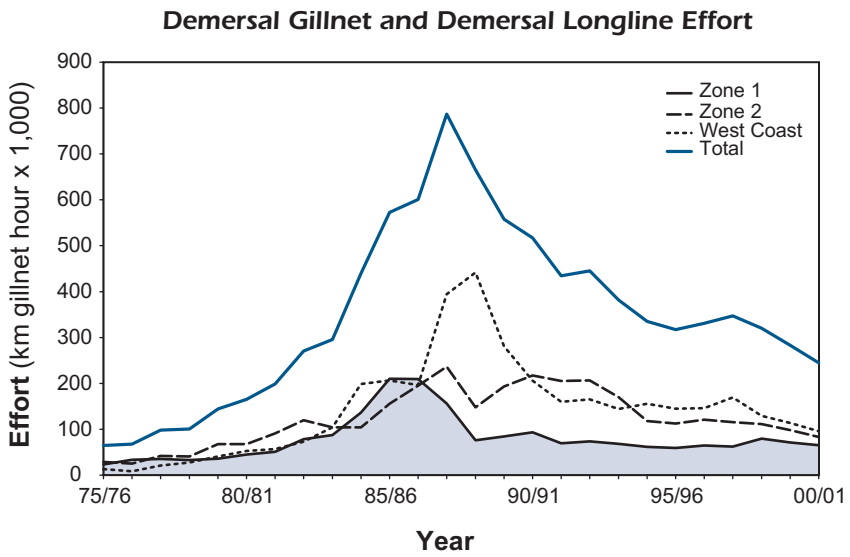
Scalefish catch species composition for the demersal gillnet and demersal longline fisheries (JASDGDLF and WCDGDLF), 2000/01.

SPECIES		CATCH (tonnes) JASDGDLF Zone 1	JASDGDLF Zone 2	JASDGDLF Total	WCDGDLF	TOTAL
Queen snapper	*Nemadactylus valenciennesi*	7	18	25	5	30
Blue groper	*Achoerodus gouldii*	8	15	22	3	26
Dhufish	*Glaucosoma hebraicum*	8	1	9	16	25
Pink snapper	*Pagrus auratus*	2	6	8	7	15
Samson fish	*Seriola hippos*	2	1	3	6	9
Redfish	*Centroberyx affinis*	< 1	3	3	0	3
Baldchin groper	*Choerodon rubescens*	1	0	1	4	4
Boarfish	Pentacerotidae	< 1	2	2	0	2
Mulloway	*Argyrosomus hololepidotus*	0	0	0	5	5
Other scalefish		62	13	75	23	97



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 2000/01.



DEMERSAL GILLNET AND LONGLINE FIGURE 2

Effort in the demersal gillnet and demersal longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2000/01.

Northern Inland Bioregion

REGIONAL MANAGEMENT OVERVIEW

The only commercial fishery in the northern inland bioregion is the Lake Argyle Freshwater Catfish Fishery. Future management arrangements for this fishery are currently under examination.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Northern inland commercial fishing is limited to the Lake Argyle Freshwater Catfish Fishery. There is limited compliance monitoring activity in this fishery, with seven commercial contacts made during the period January to June 2001. There were no compliance problems encountered during 2000/01, and monitoring continues to be a low priority.

LAKE ARGYLE FRESHWATER CATFISH FISHERY

Management Summary

The only commercial freshwater fishery in Western Australia is in Lake Argyle in the Kimberley. This fishery 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 on Lake Argyle as well as the general public and conservation groups, Lake Argyle catfish endorsement holders developed an industry code of practice which has been implemented from the 2001 season. 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

Consultation Process
Department – industry meetings

Research Summary

Data for assessing the status of this fish stock are derived from CAES returns provided by industry. These data are analysed annually using standard fisheries models to enable the following status report to be provided for management.

LAKE ARGYLE FRESHWATER CATFISH FISHERY STATUS REPORT

Prepared by S. Ayvazian and G. Nowara

FISHERY DESCRIPTION

Boundaries and access

The fishery is contained in the impounded waters of the Ord River at Lake Argyle and on part of Lake Kununurra. During 2000/01 there were six licensees who had access to the Lake Argyle catfish 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 mesh and 30 mesh deep. All fishers are prohibited from taking any fish whatsoever by means of nets during the period 1 November in any year to 31 December in the same year.

Main fishing method

Gillnet.

RETAINED SPECIES

Commercial production (season 2000/01): 168 tonnes

Landings

The fishery developed from 1979 with increasing catches to 1988/89 (133 tonnes), and then fluctuated at a lower level until 1993/94. Subsequently there was a trend towards increasing catches in this fishery, with the 1999/2000 catch of 230 tonnes being the highest on record. The 2000/01 catch has declined substantially to 168 tonnes (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 per boat of 100 m lengths of gillnet used. The fishing effort for 2000/01 was 7,020 units, which is considerably lower than the 1999/2000 fishing effort of 10,788 units (Lake Argyle Catfish Figure 1).

Catch rate

Since 1987/88, the catch rate has remained fairly constant, although it declined in the three years from 1993/94 to 1995/96. Subsequently the CPUE has remained fairly constant at this lower level with a slight increase in the past two years (Lake Argyle Catfish Figure 1).

Recreational component: Not assessed

Stock assessment completed: Yes

Last year a process error model and an observational error model replaced the biomass dynamics model previously used. The process error model forecast an estimate of the catch for 2000/01 of 193 tonnes. The results of this model indicated that the fishery was either fully fished or slightly over-fished. The alternative observational error model predicted a lower catch for 2000/01 of 105 tonnes. Under this model, the fishery would be classified as severely over-fished, and would be approaching the point at which recruitment might be adversely affected. Both models indicate that the current catch levels reported from the fishery are not sustainable.

However, both models require a number of assumptions, and the available data are not sufficiently detailed to determine whether or not these assumptions are valid, creating a high degree of uncertainty around the results. 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.

Exploitation status: **Over-exploited**

Breeding stock levels: **Decreasing**

Assessment of the current stock indicates that the breeding stock level may not be sufficient to maintain existing recruitment to the fishery if fishing continues at the current level.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

Minimal fish bycatch occurs in this fishery as a result of the large mesh size used relative to the species present in the lake.

Protected species interaction: **Low**

There is an incidental capture of freshwater crocodiles by the freshwater catfish fishery in Lake Argyle. Lake Argyle is designated as a wetland of international importance under the Ramsar Convention. While we assume that the crocodile population has increased in response to the creation of the dam, there are no assessments of the size of the population, nor of the proportion of the population being captured incidentally by the fishery. In the absence of this information, but on the basis of the fishers' anecdotal information, 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 2000/01, the average number of fishers involved in the Lake Argyle catfish fishery was 12. Additional employment occurs at local processors' and distribution networks.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000/01): **$450,000**

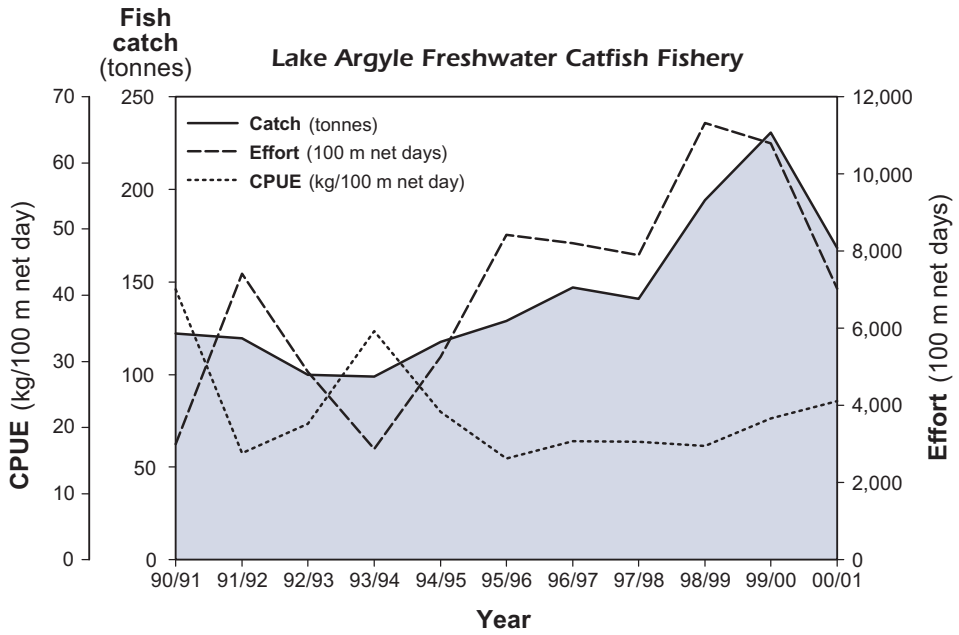
FISHERY GOVERNANCE

Acceptable catch range: **100–140 tonnes**

The acceptable catch range under the current management regime is 100–140 tonnes 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 1997/98. The catches from 1998/99 to 1999/2000 were well in excess of this range and driven by utilisation of latent effort. While the catch rates indicate that the stock was not declining rapidly in 2000/01, the catch of 168 tonnes was still well above the sustainable level determined by the observational and process models. The reasons for the catches exceeding the acceptable range are related in part to the unknown catchability and age and growth structure of the species. This level of catch still indicates that management action may be required if voluntary decreases in catch and effort do not continue (Lake Argyle Figure 1).

EXTERNAL FACTORS

A research report was made available at the annual management meeting with operators in Kununurra in April 2000, presenting the Research Division's concerns over the continuation of fishing at the high catch and effort levels current at the time. The operators have responded during 2000/01 by voluntarily reducing effort and hence catch. Nevertheless, the latent effort remaining in this fishery is of biological concern because of the specialised reproductive behaviour and the 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 are too high.



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 1990/91 to 2000/01.

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.

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, 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.

There are reporting requirements to Environment Australia in relation to the commercial harvest of syngnathids to maintain the 'Approved Wildlife Trade' status which allows these species to be exported. 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.

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

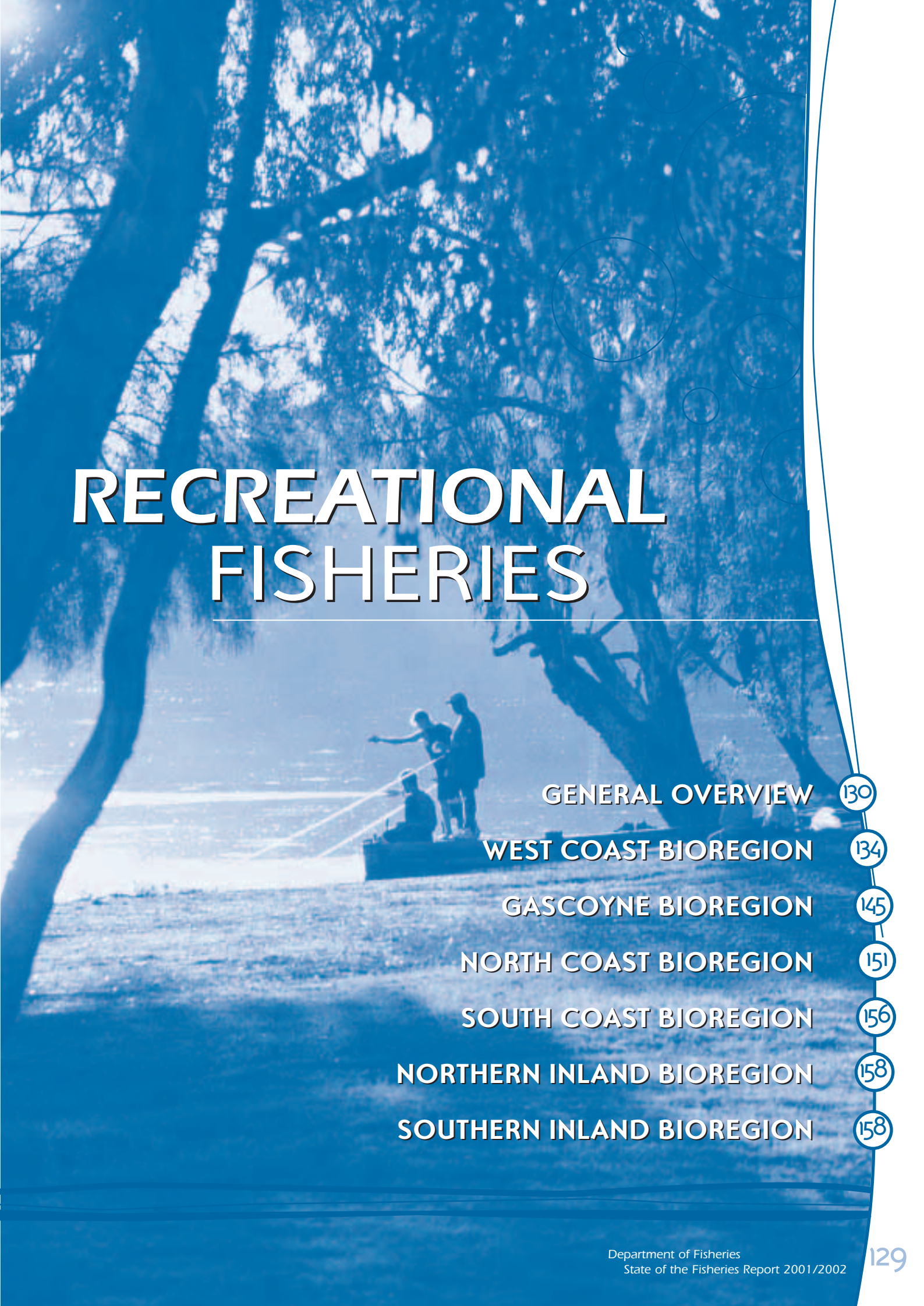
The Specimen Shell Managed Fishery comprises 34 licensees who operate under the Specimen Shell Management Plan. The fishery targets a range of specimen shell species along the entire Western Australian coastline, except where there are specific closures, for example within some marine parks and aquatic reserves.

The management plan establishes the legislative controls for the number of licences issued, boat replacement size and permitted fishing methods.

There are reporting requirements to Environment Australia to maintain the 'Approved Wildlife Trade' status which permits the continued export of specimen shells taken in the fishery. 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.

Governing Legislation/Fishing Authority
Specimen Shell Management Plan 1995
Specimen Shell Managed Fishery Licence

Consultation Process
Department–industry meeting



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 contribute directly to the cost of managing their fishery through the payment of licence fees for four species-based fisheries and one fishing activity. Licence fees have remained unchanged since 1995, but are set to increase 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 finfish fisheries.

The Recreational Fisheries Program was allocated a budget of $11.189 million including accruals in 2001/02. About $1.9 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 62,105 licences were issued in 2001/02. Recreational Fisheries Table 1 gives the breakdown of recreational licences issued over the past four years.

RECREATIONAL FISHERIES TABLE 1

Recreational fishing licences 1998/99 to 2001/02

	2001/02	2000/01	1999/00	1998/99
Rock lobster	23,343	25,566	25,714	24,335
Marron	9,507	11,206	11,966	13,063
Abalone	9,171	7,459	7.097	6,789
Netting	4,792	6,043	4,973	5,324
South-west freshwater angling	3,740	4,541	3,470	3,702
All categories (umbrella)	11,552	11,254	9,793	8,383
Total licences	**62,105**	**66,069**	**63,013**	**61,596**

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 3 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 585,000 people a year, or from 27% to 34% of the State's population over 4 years old. The most recent survey (Baharthah and Sumner 2002) estimated that the median fishing effort by recreational fishers was 6 days per year.

The estimated total recreational fishing effort for the State has risen from an estimated 3 million fishing days in 1988 to 10 million fishing days in 2002.

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 a set of 'fishing quality' indicators against which each plan can be reviewed.

Each regional strategy is being developed by a community-based working group comprising fishing, conservation and tourism interests and will include recommendations for a detailed research and management program specific to that region.

Final recommendations for the Gascoyne and west coast bioregions are with the Minister for Fisheries. Reviews of the north and south coast regions are planned for 2002/03. Specific details on changes to regional and fishery management are provided in the bioregional overviews below.

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 231 fishing tour operators' licences and 26 aquatic ecotour licences across the State's four marine bioregions. Of these, 58 fishing tour licences operate in two regions or more.

The estimated direct economic turnover of the industry is in the order of $20 million per year, with further flow-on benefits to the tourism sector and regional economies.

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 responsibilities 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 until there is sufficient data for an assessment of the sector's relative impact on the State's fish stocks.

A formal objections tribunal has been set up by the Minister for Fisheries under the *Fish Resources Management Act 1994* to hear submissions from aquatic tour applicants who have not been granted licences.

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

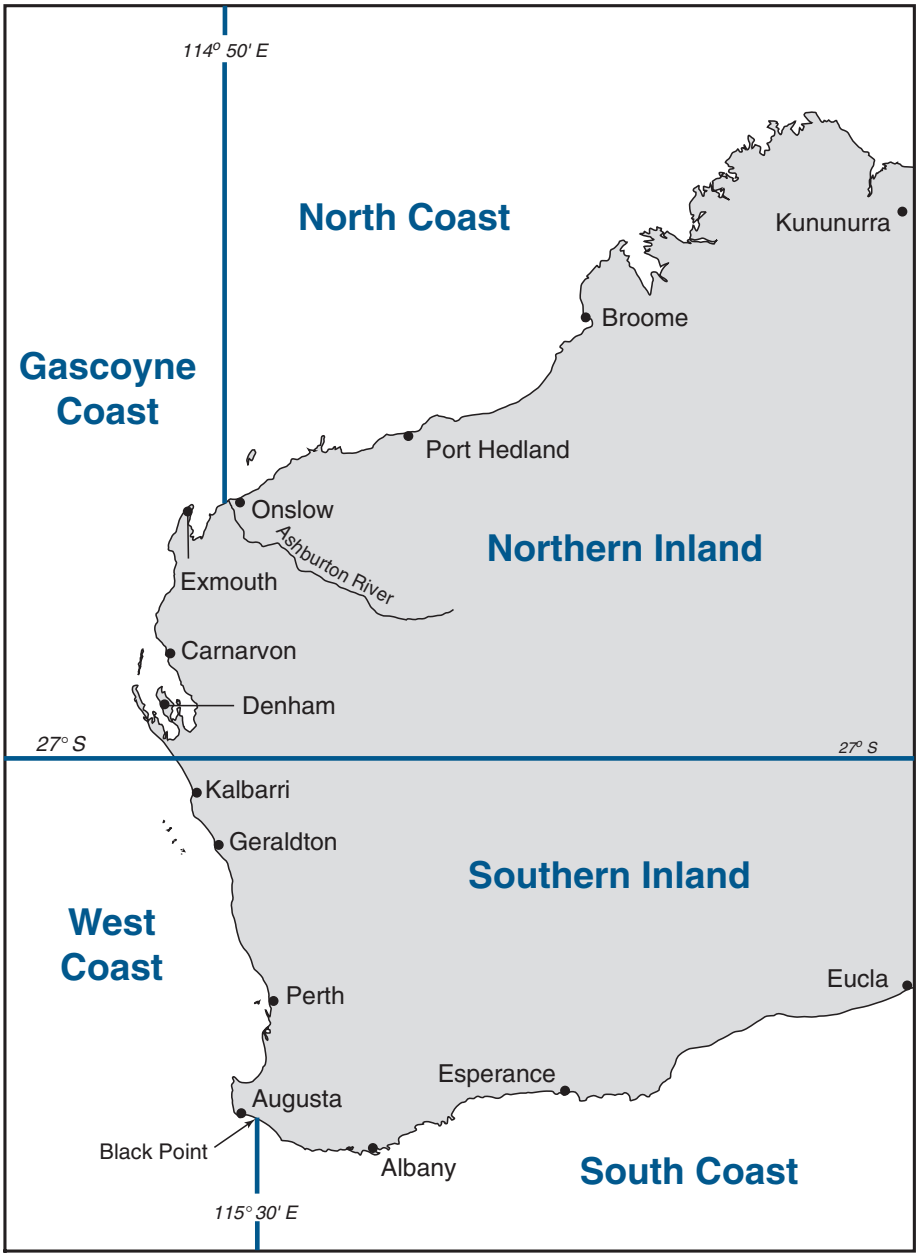
Data for the estimation of recreational catch and effort is collected through a strategic program of surveys.

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 six-year cycle. This comprehensive survey data series is used to validate and assess the level of bias in the annual telephone surveys.



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 420,000 anglers fishing an estimated five million fishing days a year. Within this region the metropolitan coastal waters between Yanchep and Mandurah attract about 150,000 fishers, generating an estimated two million fishing days a year (Baharthah and Sumner 2002). (It should be noted that these estimates of fishing effort are approximate, owing to the limitations in the survey methods previously discussed.) 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 118 fishing tour licences and 12 ecotour licences issued for the west coast bioregion.

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 tonnes 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 a final report prepared by the working group is currently being considered by the Minister for Fisheries.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Fisheries Officers working out of 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 *Baudin* 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 2000/01

A total of 23,725 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 50% 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 20% of the total hours being applied in the mid-west (Jurien to Kalbarri).

A total of 696 Fishwatch reports on illegal activity were received during the year. Approximately 30% of these reports related to marine finfish, while rock lobster, netting and crab offences accounted for 15% each, and abalone 8% of reports. The remaining reports were spread across a range of other recreational fisheries issues.

As a result of compliance activities, 470 warnings and 131 infringement notices were issued and 40 prosecutions were initiated in the west coast bioregion. Prosecutions were undertaken for the more serious offences related to under-size rock lobster and crabs, and under-size and bag limit breaches for marine finfish and abalone.

In the metropolitan and Mandurah areas the highest risks of non-compliance with the management arrangements were related to the take of under-size rock lobster and tailor, take of excessive numbers of large pink snapper and squid in Cockburn Sound, illegal recreational netting in the Swan River, under-size and over-bag-limit offences during the short abalone season, and the take of under-size crabs in the Peel/Harvey and Leschenault Estuaries.

The six-week closure to fishing for pink snapper in Cockburn Sound appeared to be well supported by the recreational fishing community, and there were few signs of fishers targeting snapper during the closed season.

A 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 and care and conservation. The VFLO program involved 77 volunteers in the Perth area, 37 in Mandurah, 34 in Geraldton and the mid-west and 29 in

Bunbury and Busselton. VFLOs reported 13,351 contacts and 2,500 interviews during the year.

Volunteers continued beachfront education programs, focusing on correct fishing techniques, ethics and bag and size limits; they attended major boat shows (Perth Boat, Dive & Fishing Show, Hillarys Boat Show, Mandurah Boat Show, Ascot Marina Boat Festival and others), and distributed educational material to tackle shops throughout the metropolitan area.

Fishing workshops for people with disabilities were also given priority, and the project received the 'Action on Access – Making a Difference to Everyday Life 2000' award from the Disability Services Commission.

The 'Fishers with Disabilities' program was also extended to Rottnest Island when Neville Thomas, VFLO Disabilities Development Coordinator, and other metropolitan VFLOs raised $11,000 to purchase the 'Marine Machine'. The 'Marine Machine' is a Triton van equipped to carry 10 passengers with disabilities, including four passengers in wheelchairs. It is used around Rottnest Island to transport fishers with a disability to popular fishing locations. This could not have been achieved without partnerships from United Way, the Rottnest Island Authority, Stirling Marine and Boat Torque Cruises.

In Mandurah a locally sponsored van assisted volunteers with longer-range patrols, and a declining trend in the number of recreational crabbing infringements can largely be attributed to the presence and educational role of the VFLOs.

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 2000/01 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	23,725
Fisher field contacts by Fisheries Officer (6 months)*	13,937
District Office contacts by Fisheries Officers (6 months)*	9,859
Fisher field contacts by VFLOs	13,351
Fishwatch reports	696
OFFENCES DETECTED	**NUMBER**
Infringement warnings	470
Infringement notices	131
Prosecutions	40

*These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

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

In Geraldton, Jurien and Dongara, three teams of VFLOs attended all major agricultural and community shows and festivals, gave school talks and conducted fishing clinics for children, adults and pensioners. They also visited the Abrolhos Islands to conduct liaison activities with fishing families and tourists.

A VFLO initiative resulted in Fisheries Officers and VFLOs participating in a Coastcare-funded 'Feral Peril' survey in conjunction with school students and the Water and Rivers Commission. The aim is to determine the abundance of exotic fish in the Chapman and Greenough Rivers and the effects of their introduction.

Initiatives for 2001/02

A number of strategies are being investigated to expand the opportunities for community volunteering within the legislative role of the Department of Fisheries and the provision of support to marine conservation groups. Education of recreational fishers in respect to the fishing rules and the 'Fish for the Future' initiative remains a priority. The completion of the West Coast Recreational Fishing Review remains a future point of interest for recreational fishers within the bioregion.

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), West 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 West Australian dhufish (*Glaucosoma hebraicum*) 29,000. The size of the recreational catch for many of these species was of a similar magnitude to the commercial catch. 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.

The current FRDC-funded project on short-term release mortality of under-size dhufish and snapper has been completed; however, longer-term mortality will continue to be examined until June 2005 through a tagging program. The research indicates that in the short term, the release mortality of under-size dhufish and snapper after capture by line is affected more by depth of capture than by hook type or release method (i.e. venting). For dhufish caught at depths greater than 40 m, preliminary analysis suggests that more than half will not survive more than three days after release.

RECREATIONAL ROCK LOBSTER FISHERY

Management Summary

The recreational component of the western rock lobster (*Panulirus cygnus*) fishery is managed under fisheries regulations which impose a mix of input and output controls on individual recreational fishers. Arrangements are designed to complement the management plan for the commercial fishery by constraining and managing the proportional impact of the recreational fishery.

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 input controls effectively limit fishing efficiency in the recreational sector, protect juvenile and breeding lobsters, and constrain the temporal spread of fishing effort.

Input controls include the requirement for a recreational fishing licence, and 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 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 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.

It is not anticipated that there will be any change to the recreational rock lobster season opening in November 2002.

Research Summary

General research for managing the rock lobster stock is undertaken through the Commercial Fisheries Program and reported in 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.

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 lobsters, and in the 2000/01 season 37,243 licences were sold. The 2000/01 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 2000/01):
564 tonnes (estimate)

The recreational catch of western rock lobster for 2000/01 was estimated at 564 tonnes, with 421 tonnes by potting and 143 tonnes by diving. Comparative catch estimates for 1999/2000 were 561 tonnes by potting and 186 tonnes by diving. The catch achieved was below the range expected, which may be due to the lower effort in 2000/01. In addition, low swell conditions were experienced during the season, which has a known negative effect on catches.

Fishing effort

37,243 people purchased licences to fish for lobsters, but only an estimated 28,453 utilised their licence. This compares to a licence usage of 29,420 in 1999/2000. The average pot and diving fishers (excluding all those who held a licence but failed to use it) used their licences on 33 and 10 days respectively during the 2000/01 fishing season. Potters and divers fished on average 34 and 11 days respectively in the 1999/2000 fishing season.

Catch rate

The average pot and diving catches were 1.3 and 2.5 lobsters per person per fishing day in the 2000/01 fishing season. In the 1999/2000 fishing season potters and divers caught 1.7 and 2.5 lobsters per person per fishing day respectively.

Commercial share: **95% (approx.)**

The commercial fishery accounted for around 95% of the overall catch of western rock lobster over the past season.

Stock assessment completed: **Yes**

The recreational catch is a relatively small proportion of the commercial catch (around 5%). For this reason overall stock assessments are an important focus of western rock lobster research and this information is given in the commercial fishery status report (pp. 8–14).

Exploitation status: **Fully exploited**

See the commercial fishery status report.

Breeding stock levels: **Adequate**

See the commercial fishery status report.

Projected catch next season (2002): **450–550 tonnes**

The recreational rock lobster catch has been estimated by mail surveys 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 tonnes 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.

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. The reason for this is that recruitment to the fishery is dependent on puerulus settlement with a three- to four-year time lag. As might be expected, sales 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 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 decreasing settlement indices in 1997/98 and 1998/99 and predicted licence usage, it is predicted that the recreational rock lobster catch will decrease to around 485 tonnes in 2001/02 (Recreational Rock Lobster Figure 1), with improved catches expected in 2002/03 and 2003/04.

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

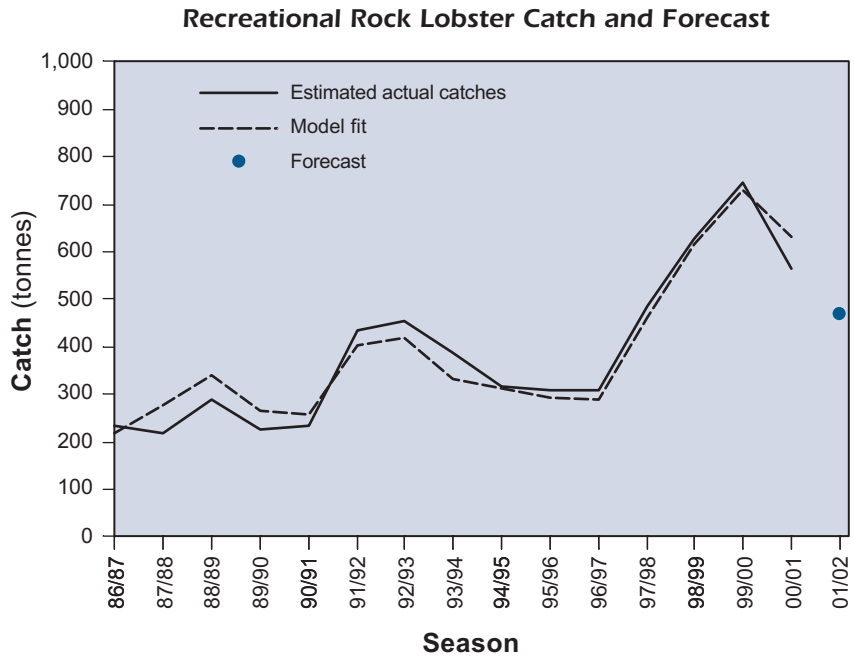
The direct value of the recreational catch in the 2000/01 season was about $15 million, however this represents only a minor proportion of the economic activity generated by this sector through the use of boats, fishing gear etc.

FISHERY GOVERNANCE

There are no direct controls on the annual take by the recreational sector in this fishery, other than size, bag limit, and seasonal constraints.

EXTERNAL FACTORS

The recreational catch is largely determined 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 with the model fit and its projection to 2001/02 based on puerulus settlement three to four years earlier and expected licence usage. Note that the model estimate for 2000/01 in this graph differs from that presented in the graph in the State of the Fisheries Report 2000/01 because the model has been refined in the interim.

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*), and is controlled through bag and size limits for each species. In the case of Roe's abalone, which is the major recreational species, additional seasonal controls apply along sections of the west coast.

These controls 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 managing the proportional impact of the recreational fishery on abalone, and also protecting other reef species such molluscs and echinoderms.

Management controls are highly restrictive, but 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 input controls effectively limit fishing efficiency in the recreational sector, protect juvenile abalone, and tightly constrain fishing effort through a limited open season. Output controls share the available catch and limit the accumulation of quasi-commercial quantities of abalone by individuals.

Input controls include the requirement for a recreational fishing licence, and a very short open season in the Perth metropolitan area (Cape Bouvard to Wedge Island) and the Greenough area (Greenough River to Flat Rocks car park). In these zones fishing is permitted for a total of nine hours over six consecutive Sundays, commencing on the first Sunday in November. Fishing on these days is permitted between 7.00 a.m. and 8.30 a.m. only. Elsewhere in the State abalone may be taken at any time of the year.

A minimum legal size of 60 mm applies to Roe's abalone, while regulations prohibiting the use of compressed air in the Greenough and Perth abalone fisheries restrict recreational fishers to reef platforms and shallower gutters. A daily bag/possession limit of 20 Roe's abalone per fisher also applies. For greenlip and brownlip abalone, the minimum legal size is 140 mm, and there is a combined daily bag/possession limit of 10.

Management arrangements for the recreational abalone fishery have been reviewed and recommendations are currently before the Minister for Fisheries. It is not anticipated that there will be any change to the management arrangements for the abalone season commencing in November 2002.

Research Summary

The recreational fishery for greenlip, brownlip and Roe's abalone can be partitioned into three main regions. These are the Perth, west coast (other than the Perth area) and south coast recreational fisheries. In the latter two fisheries all three species are taken, whereas only Roe's abalone are fished in the Perth recreational fishery. 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.

Catch and effort figures represented in this report are derived from two independent methods of estimation: telephone surveys covering all areas of the State, and field surveys for the Perth fishery only. The telephone survey estimates the catch of all three species from the three fishery regions, based on interviews stratified by licence type (abalone or umbrella) and respondent location (based on postcode) from the licensing database. The field survey estimates the catch and effort from each distinct stock within the Perth fishery. Field survey results are based on an analysis of head counts from land and aerial surveys, interview data from recreational fishers and catch weight measures of recreationally caught abalone.

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. During 2001/02 a project to describe growth at seven sites on the west coast, including five in the Perth fishery, was completed. This information has been used to determine the size range of the post-settlement year class (0+ year old abalone) and determine the time lag between settlement and minimum legal size.

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 2001 Perth and Greenough season ran from 4 November to 9 December.

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 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 fished by picking 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 estimates (2001):

Roe's Perth fishery 46 tonnes
Roe's rest of State 28 tonnes
Greenlip 46 tonnes
Brownlip 18 tonnes

All catches are shown in whole weight.

Estimating catch in tonnes requires the use of a mean weight figure for each species in each recreational catch region (see Recreational Abalone Tables 1 and 2 and Figure 1). Measurements of the mean weight of recreationally caught abalone are available only for the Perth Roe's recreational fishery for the seasons1999 to 2001. Mean weights for the other regions and species have been assumed on the basis of commercial catch weights and recreational minimum legal sizes (Recreational Abalone Table 1 and 2).

The majority of Roe's abalone were taken in the Perth fishery. Estimates of between 47.8 tonnes and 44.1 tonnes for the Perth fishery were derived from telephone and field surveys respectively. Based on these estimates, the catch for the Perth fishery has increased by about 45% from 2000 (44% and 46% for telephone and field surveys respectively). This was driven by an increase in effort and catch rate, as the mean weight of abalone was similar in 2000 and 2001 (91.3 g and 91.7 g respectively). The 33% decrease in weight of abalone taken between 1999 and 2000 was heavily influenced by the large (approximately 25%) decrease in the mean weight of abalone (119.5 g in 1999).

Catches of Roe's abalone in the other areas of the fishery were estimated using telephone surveys stratified by recreational abalone and umbrella licence holders and residential location (Recreational Abalone Table 2). The catch from the west coast increased by 52% in 2001 due to a doubling of effort. The south coast catch and effort have declined since 1999.

The recreational catch of greenlip and brownlip abalone on the west coast has increased while the catch from the south coast has remained stable (Recreational Abalone Table 2). This is despite the amount of abalone habitat on the west coast being more restricted than that on the south coast, with greenlip and brownlip abalone seldom occurring north of Cape Naturaliste. The greenlip and brownlip catch trends were driven by increasing effort on the west coast while effort on the south coast has decreased since 1999.

Fishing effort

The total recreational fishing effort during the 2001 Perth fishery was estimated at 29,649 fisher days from the telephone survey or 25,593 fisher days from the field survey. This represents increases of 36% and 29% over the 2000

estimates, and increases of 27% and 16% over the 1999 estimates, for the telephone and field surveys respectively. These increases are consistent with the increase in the number of licences to participate in the recreational abalone fishery, which rose to over 20,000 during the 2001 Perth season (including umbrella licences), with 9,076 specific abalone licences (Recreational Abalone Figure 3). The telephone survey estimated that 7,268 of these licence holders participated in the Perth fishery, which is 34% of the total number of valid licences and 62% of the specific abalone licences.

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. Recorded effort in 2001 was 9,577 fisher days for the south coast recreational fishery and 18,380 fisher days for the west coast. This represents decreases of 41% and 26% for the south coast compared to effort recorded in 1999 and 2000, with the west coast effort increasing by 87% and 79% from 1999 and 2000 respectively. The telephone survey estimated that 4,164 licence holders fished the west coast and 1,772 fished the south coast during 2001.

Catch rate

The catch rate during the Perth season was estimated at 17.6 and 18.8 abalone per fisher day by the telephone and field surveys respectively, an increase of 3.5% and 12.6% respectively over the 2000 figures. The Roe's abalone catch rates on the south and west coasts were estimated at 7.1 and 13.1 abalone/day respectively, which were similar to 2000. The catch rates for greenlip were 5.1 and 1.9 abalone/day on the south and west coasts respectively, while brownlip catch rates were 1.1 abalone/day on the south coast and 0.9 abalone/day on the west coast. These catch rates are similar to those for 2000.

Commercial share: **Roe's 55–60% (approx.)**
Greenlip/brownlip 75–80% (approx.)

The commercial fishers in the Perth Roe's abalone fishery have caught their quota of 36 tonnes in recent years. This was about 44% of the combined recreational and commercial catch in 2001, a decrease from approximately 53% in 2000 to a catch share similar to that of 1999 (45%) due to fluctuations in estimated recreational catch. For the State as a whole, the commercial Roe's abalone catch share was estimated at about 60%.

For greenlip and brownlip abalone the commercial catches were 187.5 tonnes and 31.1 tonnes respectively. These catches represent about 75–80% of the estimated total take of these two species statewide, though this ratio may be adjusted in the future when additional validation of the recreational catch is undertaken.

Stock assessment completed: **Yes**

For the Perth fishery, size distributions and densities were measured from six indicator reefs between Burns Beach and Penguin Island. Reef areas surveyed were 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 subtidal areas of abalone habitat. All abalone seen within a quadrat were counted and measured. These surveys were conducted in January and February each year from 1996 to 2002 (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).

Mean post-season densities after the recreational season have remained fairly stable since 1996. There have been slight decreases in abalone abundance on the Beaumaris and Mettams Pool platforms and a slight decrease in the subtidal densities at Bailey Street, with the Mettams Pool subtidal transect indicating a low abundance in the last five years. Abundances at the Burns Beach sample site have increased. The Waterman's Reserve, which is closed to fishing, shows stable abalone densities over the period, as does Penguin Island, which was closed from 1996 to 1999. These trends are consistent at most sites for both the under-size and legal-sized abalone, with the exception of the Mettams Pool and Beaumaris platforms. The decrease in total density at these sites is largely due to a lower density of under-size abalone on the reef plaform in 2002.

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 supports the conclusion that the incidental mortality is likely to be greater than 20%. This represents a large impact on the abalone stocks with no gain to 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.

West and south coast stock assessments are based on catch and effort data from the commercial fishery (see commercial status report, pp. 101–106).

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

See commercial fishery status report, pp. 101–106.

ECOSYSTEM EFFECTS

Habitat effects: **Low**

See commercial fishery status report, pp. 101–106.

SOCIAL EFFECTS

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

ECONOMIC EFFECTS

Not applicable.

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 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.

Year	TELEPHONE SURVEY				FIELD SURVEY				
	Effort (days)	Catch rate	Catch (number)	Catch (tonnes)	Effort (days)	Catch rate	Catch (number)	Catch (tonnes)	Mean weight (kg)
1997					16,986	18.9	323,188		
1998					20,815	17.5	369,905		
1999	23,323	17.6	410,000	48.8	22,066	17.4	383,631	45.8	0.1195
2000	21,767	17.0	369,000	33.7	19,800	16.7	330,288	30.2	0.0913
2001	**29,649**	**17.6**	**521,500**	**47.8**	**25,593**	**18.8**	**481,325**	**44.1**	**0.0917**

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 is likely to alter the individual species catch estimates when completed.

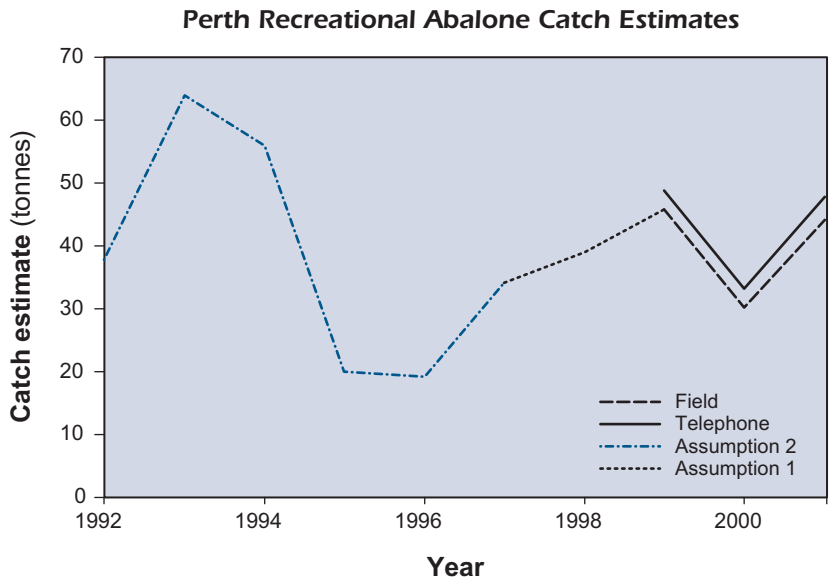
Year (days)	Effort[1]	ROE'S ABALONE			GREENLIP ABALONE			BROWNLIP ABALONE		
		Catch rate	Catch (number)	Catch[2] (tonnes)	Catch rate	Catch (number)	Catch[3] (tonnes)	Catch rate	Catch (number)	Catch[4] (tonnes)
West Coast										
1999	10,273	12.4	128,700	11.8	1.9	20,400	13.5	1.2	11,900	8.1
2000	9,820	12.7	123,500	11.2	2.3	23,400	15.5	0.6	6,900	4.6
2001	**18,380**	**13.1**	**240,700**	**21.6**	**1.9**	**35,650**	**23.6**	**0.9**	**16,200**	**11.0**
South Coast										
1999	16,289	11.0	186,800	17.0	3.0	48,400	22.6	0.7	10,930	7.1
2000	12,966	7.3	90,900	8.3	5.0	67,500	31.5	0.8	11,400	7.4
2001	**9,577**	**7.1**	**68,100**	**6.1**	**5.1**	**48,700**	**22.7**	**1.1**	**10,200**	**6.6**

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 total densities of abalone greater than 5 mm and mean densities of legal-sized abalone (> 60 mm) 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		METTAMS POOL		BAILEY STREET		PENGUIN ISLAND	
	Total	60+	Total	60+	Total	60+	Total	60+	Total	60+	Total	60+
Reef platform												
1996	124	34	90	46			84	23	110	37		
1997	101	43	119	62	90	31	80	39	107	51	76	34
1998	119	42	122	65	109	46	81	31	109	38	104	50
1999	127	45	92	45	106	36	90	35	88	25	149	53
2000	137	46	86	47	84	45	88	27	86	21	131	55
2001	155	56	88	50	95	45	74	25	87	26	138	54
2002	**168**	**61**	**69**	**45**	**103**	**49**	**56**	**26**	**85**	**33**	**130**	**53**
Subtidal reef												
1997	17	14	16	12	36	24	32	17	37	33	51	30
1998	19	16	20	14	57	38	9	8	33	25	52	30
1999	19	14	22	12	53	35	0	0	20	16	31	21
2000	28	22	12	11	53	39	1	1	12	9	46	40
2001	25	19	17	14	48	35	1	1	14	10	47	36
2002	**35**	**29**	**20**	**15**	**52**	**40**	**1**	**1**	**16**	**12**	**35**	**28**

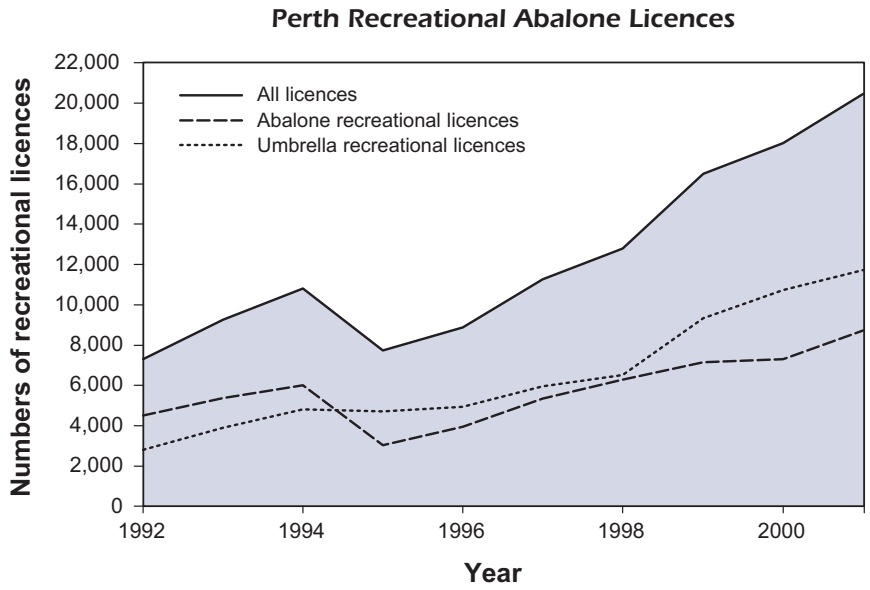


RECREATIONAL ABALONE FIGURE 1

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 during 1992 to 1996 is equal to the average of the two mean weight values measured for 1999 and 2000.



RECREATIONAL ABALONE FIGURE 2

The number of licences issued in the Perth recreational abalone fishery, by licence type, for the period 1992 to 2001.

Note that the recreational season totalled 16 days in 1993, 12 days in 1992 and 1994, 5 days in 1996 and 6 days in 1995 and 1997–2001. Since 1995 permissible fishing time per season day has been 1.5 hours (7.00 to 8.30 a.m., Sundays only). In 1992–1994 fishing was permitted for two hours per season day (7.00 to 9.00 a.m., Saturdays and Sundays).

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 (particularly at spawning), makes the stock 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, and several proposals, including an increase in the minimum legal size and a special bag limit on tailor over 600 mm, are under consideration by the Minister for Fisheries.

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. A further research project to investigate the basic biology of tailor will provide information on the age structure, growth and reproduction of this important recreational species. These data will be included in further modelling of the dynamics of tailor populations that will allow better assessment of future fishery management options.

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 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, gillnet.

RETAINED SPECIES

Recreational catch (season 2001): **Not assessed**

Recreational tailor catch estimates are not available for the current year. However, a boat-based angler survey conducted between Kalbarri and Augusta during 1996/97 estimated the tailor catch at 26,627 fish (10 tonnes) kept. As expected, the catches were greatest in the southern Perth region, from south of the Swan River to Warnbro Sound (Sumner and Williamson 1999). There have been no comparable surveys of shore-based catches. Thus, the total recreational catch from this region is likely to be considerably higher.

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 tonnes) (± 1,276 fish) and 1,567 released. There was an equal distribution of tailor caught between shore and boat anglers. The greatest proportion of the Gascoyne tailor catch (87%) was taken from the Shark Bay Marine Park (Sumner et al. 2002).

Fishing effort

The participation level for the tailor fishery is unknown for 2001. However, the estimated annual recreational angling effort calculated from the boat-based survey conducted between Kalbarri and Augusta during 1996/97 was 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) (Sumner and Williamson 1999).

The fishing effort from the boat- and shore-based angler survey in the Gascoyne region (Steep Point to Exmouth Gulf) between 1 April 1998 and 30 March 1999 indicated the total annual recreational fishing effort for the Gascoyne region was 339,000 fisher days (Sumner et al. 2002).

Catch rate

The mean catch rate for boat-based anglers from the southern Perth district targeting tailor was 1.73 fish per angler day (Sumner and Williamson 1999).

Commercial share: **State 41.5 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 1.5 tonnes, representing approximately 3.5% of the total 2001 annual commercial catch. The three estuaries reported a combined catch of 6.3 tonnes, which is approximately 15% of the total 2001 annual commercial catch.

Approximately 63% (26.1 tonnes) of the 2001 total State commercial catch was recorded from the Shark Bay Beach Seine and Mesh Net Managed Fishery. A further 17% (7.1 tonnes) 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 in this sector.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

While targeting tailor, marine anglers may catch a variety of species including juvenile Australian salmon, Australian herring and mulloway. It is not clear what the impact is on the stocks of these other species.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Young-of-the-year tailor spend their first year living in coastal and estuarine habitats, feeding predominantly on small baitfish. Subsequently, most fish move offshore. As tailor are a top predator species it is possible that the expanding recreational fishery has the potential to decrease

mortality on their prey species. However, given the annual variability in tailor biomass, the fishing effect is likely to be similar in magnitude to other factors influencing prey availability. Overall the impact of the fishery is assessed as low.

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 which 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 8% of the State's fishers or 50,000 fishers a year (Baharthah and Sumner 2002).

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 recent 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 66 fishing tour licences and 7 ecotour licences issued for the Gascoyne bioregion.

A review of recreational fisheries management arrangements for the Gascoyne bioregion has been completed. A discussion paper prepared by a community-based working group was released in May 1999 for public comment. The working group has reviewed public submissions and prepared a recreational fishing management strategy which is currently being considered by the Minister for Fisheries.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

The Gascoyne coast bioregion has nine Fisheries Officers working out of three offices located at Denham, Carnarvon and Exmouth. The officers deal with a wide range of recreational fisheries within the region, encompassing boat and shore angling (including diving), rock lobster, 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 craft are used to service protected waters and creek fishing activities. Carnarvon staff utilise small dinghies for inshore coastal and creek patrols, and have recently acquired a quad-bike to access certain mangrove creeks and beaches.

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 therefore regularly

discreetly observe fishers from a distance, particularly in response to information provided to them through the toll-free Fishwatch service.

Activities during 2000/01

During 2000/01, Fisheries Officers delivered 7,470 hours of compliance work to recreational fisheries in the Gascoyne coast bioregion (Gascoyne Coast Recreational Compliance Table 1), concentrating mainly on checking shore-based and boat-based anglers. As a result of these compliance activities, 25 infringement warnings and 20 infringement notices were issued, while 10 prosecutions were initiated for more serious offences.

During the same period (2000/01), a total of 85 Fishwatch calls were received. The Fishwatch system is a statewide 24-hour telephone hotline utilised by members of the public who wish to report instances of observed illegal fishing activity. While these calls may relate to matters of all kinds, traditionally the majority involve possible recreational fishing offences. Complaints received by the service in relation to the Gascoyne bioregion tend to focus on the taking of fish in excess of bag or boat limits, the taking of under-size or totally protected fish, and cases of people netting in closed waters or fishing in sanctuary zones in the Ningaloo Marine Park.

A VFLO program focusing on the education of recreational fishers supplemented the more formal compliance activities conducted by Fisheries Officers in the bioregion. The Gascoyne VFLOs are generally very keen anglers committed to protecting the aquatic environment and promoting the 'Fish for the Future' ethic.

In 2000/01, the Gascoyne Region VFLO program recorded 346 contacts for the year and involved approximately 8 volunteers. Community education activities conducted in the bioregion included attendance and presentations by Fisheries Officers and VFLOs at regional shows and expos, primary and high schools, and community group meetings.

Initiatives in 2001/02

During 2001/02 Fisheries Officers combined efforts with VFLOs, through joint patrols and activities, to place greater emphasis on educating Gascoyne communities and visitors on the need to adhere to the 'Fish for the Future' ethic and the rules and regulations.

This incorporated an extensive workshop at Coral Bay during school holidays. A range of hands-on activities provided attendees with education about minimum legal sizes, bag limits, possession limits and areas closed to certain fishing activities, as well as the promotion of the important 'Catch Care' message.

Fisheries Officers at the Carnarvon District Office also made use of a four-wheel motorbike to access areas of mangrove creek and coastline difficult or impossible to access by normal 4WD vehicles. This produced some excellent results and the incorporation of this bike into more recreational patrols throughout the Gascoyne bioregion will be continued during 2002/03.

GASCOYNE COAST RECREATIONAL COMPLIANCE TABLE 1

Summary of compliance and educative contacts and infringement types in recreational fisheries within the Gascoyne coast bioregion during the 2000/01 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	7,470
Fisher field contacts by Fisheries Officers (6 months)*	3,626
District Office contacts by Fisheries Officers (6 months)*	931
Fisher field contacts by VFLOs	346
Fishwatch reports **	85
OFFENCES DETECTED	**NUMBER**
Infringement warnings	25
Infringement notices	20
Prosecutions	10

* These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

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

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, given the concern over the status of these two fish stocks.

Staff from the Exmouth District Office promoted the unique Ningaloo Marine Park experience to those they encountered, while reminding them of the specific requirements placed on those fishing in the area in relation to possession limits, landing limits, sanctuary zones and bag limits.

The finalisation of the Gascoyne Review, anticipated in 2002/03, will also bring a need for extensive educational and compliance patrols throughout the bioregion, and these are expected to involve 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 recreation catch of all finfish species for the region in 1998/99 was estimated at 350 tonnes, excluding charter vessel catches. This was approximately one-third of the commercial catch of 1,082 tonnes at the time.

Important recreational species, in order of weight caught, were spangled emperor (*Lethrinus nebulosus*) (30,000 fish kept, or 79 tonnes); pink snapper (*Pagrus auratus*) (28,000 fish or 79 tonnes); mackerel (*Scomberomorus* spp.) (Spanish mackerel 8,000 fish or 47 tonnes, other mackerel 8 tonnes); black snapper or grass emperor (*Lethrinus laticaudis*) (33,000 fish or 34 tonnes); golden trevally (*Gnathanodon speciosus*) (6,000 fish or 20 tonnes); sweetlip emperor (*Lethrinus miniatus*) (13,00 fish or 16 tonnes); Chinaman cod (*Epinephelus rivulatus*) (23,000 fish or 10 tonnes gilled and gutted); western yellowfin bream (*Acanthopagrus latus*) (10,000 fish or 5 tonnes); tailor (*Pomatomus saltatrix*) (7,000 fish or 5 tonnes); and whiting (Sillaginidae*)* (34,000 fish or 5 tonnes).

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 tonnes. A second survey to monitor the recreational catch of pink snapper and other species in Shark Bay was conducted from May 2000 to April 2001.

The National Recreational Fishing Survey has collected further information for this and other regions of the State during 2000/01. The results from this latter study will become available during 2002/03.

INNER SHARK BAY RECREATIONAL FISHERY

Management Summary

As a result of excessive fishing pressure on the inner Shark Bay snapper stocks, a series of modifications have been made to the management arrangements in the area.

In 1997 a bag limit of 2 pink snapper (*Pagrus auratus*) per person, a minimum size limit of 500 mm and a maximum size of 700 mm were introduced for the eastern gulf. The eastern gulf was then closed to pink snapper fishing on 9 June 1998 to enable this stock to recover from several years of intensive recreational fishing effort leading to recruitment over-fishing.

For the western gulf, a minimum size of 450 mm, a bag limit of 4 and a limit of 2 fish over 700 mm per person were introduced during 1998. Due to ongoing concerns for pink snapper stocks in the western gulf, revised regulations were introduced from 25 August 2000. These included a minimum size limit of 500 mm, bag limit of 2 and a limit of one fish over 700 mm per person. A closure in Freycinet Estuary (south of Goulet Bluff) between 15 August and 30 September, during the spawning period, was also introduced.

The latest revisions have reduced the recreational catch in the western gulf and provided protection for at least one year-class of mature snapper. However, adult stock levels in both Freycinet Estuary and Denham Sound are well below appropriate biological reference points, and a further review of management will be undertaken in 2002/03.

The eastern gulf will remain closed to the take or landing of pink snapper until the initial biological reference point of 100 tonnes spawning biomass is reached. Following that, management will need to ensure that the recreational and commercial catch of snapper is maintained at a level which allows continued rebuilding to 40% of the estimated unfished spawning 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.

Existing fishing controls in Shark Bay constrain the take of this species to a maximum of 5 per person per day as part of a mixed daily bag limit, and in the eastern gulf a mixed species boat limit of 10 per day also applies. Within the Ningaloo Marine Park a mixed bag limit of 7 applies.

The Gascoyne regional recreational fisheries management strategy recommends a reduced bag limit of 6 for all *Lethrinus* species as part of a mixed species bag limit of 7 (down from 8) across the region. An increased minimum size limit of 320 mm (up from 280 mm) is also recommended for this species until biological and stock assessment research is completed.

Research Summary

Research to support the management of Shark Bay pink snapper undertaken during the 1980s identified genetically separate stocks in each of the Shark Bay gulfs. Concerns about increasing recreational fishing pressure on the inner gulf stocks during the early 1990s, and the outcome of research surveys for juvenile snapper in November 1996 and February 1997, resulted in the development of a detailed research project commencing in June 1997. Since then this research has provided scientific assessments of the status of the inner bay snapper stocks for management of this key

target species in the important recreational fishery within Shark Bay.

Research to support the management of the increasingly popular black snapper or grass emperor, the second most commonly taken recreational species in the inner gulf region of Shark Bay, commenced in July 1999. The specific objectives of this research are to examine stock delineation using stable isotope analysis of otolith carbonate, determine the age structure, growth rate and reproductive biology of black snapper, and use this information to develop a stock assessment model for black snapper stocks from the inner gulfs of Shark Bay.

Estimates of recreational catch and effort inside Shark Bay have been derived from results of creel surveys, undertaken initially in 1998/99 as part of a broader survey of the whole Gascoyne region, and more recently at key boat ramps inside Shark Bay between May 2000 and April 2001.

During the 1998/99 Gascoyne Recreational Fishing Survey (Sumner et al. 2002) the entire Shark Bay Marine Park was surveyed, including sites on the east shore of the eastern gulf from Uendoo Creek (south of Carnarvon) to Gladstone. While almost all the fishing activity occurred within the boundaries of the Shark Bay Marine Park, the survey results include some catches from vessels which were launched within the marine park but also fished outside the park boundaries, for example in Denham Sound or west of Dirk Hartog Island. There are specific regulations that apply to pink snapper caught within Shark Bay. Statewide fishing regulations apply to other species.

The estimated annual recreational fishing effort for Shark Bay during 1998/99 (excluding the recreational charter operators who could not be surveyed) was 89,000 fisher days. This comprised 49,000 fisher days by boats launched from public ramps at Nanga, Denham and Monkey Mia, 18,000 fisher days by boats launched from beaches within the marine park and 22,000 days by shore-based fishers.

The most common species kept by all recreational fishers in Shark Bay were (in order of estimated weight kept) pink snapper (*Pagrus auratus*) 58 tonnes, black snapper (*Lethrinus laticaudis*) 22 tonnes, Spanish mackerel (*Scomberomorus commerson*) 15 tonnes, spangled emperor (*Lethrinus nebulosus*) 7 tonnes, tailor (*Pomatomus saltatrix*) 4 tonnes, whiting species (Sillaginidae) 3 tonnes, western butterfish (*Pentapodus vitta*) 2 tonnes and mullet species (Mugilidae) 2 tonnes. The catch of pink snapper includes the inner gulf stock (41 tonnes) and oceanic stock (17 tonnes) landed in Shark Bay.

The recreational catch of pink snapper landed at Nanga and Denham during 2000/01 was estimated as 8,000 fish kept (25 tonnes). A further 100 fish were estimated to have been eaten by sharks. Almost all the recreational catch landed at Nanga and Denham was from the western gulf stock rather than the oceanic stock. The catch of oceanic snapper landed at Peron Peninsula and Shelter Bay (South Passage) was not included in the inner bay estimates. The eastern gulf was closed to pink snapper fishing for the period when the survey was conducted.

The recently introduced management measures in the western gulf appear to have been effective in protecting pink snapper stocks by reducing the estimated recreational catch from 38 tonnes during 1998/99 to 25 tonnes in 2000/01. Most of the reduction has occurred in the Freycinet Estuary where the catch was reduced from 26 tonnes in 1998/99 to 16 tonnes during 2000/01.

INNER SHARK BAY PINK SNAPPER STOCKS STATUS REPORT

Prepared by G. Jackson and N. Sumner

FISHERY DESCRIPTION

Boundaries and access

Evidence from various stock identification studies carried out since the 1980s (genetics, tagging, otolith stable isotope analysis, variation in head shape, comparison of life-history parameters, hydrodynamic modelling of egg and larval dispersal) suggests that a number of reproductively isolated populations of pink snapper (*Pagrus auratus*) inhabit the inner gulfs of Shark Bay. Although further research (e.g. a DNA-based technique) is required to fully explain the genetic relationship between these snapper populations, management now recognises three fishable stocks in the inner gulfs. 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 (Gascoyne Recreational Fishing 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.

Although commercial fishing for pink snapper has historically been undertaken in the inner gulfs, snapper in these waters have primarily become the target of recreational fisheries since about the 1980s. The eastern gulf snapper fishery, closed in June 1998 to allow the recovery of the spawning stock, remains closed. Bag/size limits and a seasonal spawning closure (Freycinet Estuary only) apply in the western gulf. Commercial snapper fishing in these gulf waters is now limited to the 11 licensed fishing units of the Shark Bay Beach Seine and Mesh Net Managed Fishery (also subject to the eastern gulf snapper closure).

Main fishing method

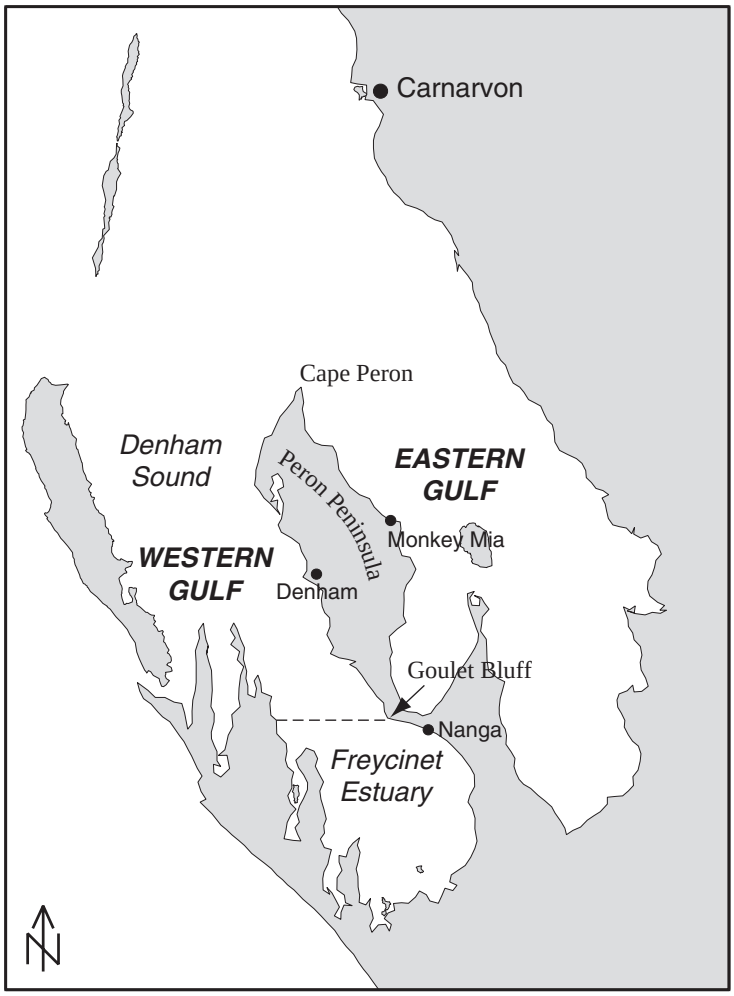
Recreational:	Rod and line, handline.
Commercial:	Handline, beach seine, haul net, gillnet.

RETAINED SPECIES

Recreational catch (season 2001): **Eastern gulf closed**

Western gulf:
Freycinet Estuary 22 tonnes (estimated)
Denham Sound 8 tonnes (estimated)

Following an aerial and boat ramp survey in 1983, the recreational catch of pink snapper in the inner gulfs of Shark Bay was estimated at approximately 7 tonnes from the eastern gulf, 12 tonnes from Denham Sound and 17 tonnes from the Freycinet Estuary. In 1998, the recreational snapper catches were estimated at approximately 3 tonnes from the eastern gulf (for the period April–June only, prior to the snapper fishery closure), 12 tonnes from Denham Sound and 26* tonnes from Freycinet Estuary. In 2000, the estimates were approximately 9 tonnes from Denham Sound and



GASCOYNE RECREATIONAL FISHING FIGURE 1

The recreational fishing areas of inner Shark Bay.

16* tonnes from Freycinet Estuary, with no catch in the eastern gulf. In 2001 (May 2001–April 2002), a further survey estimated the recreational snapper catch in Denham Sound to be approximately 8 tonnes and in the Freycinet Estuary approximately 22 tonnes (Nanga 17 tonnes, Tamala 5 tonnes), again with no catch in the eastern gulf. From the results of the most recent survey, 94% of all snapper caught in Denham Sound were released compared with 79% at Nanga and 88% at Tamala.

* It should be noted that, in both 1998 and 2000, the Freycinet Estuary estimates are for the Nanga boat ramp only and do not include Tamala, and therefore represent an under-estimate of the total catch. .

Fishing effort

The Gascoyne Recreational Fishing Survey of 1998/99 (Sumner et al. 2002) indicated that approximately 49,000 fisher days were expended in the inner gulfs in 1998 by boat fishers launching from public ramps, with approximately 80% of the effort in the western gulf and 20% in the eastern gulf (closed to the take of pink snapper in June 1998). Effort decreased in 2000, when 35,000 days were expended by boats fishing from the public ramps at Nanga, Denham and Monkey Mia, with approximately 70% of the effort in the western gulf and 30% in the eastern gulf. From the most recent survey, effort was similar in 2001, with boat fishing effort from the same ramps estimated at 34,000 days, approximately 80% of which was in the western gulf and 20% in the eastern gulf.

Commercial share: **Eastern gulf closed**
Western gulf 6% (approx.)

The total commercial catch of pink snapper taken by the Shark Bay Beach Seine and Mesh Net Managed Fishery appears never to have been large, in more recent years rising from approximately 5 tonnes in 1993 (eastern gulf 3 tonnes, western gulf 2 tonnes) to a peak of approximately 9 tonnes in 1997 (eastern gulf 3 tonnes, western gulf 6 tonnes). In 2001, as in 2000, there was no catch in the eastern gulf (fishery closed) and approximately 2 tonnes in the western gulf.

Stock assessment completed: **Yes**

The daily egg production method has been used to directly estimate the size of the snapper spawning stock in the eastern gulf, Denham Sound and the Freycinet Estuary each year since 1997. Research trawl surveys (1996 to the

present) and trap surveys (1998–2000) have been used to provide information on the abundance of 0+ age snapper in both gulfs, and thereby measure variation in recruitment. Preliminary results indicate that snapper recruitment is highly variable, particularly in the Freycinet Estuary.

In recent years these data, combined with estimates of commercial and recreational catches, have been use independently to determine the status of each inner gulf 'stock'. Information on the age composition of recreational snapper catches and estimates of the key biological parameters (growth rates, size/age at maturity) have now been incorporated into quantitative age-structure models to independently assess the status of each snapper 'stock', to investigate the dynamics of the fishery and evaluate alternative management strategies.

Exploitation status: **Eastern gulf closed**

Western gulf:
Freycinet Estuary over-exploited
Denham Sound over-exploited

Breeding stock levels:
Eastern gulf inadequate but increasing

Western gulf:
Freycinet Estuary inadequate (locally depleted)
Denham Sound inadequate but increasing

Following extensive community consultation in 1998 prior to the closure of the eastern gulf snapper fishery, management targets for the spawning stock in each area were agreed based on the limited information available at the time. More recently, following model-based stock assessments, these management targets have been re-evaluated. Given the uncertainty surrounding historical catch levels in this fishery, the stock levels from 1983 – the earliest reliable estimate – have been used as the nominal baseline. A biological reference point of 40% of the 1983 spawning biomass has therefore been adopted for each 'stock'.

Stock assessment modelling indicates that the eastern stock virgin biomass was greater than previously estimated, at approximately 400 tonnes. Although the adult stock has recovered steadily since the fishery was closed in 1998, the spawning biomass is currently estimated to be just below the biological reference point of 150 tonnes. In Denham Sound, although the spawning biomass is currently estimated to be well below the biological reference point of 110 tonnes, some recovery is apparent. The high proportion of under-sized snapper released by recreational fishers in this area indicates good recruitment in recent years. The Freycinet spawning biomass is estimated to be at a critically low level relative to the biological reference point of 120 tonnes. However, trawl surveys have indicated that particularly strong recruitment occurred in 2000, with the cohort expected to enter the fishery in 2003/04. Although this is likely to make a significant contribution to the breeding stock, it needs to be viewed in the context of the severely depleted state of the older age classes in the spawning population.

FISHERY GOVERNANCE

Management of the eastern 'stock' through a total closure has been successful in rebuilding the breeding stock. Some level of fishing in the eastern gulf may be possible in 2003 although the catch will need to be limited to a sustainable level (approximately 10–12 tonnes) to achieve full recovery to the biological reference point by 2007. Management measures introduced in the western gulf in 2000 (increase in minimum size to 500 mm, further protection of fish > 700 mm, reduction of daily bag limit to 2 fish, six-week spawning season closure in Freycinet only) have had only a limited effect in reducing the snapper catch in Denham Sound and the Freycinet Estuary. Although further measures may not be required in Denham Sound provided the annual catch is maintained at the current level (10 tonnes) and the spawning biomass recovery continues, more drastic action is necessary immediately in the Freycinet Estuary to recover the spawning stock. A Snapper Working Group, recently appointed by the Minister, is currently considering the available scientific information and will be making recommendations in relation to a range of strategies to manage inner gulf snapper into the future.

EXTERNAL FACTORS

Information on inner gulf snapper 'stocks' obtained since 1996 suggests that annual recruitment, particularly in the Freycinet Estuary, may be highly variable, possibly due to the effect of environmental factors on the survival of snapper larvae and early stage juveniles. Such recruitment variability has been shown to be important in snapper fisheries elsewhere in Australia and New Zealand, where strong year classes resulting from high but infrequent recruitment can maintain a fishery through more numerous years of poor or average recruitment. Understanding these effects and the relationship between the size of the spawning stock and juvenile recruitment in the inner gulfs of Shark Bay is critical to assessing sustainable catch levels for each 'stock' and will be the focus of future research. There is also some local community concern regarding the potential impact of the seasonal prawn trawling in Denham Sound on juvenile snapper recruitment and the consequences for the recreational snapper fishery in this area. Research projects recently completed or currently under way, including bycatch reduction technology for prawn trawlers, identification of nursery areas used by snapper in the western gulf, and assessment of the interaction between prawn trawling and juvenile snapper in Denham Sound, will provide information on the potential significance of prawn trawling on the snapper population in that area.

INNER SHARK BAY BLACK SNAPPER STOCK STATUS REPORT

Prepared by S. Ayvazian

FISHERY DESCRIPTION

Boundaries and access

A stock discrimination study, using 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, indicates that samples of black snapper from waters of different salinity can be distinguished by their O^{18} values. Initial results of a recently conducted 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 some 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): **Not assessed**

Recreational catch estimates are not available for the current year. However, the Gascoyne Recreational Fishing Survey of 1998/99 estimated a total recreational catch of 30,000–37,000 black snapper retained (approximately 34 tonnes) and 40,000–50,000 released. This was the second most popular species caught (in order of number kept) after whiting. Essentially, all of the catch was taken by boat-based fishers, with catches from the Shark Bay Marine Park making up about three-quarters of the total regional catch (Sumner et al. 2002).

Fishing effort

Not assessed for 2001.

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**

FISHERY GOVERNANCE

At this time, control of the exploitation rate is managed through a daily possession 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 fishing 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. The results from the black snapper research program should be available by the end of 2002 to assist with the sustainable management of this species.

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 12% of the State's recreational anglers, or some 70,000 anglers per year generating 1 million fishing days (Baharthah and Sumner 2002). Recreational fishing shows distinct seasonal peaks, with the highest number of visitors during the winter months.

A recent 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. Detailed catch results from this survey will be found in the following pages.

Charter activity is also significant, with 85 fishing tour licences and 5 ecotour licences issued for the north coast bioregion.

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. A working group formed in March 2000 developed a number of recommendations for

both the commercial and recreational exploitation of the species, and legislation to implement new management arrangements was introduced in early 2002. In addition, a recreational fishing zone has been established in the lower Ord River to maintain the high-quality recreational fishing and aquatic ecotourism experience. Special management arrangements in this area include a minimum size limit of 550 mm, a maximum size of 800 mm and a possession limit of one barramundi per person.

A review of recreational fishing in the north-west and development of a recreational fishing management strategy is expected to commence in 2002/03.

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, 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 and inspecting gear and catch, and include responses to Fishwatch calls on a needs basis.

Activities during 2000/01

A total of 4,829 hours of field activity were undertaken by Fisheries Officers during 2000/01 in relation to coastal boating and land-based recreational fishing activities, particularly netting, with a total of 1,051 compliance and education contacts recorded in the six months from January to June.

As a result of compliance activities a total of 7 infringement notices and 13 infringement warnings were issued during the year for a variety of recreational offences, while a further 7 incidents resulted in prosecution.

The VFLO programs in Broome and the Pilbara are coordinated by Fisheries Officers, with volunteers from these groups providing assistance in several community displays in Karratha and Port Hedland. Volunteers reported 35 contacts throughout the year.

Regional Recreational Fishing Advisory Committees operate in Kununurra, Broome and Karratha, with meetings 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 for these committees is provided by Department of Fisheries officers.

NORTH COAST 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 2000/01 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	4,829
Fisher field contacts by Fisheries Officers (6 months)*	613
District Office contacts by Fisheries Officers (6 months)*	438
Fisher field contacts by VFLOs	35
Fishwatch reports **	25
OFFENCES DETECTED	**NUMBER**
Infringement warnings	13
Infringement notices	7
Prosecutions	6

* These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

** 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 2001/02

During 2001/02, close liaison has been maintained with the WA Police Department in the region, and on several occasions their assistance was provided on patrols. In general, compliance levels have been good, although several offences were detected relating to netting and catches in excess of bag limits.

The introduction of the Barramundi Accord in early 2002 saw changes made to recreational netting and barramundi regulations across the Pilbara and Kimberley. As a consequence, increased patrols are being carried out to popular fishing destinations throughout the region. The appointment in 2002 of a regional coordinator for the VFLO program, together with the planned publication of a new fish identification brochure and installation of new signage regarding the barramundi rules, will also improve community awareness.

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 is now being written up and will provide detailed biological and fishery data on these important recreational species.

A major project which began in July 2000 is collecting 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.

To estimate total catch for recreational stock management purposes, a 12-month creel survey of recreational boat- and shore-based fishing from Exmouth Gulf to Broome (including the Dampier Archipelago) was undertaken between December 1999 and November 2000. Preliminary data from this survey are reported in the following pages. The results from this study will be complemented by data from the National Recreational Fishing Survey undertaken during 2000/01.

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.

PILBARA RECREATIONAL FISHING SURVEY

Prepared by N. Sumner, P. Williamson and B. Malseed

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. Recreational fishing records from charter boats were not included in the survey; however, a logbook has been developed to collect catch and fishing effort information from tour operators and these data will be provided in future years. Furthermore, 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.

In summary, the total annual recreational fishing effort for the Pilbara region in 1999/2000 was 190,000 fisher days. This comprised 109,000 fisher days by boats launched from public ramps, 23,000 fisher days by boats launched from beaches and 58,000 days by shore-based fishers. The spatial distribution of fishing effort from boats launched from public ramps was estimated for each 5 x 5 nautical mile block from the survey data collected (Pilbara Recreational Fishing Figure 1). Effort from boats launched from beaches and from shore-based fishers was estimated separately for each of the two survey regions, Onslow to Karratha and Karratha to Broome.

The total recreational catch of all scalefish species for the region in 1999/2000 was estimated at 300 tonnes, excluding charter vessel catches. This equates to approximately 12% of the commercial demersal scalefish catch (2,311 tonnes) and commercial mackerel catch (130 tonnes) for this region during the same period. Spangled emperor, red emperor, barramundi, threadfin salmon species and mackerel species were taken by both the recreational and commercial sectors; however, most recreational species were not taken by the commercial sector or were only taken in small quantities. (For simplicity, the preliminary catch estimate for each species is shown as a point estimate rather than an estimated range. Where commercial catches are quoted, the data are from the CAES records for the same year.)

The important recreational species (in order of tonnages landed), which together comprised 76% of the total catch by weight, were as follows.

Trevally species

Trevally species (family Carangidae) are predominantly caught recreationally. The estimated recreational catch of golden trevally (*Gnathanodon speciosus*) for the region was 12,000 fish kept (38 tonnes) and 16,300 released. A further 200 fish were estimated to have been eaten by sharks. Golden trevally was predominantly (62%) caught by boat-based fishers. Only 9 tonnes (24%) of the catch was taken from the Dampier Archipelago. There was no minimum size for northern trevally species at the time of the survey.

The estimated recreational catch of giant trevally (*Caranx ignobilis*) for the region was 2,300 fish kept (10 tonnes) and 10,600 released. All giant trevally was caught by boat-based fishers.

The estimated recreational catch of big-eye trevally (*Caranx sexfasciatus*) for the region was 2,800 fish kept (2 tonnes) and 1,700 released. All big-eye trevally was caught by boat-based fishers.

Narrow-barred Spanish mackerel and other mackerel species

In the region, all narrow-barred Spanish mackerel (*Scomberomorus commerson*) was caught by boat-based fishers. The estimated recreational catch for the region was 4,300 fish kept (30 tonnes). A further 1,200 fish were estimated to have been eaten by sharks. The commercial catch for the Pilbara region during 2000 was 105 tonnes (see Spanish Mackerel Stock Status Report, pp. 87–91). A stock assessment of the fishery is presently under way.

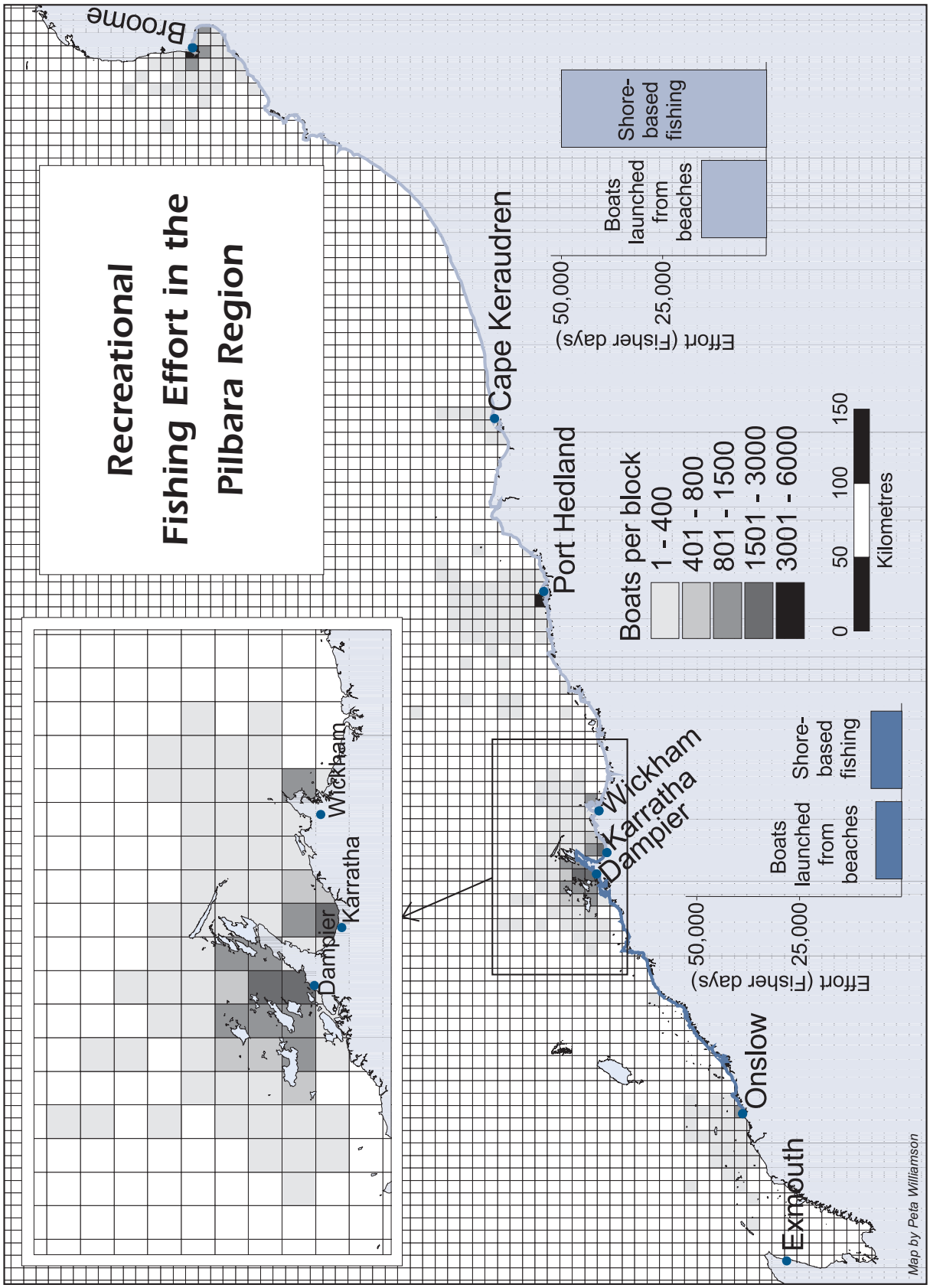
Recreational fishers also caught 2,600 (3 tonnes) Queensland school mackerel (*Scomberomorus queenslandicus*), 500 (3 tonnes) broad-barred Spanish mackerel (*S. semifasciatus*), 200 shark mackerel and 7,000 (8 tonnes) other mackerel species. The commercial catch of other mackerel species for the same period was 27 tonnes (see Spanish Mackerel Stock Status Report).

Black snapper (grass emperor)

Black snapper (*Lethrinus laticaudis*), known locally as grass emperor and also called blue-lined emperor, is predominantly a recreationally caught species. The estimated recreational catch for the region was 18,400 fish kept (22 tonnes) and 37,100 released. A further 300 fish were estimated to have been eaten by sharks. All black snapper was caught by boat-based fishers. Only 4 tonnes (19%) of the catch was taken from the Dampier Archipelago.

Tuskfish

The estimated recreational catch of blackspot tuskfish (*Choerodon schoenleinii*) for the region was 7,700 fish kept (20 tonnes) and 17,200 released. Blackspot tuskfish was predominantly (81%) caught by boat-based fishers. One quarter of the catch (25%) was taken from the Dampier Archipelago.



PILBARA RECREATIONAL FISHING FIGURE 1

Spatial distribution of recreational fishing effort in 2000/01.

The estimated recreational catch of blue tuskfish (*Choerodon cyanodus*) for the region was 700 fish kept (1 tonnes) and 3,822 released. All blue tuskfish was caught by boat-based fishers. There was also a small catch of purple tuskfish (*C. cephalotes*) and bluespotted tuskfish (*C. cauteroma*).

Threadfin salmon species

Threadfin salmon species were predominantly caught recreationally. The recreational catch comprised blue threadfin salmon (*Eleutheronema tetradactylum*), giant threadfin salmon (*Polydactylus macrochir*) and northern threadfin salmon (*P. plebius*). The estimated recreational catch of threadfin salmon species for the region was 15,200 fish kept (18 tonnes) and 9,500 released. Approximately half (53%) of the threadfin salmon species were caught by shore-based fishers. There was also a small catch of black-finned threadfin (*P. nigripinnis*) and Gunther's threadfin (*P. multiradiatus*).

Spangled emperor

Spangled emperor (*Lethrinus nebulosus*) is an important species for recreational and commercial fishers. The estimated recreational catch for the region was 8,700 fish kept (12 tonnes). A further 300 fish were estimated to have been eaten by sharks. The commercial catch from the region for the same period was 18 tonnes. All spangled emperor was caught by boat-based fishers. Only 3 tonnes (28%) of the catch was taken from the Dampier Archipelago. Many fish kept (1,200) were below the minimum size limit at the time of 410 mm.

Estuary cod

The estimated recreational catch of estuary cod (*Epinephelus coioides*) for the region was 5,300 fish kept (12 tonnes) and 13,600 released. Estuary cod was predominantly (86%) caught by boat-based fishers. One quarter of the catch (25%) was taken from the Dampier Archipelago.

Stripey seaperch (Spanish flag)

Stripey seaperch or Spanish flag (*Lutjanus carponotatus*) is an important recreational species with 20,800 fish kept (11 tonnes). A further 500 were estimated to have been eaten by sharks. Although at the time of the survey there was no size limit and a bag limit of 40 applied to this species, 48,100 were released. Almost all stripey seaperch (99%) were caught by boat-based fishers. Only 3,600 fish (17%) were taken from the Dampier Archipelago.

Coral trout

The estimated recreational catch of coral trout (*Plectropomus leopardus*) for the region was 2,100 fish kept (5 tonnes) and 3,400 released. A further 300 fish were estimated to have been eaten by sharks. Coral trout was predominantly (96%) caught by boat-based fishers. Most of the catch (59%) was taken from the Dampier Archipelago.

The estimated recreational catch of bar-cheeked coral trout (*Plectropomus maculatus*) for the region was 1,200 fish kept (3 tonnes) and 500 released. All bar-cheeked coral trout was caught by boat-based fishers. Most of the catch (95%) was taken from the Dampier Archipelago.

Sweetlip emperor

The estimated recreational catch of sweetlip emperor (*Lethrinus miniatus*) for the region was 4,668 fish kept (7 tonnes). Most sweetlip emperor (60%) was caught by boat-based fishers. One third of the catch (30%) was taken from the Dampier Archipelago.

Red emperor

Red emperor (*Lutjanus sebae*) is an important species for recreational and commercial fishers. The estimated recreational catch for the region was 1,700 fish kept (6 tonnes) and 3,000 released. The commercial catch from the region for the same period was 115 tonnes. All red emperor were caught by boat-based fishers.

Mangrove jack

The estimated recreational catch of mangrove jack (*Lutjanus argentimaculatus*) for the region was 7,300 fish kept (5 tonnes) and 12,900 released. Mangrove jack was predominantly (92%) caught by boat-based fishers. Approximately one quarter of the catch (27%) was taken from the Dampier Archipelago.

Western yellowfin bream

The estimated recreational catch of Western yellowfin bream (*Acanthopagrus latus*) for the region was 9,000 fish kept (4 tonnes) and 13,396 released. Western yellowfin bream was predominantly (71%) caught by shore-based fishers.

Moses perch

The estimated recreational catch of moses perch (*Lutjanus russelli*) for the region was 4,000 fish kept (4 tonnes) and 4,300 released. Moses perch was predominantly (87%) caught by boat-based fishers.

Spotted javelinfish

The estimated recreational catch of spotted javelinfish (*Pomadasys kaakan*) for the region was 3,400 fish kept (4 tonnes) and 4,400 released. Spotted javelinfish was predominantly (56%) caught by boat-based fishers.

Crab species

In the Pilbara region blue swimmer crab (*Portunus pelagicus*) is a recreational species with 72,000 (22 tonnes) kept and 33,000 released. Most of the catch (20 tonnes) was taken from Nickol Bay. Almost all blue swimmer crabs were caught by boat-based fishers. Recreational fishers in the region kept 19,000 (17 tonnes) green mud crabs (*Scylla serrata*) and released 13,000. Green mud crabs were predominantly (93%) taken by boat-based fishers. Recreational fishers also kept 7,000 (4 tonnes) brown mud crabs (*S. olivacea*) and released 10,000. Almost all brown mud crabs (99%) were taken by boat-based fishers.

Tropical lobsters

The estimated recreational catch of green (painted) lobster (*Panulirus versicolor*) is 2,400 (2 tonnes) kept and 1,100 released. Most green lobsters (90%) were taken from the Dampier Archipelago. A small number of ornate lobsters (*P. ornatus*) were also kept. All lobsters were taken by boat-based fishers.

Northern calamari

The estimated recreational catch of northern calamari (*Sepioteuthis lessoniana*) for the region was 5,600 kept (6 tonnes) and 500 released. All northern calamari was caught by boat-based fishers.

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 20% of recreational anglers (Baharthah and Sumner 2002), or some 120,000 anglers per year generating 2 million fishing days.

Charter activity is also important, with 20 fishing tour licences and 2 ecotour licences issued for the south coast bioregion.

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 fishing on the south coast and development of a recreational fishing management strategy is expected to commence in 2002/03.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Fisheries Officers working out of offices located at Esperance and Albany deal with a number of recreational fisheries within the region, including abalone, rock lobster, marine boat- and shore-based angling and estuarine netting fisheries. Officers utilise one 6.5 m patrol vessel to conduct inshore at-sea inspections, and several smaller craft to service estuarine fishers. Work in recreational fisheries principally involves checking that anglers and shellfish collectors are adhering to size and bag limits

As well as personal contacts with anglers, covert observation also plays an important role in ensuring high levels of compliance. While most recreational fishers are aware of the rules governing a fishery, and do their best to obey them, high penalties for breaking rules mean that some unscrupulous fishers are very careful to hide their illegal activities. Officers therefore regularly observe fishers from a discreet distance, particularly in the high-value abalone fishery.

Activities during 2000/01

During 2000/01, Fisheries Officers delivered 4,536 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 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.

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 34 reports of illegal fishing activity to the Fishwatch hotline in 2000/01 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 2000/01, the VFLO program involved 17 volunteers in the Albany and Denmark areas and 7 in Esperance, accounting for 798 contacts during the year. Community education activities conducted in the bioregion also included attendance and presentations by Fisheries Officers and VFLOs at regional shows and festivals, primary and high schools and community group meetings.

As a result of compliance activities, 15 letters of warning and 9 infringement notices were issued and 8 prosecutions initiated in the south coast bioregion. Prosecutions occur for more serious offences, and in 2000/01 most of these arose from illegal take of abalone and illegal net fishing.

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 2000/01 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	4,536
Fisher field contacts by Fisheries Officers (6 months)*	1,325
District Office contacts by Fisheries Officers (6 months)*	516
Fisher field contacts by VFLOs	798
Fishwatch reports **	34
OFFENCES DETECTED	**NUMBER**
Infringement warnings	15
Infringement notices	9
Prosecutions	8

* These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

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

With increasing restrictions being placed on the 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 increased during 2000/01, and this is likely to escalate in coming years.

User group conflict between the recreational and commercial sectors is a continuing problem, particularly with the estuarine, beach seine and salmon fisheries. Similarly, recreational users are concerned with the development of aquaculture sites within the region and the impact this has on their use of waters and land surrounding lease sites.

Initiatives in 2001/02

It is anticipated that the new weekend closures in the commercial South Coast Estuarine Fishery, to be introduced in July 2002, will help mitigate perceptions among recreational users that this particular fishery is impacting on their catches within the local waterways.

The planned south coast review and south coast recreational fishing survey are expected to provide important data on fishing frequency and target species, as well as participants' attitudes towards conservation and the Department's compliance and education activities.

The appointment of a Community Education Officer for the southern region, scheduled for 2002, will provide a more structured and coordinated regional approach to the community education and VFLO programs. While Fisheries Officers in the districts will still have an important role to play in the VFLO program, the overall strategies for the program will be formulated by the Community Education Officer, with input from the Fisheries Officers and the VFLOs themselves.

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 Walpole/Nornalup Inlets (e.g. Potter et al. 1993, Potter and Hyndes 1994).

These studies, supported by and utilising the commercial fisheries database, have provided a good basic knowledge of the key species black bream, cobbler (*Cnidoglanis macrocephalus*) and King George whiting. Relevant abundance information and stock status for these recreational/commercial stocks are reported on pp. 106–110.

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*), western sand 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 will be undertaken in 2002/03.

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. 120). 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 reported under the north coast bioregion (pp. 151–152), 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 2% of recreational fishers (Baharthah and Sumner 2002), or some 12,000 fishers per year generating 190,000 fishing days.

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. 72–74. 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.

Recreational catch information for this region may be provided by the National Recreational Fishing Survey undertaken in 2000/01.

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 catfish or freshwater cobbler (*Tandanus bostockii*) is also taken in small numbers, as are black bream (*Acanthopagrus butcheri*) artificially stocked into some inland impoundments.

Recreational fishing participation for inland freshwater fishing (including marron) in the south of Western Australia is estimated at around 3% of recreational fishers (Baharthah and Sumner 2002), or some 18,000 fishers per year generating 80,000 fishing days.

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. Please note that, as the records of VFLO contacts do not differentiate between coastal and inland activities, and to ensure that their contact information is not duplicated in this report, they have not been included in the table below.

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 to 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 2000/01

Most hours delivered in this bioregion are targeted at compliance and education activities within the marron fishery. The season for this fishery ran from 6 January to 28 February 2001, however numerous patrols were conducted in November and December to target out-of-season fishing. There were some prosecutions for fishing in the closed season, but the majority of the infringements were issued for the use of scoop nets or drop nets in ‘snare-only’ areas.

There has also been an increase in the incidence of people illegally taking marron from licensed aquaculture farm dams, and this is impacting on the livelihoods of the farmers operating these businesses. A single raid on a dam can remove the bulk of the stock for that farm and have a flow-on effect on production for many years. Department of

Fisheries officers are working with the WA Police and the Marron Growers' Association to address this issue.

The VFLOs conducted education displays for the opening of the marron season, and focused on Walpole and dams in the south-west during the opening weekend. Several VFLOs from Albany also attended the Broomehill Aquafest and held fishing clinics and a 'Learning Circles' program throughout the weekend.

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 2000/01 financial year.

CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	NUMBER
Hours delivered in bioregion	3,047
Fisher field contacts by Fisheries Officers (6 months)*	1,996
District Office contacts by Fisheries Officers (6 months)*	2,357
Fisher field contacts by VFLOs	NA
Fishwatch reports **	34
OFFENCES DETECTED	**NUMBER**
Infringement warnings	36
Infringement notices	11
Prosecutions	6

* These figures represent regional activities conducted between 1 January and 30 June 2001, following the introduction of a new, more comprehensive system for collection of regional activity data. Since this represents an incomplete year of data, collected while Fisheries Officers were still undergoing training in the system, figures should be treated with caution.

** 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 2001/02

A workshop was held in June 2002 involving the WA Police, Department of Fisheries staff and members of the Marron Growers' Association to ensure that adequate compliance measures with suitable deterrents are in place to safeguard the marron stocks in farm dams. Some of the initiatives will include joint patrolling with the police, clear definition around whether the illegal take of marron will be dealt with as theft by the police or under the *Fish Resources Management Act 1994,* and promotion of preventative measures which can be taken by the growers themselves.

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

The recreational fishery for Western Australia's native freshwater crayfish, the marron (*Cherax tenuimanus*), operates in freshwater dams and rivers throughout the south of the State. Stocks of marron have been extended well beyond their original range through translocation, and can now be found as far north as Hutt River near Geraldton and as far east as Esperance.

A recreational fishing licence is required to take marron. Other fishing controls include bag and size limits, gear controls and a closed season. The fishing season is in January–February each year. 'Snare-only' waters have received widespread support from fishers. A number of areas have now been set aside for snaring only, which has had the beneficial effect of reducing localised fishing effort and improving the size of the marron caught in some waters.

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 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 one additional snare-only area each year until 2005.

These measures have had limited success in maintaining catch rates, partly as a result of the impacts of reduced rainfall and environmental degradation on the productivity of the marron stock. A major review of the marron fishery has commenced due to concerns over the long-term sustainability of the fishery.

Research Summary

Detailed research on the marron stocks in south-west rivers and estuaries has been undertaken since the 1970s and 1980s. 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.

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 2001 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); and Samson Dam (1996).

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 2001): 17.3 tonnes

An estimated total of 138,593 legal-sized marron (minimum of 17.3 tonnes) were taken in the 2001 season (2000: 200,000 marron, 25 tonnes; 1999: 158,000 marron, 19.7 tonnes; 1998: 206,000 marron, 25 tonnes) (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. As a result, 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 2001, the total catch of marron was estimated at approximately 32.3 tonnes using the average weight of marron landed by logbook holders (233 g).

Fishing effort

The number of licences issued for the 2001 season was 21,833, with an estimated 9,785 of these (unusually low at 44.8%) used to marron on one or more days, at an estimated average of 3.36 days of marroning per active licence holder during the 2001 fishing season. For 2001, days of effort are used, whereas in previous years the number of fishing trips was reported. (2000: 21,894 licences, with 11,493 (53%) used to make one or more trips; 1999: 21,330 licences, with 13,899 (65%) used to make one or more trips.) A total of approximately 32,872 days were spent marroning in 2001, comprising an estimated 8,686 days of marroning in dams and 24,185 days in rivers. (2000: 40,835 total trips, with 12,027 trips to dams and 28,808 trips to rivers; 1999: 40,910 total trips, with 12,675 trips to dams and 26,662 trips to rivers.)

Catch rate

The average catch rate in 2001 was estimated at 4.22 legal-sized marron per licence holder per night (2000: 5.02; 1999: 3.84). The decrease in the catch rate over that recorded for the 2000 season is likely to be due to the lower than average rainfall in the 2000 winter, with fewer marron reaching legal size prior to the season opening. 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 differ, the stock assessment process 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 phone 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, has been relatively stable during the 1990s. However, the catch rate (Figure 2) in 2001, although similar to 2000, is likely to be biased upward owing to the significantly lower effort in the 2001 season.

A good correlation exists between catches (numbers) and rainfall during the previous winter relative to the long-term rainfall of the south-west ($r = 0.63$). 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 of the 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 (2002):
Approx. 94,700 marron (11.8 tonnes)

Based on rainfall records during the year 2001, the catch for the 2002 season is likely to be significantly lower than the catch in 2001. Bureau of Meteorology data indicate that the rainfall during 2001 was approximately 68.4% of the long-term average. Based on this figure, the expected catch of marron is predicted to be approximately 94,700 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 relatively high during 2002 but may be much lower than expected in future years. Further, modifications to several major dams in the Harvey River catchment have resulted in limited access to certain marron stocks (e.g. Stirling Dam, Harvey Weir, Waroona Dam). Thus lower catches are expected during the 2002 marron 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 many smaller animals are released.

Protected species interaction: **Negligible**

This fishery does not interact with protected species. However, recent discussions with other researchers indicate 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 species or sub-species of marron. The taxonomy will be further investigated and appropriate action instigated to protect the Margaret River marron.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The removal of legal-sized marron from freshwater rivers is unlikely to have a significant effect, noting that the bulk of the marron biomass is below legal size. Similarly, marron biomass taken from man-made dams does not significantly impact on the natural freshwater ecosystems.

Habitat effects: **Negligible**

The impact of this fishery on the aquatic habitat is negligible. The major effects are the litter in surrounding areas and the trampling of small areas of riparian vegetation by marroners.

SOCIAL EFFECTS

The marron fishery in the 2001 season involved approximately 9,785 licence holders and their families undertaking about 32,872 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 2001 season recreational marron catch was in the approximate range $420,000–$770,000 (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). In addition, the estimated 32,872 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 the 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. A major FRDC research proposal to examine and quantify this and other issues in the marron fishery was not successful in the 2001/02 funding round and is being resubmitted in 2002/03.

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 and by maintaining water volume and quality. It may also affect the ease with which fishers can access the water bodies.

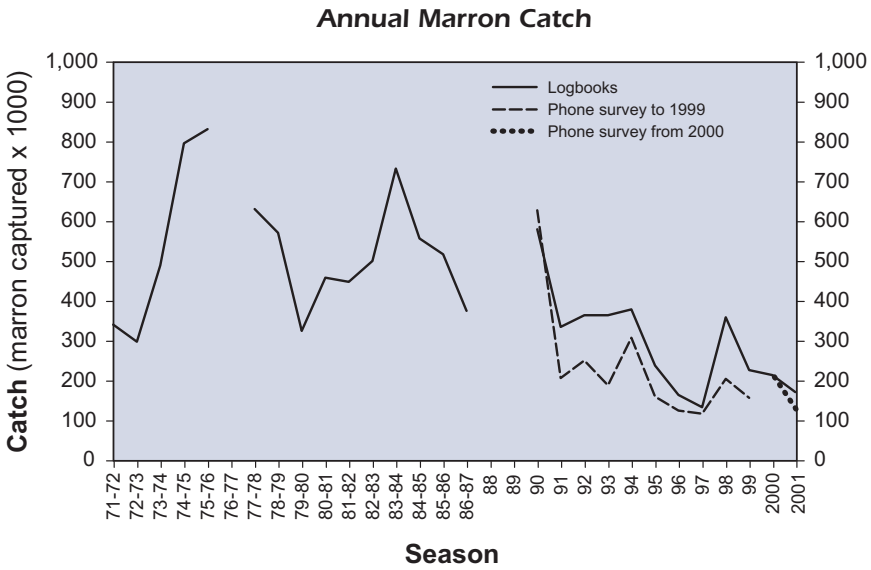
A second major issue in this fishery is access to irrigation dams. The Water Corporation has recently closed access to Stirling Dam (Harvey River catchment) owing to the diversion of this water to the metropolitan water supply, and has limited the access to Harvey Weir. Further, the Water Corporation is currently refurbishing Waroona Dam, which involves the complete draining of the dam. Thus, a redistribution of fishing effort is likely to occur and extra effort is likely to be applied to other water bodies, especially Logue Brook Dam and Wellington Dam. The Department of Fisheries is working closely with the Water Corporation to ensure the refurbished and refilled dams will provide a high-quality marron fishery by installing refuges, adding marron and controlling introduced species.

The major introduced species that impact on the marron fishery are redfin perch (*Perca fluviatilis*), trout

(*Oncorhynchus mykiss* and *Salmo trutta*) and yabbies (*Cherax albidus*). Redfin perch, which 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.

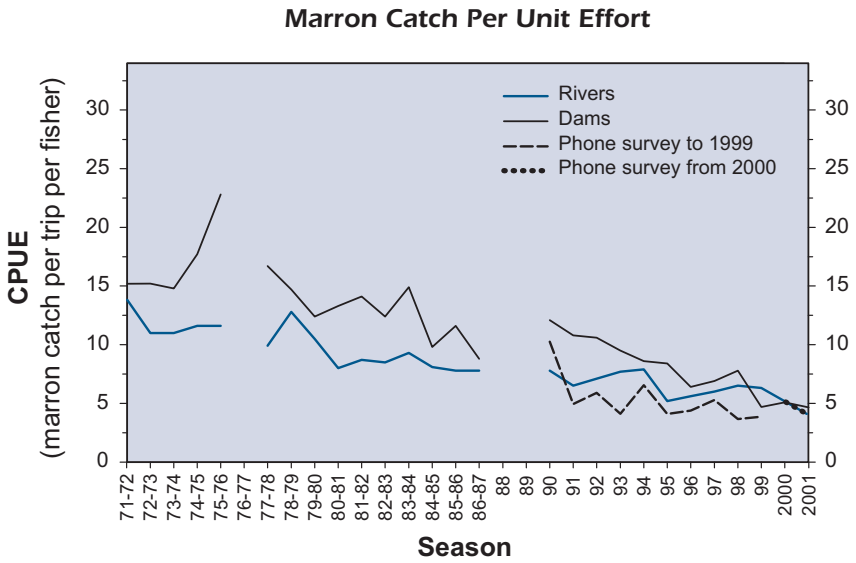
Trout will also predate on marron but to a lesser extent than redfin due to the wider diet of trout, particularly rainbow trout, which prey predominantly on freshwater insects. The potential for increasing the marron survivorship rates and the carrying capacity of water bodies by installing artificial structures is currently being investigated by the Department of Fisheries and will shortly be tested in large irrigation dams.

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 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 spawning and 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 native catfish or freshwater cobbler *(Tandanus bostockii)*. No minimum legal size limit applies to this species. No bag limit or size limit applies to redfin perch (*Perca fluviatilis*).

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. The stocking of trout is currently under review against a range of environmental impact criteria as part of a translocation assessment process.

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 South West Freshwater Research and Aquaculture Centre (SWFRAC), Pemberton (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 SWFRAC strain, a natural strain and hybrids of rainbow trout. Research information from these projects and the annual report from the manager of the SWFRAC 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 being trialled for their aquaculture potential in inland saline waters which may also provide some recreational fishing opportunities.

Main fishing method

Angling with rod and line.

RETAINED SPECIES

Recreational catch (season 2000/01): 29.3 tonnes

Based on an annual telephone survey, an estimated total of 91,300 fish were captured by freshwater anglers during the 2000/01 season, with an estimated weight of 29.3 tonnes. This comprised approximately 3.9 tonnes of rainbow trout (13,900 fish), 0.5 tonnes of brown trout (1,700 fish), 23.6 tonnes of redfin perch (71,600 fish) and 1.3 tonnes of native catfish (4,100 fish). Overall, this is slightly below the catch estimated from the mail survey in 1998/99, which was 34.1 tonnes overall (110,100 fish), comprising rainbow trout 6.8 tonnes (22,400 fish), brown trout 0.4 tonnes (1,300 fish), redfin perch 26 tonnes (83,800 fish) and native catfish 0.8 tonnes (2,600 fish).

Fishing effort

The number of licences issued during the 2000/01 season was 15,242, with an estimated 4,039 of these (26.5%) used to make one or more trips, at an estimated average of 7 days per active licence holder. A total of approximately 28,300 days of angling occurred (approximately 10,400 days to dams and 17,900 days to rivers). Although the participation rates were lower than in 1998/99 (53.6%), the total effort to the fishery was higher in 2000/01 (1998/99: 20,700 trips).

Catch rate

The average catch rate in 2000/01 was estimated at 3.22 fish per active licence holder per day, consisting of 2.49 fish retained and 0.72 fish released. This is lower than the estimated catch rate in 1998/99. However, it should be noted that the survey was carried out in different ways on the two occasions (by mail in 1998/99 and by telephone in 2000/01). In the future, this fishery will be monitored via standardised telephone survey.

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 SWFRAC and released annually into public waters. A total of 515,000 trout fry (490,00 rainbow trout fry and 25,000 brown trout fry) produced at the SWFRAC were stocked into public waters during 2000/01. In addition, approximately 310,000 rainbow trout fry were sold to private dam owners for tourist fishing and private club fishing and 70,000 rainbow trout fry were sold to commercial producers. Older fish were also produced and sold from the SWFRAC during the year. Approximately 21,000 rainbow trout yearlings were stocked into the public fishery, while 2,700 ex-broodstock rainbow trout entering their second and third years of life and 700 ex-broodstock brown trout entering their third and fourth years of life were also stocked into the recreational fishery for the 2000/01 season.

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 catfish are self-sustaining. Introduced redfin perch breed naturally 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.

ECOSYSTEM EFFECTS

Food chain effects: **Medium**

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 by members of the public, although not recommended, occurs at high levels and may result in a decline of fishing quality. The Department of Fisheries encourages anglers to retain any redfin caught, regardless of size.

Rainbow and brown trout are also introduced species but have a much broader diet 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 24 discrete locations and not throughout the 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 more acceptable as an introduced recreational species.

Stocking in future will be influenced by a translocation evaluation, currently being finalised, of the environmental impact of trout stocking. Further, detailed research on the survival of fry and yearling trout has commenced, as has an analysis of the diets of trout and redfin.

Habitat effects: **Negligible**

SOCIAL EFFECTS

A large number of freshwater angling licences are sold annually. For the 2000/01 season, a total of 15,242 licences were sold, including umbrella licences. This represents an increase of about 7% in the number of valid licences when compared to the 1999/2000 season (14,209).

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.

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 rainfalls have a negative influence on the freshwater angling fishery.

A major issue in this fishery is access to irrigation dams. The Water Corporation has now closed access to Stirling Dam owing to the diversion of this water to the metropolitan water supply. Further, construction of the new Harvey Weir has resulted in limited access to this water by recreational anglers. Thus, a redistribution of fishing effort is likely to occur and extra effort is likely to be applied to other water bodies. Waroona Dam is currently undergoing draining and reconstruction and no stocking will occur until the dam is refilled. Thus, effort is likely to be redistributed during the period of dam construction. 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.

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 commercial aquaculture industry in Western Australia.

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 (PIAC), 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. 173–174).

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 (ADC), 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 increase in value and tonnage of aquaculture product for 2000/01 were 13% and 30% respectively, compared to 1999/2000. Commercial aqaculture enterprises in Western Australia include production of mussels, edible oysters, marron, yabby, trout, algae (for beta carotene), barramundi, abalone, ornamental fish and non-*maxima* pearl oysters.

The first commercial harvest of black pearls from Shark Bay and the Abrolhos Islands was an important step in the development of this new industry for Western Australia. The quality of the pearls has been encouraging.

The first commercial hatchery production of scallop spat and the 'seeding' of an aquaculture site off Geraldton in the Mid West Region is an exciting first step in the process of developing a new industry.

The approval by the Department of Environmental Protection of an increase in barramundi production at Lake Argyle from 100 tonnes to 600 tonnes per year is a very important step in the development of a significant aquaculture industry on the lake.

The establishment of 'new' mussel farms on the Southern Flats site in Cockburn Sound is important for the growth of what is becoming a very important industry.

The successful 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.

Prawn farming is also being developed, with three farms licensed but not yet built. Prawn farming is positioned to be a major contributor to regional economic development and employment in the next few years.

Following a process led by the Department of Fisheries, the Department of Land Administration has released an expression of interest for groups interested in working with indigenous communities in the Dampier Peninsula for the development of prawn aquaculture opportunities.

The establishment of a 60 tonne abalone growout 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 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.

During 2001/02, 12 new aquaculture licences were issued for sites in coastal waters, 11 for reef reseeding of trochus. Two new larger-scale aquaculture licences were issued, including one for a 650 hectare prawn farm near Derby. Three new marine-based aquaculture licences are being assessed.

The Department assessed 48 new applications, 14 variations and nine 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.

The major policy outcomes for the year were:

- completion of land-based site identification process for abalone and finfish;
- development of a policy paper with the WA Police Service concerning the theft of aquaculture stock from farm dams;
- preparation of guidelines for aquaculture leases;
- development of a draft policy position on the issuing of long-term licences for the aquaculture industry in Western Australia; and
- finalisation and implementation of Fisheries Management Paper no. 159 (Thorne 2002) on the translocation of barramundi.

Considerable effort on shellfish quality assurance resulted in continued export approval for three growing sites and the commencement of sampling protocols for an additional mussel farm and a growout site for tropical clams.

Research was undertaken in a range of areas, including freshwater crustaceans, finfish, abalone, rock lobster and nutrition. Major project funding was received for research projects including:

- marron genetic improvement and husbandry;
- improved fees for larval finfish;
- using lupins and canola in aquaculture feeds;
- training farm managers and constructing ponds for freshwater aquaculture;
- identifying potential for aquaculture by indigenous communities;
- identification of large-scale potential sites for land-based aquaculture; and
- developing tools for detecting fish and prawn viruses and modelling nutrient release from aquaculture facilities.

Major advisory and extension publications on key species were revised and the number of aquaculture publications held by the Department's library was increased. Fish health diagnosis and management is another important function of the Aquaculture Sub-Program, which also collected and collated aquaculture production returns from all industry sectors.

Aquaculture development in regional areas focused on the provision of extension services and technical advice to existing operators and prospective investors. These services were provided by regionally based Aquaculture Development Officers who work closely with individual proponents and existing licensees.

The Kimberley Aquaculture Aboriginal Corporation $3.2 million multi-species hatchery has been completed at the Broome Tropical Aquaculture Park. A hatchery for the production of trochus was established with an Aboriginal community in the Kimberley in 2000. A project to work with Aboriginal communities to identify land-based sites for prawn aquaculture has been commenced, with a view to promoting aquaculture development.

The growth in the granting of aquaculture licences is extremely encouraging. As of 30 June 2002, the Department of Fisheries had issued 462 aquaculture licences – a 6% increase on the previous year (438).

Licence growth of 387.5% since 1994 gives a clear indication of the level of interest and human activity in the aquaculture sector in Western Australia. This figure understates the level of involvement in aquaculture, given that yabby farmers generally do not require an aquaculture licence and anecdotal evidence suggests that interest and activity have increased substantially in this area. In addition, around 200 agricultural farmers have participated in growout trials of rainbow trout in farm dams, in a project known as 'Outback Ocean'.

West Coast Bioregion

REGIONAL MANAGEMENT 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 is currently negotiating with farmers a process for reallocation of farm sites. 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 two years ago. The Department is currently discussing 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. Mussel production in Cockburn Sound reached 964 tonnes in 2000/01, an increase of 30% on the previous year's production.

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 2001/02 included the completion and submission to AQIS of update reports on the farm sites at the Kwinana Grain Terminal and Oyster Harbour. AQIS conducted its annual audit of the WASQAP in March 2002. Following the submission of a sanitary survey report, AQIS also gave unconditional approval for the export of product from the new growing area of Southern Flats.

Aquaculture in the Abrolhos Islands is a carefully managed, sustainable and productive new industry. In the past year, aquaculture has expanded in line with the recommendations of the aquaculture plan for the Islands (Fisheries WA 2000), with seven licensees engaged in the culture of black pearls. Currently there are over 1,300 ha licensed for the culture of pearl oysters in the Abrolhos Islands, with site utilisation set to increase. It is estimated that the average projected growth in site utilisation per licence will be approximately 45% over the next 12 months, based on the projected increase in the number of longlines.

Trial harvests of pearls from Abrolhos Islands pearl oysters have proven that product of acceptable quality can be produced and is readily sought in the market. The colour of Abrolhos Islands pearls is quite different to that of Pacific black pearls. The distinctive colour is likely to be the result of a combination of genetic differences and site-specific nutritional variation and may prove to be a useful marketing tool.

Over the last 12 months, development of saucer scallop (*Amusium balloti*) aquaculture through reseeding of hatchery-produced spat on to the seabed has taken an exciting step forward. The successful deployment of approximately one million saucer scallops on a site in the Geelvink Channel off Geraldton in January 2002 was a first for Australian saucer scallop enhancement.

Experience and innovation in identification of good quality broodstock, spawning induction techniques, and rearing/handling of saucer scallop larvae and spat, is providing increased security for the scaling up of production. Spawnings from early January 2002 provided sufficient spat to conduct the first saucer scallop reseeding trials undertaken in Australia. The rapid growth in the larval phase led to settlement at around 9–11 days and a further 10–15 days in culture prior to reaching the 1 mm shell size suitable for handling and seeding. After settlement and prior to seeding, spat were examined by the Department's Fish Health Section and certified disease-free.

On the day of transport, spat were harvested from the settlement tanks, counted, placed in the transport container and transferred to the licensed site for deployment on the bottom. Once anchored, the spat were pumped to the seabed through a hose where it is hoped they will grow out to a harvestable size within 12–18 months. Further surveys are planned in 2002 to determine the survival rate of scallops from this deployment.

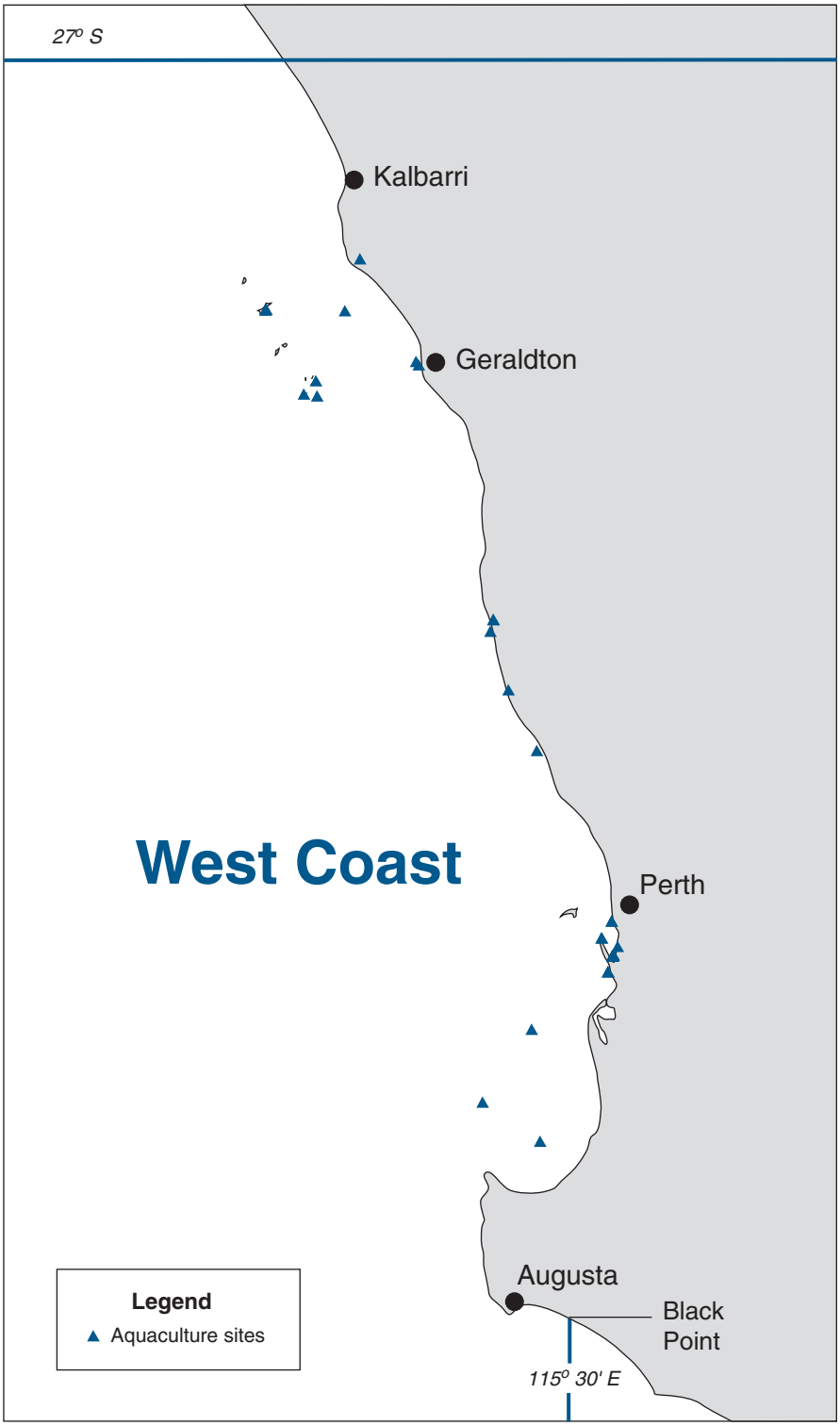
West Coast Aquaculture Figure 1 shows the major licensed aquaculture sites in this bioregion.

REGIONAL DEVELOPMENT AND COMPLIANCE OVERVIEW

Development activities during 2001/02 included public enquiries, technical support – particularly for black pearl farmers in the Abrolhos Islands – and site identification work. Small-scale 'on farm' experimentation and environmental monitoring has identified preferred methods of pearl oyster nursery culture at the Southern Group of the Abrolhos Islands. Subsequent trials under way are comparing a range of husbandry techniques used by the growers in the region and these results will be provided to growers through presentations at future industry meetings.

Further technical extension was provided to the Geraldton scallop hatchery through assistance in the development of more efficient larval rearing practices. Several experiments were conducted leading to the identification of optimal incubation gamete density and husbandry techniques for scallop larvae that would increase yield by more than 20%.

Compliance activities were focused on ensuring the successful relocation of mussel farms to Southern Flats and adherence to licence conditions. In particular, resources were directed at ensuring compliance with navigational marking requirements, boundaries of leases and correct procedures for translocation of fish species. Resources also continued to be directed to shellfish quality assurance within Cockburn Sound.



WEST COAST AQUACULTURE FIGURE 1

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

REGIONAL RESEARCH OVERVIEW

Around Perth activities included joint research with the WA Maritime Training Centre (WAMTC) on marine finfish and abalone aquaculture, which has produced encouraging results especially with hatchery and nursery phases for yellowtail kingfish (*Seriola lalandi*) culture. Snapper (*Pagrus auratus*) and kingfish larvae have been reared in an excellent new larval rearing system designed by research staff for joint research with WAMTC and James Cook University (part-funded by FRDC). Finfish and fish health staff have provided very useful support for successful, pilot-scale farming trials with mahi mahi (*Coryphaena hippurus*). Further collaborative effort with WAMTC and the Department of Agriculture, with funding support from the Grains Research and Development Corporation and Grains Research Council, involved completion of projects on evaluation of local agricultural products such as lupins and canola in aquaculture feeds. This information is being communicated to feed companies and nutritionists worldwide through website-based reviews, international trade presentations, joint trials in France and numerous scientific and popular publications.

Field research on the environmental impact of sea-cage farming of snapper and rainbow trout (*Oncorhynchus mykiss*) in experimental cages in Fremantle Harbour has been completed with the University of Stirling, Scotland, and showed that fish and benthic animals can utilise much of the waste nutrients from sea cages. Laboratory trials have been completed with the University of WA aimed at customising feed design for snapper to meet environmental challenges posed by different farming systems. An internet-based input–output model was developed for predicting growth and waste output, for a range of species, diets and water temperatures. This was a joint project with Israeli and University of WA collaborators. It incorporates results from the above snapper and rainbow trout research and was funded by the Aquaculture Development Fund (ADF).

Joint laboratory and field trials with Curtin University (part-funded by the ADF and FRDC), aimed at rearing western rock lobster (*Panulirus cygnus*) larvae and assessing the potential for growout of wild-caught pre-juveniles (puerulus), have been completed. Joint research with other universities is fostering husbandry, disease and nutritional research for marine aquaculture. Several of these joint projects with universities are now being written up as PhD theses.

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 (2000/01): **964 tonnes**

Number of producers for year 2000/01: **14**

Production projection next year (2001/02): **800–1,000 tonnes**

ECOSYSTEM EFFECTS

Mussel farms present a low risk to the environment because there is no addition of feeds. Secondly, faecal wastes from the farms are far less likely to cause high organic loadings on the sea bed in Western Australia than in other mussel industries, as local mussel lines are more widely separated in response to low food (plankton) levels. Monitoring of 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 and are thought to consume significant amounts of mussels. This is a major cause of concern to farmers, who are investigating methods to deter the fish.

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 2000/01: **$2.27 million**

INDUSTRY GOVERNANCE

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

The mussel industry must also meet the requirements of the WA Shellfish Quality Assurance Program.

EXTERNAL FACTORS

Production levels for this species are related to dissolved nutrient levels which provide the basis for phytoplankton, the main food of mussels. Productive areas are therefore generally 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 MANAGEMENT OVERVIEW

The Gascoyne coast bioregion includes the areas of inner Shark Bay (Denham), outer Shark Bay (Carnarvon), and Exmouth Gulf. Whilst the production of pearls and pearl oysters remains the primary coastal aquaculture activity within this bioregion, there has been recent development in the production of a range of aquaculture species.

Hatchery production of *Pinctada maxima* pearl oysters is of critical importance in this region, where recruitment of oysters in the wild is irregular and unable to be relied upon for commercial operations. Two hatcheries, one in Carnarvon and one in Exmouth, are producing significant quantities of spat to supply pearl farms in Exmouth Gulf and the Montebello Islands. Similarly, the production of black lip pearl oyster *Pinctada margaritifera* at several hatcheries continues to supply juveniles selected from high-quality broodstock and provides an entirely sustainable production base for this growing industry.

Black pearl production through culture of *P. margaritifera* has expanded during 2001/02, 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 more experienced staff.

Culture of high-value marine crustaceans has advanced in the north-west of the region 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*). Other species being examined for potential aquaculture production include two species of tropical rock lobsters, the painted, *Panulirus ornatus,* and the green, *Panulirus versicolor.*

Research and development of techniques for the aquaculture production of serranid finfish such as estuary cod (*Epinephelus coioides*) in the Gascoyne have made considerable progress this year with the production of hatchery-reared juveniles for the first time in Western Australia.

Inland aquaculture on pastoral rangeland stations is a growing sector of the regional aquaculture profile. The Gascoyne Inland Aquaculture Group increased in membership this year and production of ornamental aquarium fish in artesian bore water on pastoral leases has advanced with the licensing of several growers. Additionally, marine ornamental finfish culture has progressed with the production of juvenile clown fish this year.

One aquaculture product of high value on the export market is beta carotene which is extracted from the cultured microalgae, *Dunaliella salina*. The pilot production plant on Lake MacLeod has constructed ponds and is developing management protocols for the growth of algae biomass under optimal conditions.

Management activities during 2001/02 included the processing of a number of licence applications for licences for coastal water pearl farm sites and the development of a process to permit the assessment of applications for aquaculture leases in coastal waters.

Gascoyne Coast Aquaculture Figure 1 shows the major licensed aquaculture and pearl farming sites in this bioregion.

REGIONAL DEVELOPMENT AND COMPLIANCE OVERVIEW

Development and extension activities during 2001/02 included the facilitation of meetings, the development of grower groups and the completion of extension material regarding the culture of non-*maxima* pearl oysters. Aquaculture licensing advice, and assessment of applications for licences or variations to licences, remained important responsibilities in the Gascoyne region. Liaison with existing and prospective aquaculturists and the provision of information, advice and assistance continued through field visits and remote communication.

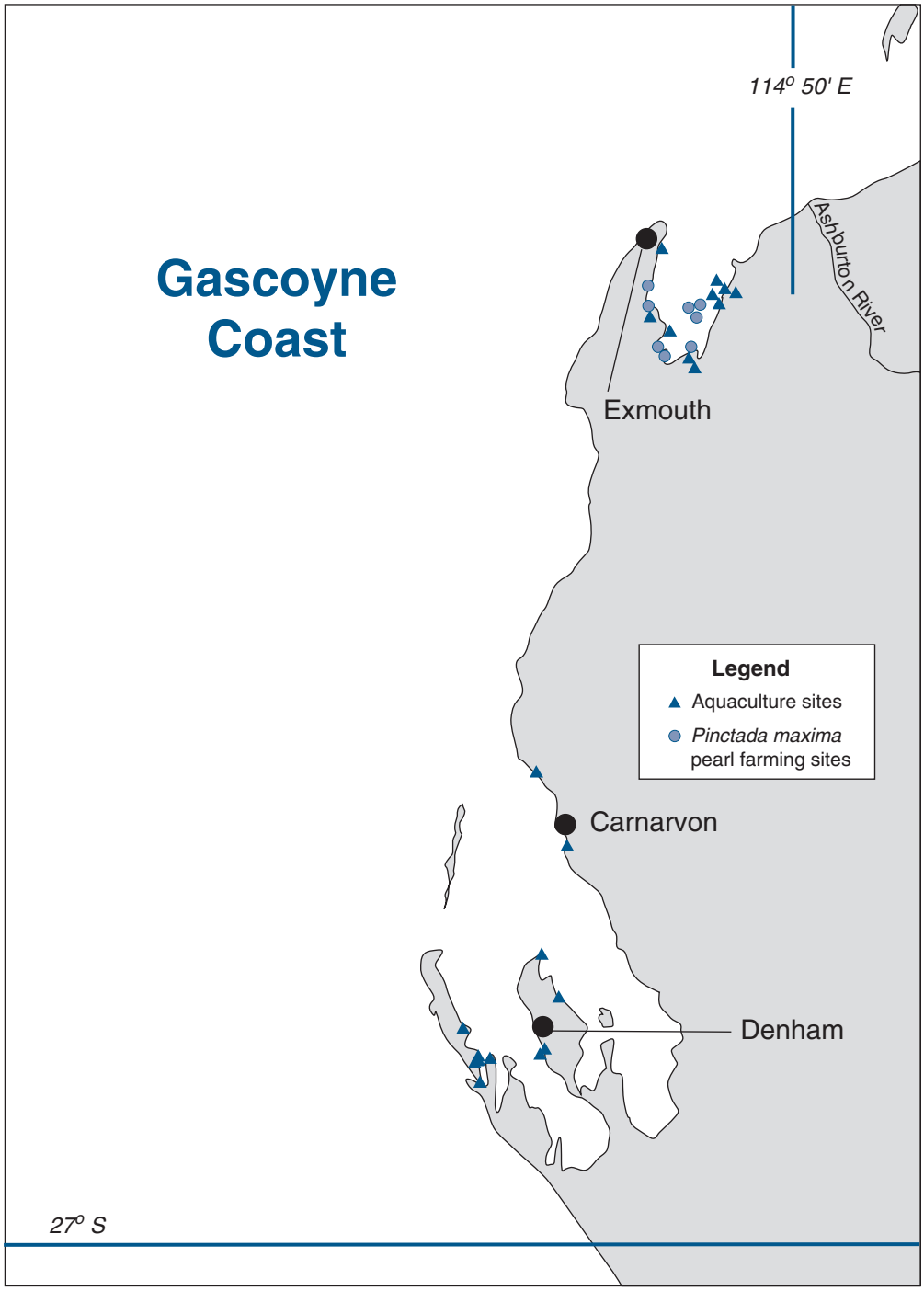
Extension work included assistance in relation to the identification of several sites for pearl production in Shark Bay and Exmouth Gulf and site selection and systems design on inland stations.

During 2001/02, 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 included implementing the new Aquaculture Compliance Checklist during the site inspections and audits. While focusing on the non-*maxima* pearl farms in the region, the field testing of this process led to the efficient delivery of the compliance program over the region in a consistent manner.

The Aquaculture Program supported the implementation of the compliance plan by providing specific training to Fisheries Officers in several technical fields of the aquaculture industry, together with field guides and species identification keys. It is expected that in the future there will be an increased demand for the training of compliance staff in aquaculture principles and husbandry techniques to 'keep up' with this rapidly developing industry.

REGIONAL RESEARCH OVERVIEW

Very large-scale, land-based coastal sites with considerable potential for aquaculture were identified in the Gascoyne and other bioregions in a major site identification study undertaken by the Department of Fisheries for the Aquaculture Development Council. These sites could be used for marine prawn or finfish farming.



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 MANAGEMENT OVERVIEW

The north coast bioregion extends from Onslow to Kununurra and is dominated by the production of pearls from the species *Pinctada maxima*. This industry is reported separately in the following pages.

Other aquaculture management initiatives in the north coast bioregion were focused on assisting the Department of Land Administration with the development of an expression of interest for prawn farming on the Dampier Peninsula. This is aimed at attracting investment in prawn aquaculture involving local indigenous communities.

Through the Kimberley Aquaculture Research Project initiated by the Kimberley Development Commission, hatchery technology of *Penaeus monodon* was successfully transferred to the multi-species hatchery in the Broome Tropical Aquaculture Park. Assistance by Aquaculture Development Officers in identifying black tiger prawn broodstock locations played an important part in what is now considered a good basis for prawn farming in the region.

The services provided at the Broome Tropical Aquaculture Park were upgraded and a 12-month promotional campaign aimed at attracting further investment was launched this year.

North Coast Aquaculture Figure 1 shows the major licensed aquaculture and pearl farming sites in this bioregion.

REGIONAL DEVELOPMENT AND COMPLIANCE OVERVIEW

The principal development activities focused on public enquiries and planning for future aquaculture expansion in the north coast bioregion. Indigenous aquaculture expanded, with Aquaculture Development Officers assisting with feasibility studies in several locations across the Kimberley covering aquarium fish, cherabin (*Macrobrachium rosenbergii*), redclaw (*Cherax quadricarinatus*) and barramundi (*Lates calcarifer*). The recently completed multi-species hatchery is set to produce trochus (*Tectus niloticus*), which will provide benefits to Aboriginal corporations with aquaculture licences for reef-top molluscs.

Compliance activities in this region are dominated by pearling, which is reported separately. In addition, Aquaculture Development Officers carried out site inspections for new licence applications and to ensure compliance with existing licence conditions.

REGIONAL RESEARCH OVERVIEW

During 2001/02, research staff took a lead role in commissioning the Aboriginal-owned multi-species hatchery at Broome. This hatchery will provide stock for enhancing reefs near King Sound. Research staff also completed an international project funded by the Australian Centre for International Agricultural Research, the Aboriginal and Torres Strait Islander Commission and the ADF. It showed that hatchery-reared trochus, when released on some reefs, can increase densities of larger trochus.

A major study of salt field biota, including *Artemia* (brine shrimp) resources, has been completed in one major salt field. The Department of Fisheries has helped fund broodstock and hatchery production trials with marine prawns at the Kimberley College of TAFE and the multi-species hatchery at Broome. Research on disease status of wild prawn stocks used for broodstock has provided encouraging results and is continuing. Research staff also helped identify very large, coastal land-based sites with potential for aquaculture (see Gascoyne Regional Research Overview, p.171) as well as a range of large sites with potential for prawn farming on the Dampier Peninsula (by agreement with Aboriginal communities). A modelling study has been initiated with the University of WA to predict water temperatures in prawn farming ponds, depending on location and farm design.

PEARL PRODUCTION

Management Summary

Activities within the Western Australian *Pinctada maxima* pearling industry range from the hatchery production of oysters suitable for the seeding of round pearls, to the fishing of wild-stock oysters for the culturing of pearls on a large number of pearl leases situated in the State's northern waters. Management of the industry in accordance with the *Pearling Act 1990* is focused on ecologically sustainable development principles, ensuring a sustainable catch from the wild, minimising the impact of pearling on the marine environment and optimising the returns to the State through controls on hatchery production to maintain high pearl prices. The Department of Fisheries' research program conducts annual stock assessment and ongoing disease monitoring programs to ensure the industry remains in a healthy condition. These management arrangements have been developed over the years in conjunction with the Pearling Industry Advisory Committee (PIAC), a Ministerial management advisory committee established under the *Pearling Act*.

The wild-stock pearl oyster fishery is managed on a system of individual quotas with a total allowable catch. The status of stocks is reviewed each year by the Department of Fisheries in liaison with pearling licensees and PIAC. There are 16 pearling licensees, who hold between them 572 units in the wild-stock fishery and 350 hatchery units.

The research data for 2001 showed that wild pearl oyster stocks in Zone 1 had been slow to recover from past cyclone events, therefore the TAC from Zone 1 for the 2002 season was reduced from 115,00 to 55,000 shell in 2002 to further relieve pressure on the stocks. Zone 1 licensees are permitted to substitute hatchery-produced oysters for wild captured oysters to maintain their annual pearl production. A maximum size limit of 160 mm was maintained for shell taken in Exmouth Gulf to protect the breeding stock.

The TAC in 2002 in Zone 2/3 was also reduced marginally from the previous year's level of 1,100 oysters to 1,050 oysters per unit. 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 shell stocks were returning to their more normal sustainable levels of 1,000 shell per unit.

The seeding of hatchery-produced oysters continued during 2001/02, with most companies having now demonstrated an adequate commitment to hatchery technology to enable the conversion of their hatchery options to hatchery quota.

Pearl oyster farms are predominantly situated in sheltered waters and range from Exmouth Gulf to the northern waters of the Kimberley. There are presently 94 pearl farm leases, covering a total area of 184 square nautical miles.

Assessment of pearl farm lease applications through a public consultation process continued to be a major activity throughout 2001/02. The Executive Director of Fisheries considered nine lease applications and the Minister determined two appeals. Meetings were held with the pearling industry, tourism charter boat operators, the Wyndham/East Kimberley Shire Council and environmental groups to discuss concerns about access to sheltered bays and perceived loss of wilderness opportunities in the Kimberley.

Overall, 2001/02 was a difficult year for the Western Australian pearling industry. The industry experienced a decline in pearl prices resulting mainly from the general economic downturn, particularly in Asia, and over-supply of low- to medium-quality pearls on the global market. Consequently, several pearling companies rationalised their operations to improve competitiveness. The annual value of production of the Western Australian pearl industry in 2000/01 was estimated to be around $150 million, compared to previous years' figures which fluctuated between $180 million and $220 million.

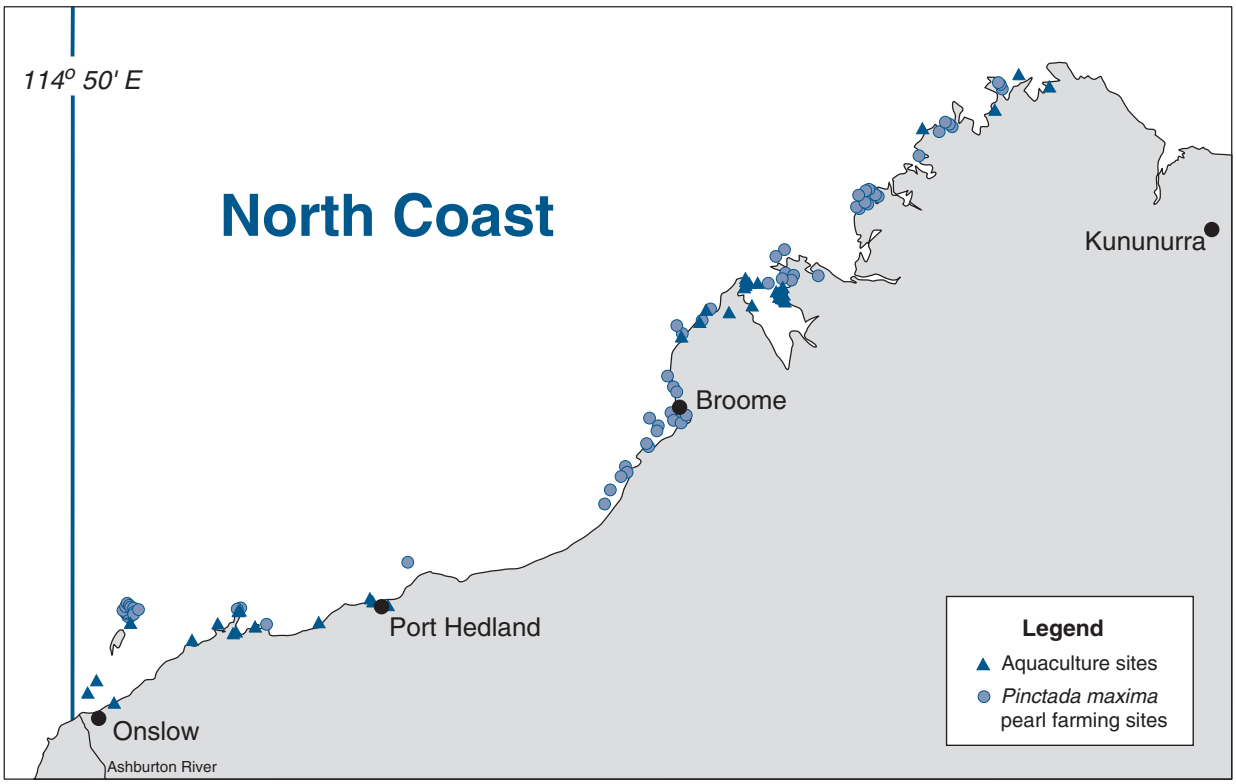
PIAC met on three occasions, with an extraordinary meeting held in February 2002 to consider the strategic direction of the industry, given the economic climate.

The Government announced its decision in relation to the National Competition Policy review of the Pearling Act in March 2002. Implementation of the recommended outcomes will be ongoing throughout the coming year. The review of the legislative framework for pearling also continued during 2001/02, with significant progress made towards the development of a new Pearling Act. Legislative provisions to implement the NCP outcomes will be considered during this process.

The pearl oyster fishery was subject to an ESD assessment to meet the Commonwealth Government's export approval requirements. Industry members, conservation groups and Departmental staff contributed to an environmental risk assessment workshop for pearling, which provided the basis for the ESD assessment report. The draft assessment, which is still to be considered by Environment Australia, indicated that pearling is an environmentally benign industry and the environmental risks surrounding fishing for pearl oysters or farming pearls are insignificant.

Other issues, including budget development and management, operational planning and management of pest incursions, continued to be a focus of attention during 2001/02.

An unknown parasite was detected in pearl oyster spat on a pearl farm in Zone 1. The Department's emergency response plan was invoked to ensure that the parasite was not spread



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.

throughout the fishery while investigations were under way to determine its possible impact on the industry. While the source of the parasite has not yet been determined, it appears that the parasite only affects young shell and poses no significant risk to pearl production or the environment.

Governing Legislation/Fishing Authority
Pearling Act 1990

Consultation Process
Pearling Industry Advisory Committee
Department–industry meetings

Compliance and Community Education Summary

During 2001/02, Fisheries Officers based in Broome, Karratha and Exmouth undertook compliance monitoring across all zones of the pearl oyster fishery, from Exmouth Gulf (Zone 1) to the Kimberley development zone (Zone 4). Fishing operations in Zone 1 of the fishery are now all monitored by VMS.

During the year, 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 industry.

Companies have continued to increase production of hatchery-reared shell, and the compliance focus has shifted to the monitoring and control of this product. Compliance issues involving the verification of shell numbers, 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 growout and to ensure that farms and leases were appropriately marked with navigational markers to approved standards.

All but two companies have now converted their hatchery options to quota and there has been an increase in the quantity of hatchery-reared shell being used for seeding operations in lieu of wild stock.

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. As a result of a routine pathology test of pearl oysters grown in Zone 1, an unknown parasite was discovered requiring quarantine procedures to be introduced for the movement of all pearl oysters from two pearl farms in this zone. Fisheries Officers were required to ensure that strict quarantine restrictions were complied with.

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 small agency vessels being used as dive platforms.

Research Summary

Research for managing the pearl oyster stocks utilises detailed diver logbook records (catch and effort), at-sea sampling of catches and information gathered 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). 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 C. Skepper

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 2001): 571,415 shell

Landings

In 2001 the total allowable catch for the pearl oyster fishery of north-western Western Australia was 617,500 shell (including a 2,000 shell special allowance for tourism purposes).

The Zone 2/3 TAC for 2001 remained at the level set in 2000 (502,500 shell), which was 10% greater than the TAC set in 1998 and 1999. This total allowable catch was allocated because average catch rates within Zone 2 for the previous season were at least 50% greater than a pre-defined 10-year average. The reported catch for Zone 2/3 for the 2001 season was 502,484 shell (Pearl Table 1).

Zone 1 of the pearl oyster fishery had a TAC of 115,000 shell in 2001. The reported catch of 68,931 shell (Pearl Table 2) was similar to 2000 but well below the allocation, as some licensees chose to use hatchery-reared shell in preference to wild stock during the 2001 season, effectively resulting in a TAC of 70,000. This conversion to hatchery stock is due to a decrease in 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.

Fishing effort

Total effort in all zones was 21,534 dive hours, within the acceptable range (15,331–22,599 dive hours) defined for all zones in 2001. The total effort for 2001 in Zone 2/3 was 12,054 dive hours (acceptable range 12,003–16,576 dive hours), which represented a 30% increase on the 2000 Zone 2/3 effort of 9,258 dive hours. This increase reflects a shift in effort towards a more traditional figure for Zone 2/3, as the effort in 2000 was the lowest ever recorded. The total effort in Zone 1 during 2001 was 9,480 dive hours, representing a 61% increase on the 2000 total effort of 5,893 dive hours, and well above the acceptable range (3,328–6,023 dive hours) defined for Zone 1. This increase in Zone 1 occurred despite there being only a slight increase in catch (Pearl Table 2), and may be attributed to three main factors: firstly, a lower abundance of culture-size shell (120–165 mm), particularly in the northern and southern sectors of the fishery; secondly, poor diving conditions experienced on traditional fishing grounds; and thirdly, loss of traditional fishing grounds in some areas of Exmouth Gulf due to cyclone damage.

Catch rate

The catch rate for the pearl oyster fishery (all zones) was 26.5 shells per dive hour (shells/hr) in 2001. This represents a 29% decrease on last season's overall catch rate (37.5 shells/hr).

Catch per unit effort in Zone 2/3 in 2001 was 41.7 shells/hr. Although this was lower than the rates recorded in 1999 and 2000 (when CPUE at 54.2 shells/hr was the highest ever recorded), it still represented a 41% increase on the 10-year (1988–1997) average of 29.5 shells/hr (see Pearl Table 1). As in 2000, the high catch rates in Zone 2 were not as evident in Zone 3. In Zone 2, the catch rate was 42.5 shells/hr, while in Zone 3 it was 31 shells/hr.

The Zone 1 CPUE in 2001 was the lowest ever recorded at 7.3 shells/hr, which represented a 36% decrease from 2000 (Pearl Table 2). Effort in 1998–2000 shifted across Zone 1, from the historically significant southern sector (Exmouth Gulf) to the northern sector (including the buffer zone extension) around Port Hedland. In 2001 effort shifted again, with the southern sector yielding just 4% of the catch (compared to 50% of catch on average since 1990), while the northern sector contributed only 10% of the catch (32% of catch on average since 1990, and 64% since 1998).

Previously under-utilised areas in the middle sector of Zone 1 provided 86% of overall landings in 2001. The catch rate in the northern sector has steadily decreased from 26.4 shells/hr in 1998 to 6 shells/hr in 2001, while in the southern sector catch rates fell to 3.3 shells/hr, continuing the rapid decline in this area which has been affected by cyclone damage. Although significant catches were taken from the middle sector in 2001, the catch rate in this area fell to 7.9 shells/hr.

Recreational component (2001): **Nil**

Stock assessment completed: **Yes**

Zone 2/3: In Zone 2/3 the high level of catch rate recorded in recent years (1994–1996 and 1999–2001) had previously only been experienced during the late 1970s and early 1980s when the pearling fleet was fishing both culture and mother-of-pearl (MOP) shell. When comparing catch rates over the history of the fishery, however, the technological changes related to the introduction of GPS in the early 1990s need to be taken into account. The increase in diver efficiency resulting from this technology had probably stabilised by the mid-1990s, such that catch rates since that time can be directly compared, but are likely to be biased upwards when compared with those prior to 1990.

The high catch rates recorded in 1999–2001 are undoubtedly due mainly to a large pulse of recruits passing through the size range targeted by the fishery. A similar pulse was recorded previously in 1994–96, when the total allowable catch was also increased in response to a high level of recruitment. This increase in recruitment abundance can be partially attributed to the presence of environmental conditions enhancing larval and juvenile survival in the preceding two years. Increases in recruitment have been observed one to two years after ENSO events, with the latest event occurring in 1997/98. Weather patterns and underwater visibility in Zone 2/3 were again favourable during the main fishing periods in 2001, with the resulting good diving conditions and consequent increase in catchability also having a positive influence on catch rates.

The distribution of catch and effort in Zone 2/3 during 2001(as reported in 10 x 10 mile grid squares) was similar to that in 2000, with catches made in less than half the area that was utilised at the beginning of the 1990s. This decrease in effective search time and fishing area again reflects both increased stock abundance and the fleet's ability to target productive areas through the use of GPS and plotter technology. During recent seasons, favourable conditions have also allowed fishers to concentrate fishing effort in shallower water (< 12 m on average), which further increases efficiency by providing additional bottom time. During the last six years the average depth fished has generally decreased.

Assessment of the size of oysters fished in Zone 2/3 shows that around 60% of the catch comes from the 120–140 mm shell height size classes, which are the smaller, newly recruited oysters preferred for pearl culture. These results, together with the fact that an increasing proportion of the fishable area off the Eighty Mile Beach is not being fished annually, suggest that the overall exploitation rate in this sector of the fishery is decreasing.

Zone 1: The distribution of catch and effort in Zone 1 shifted considerably in 2001 when compared to 1998–2000.

Management decisions designed to reduce fishing pressure in Exmouth Gulf were implemented in 1998, and involved setting a separate TAC of 40,000 shell for Exmouth Gulf, and extending the Zone 1 buffer zone 30 miles east to allow operators access to previously under-utilised grounds in the southern areas of Zone 2. Further management arrangements were introduced for the 2001 season, with a TAC of 25,000 shell applied to the northern sector (which includes the buffer zone extension) of Zone 1 in an attempt to control fishing pressure in this area. In addition, the northern sector was divided into three sub-areas, with a TAC for each sub-area also introduced.

During the period 1998–2000 the northern sector had provided 52–75% of the Zone 1 catch, although catch rates decreased every season. The catch from the northern sector decreased significantly during the 2001 season, with a sharp decline in catch rate. Catch monitoring during this period has revealed that fishers are reliant on taking a percentage of catch from larger, less sought-after shell sizes (150–165 mm shell height). In addition, trial 'piggyback' spat collection results were low relative to those recorded for Zone 2/3 of the fishery. The generally low spat collection results are in line with the general assessment that recruitment in Zone 1 is lower and less regular than in Zone 2/3.

Fishing grounds in the middle sector of the fishery which were productive historically provided 86% of the overall Zone 1 catch in 2001, although the very low catch rates recorded must remain an area of concern. The significant increase in catch from this area follows steadily improving catches in recent years, and signs of increased recruitment based on length frequency sampling which shows a high proportion of recently recruited oysters. The middle sector had provided only limited numbers of pearl oysters during the 1990s owing to poor recruitment and unfavourable diving conditions, and consequently has been fished only lightly in recent seasons. The concentration of effort in this sector during 2001 has eased fishing pressure in the previously heavily fished northern and southern sectors of Zone 1.

Exmouth Gulf (southern sector) was lightly fished during 2001, with poor catch rates continuing the trend of declining catch rates in this area during recent seasons. In addition to the loss of productive ground through cyclone impacts on the sea floor, some traditionally productive fishing areas in the south of the Gulf are no longer being fished because they are contained within pearl farm lease boundaries.

The shift in distribution of effort towards the middle sector in 2001 highlights the concerns regarding productivity in Zone 1. While encouraging numbers of pearl oysters were taken from the middle sector, the other sectors have declined considerably in 2001 when compared to catches taken since 1998. Management controls in the southern and northern sectors will again focus on limiting effort and encourage the rebuilding of pearl oyster stocks in these areas (see 'Fishery Governance'). If there is a further decline in abundance indicators in 2002, further controls will be required in this fishery.

Exploitation status: **Fully exploited**

Pearl oyster stocks are considered to be fully exploited within the management parameters of diver safety and 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 in the fishery 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. 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. 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.

SOCIAL EFFECTS

Pearl oyster fishing vessels operate from the Lacepede Islands north of Broome down to Exmouth Gulf in the south. 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 (2000/01): $150 million

The value of cultured pearls and by-products is considered to be approximately $150 million for the year 2000/01. However, a precise estimate of the value of product is difficult to achieve owing to the variable time lags which 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

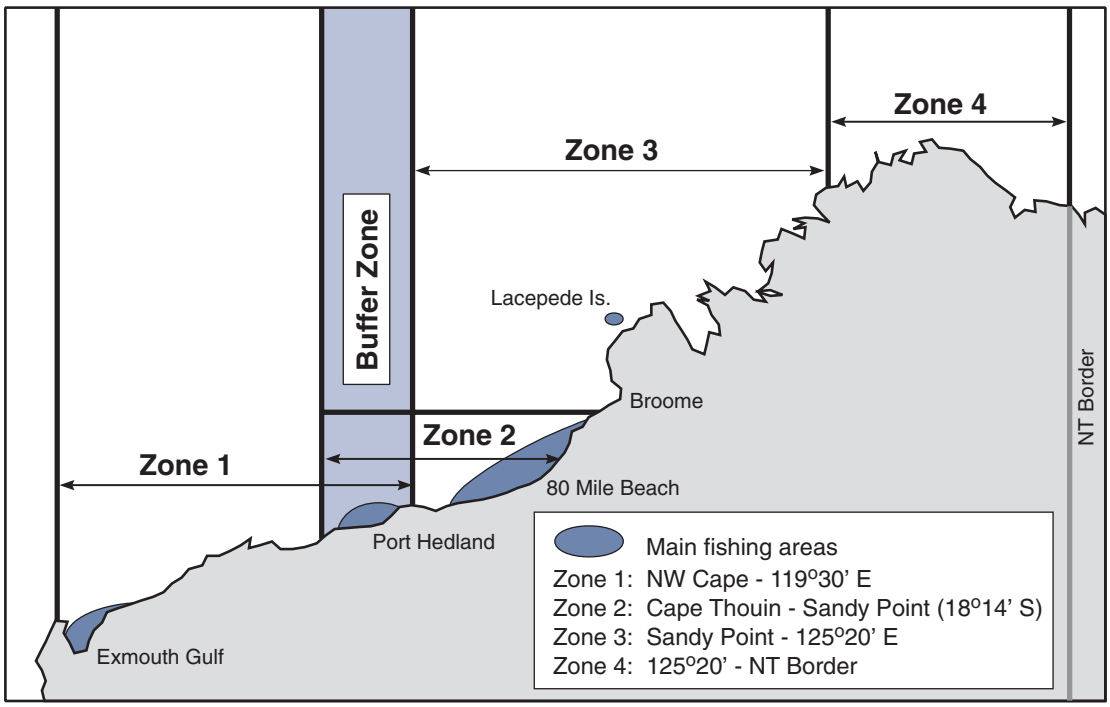
Catch figures in Zone 2/3 have shown significantly elevated catch rates in the last three seasons, above the agreed threshold that triggers quota considerations. Owing to this indication of increased stock abundance, the 2000 and 2001 quota for Zone 2/3 was increased from its traditional level by 10% to 502,500 shell. The 2002 quota has dropped back to 479,750 shell (an increase of 5% on the traditional level) as a precautionary measure reflecting the slightly lower abundance in 2001. It is expected that Zone 2/3 of the pearl oyster fishery should achieve its 2002 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 level of effort in Zone 1 was significantly above the acceptable range defined for the 2001 season. In response to concerns regarding the increasing level of effort required to take wild-stock quota in Zone 1, licensees have been allocated a reduced overall wild-stock TAC of 55,000 shell in 2002. The overall 115,000 shell TAC will be maintained by substituting the shortfall in quota with hatchery-reared stock. The wild-stock TAC is to be reviewed in May 2002, when any adjustment to the TAC will be made following analysis of available catch and effort data.

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). If Zone 1 is not able to achieve this catch within this acceptable effort range, then additional management changes to the TAC for 2003 may be required to ensure adequate numbers of oysters flow through to the breeding stock in all sectors of Zone 1.

EXTERNAL FACTORS

The pearl oyster stocks underpinning the fishery in Zone 2 (83% of total pearl oyster catch in 2001) continue to provide an elevated level of production to support this major Western Australian industry. A current project (part-funded by FRDC) 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. In a fishery that targets pearl oysters for approximately three years once they reach 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	QUOTA	NO. OF CULTURE SHELLS	NO. OF MOP SHELLS	TOTAL SHELLS	DIVE HOURS	CULTURE SHELLS/HR	MOP SHELLS/HR	TOTAL SHELLS/HR
1978		404,952	146,692	551,644	10,583	38.3	13.9	52.1
1979		371,806	355,599	727,405	16,068	23.1	22.1	45.3
1980		364,502	260,714	625,216	18,568	19.6	14.0	33.7
1981		481,193	210,649	691,842	23,320	20.6	9.0	29.7
1982	460,000	439,092	132,931	572,023	15,710	27.9	8.5	36.4
1983	520,000	365,381	87,049	452,430	19,019	19.2	4.6	23.8
1984	375,000	242,828	47,230	290,058	11,615	20.9	4.1	25.0
1985	342,000	272,869	53,831	326,700	12,423	21.0	4.3	26.3
1986	360,000	337,566	10,929	348,495	16,478	20.5	0.7	21.2
1987	380,000	365,397	0	365,397	17,476	20.9	0	20.9
1988	445,000	379,657	0	379,657	14,600	26.0	0	26.0
1989	445,000	445,364	0	445,364	18,625	23.9	0	23.9
1990	457,000	453,705	0	453,705	23,263	19.5	0	19.5
1991	457,000	460,608	0	460,608	21,657	21.3	0	21.3
1992	457,000	461,599	0	461,599	19,455	23.7	0	23.7
1993	457,000	457,186	0	457,186	14,733	31.0	0	31.0
1994	457,000	456,832	0	456,832	12,384	36.9	0	36.9
1995	512,000	511,633	0	511,633	12,217	41.9	0	41.9
1996	512,000	511,756	0	511,756	12,774	40.1	0	40.1
1997	512,000	512,314	0	512,314	16,893	30.3	0	30.3
1998	457,000	457,266	0	457,266	14,499	31.5	0	31.5
1999	457,000	457,842	0	457,842	10,300	44.4	0	44.4
2000	502,500	501,419	0	501,419	9,258	54.2	0	54.2
2001	**502,500**	**502,484**	**0**	**502,484**	**12,054**	**41.7**	**0**	**41.7**

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	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	0	132,316	6,291	21.0	0	21.0
1995	115,000	121,312	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	0	90,414	4,789	18.9	0	18.9
2000	115,000	66,772	0	66,772	5,893	11.3	0	11.3
2001	**115,000**	**68,931**	**0**	**68,931**	**9,480**	**7.3**	**0**	**7.3**

Notes:

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.

Hatchery stock used during 1999–2001 reduced the need for wild-stock shell.

South Coast Bioregion

REGIONAL MANAGEMENT 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*) and mussels (*Mytilus edulis*) in Albany. Hatcheries for greenlip abalone (*Haliotis laevigata*) have been established in Albany and in Bremer Bay and several sites in Esperance have been identified as suitable for abalone aquaculture.

The Albany Aquaculture Park, which contains two sites leased for oyster and abalone production, continues to be an important resource for the development of aquaculture in the south coast bioregion. Two sites remain available for lease. Leaseholders in King George Sound prepared an environmental monitoring plan to meet licensing requirements for sea-based abalone growout.

Administrative oversight of the WA Shellfish Quality Assurance Program was continued.

REGIONAL DEVELOPMENT AND COMPLIANCE OVERVIEW

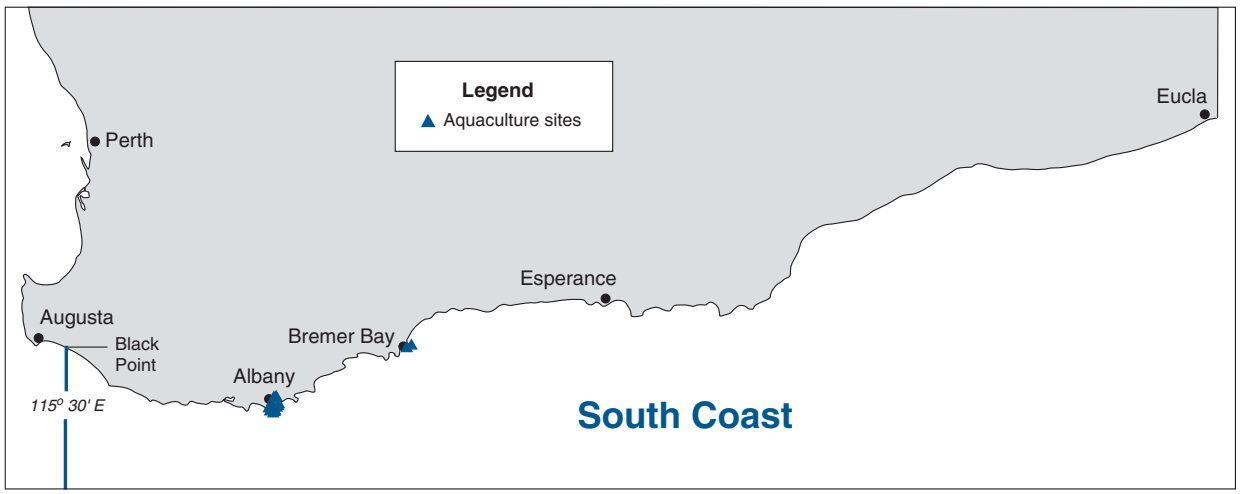
Regional officers were involved in supervising the sampling of waters and shellfish and monitoring harvest closures as part of the WASQAP. Development activities in the Esperance area related to a support role provided to the Esperance Shire's expression of interest process for land to be developed for aquaculture use. Public enquiries were received from across the region concerning a range of issues from development and investment opportunities to licensing and policy advice, particularly in relation to abalone aquaculture.

At-sea inspections were conducted on lease sites in Oyster Harbour, King George Sound and Wilson Inlet to ensure compliance with marking and lighting requirements, with one letter of warning issued for failing to display approved lighting.

Fisheries Officers also carried out inspections on licensed abalone hatcheries to monitor adherence to the requirements for broodstock collection and destruction.

REGIONAL RESEARCH OVERVIEW

Major progress has been made with conditioning greenlip abalone broodstock out of season and using these for commercial production of juvenile abalone. Use of novel types of algae has greatly increased production in experimental and commercial greenlip nursery tanks. A major review of abalone biology and farming has been released and a detailed study of waste outputs from land-based abalone tanks has commenced. Performance of greenlip abalone in sea-based culture near Albany continues to be encouraging and an environmental monitoring program has been developed. Assessment of the potential environmental impact of mussel farming on benthic habitats, supported by the Department of Fisheries, FRDC and ADF, was completed near Albany and indicated that effects were minor, although the farms were not in full production.



SOUTH COAST AQUACULTURE FIGURE 1

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

Northern Inland Bioregion

REGIONAL MANAGEMENT OVERVIEW

Small-scale cage farming of barramundi (*Lates calcarifer*) on Lake Argyle has been successfully developed by a local fishing company over recent years. During 2001/02, environmental approvals have been sought and gained allowing significant increases in production to occur this year and for the next several years. The interest of additional participants has also been fostered.

Other management activities in the bioregion included the provision of technical advice to landholders on the Ord irrigation system around Kununurra in relation to the production of redclaw (*Cherax quadricarinatus*), aquarium fish, sooty grunter (*Hephaestus jenkinsi*) and barramundi. Particular emphasis has been placed on the development of several community-based indigenous aquaculture projects.

Northern Inland Aquaculture Figure 1 shows the major licensed aquaculture sites in this bioregion.

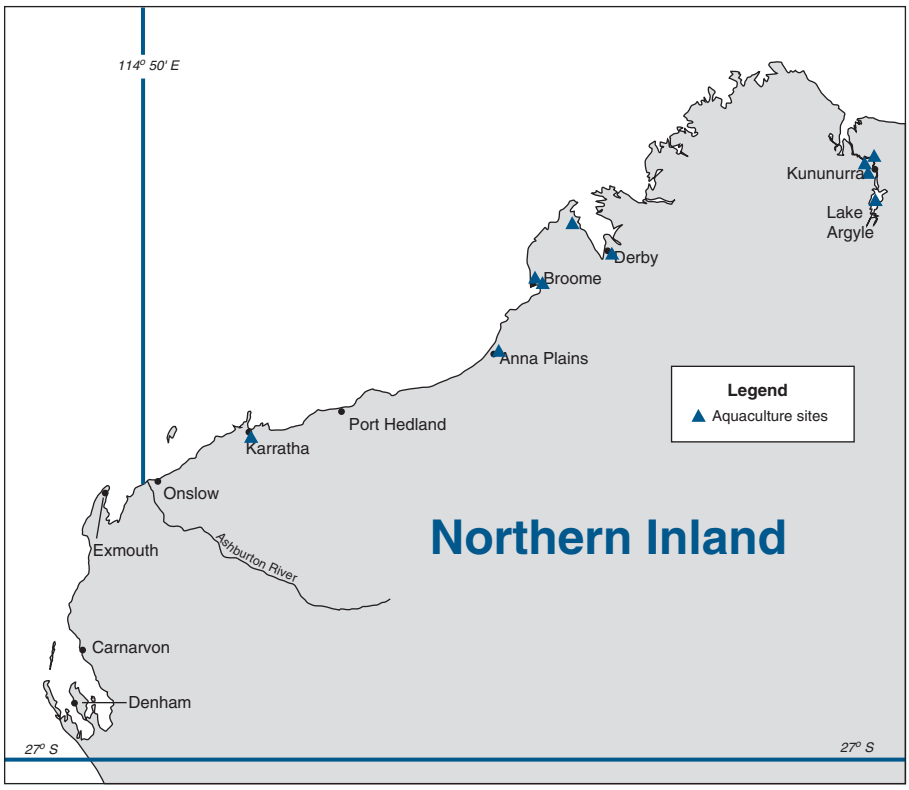
REGIONAL DEVELOPMENT AND COMPLIANCE OVERVIEW

Aquaculture Development Officers are stationed in Broome and Kununurra. One of their major roles is to facilitate the necessary approvals to commence major aquaculture ventures in the Kimberley. During the year special efforts were focused on assisting Aboriginal communities to meet their aquaculture development objectives. In addition, the officers were directly involved in the production of juvenile barramundi in liaison with the Broome TAFE, and in aquaculture site identification on pastoral leases for preliminary planning for the production of redclaw. Pre-feasibility studies were conducted for other crustaceans and finfish.

Further south, assistance was provided to the Gascoyne Inland Aquaculture Group which is investigating the production of ornamental fish in artesian waters. Ongoing technical advice was also provided in response to public enquiries.

REGIONAL RESEARCH OVERVIEW

Evaluation of waste outputs from a range of barramundi feeds (part-funded by the ADF) has been undertaken at Lake Argyle with a commercial farm. This complements the environmental monitoring program developed for this farm by research staff and will permit updating of an internet-based model for predicting potential waste output for a range of farmed species including barramundi (part-funded by the ADF). A project proposal to the FRDC on minimising phosphorus input into Lake Argyle from barramundi farms was developed and submitted. The effort being made on barramundi projects reflects the potential for Lake Argyle to sustain very large tonnages of barramundi production.



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 sea water.

AQUACULTURE PRODUCTION

Production current season (2000/01): **45 tonnes**

Number of producers for year 2000/01: **7**

Production projection next year (2001/02): **75–125 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 design are used which minimise uneaten food and soluble nutrient release.

Native fish 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 tonne 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 2000/01: $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 be developed and maintained.

EXTERNAL FACTORS

This industry has the potential to grow significantly, particularly in Lake Argyle where a 500 tonne production licence has been issued. Growth in production has been delayed by some farmers moving to production of 3 kg fish for fillets rather than smaller, plate-size fish.

Southern Inland Bioregion

REGIONAL MANAGEMENT OVERVIEW

The southern inland bioregion is dominated by production of yabbies (*Cherax albidus*), marron (*Cherax tenuimanus*) and freshwater finfish, while the development of inland saline aquaculture continues to grow. Management and licensing arrangements have not changed significantly over the past year.

Coordination has improved within the aquaculture industry. The two main trout grower groups are working together to deal with issues facing their industry, which produces both rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*).

The Department of Fisheries facilitated a government workshop in February 2002, and organised an industry workshop in Narrogin during April, in relation to inland saline aquaculture. The government workshop resulted in a commitment by the attendees from various agencies to form a working group to achieve better communication and co-operation and a strategic approach to the development of inland saline aquaculture. Industry participants resolved to develop strategies through the Aquaculture Council of WA.

Trout ova and fry from the South West Freshwater Research and Aquaculture Centre (SWFRAC) at Pemberton were again sold to freshwater trout farmers, and yearlings were sold to growers using inland saline waters.

The Silver Perch Growers' Association are working on developing a code of practice and marketing strategies for exporting their product (*Bidyanus bidyanus*).

The production of freshwater and marine ornamental fish species is a small but rapidly growing sector of the aquaculture industry in Western Australia.

REGIONAL DEVELOPMENT AND COMPLIANCE OVERVIEW

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. For 2001/02 there was a particular focus on the production of trout, marron and yabbies, including the Yabby Roadshow, the SWFRAC open day and a series of workshops on inland saline aquaculture, with extensive resources being directed to providing development and extension assistance to farmers.

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.

The theft of marron from farm dams is of major concern, with an increase in incidents of theft reported by licensed aquaculturists. Department of Fisheries staff are working with the police and the Marron Growers' Association to address this issue.

REGIONAL RESEARCH OVERVIEW

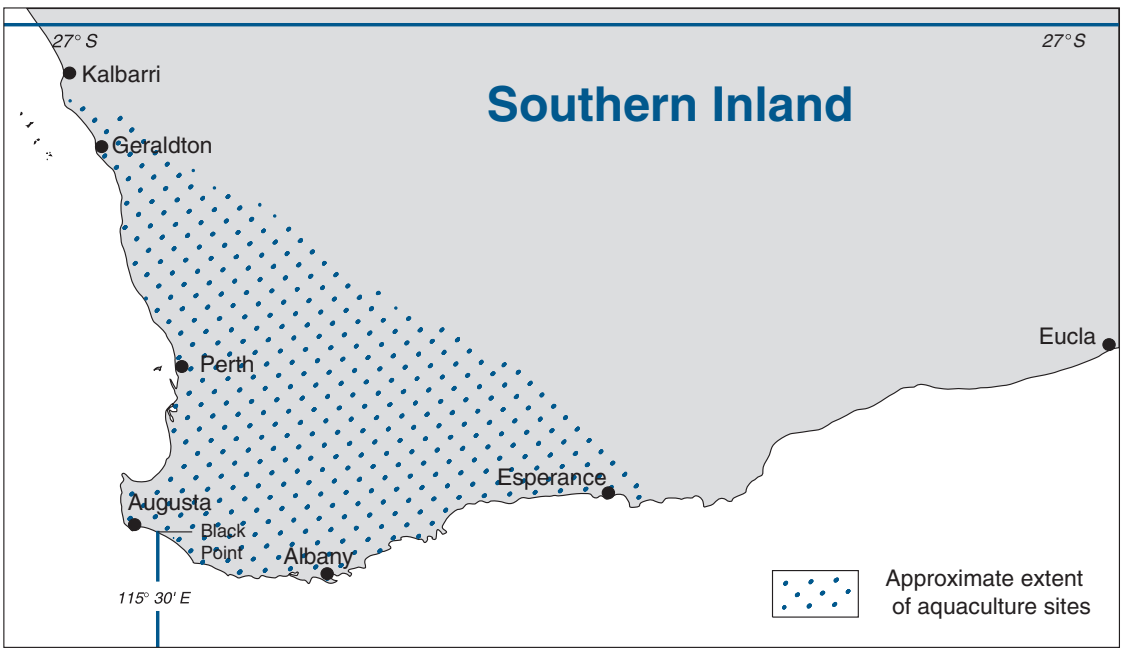
Research activities have focused on work to assist marron, yabby and rainbow trout farming industries and to produce yearling trout at the SWFRAC for inland saline farming trials throughout the region. Research staff based at Perth and Pemberton provided advice to many farmers, particularly through workshops and a major field day at SWFRAC.

Research facilities have been greatly expanded to help improve the profitability of marron farming through genetic and pond management and by treating discharge water for reuse, particularly in summer. Model ponds and aquaria have been established at a joint facility with the University of WA at Shenton Park (with additional funding from ADF, FRDC and industry), while a pond complex has been commissioned at the SWFRAC (with additional funding from the Commonwealth Regional Assistance Program, South West Development Commission, the Department of Training and the Water Corporation of WA). This has enabled the SWFRAC to expand its role as a demonstration facility.

Research trials involving four commercial farms and the research facilities at Shenton Park and Pemberton have shown great potential for improving the quality of commercial marron farming lines. Useful results have also been generated by University of WA research students in other marron projects at Shenton Park.

Yabby research supported by the FRDC and the ADF has shown that hybrid Australian yabbies grew twice as fast as existing commercial yabbies under pond conditions. Ongoing efforts are being made with commercialising this technology, with stocks of parental strains being developed at a separate facility at Shenton Park and in the pond complex operated by the Department of Fisheries within the Department of Agriculture's Avondale Research Centre at Beverley.

Upgrading of production facilities at the SWFRAC allowed increased production of yearling rainbow trout for farmer assessment of production in saline ponds or dams. However, the late start to winter and associated dry conditions have depressed demand in 2001. Production trials for inland saline trout, including marketing initiatives, continued with assistance from the Development and Better Interest Fund. Additional trials with snapper grown in inland saline bore water have been initiated by the WA Maritime Training Centre.



SOUTHERN INLAND AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture sites of the southern inland bioregion.

MARRON FARMING

MARRON FARMING STATUS REPORT

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Licensed purpose-built farms for marron (*Cherax tenuimanus*) extend from Esperance to Hutt River north of Geraldton, though the bulk of farms are concentrated in the higher-rainfall south-west coastal areas.

Two types of marron licence are available:

1. 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.
2. An Aquaculture Licence (Marron Limited) allows the licence holder to sell marron of 76 mm 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 (2000/01): 52 tonnes

Number of producers for year 2000/01: 172

Production projection next year (2001/02): 50–60 tonnes

Production in the 2000/01 and 2001/02 years is being impacted by the drought conditions experienced in the growing areas. Production capacity is increasing, and this is expected to sustain existing total production despite the low water supply.

ECOSYSTEM EFFECTS

Marron farms present a low risk to the environment because there is relatively little water discharged from marron farms. The Department of Fisheries recommends use of 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 been constructed at the SWFRAC. Escape of farmed stock into natural waterways is of concern, particularly if genetically selected stocks are used. The demonstration facility includes designs for electric fences which are eco-efficiency tools, that is, they prevent such escapes while improving profitability through deterring predators such as water rats.

SOCIAL EFFECTS

Marron farming is being utilised as a means of diversification of farm income. 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 2000/01: $1.2 million

INDUSTRY GOVERNANCE

Licence approvals are required.

EXTERNAL FACTORS

A significant number of new purpose-built marron farms have been developed during 2001/02, 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 SWFRAC as these have the potential to help drought-affected marron farms, although farmers cannot sustain an excessive number of ponds for the available water supply. As production expands, the industry will need to efficiently harvest 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.

YABBY FARMING

YABBY FARMING STATUS REPORT

Prepared by G. Maguire

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 developed 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 (2000/01): 201 tonnes

Number of producers for year 2000/01: 23

(This number refers to licensed farmers or processors. Note most farmers do not require licences.)

Production projection next year (2001/02): 180–220 tonnes

Production is limited by water levels in farm dams which have been restricted by low rainfall in 2000/01 and 2001/02.

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. 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 commercially, these should further reduce environmental risks as they do not breed with the parental strains. The current commercial yabby stocks have been shown not to be destructive burrowers, but rather build shallow burrows (research part-funded by the ADF).

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 2000/01: $2.51 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 (e.g. monosex growout, improved feeding regimes and regular, more effective trapping) are adopted by industry, although production depends greatly on rainfall.

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 G. Maguire

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. On an experimental basis, sea cage trials have been undertaken at Fremantle in more protected inshore waters.

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 (2000/01): 18 tonnes

Number of producers for year 2000/01: 6

Production projection next year (2001/02): 20–25 tonnes

The drought conditions during 2001 restricted the number of inland farmers able to purchase yearlings and thus curtailed inland saline farming trials during winter/spring of 2001.

ECOSYSTEM EFFECTS

Trout farming is considered to present a low to medium risk to the environment. Farms producing more than one tonne 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 been constructed at the SWFRAC. 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 from land-based farms is low 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 2000/01: $170,000

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 SWFRAC 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 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 be similar to that of the trout grown for the general fish market trade. Inland saline farming trials based on growing yearling rainbow trout to table size have been promising and may help the industry recover to earlier production peaks (more than 40 tonnes per year), but production still is rainfall-dependent and profitability not established.

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.

ORNAMENTAL FISH FARMING

ORNAMENTAL FISH FARMING STATUS REPORT

Prepared by G. Maguire

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; breeding and rearing of juveniles for live sales.

AQUACULTURE PRODUCTION

Production current season (2000/01): 288,000 fish

Number of producers for year 2000/01: 22

Production projection next year (2001/02): 250,000–350,000 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 2000/01: $250,000

INDUSTRY GOVERNANCE

Specific licence approvals are needed for commercial production.

EXTERNAL FACTORS

Annual commercial production recorded for this sector indicates considerable volatility in production 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, create an interstate marketing opportunity for local producers.

FISH AND FISH HABITAT PROTECTION

FISH AND FISH HABITAT PROTECTION

General Overview

The aquatic environment of Western Australia supports a range of outstanding recreational fishing, commercial fishing, pearling and aquaculture industries. These activities all depend upon a healthy environment for their continuing success. The Western Australian Government is committed to the conservation of the aquatic environment so that it may be used and enjoyed for generations to come.

The Fish and Fish Habitat Protection Program coordinates the Department's role in the protection of the marine estuarine and riverine environments as required by the Government's fisheries policy. The Program develops policy and manages projects which have application to the Department's other Programs of Aquaculture, Pearling and Commercial 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 routinely contributes to the State's environmental protection processes by providing advice to the Environmental Protection Authority (EPA) and other Government agencies on coastal and marine developments and on marine and environmental policy.

To facilitate these activities on behalf of the wider community, a stakeholder reference group provides input on fish habitat protection, ecologically sustainable development 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 EPA 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 2003, 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 2003. During 2001/02, the Department of Fisheries continued its progress toward that goal by producing final assessment reports for the West Coast Rock Lobster, Shark Bay Prawn, Exmouth Gulf Prawn and Shark Bay Scallop Managed Fisheries. In addition, draft assessment reports have been prepared for the Abalone and Shark Bay Snapper Managed Fisheries and the Pearl Oyster Fishery. 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 2001/02 the Fisheries Action Program supported 6 continuing and 2 new projects with funding totalling $300,600, while Fishcare WA provided $31,068 in funding for 11 community-based projects. This brings the total amount of funding granted under both programs to $1,544,047 since 1996.

One newly-funded Fishcare WA project provided benefits across more than one bioregion. This was the Coast Law Conference and book coordinated by the Environmental Defender's Office. Other projects were regionally based and are listed in relevant bioregion sections below.

Marine Reserves and Marine Planning

The Department of Fisheries continues to work with CALM to implement the Government's marine reserves 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 which may harm or alter the environment. The waters of the Abrolhos Islands, Cottesloe Reef and Lancelin Island Lagoon are reserved as FHPAs. During the year, the draft plan of management for the proposed Miaboolya Beach FHPA was released and additional FHPAs are also being considered at Quobba and Kalbarri.

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 and Esperance. An additional protection area is also proposed at a wreck site near 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:

- The Department is working with the National Taskforce on Introduced Marine Pests to develop a single national system for the management of marine pest incursions. In addition, Fisheries Officers and Policy Officers have attended training programs on emergency response to introduced marine pests.
- The Department, in collaboration with the Water and Rivers Commission, has maintained a fishkill response capability aimed at responding to fishkill incidents in a timely way in order to identify the cause of kills and to institute appropriate management actions.
- A comprehensive set of guidelines for the establishment of FHPAs has been finalised. The guidelines outline a process which enables community groups to initiate the establishment of FHPAs and other protected areas.
- A draft discussion paper has been developed which identifies possible methods to manage the recreational collection of coral in Western Australian State waters. This is expected to be released to the public by the end of this year and will guide future management of this sensitive issue.
- A 'Shark Incident Response Plan' was prepared for use by staff of the Department of Fisheries in the event of a shark sighting in near-shore metropolitan waters or a shark attack.
- 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 a digital form in a Geographic Information System (GIS) administered by the Fish and Fish Habitat Protection Program.

The spatial data stored includes administrative boundaries for managed fisheries, interim managed fisheries, joint authority managed fisheries, declared fishing zones,

closures as prescribed in regulations, orders and notices, FHPAs, RPAs, and aquaculture and pearling leases.

Other administrative boundaries stored include non-departmental data such as Australian maritime zones, CALM parks and reserves boundaries, Department of Land Administration (DOLA) cadastre, native title claims and petroleum and mining leases. Also included are data relating to infrastructure such as road networks, dam locations, boat ramp locations, mooring locations and a range of named feature locations (DOLA Geonoma).

Physical and biological data relating to the Western Australian environment are also stored. These data include, but are not restricted to, fish species distributions and biology, marine benthic habitat information, marine flora and fauna distributions, bathymetry, salinity, water temperature, digital imagery (satellite and aerial photography) and human activity data (e.g. commercial and recreational fishing catch and effort).

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 EPA and the Department of Fisheries in 1997. A total of 37 assessments have been undertaken throughout the year, providing for the sustainable development of the aquaculture industry within Western Australia.

During the year, two Fisheries Management Papers have been published which deal specifically with translocation issues. Fisheries Management Paper no. 159 (Thorne 2002) deals with the translocation of barramundi for aquaculture and recreational fishery enhancement. 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

A number of projects which will give greater protection to fish and their habitats were advanced in the west coast bioregion during 2001/02. This included further progress on marine protected areas, including finalisation of the Jurien Bay Marine Park Plan which is being prepared by CALM, and the management of the Abrolhos system.

In April 2001, the Minister established the Lancelin Island Lagoon FHPA. The Department of Fisheries worked with the Marine Conservation Society of WA to set aside this marine protected area. In September 2001, the Minister established the Cottesloe FHPA and the final plan for the management of the area was released. The Department continues to work with the Cottesloe Management Protection Group on this project. Both of these areas were identified by community groups who considered them important for educational purposes. These groups expressed a willingness to take a lead role in the stewardship of the areas and have established working groups to progress implementation of the management strategies. This includes the installation of land-based information and interpretation signs and the installation of a number of environmentally sensitive boat moorings with financial assistance from Environment Australia's National Moorings Program.

An additional FHPA is now being considered at Kalbarri (the Blue Holes) to assist in the long-term protection of this area in conjunction with local community groups.

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:

- Work commenced on the upgrading of the Department's operational base at the Abrolhos Islands with the construction of a new jetty.
- A series of signs were erected to inform visitors about the Abrolhos and assist in protecting the environment.
- The Department published two volumes of a major research report on natural and human use impacts on the marine environment of the Abrolhos Islands (Webster et al. 2002; Chubb et al. 2002). This report provides a very useful basis for the development of strategies to minimise the effects of human activities on the Abrolhos marine environment.
- With the assistance of funding provided under the Natural Heritage Trust, nine additional environmentally sensitive public moorings were installed at the Abrolhos. These facilities will enable the general public to access dive sites without damaging the environment.
- Work continued on the draft bycatch action plan for the Abrolhos Islands and Mid West Trawl Managed Fishery.

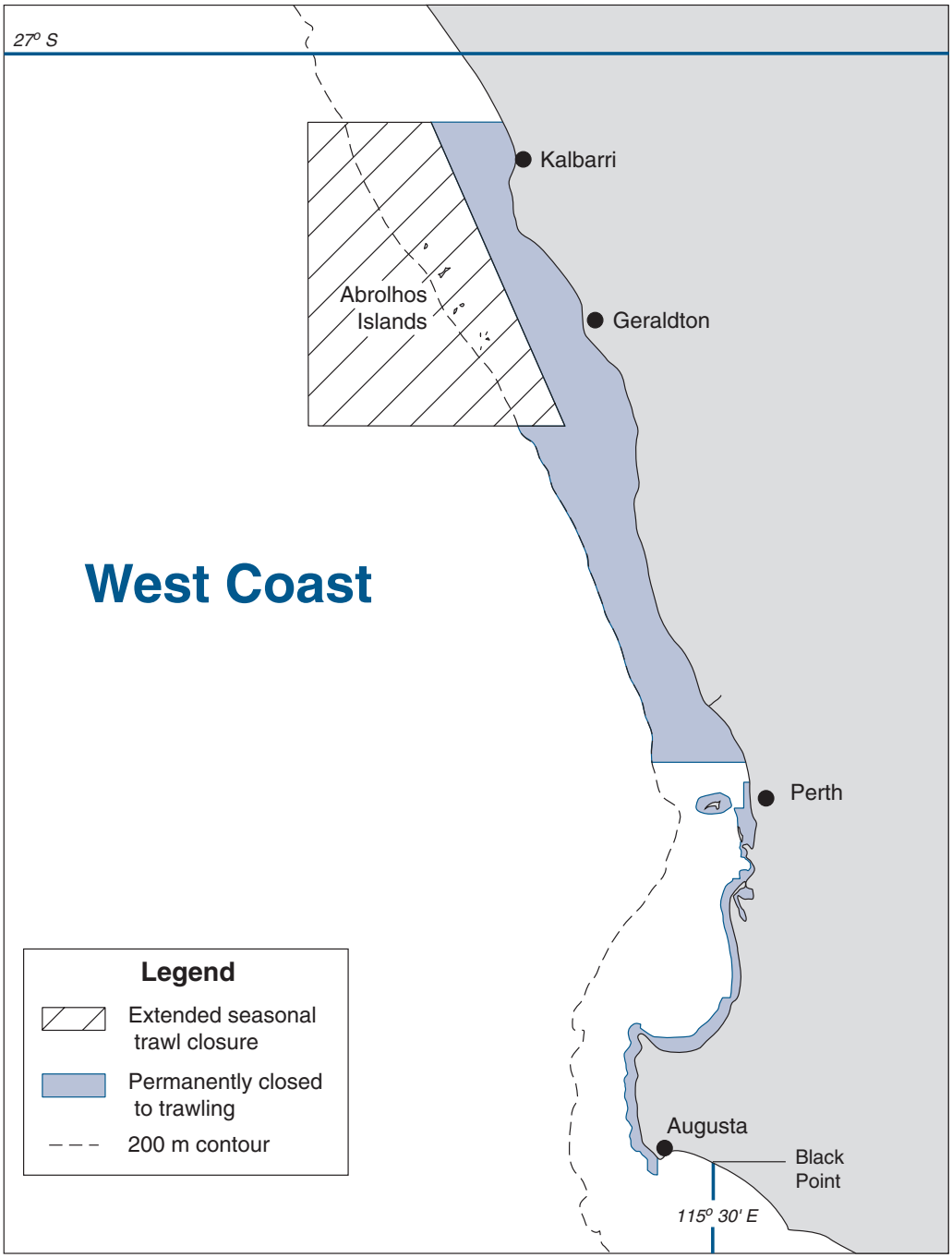
Two new Fishcare WA projects were funded in the west coast bioregion. These were:

- Field establishment and monitoring of the Lancelin Island Lagoon Fish Habitat Protection Area (Lancelin Island Lagoon FHPA Management Group).
- Save the Blue Holes (Friends of the Blue Holes).

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



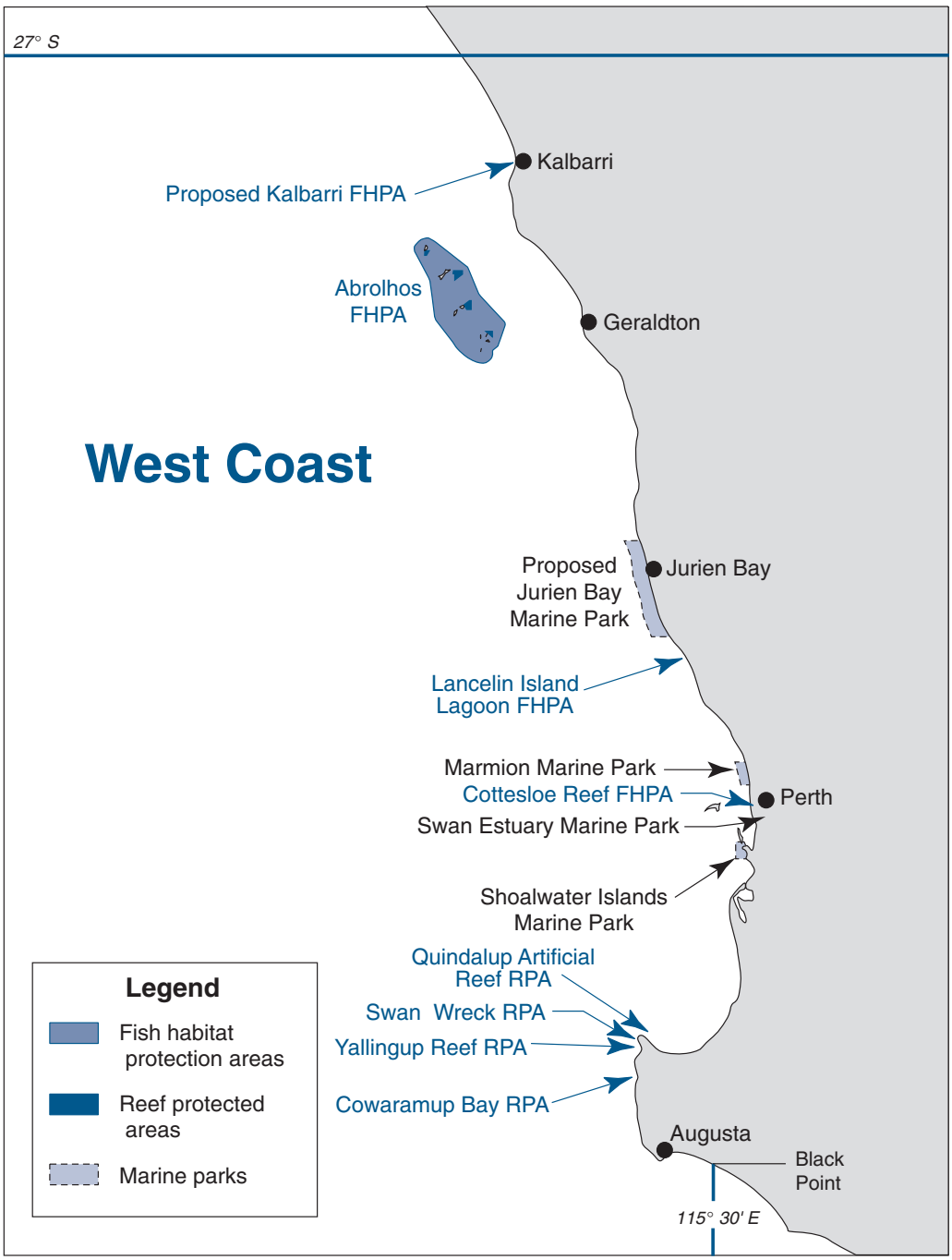
WEST COAST HABITAT PROTECTION FIGURE 1

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

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).

The dedicated two-man field operations team established in the Abrolhos Islands during 2000/01 continued to enhance service delivery and public awareness of important environmental issues in this remote location. Patrols of the RPAs continued with an educative focus, but with some apprehensions for illegal fishing activities.



WEST COAST HABITAT PROTECTION FIGURE 2

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

Gascoyne Coast Bioregion

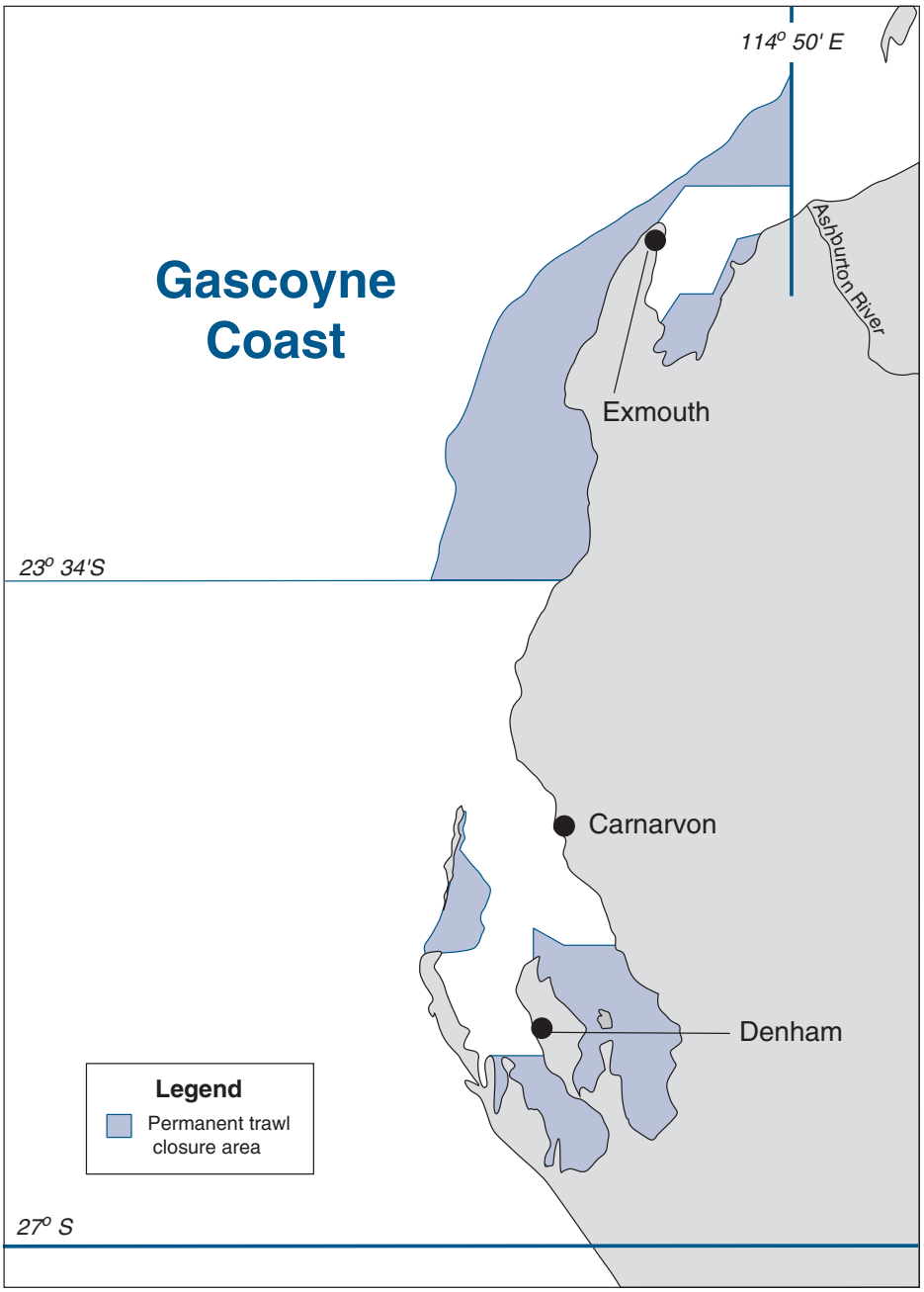
ENVIRONMENTAL MANAGEMENT OVERVIEW

The management of the environmental effects of fishing continues to be a major focus of the Department's operations in the Gascoyne bioregion.

The draft bycatch action plan for the Shark Bay Prawn Managed Fishery was completed and released in April 2002. The public submissions are being analysed and will be incorporated into the final plan. Research on bycatch reduction devices is continuing and BRDs (grids) were used on all prawn trawl fishing boats this season. Work is continuing on the development of fish escape devices. Work also continues on the bycatch action plans for the Shark Bay Scallop and Exmouth Gulf Prawn Managed Fisheries.

The draft Gascoyne Region Fisheries Environmental Management Plan was completed and will be available for public comment until October 2002.

The draft plan of management for the proposed Miaboolya Beach FHPA at Carnarvon was released for public review in



GASCOYNE COAST HABITAT PROTECTION FIGURE 1

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

March 2002 and has been well received by the local community. The final plan is nearing completion and is expected to be released by the end of the year.

An additional FHPA is now being considered at Point Quobba, in conjunction with local community groups, to assist in the long-term protection of this area.

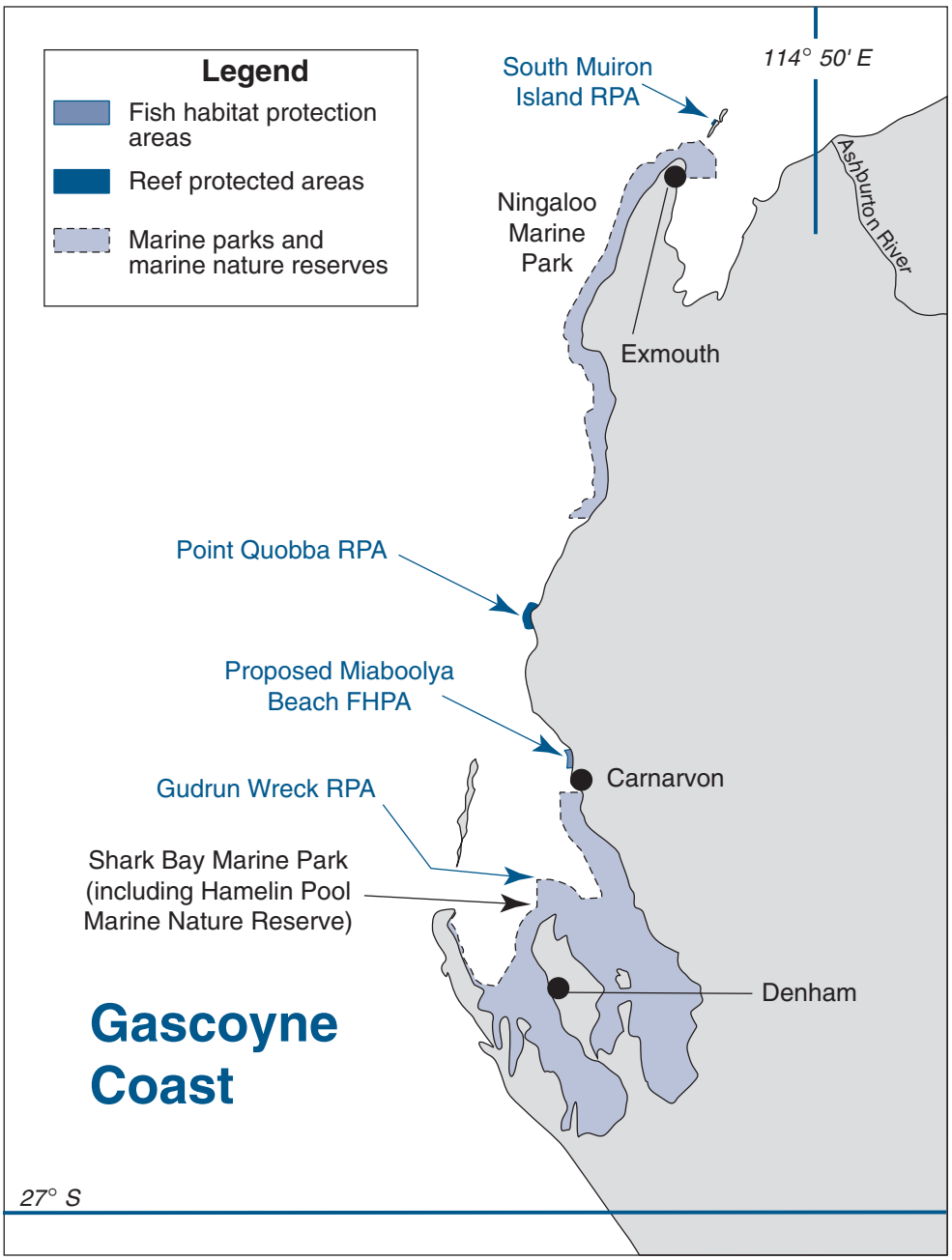
Two new Fishcare WA projects were funded in the Gascoyne region. These were:

- Ningaloo Reef Youth Education Program (Melville District Venturers).
- Public education on reef shark breeding area north of Coral Bay (Ecocean).

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 2001/02, the Department of Fisheries has worked with CALM as part of the planning process for the Dampier Archipelago and Montebello Islands marine reserve proposals. The Department has also liaised with Environment Australia, which released the final plan for the Ashmore Reef and Cartier Island reserves.

Work has also commenced on the preparation of the Fisheries Environmental Management Review for the northern bioregion. This will include the Pilbara and Kimberley marine areas out to 200 m.

Bycatch reduction devices or grids have been trialled in all of the prawn trawl fisheries in the bioregion. It is anticipated that full implementation of BRDs will occur in the coming fishing 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 2005 for all fisheries exporting product.

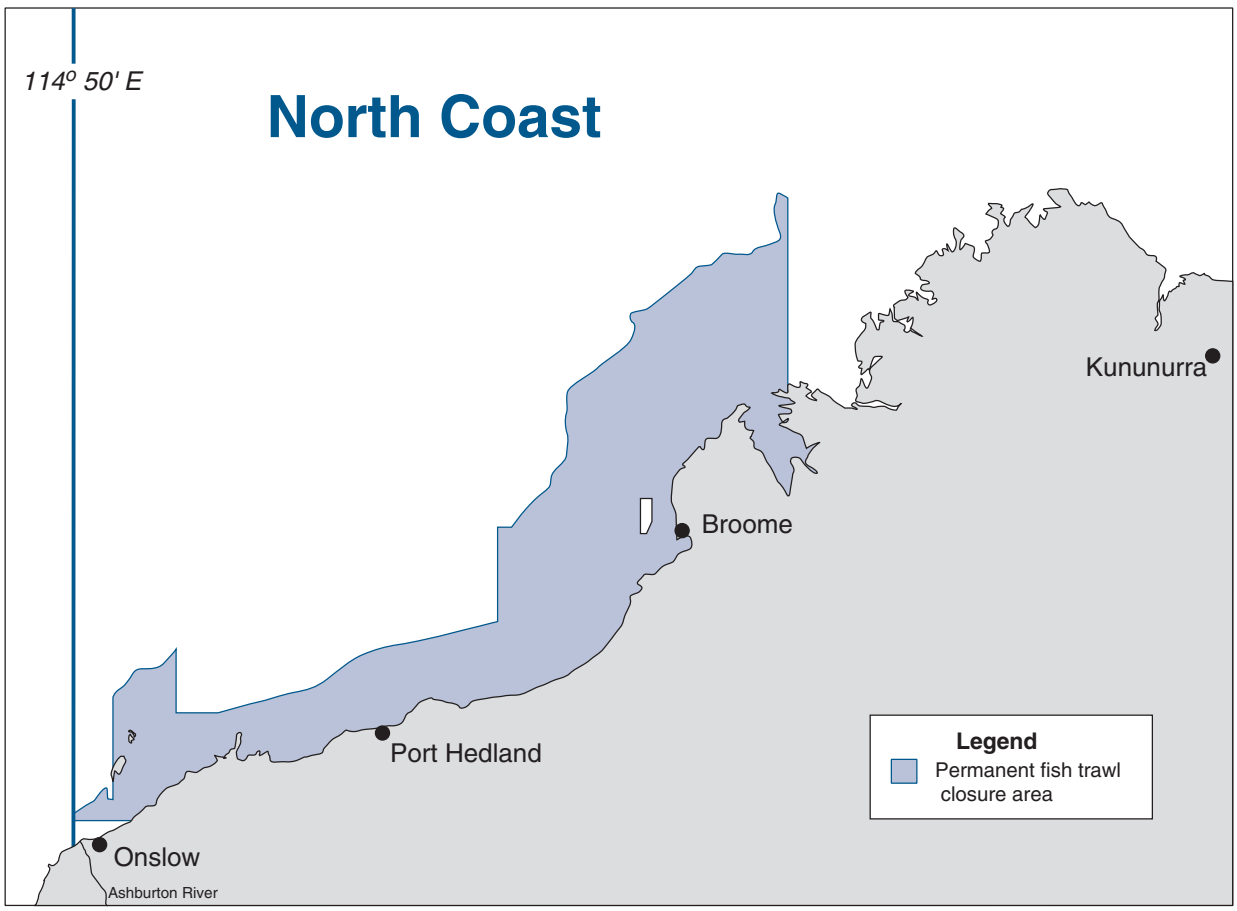
One Fishcare WA project and one new Fisheries Action Program project were funded in the north coast bioregion. These were:

- Brochures and signage to protect the marine area surrounding wrecks *Kunmunya* and *Samson II* (Port Walcott Dive Club, Point Samson).
- Bycatch survey in the Pilbara Fish Trawl Fishery (Department of Fisheries).

FISH HABITAT PROTECTION OVERVIEW

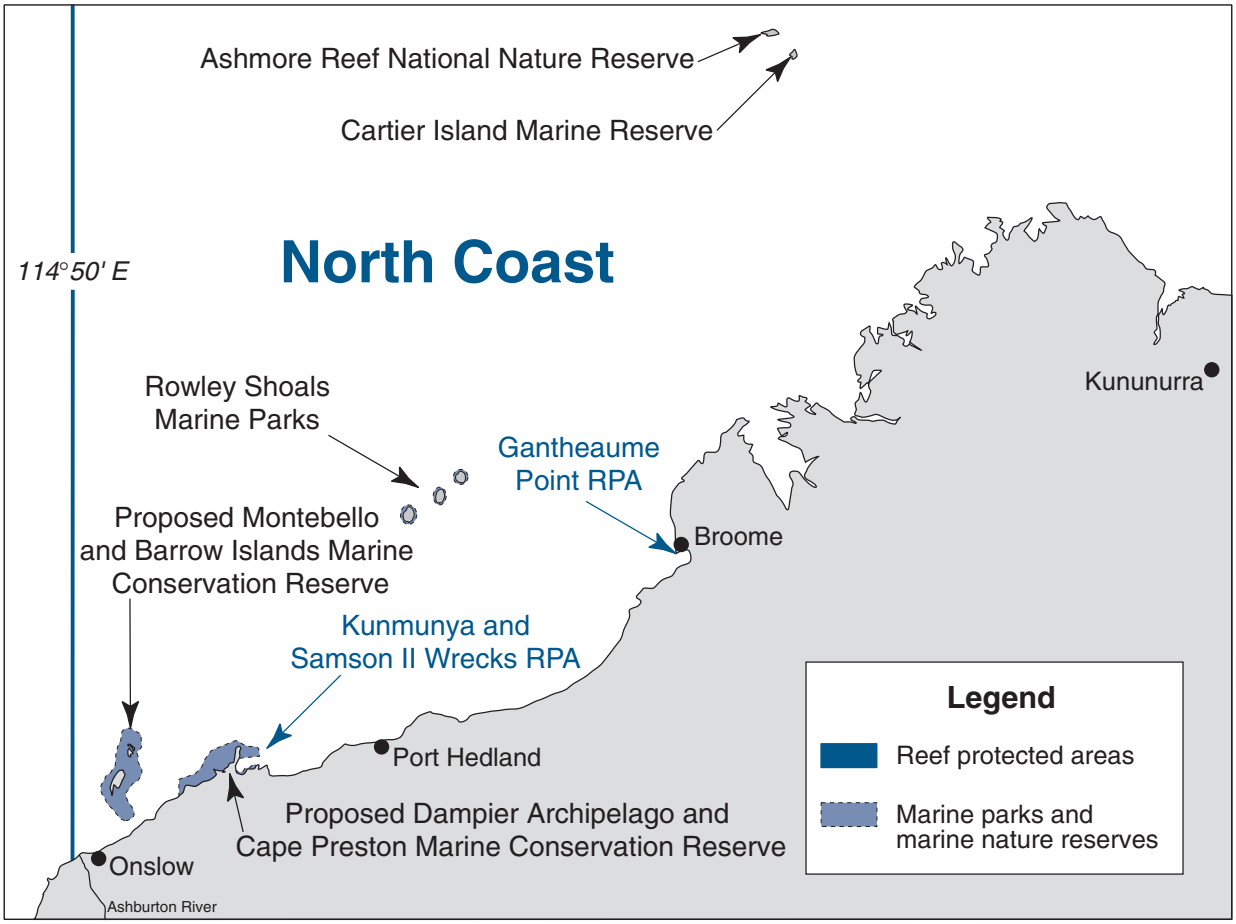
The north coast bioregion has extensive closures to fish trawling in all coastal waters west of longitude 120° E to protect inshore fish nurseries. Similarly, the coastal area off Eighty Mile Beach and north to King Sound, apart from a suitable prawn trawling habitat area, has been permanently closed 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. 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 University of WA has undertaken an extensive survey of the fish habitats of the Recherche Archipelago. The Department serves on the coordinating committee guiding this work.

In November 2001 the HMAS *Perth* was scuttled in King George Sound as an artificial reef and dive wreck. To ensure effective management of the site, the City of Albany has requested that a protection area be declared around the wreck. The Department of Fisheries has supported this move and a prohibition of fishing order is being prepared under Section 43 of the *Fish Resources Management Act 1994*.

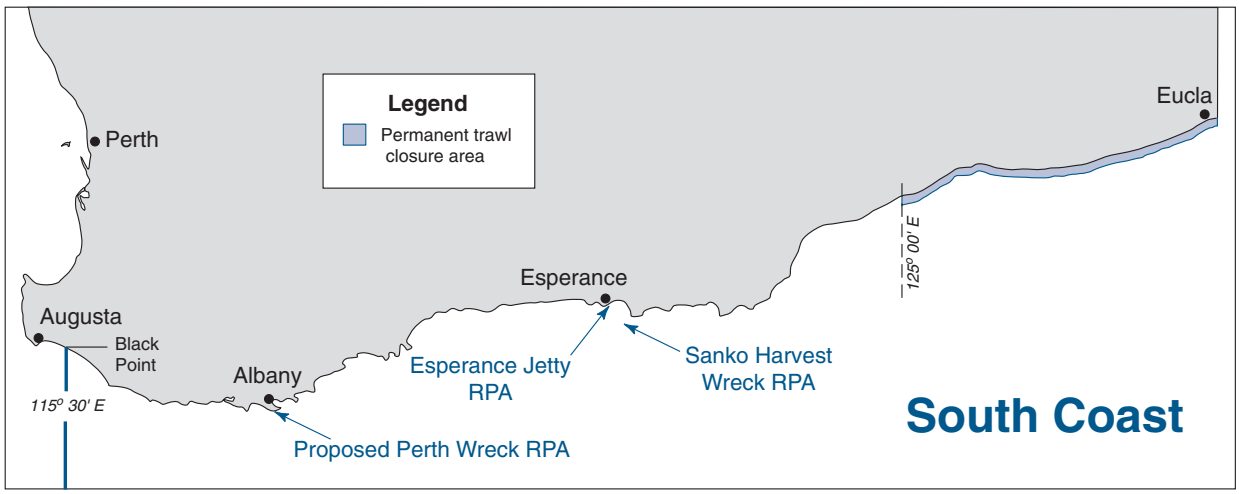
One new Fishcare WA project was funded in the south coast bioregion. This was:

- Dragonsearch Project – encouraging the recording of seadragon sightings online (Australian Marine Conservation Society WA).

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 and the end of the old Esperance Jetty.



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

Work continues on a survey of northern inland streams to help develop our understanding of the freshwater native fish in the region. The project, 'Biology and distribution of fish in inland waters of the North West/Pilbara', is being undertaken by staff and students from Murdoch University, and is supported by funds from the Fisheries Action Program and the Department of Fisheries.

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 May 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. When the comments have been considered, a management plan will be prepared to minimise the effects of these species on native freshwater fish.

Also in May, the Department hosted a workshop to consider issues and management options surrounding the declining Margaret River marron strain. Proceedings from the workshop are currently being prepared and will be circulated by the end of the year.

Engineering design work has commenced for a vertical slot fishway to be constructed at the gauging weir on the Goodga River. Construction is planned for completion by March 2003. The fishway is being built to enable the rare trout minnow, *Galaxias truttaceus,* and other native fish species to access the upper reaches of the Goodga River system, which will more than double the available habitat and provide access to valuable spawning areas.

Four new Fishcare WA projects were funded in the southern inland bioregion. These were:

- Rehabilitation of fish habitat at Boyagarra Pool (Friends of Boyagarra Pool/Brookton LCDC).
- The recent evolutionary history of fish populations in Lake Jasper and nearby marine sites (Murdoch University).
- Biology of *Galaxias maculatus* in south-east rivers of WA (Murdoch University).
- Revegetation of fish migratory pathway (Bennett Brook Catchment Group).

One new Fisheries Action Program project was funded in the Southern Inland region. This was:

- Save the trout minnow (*Galaxias truttaceus*) – construction of a fishway at Goodga River Weir (Department of Fisheries).

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APPENDICES

APPENDICES

APPENDIX 1

Stock Exploitation Status and Catch Ranges for Major Commercial Fisheries

(Appendix 8 from Annual Report 2001/2002)

Fishery	Stock assessment complete	Exploitation status	Breeding stock assessment	Previous acceptable catch (and effort) range in tonnes (days)	*Catch (tonnes) for season reported	Season reported	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	11,266	2000/01	8,166-14,523	Low catch within predicted range due to reduced puerulus settlement 3–4 years previously.
Roe's abalone	Yes	Fully exploited	Adequate	107.9 (Q) (725-929 days)	99.2 (719 days)	2001	107.9 (725-929 days)	Quota voluntarily reduced to accommodate low stock levels in Area 8..
South-West trawl	NA	NA	NA	Not available	Prawns 10 Scallops 23	2001	Not available	Prawn catch is king prawns mainly recruited from the Peel/Harvey Estuary.
Abrolhos Islands & Mid-West trawl	NA	Fully exploited	Adequate	50-600	1,182	2001	50-600	Recruitment is dependent on environmental conditions each year. Above acceptable catch range due to high levels of recruitment over a wide spatial scale.
West coast purse seine	Yes	Fully exploited	Increasing	260	148	2001	NA	Catch limit set to allow stock recovery.
Estuarine fisheries (west coast)	Yes**	Fully exploited**	NA	Not available	264	2001	Not available	Includes fish and crustaceans. Closure of Leschenault Inlet caused decrease in catch.
Deep-sea crab	NA	NA	Adequate	NA	213	2000/01	NA	Developing fishery undertaking test fishing (reported for the first time).
GASCOYNE COAST BIOREGION								
Shark Bay prawn	Yes	Fully exploited	Adequate	1,501-2,330	1,696	2001	1,501-2,330	Tiger prawn catches lower than acceptable range due to lower recruitment levels in 2001 and reduced effort on tiger prawn stocks to ensure spawning stock protection.
Exmouth prawn	Yes	Fully exploited	Adequate	771-1,276	670	2001	771-1,276	Tiger prawn recruitment levels improving but still low due to negative cumulative cyclone effects. Overall catches reduced by temporary closures.
Shark Bay scallop	Yes	Fully exploited	Adequate	1,250-3,000	1,082	2001	1,250-3,000	Catches low due to continuing negative environmental impacts on recruitment.
Shark Bay snapper	Yes	Fully exploited	Adequate	550 (Q) (820-950 days)	467 (894 days)	2001	550 (Q) (820-950 days)	Reduced catch due to market limitations. TAC applies only to snapper.
Shark Bay beach seine & mesh net	Yes**	Fully exploited**	Adequate**	95-140 (whiting)	115 (whiting)	2001	95-140 (whiting)	Catch range for whiting only.
NORTH COAST BIOREGION								
Onslow prawn	NA	NA	NA	60-130	63	2001	60-130	
Nickol Bay prawn	NA	NA	NA	90-300	11	2001	90-300	Banana prawn catches well below catch range due to unfavourable environmental conditions
Broome prawn	Yes	Under-exploited	Adequate	King prawn 35-170	King prawn 62	2001	King prawn 35-170	Fishing season in 2001 not fully matched to lunar-phase-driven catchability, resulting in low catch.
Kimberley prawn	NA	NA	NA	240-500	303	2001	240-500	Banana prawn catch in expected range for observed rainfall levels.

APPENDIX 1 Stock exploitation status and catch ranges for major commercial fisheries

Fishery	Stock assessment complete	Exploitation status	Breeding stock assessment	Previous acceptable catch (and effort) range in tonnes (days)	*Catch (tonnes) for season reported	Season reported	Acceptable catch (and effort) range in tonnes (days) for next season	Comments on catch in reported season
NORTH COAST BIOREGION (cont.)								
Pearl oyster	Yes	Fully exploited	Adequate	572,500 oysters[1] (Q) (15,331-22,599 dive hours)	571,415 oysters (21,534 dive hours)	2001	534,750 oysters[1] (Q) (14,071-20,551 dive hours)	Zone 1 wild stock quota reduced and offset by hatchery-produced oysters.
Pilbara trawl	Yes**	Fully exploited	Adequate	1,900-2,200	2,221	2001	1,900-2,200	Assessment only includes major species.
Pilbara demersal trap & line	NA	Fully exploited	Adequate	150-300	266	2001	150-300	Range for trap only as line fishing has yet to come under management..
Northern demersal	NA	Fully exploited**	Adequate**	600-1,000	504	2001	600-1,000	Catches have remained around 500 tonnes due to unutilised effort.
Kimberley gillnet & barramundi	Yes**	Fully exploited**	Adequate**	25-40 (barramundi)	44 (barramundi)	2000/01	25-40 (barramundi)	Only barramundi assessed. Increasing catch above range due to increasing abundance with low effort.
North coast shark	NA	NA	NA	NA	272	2000/01	NA	Developing fishery. Effort now stabilising.
Spanish mackerel	Yes	Fully exploited	Adequate	249-358	390	2001	249-358	Commercial catch of Spanish mackerel only. Landings above range due to high west coast recruitment.
SOUTH COAST BIOREGION								
Esperance rock lobster	Yes	Fully exploited	Adequate	50-80	79	2000/01	50-80	Catch figures and projections include three management zones: Esperance, GAB and Albany.
Abalone (greenlip/ brownlip)	Yes	Fully exploited	Adequate	229.54 (Q) (1,110-1,520 days)	218.55 (1,259 days)	2001	229.54 (Q) (1,110-1,520 days)	Small voluntary reduction in catch to improve abalone sizes taken.
WA salmon	Yes	Fully exploited	Adequate	1,300-3,600	2,392	2001	1,300-3,600	Environmental factors (Leeuwin Current) influence recruitment and catch levels in subsequent years.
Australian herring trap	Yes	Fully exploited	Adequate	450-1,200	759	2001	450-1,200	South coast catch only.
Southern & west coast demersal gillnet & longline	Yes**	Over-exploited**	Declining**	725-975**	714	2000/01	725-975**	Three key species only reported. Breeding stocks of two of the three key species are declining and of concern.
Estuarine fisheries (south coast)	Yes**	Fully exploited**	NA	200-500	274	2001	200-500	Includes fish, molluscs and crustaceans.
Albany/King George Sound purse seine	Yes	Not applicable	Increasing	120	104	2001	NA	Quotas being adjusted within year as stock recovers. Historical effort unusable.
Bremer Bay purse seine	Yes	Not applicable	Increasing	250	213	2001	NA	Quotas being adjusted within year as stock recovers. Historical effort unusable.
Esperance purse seine	Yes	Fully exploited	Increasing	1,060	664	2001	NA	Quota not achieved due to low stock availability. Historical effort unusable.
NORTHERN INLAND BIOREGION								
Lake Argyle catfish	Yes	Over-exploited	Decreasing	100-140	168	2000/01	100-140	Catch well above historic levels but reducing due to lower effort.

* Catch figures supplied for latest year available.

** For key species only.

NA No assessment.

Q Quota management

1 Pearl catch quota is in individual oysters.

Note: the Cockburn Sound finfish fishery is no longer reported for confidentiality reasons (too few operators).

APPENDIX 2

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APPENDIX 2 Fisheries Research Division staff publications

CONFERENCE/WORKSHOP PAPERS (in press)

Molony, B.W. Trout (*Oncorhynchus mykiss*) production and stocking in Western Australia: An examination of the fishery and evaluation of the stocking program. *Stock Enhancement of Marine and Freshwater Fisheries: Proceedings of the Australian Society for Fish Biology Workshop, Albury, NSW, 7-13 August 2000*.

POPULAR ARTICLES AND CLIENT INFORMATION

Baharthah, T. Future looking good for recreational abalone catches. *Western Fisheries* Summer 2001/02, p. 27.

Brasseur, M.M. and Maguire, G.B. 2001. Estimated Western Australian aquaculture production for 1999/2000. Aqua Info no. 28, Department of Fisheries, Western Australia, 8 p.

Brasseur, M.M. and Maguire, G.B. 2001. Frequently asked questions about monthly aquaculture production. Aqua Info no. 16, Department of Fisheries, Western Australia, 3 p.

Brasseur, M.M. and Maguire, G.B. 2001. Value of WA aquaculture rises strongly in 1999-2000. *ACWA News* 35: 14-15.

Cassells, G., Brand-Gardner, S. and Maguire, G. Marron farming calendar. *Marron Growers Bulletin* 24(2): 28.

Commercial Fisheries Production Bulletin: Western Rock Lobster Fishery no. 24, 30 October 2001. Research Division, Department of Fisheries, Western Australia, 4 p.

Commercial Fisheries Production Bulletin: Western Rock Lobster Fishery no. 25, 20 February 2002. Research Division, Department of Fisheries, Western Australia, 4 p.

Commercial Fisheries Production Bulletin: Western Rock Lobster Fishery no. 26, 22 May 2002. Research Division, Department of Fisheries, Western Australia, 4 p.

Crowe, T.P., Amos, M., Dwiono, P., Dobson, G. and Lee, C. 2002. *Trochus hatchery seeding techniques: A practical manual.* Australian Centre for International Agricultural Research, Canberra, 34 p.

Glencross, B.D. 2001. *Feeding lupins to fish: A review of the nutritional and biological value of lupins in aquaculture feeds*. Online: http://www.fish/wa.gov.au/res/broc/report/lupin. 126 p.

Glencross, B.D., Curnow, J.G. and Hawkins, W.E. 2001. Substituting the fish oil component of aquaculture diets with canola oils: Influence of oil grade on its value to a marine fish. *Asian Aquaculture Magazine* Nov/Dec 2001, p. 32.

Glencross, B.D. and Felsing, M. 2002. Food for thought: Maximising production, but not at an environmental cost. *ACWA News* 37: 24-25.

Lawrence, C.S, Maguire, G., Cassells, G. and Jones, B. 2001. *Proceedings: Marron Farming Open Day, Pemberton, Sunday 24th Feb 2001*. Fisheries WA, 15 p.

Lee, C. (ed.). 2001. Trochus Information Bulletin no. 8, Secretariat of the Pacific Community, 32 p.

Lee, C. 2001-02. Kimberley Aboriginal Aquaculture Corporation quarterly newsletter no. 6 (2001), 9 p.; no. 7 (2001), 7 p.; no. 8 (2002), 6 p.

Lee, C., Purcell, S. and Maguire, G.B. 2001. Farming trochus. Aquaculture WA no. 8 (revised), Department of Fisheries, Western Australia, 8 p.

McAuley, R., Newbound, D. and Ashworth, R. 2002. *Field identification guide to Western Australian sharks and shark-like rays*. Fisheries Occasional Publication no. 1, Department of Fisheries, Western Australia, 32 p.

Maguire, G. 2001. Joint aquaculture project with Israel cheers lupin growers. *ACWA News* 34: 28.

Maguire, G. 2001-02. Research news. *ACWA News* 34: 18-19; 35: 16-18; 37: 6-9.

Maguire, G. 2002. Marron miscellania. *Marron Growers Bulletin* 24(2): 25-27.

Maguire, G.B. 2001. Farming abalone. Aquaculture WA no. 7 (revised), Department of Fisheries, Western Australia, 12 p.

Mitchell, R. Rec fishers support Thevenard Island project. *Western Fisheries* Autumn 2002, pp. 40-41.

Purcell, S.W. 2002. Cultured vs wild juvenile trochus: disparate shell morphologies send caution for seeding. Trochus Information Bulletin no. 9, Secretariat of the Pacific Community, pp. 6-8.

Sumner, N.R. 2002. Estimating the impact of recreational fishing on fish stocks. *Waves* 8(4), Marine and Coastal Community Network, p. 10.

Webster, F. The Abrolhos: Humans in a unique environment. *Western Fisheries* Summer 2001/02, pp. 17-21.

APPENDIX 3

Table of Catches from Fishers' Statutory Monthly Production Returns for 2000/01

This table contains the landed and estimated live weight 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	1,402	1,402
Anchovy	*Engraulis australis*	5,651	5,651
Barracuda (northern pike)	Sphyraenidae	1,515	1,515
Barramundi (giant perch)	*Lates calcarifer*	27,794	45,110
Bigeye (not tuna)	Priacanthidae	31,207	31,207
Boarfish	Pentacerotidae	3,535	3,852
Bonito	*Sarda australis*	2,156	2,162
Bream, black	*Acanthopagrus butcheri*	30,916	30,916
Bream, monocle	*Scolopsis* spp.	10,263	10,263
Bream, Robinson's	*Gymnocranius grandoculis*	57,129	57,162
Bream, sea	*Gymnocranius* spp.	600	600
Bream, silver (tarwhine)	*Rhabdosargus sarba*	12,223	12,223
Bream, western yellowfin	*Acanthopagrus latus*	12,224	12,224
Catfish, sea (golden cobbler)	Ariidae	41,706	42,312
Chinaman fish (not cod)	*Symphorus nematophorus*	14,898	15,192
Cobbler	*Cnidoglanis macrocephalus*	41,856	58,572
Cobbler, silver	*Arius midgleyi*	84,343	168,271
Cod	Serranidae	98,380	102,017
Cod, bar (grey-banded, 8-bar)	*Epinephelus octofasciatus, E. septemfasciatus*	6,341	6,490
Cod, chinaman	*Epinephelus rivulatus*	4,456	4,947
Cod, Rankin	*Epinephelus multinotatus*	77,275	81,865
Cod, spotted	*Epinephelus microdon, E. areolatus, E. bilobatus*	41,892	41,967
Dhufish, West Australian (jewfish)	*Glaucosoma hebraicum*	208,477	223,530
Dolphinfish	*Coryphaena hippurus*	534	625
Emperor, blue-lined (grass, black)	*Lethrinus laticaudis*	2,069	2,340
Emperor, blue-spot	*Lethrinus hutchinsi*	228,840	228,840
Emperor, red	*Lutjanus sebae*	234,517	236,369
Emperor, red-spot (snapper)	*Lethrinus lentjan*	58,312	58,312
Emperor, spangled	*Lethrinus nebulosus*	68,465	71,609

APPENDIX 3 Table of catches from fishers' statutory monthly production returns for 2000/01

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (KG)	LIVE WEIGHT (KG)
FISH (cont.)			
Emperor, sweetlip	*Lethrinus miniatus*	76,564	79,838
Flagfish (Spanish flag)	*Lutjanus vitta*	192,178	192,193
Flathead	Platycephalidae	11,411	11,453
Flounder	Bothidae	2,983	2,991
Footballer (footballer sweep, banded sweep)	*Scorpis georgianus*	710	801
Foxfish (hogfish, pigfish)	*Bodianus* spp.	923	931
Garfish, sea	*Hyporhamphus melanochir*	27,085	27,085
Groper	Labridae	1,630	1,657
Groper, baldchin	*Choerodon rubescens*	38,150	40,965
Groper, blue	*Achoerodus gouldii*	24,721	30,762
Gurnard	Triglidae	855	856
Hapuku	*Polyprion oxygeneios*	24,042	24,140
Herring, Australian	*Arripis georgianus*	761,077	761,226
Herring, Perth	*Nematalosa vlaminghi*	11,559	11,559
Javelin fish	*Pomadasys* spp.	31,350	31,350
Jewfish *see* dhufish			
Jobfish (*see also* snapper, goldband)	*Pristipomoides* spp.	117,211	117,307
Jobfish, rosy	*Pristipomoides filamentosus*	101,024	101,195
Kingfish, black (cobia)	*Rachycentron canadum*	31,047	31,928
Kingfish, yellowtail	*Seriola lalandi*	1,074	1,079
Knifejaw	*Oplegnathus woodwardi*	8,551	8,627
Leatherjacket	Monacanthidae	46,450	72,617
Mackerel, blue	*Scomber australasicus*	1,146	1,146
Mackerel, grey (broad-barred)	*Scomberomorus semifasciatus*	19,219	20,920
Mackerel, other	Scombridae	51,570	56,261
Mackerel, scaly	*Sardinella lemuru*	1,873,257	1,873,257
Mackerel, shark (salmon)	*Grammatorcynus bicarinatus*	854	882
Mackerel, Spanish	*Scomberomorus commerson*	280,264	350,890
Mackerel, spotted	*Scomberomorus munroi*	744	810
Mangrove jack	*Lutjanus argentimaculatus*	17,044	17,062
Maray	*Etrumeus teres*	155,882	155,882
Mullet, other	Mugilidae	6,376	6,376
Mullet, red	Mullidae	57,695	57,695
Mullet, sea	*Mugil cephalus*	265,536	265,719
Mullet, yellow-eye	*Aldrichetta forsteri*	65,495	65,720
Mulloway	*Argyrosomus hololepidotus*	68,124	70,132
Parrot fish	Scaridae	6,921	6,942
Perch, Moses	*Lutjanus russelli*	55,242	55,359
Perch, other	Lutjanidae	8,429	8,714
Perch, pearl	*Glaucosoma buergeri*	33,204	33,345
Perch, yellowtail	Terapontidae	1,610	1,610
Pike, sea	*Sphyraena novaehollandiae*	2,039	2,048
Pilchard	*Sardinops sagax ocellatus*	869,978	869,978

APPENDIX 3 Table of catches from fishers' statutory monthly production returns for 2000/01

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (KG)	LIVE WEIGHT (KG)
FISH (cont.)			
Queenfish	*Scomberoides commersonnianus*	727	2,075
Redfish	*Centroberyx affinis*	76,485	77,329
Redfish, Bight	*Centroberyx gerrardi*	13,985	14,422
Salmon, Western Australian	*Arripis truttaceus*	2,406,514	2,414,774
Samson fish (sea kingfish)	*Seriola hippos*	88,127	95,530
Scad, yellowtail	*Trachurus novaezelandiae*	6,608	6,608
Seaperch, red (maroon perch)	*Lutjanus* spp. (large)	13,533	13,710
Seaperch, scarlet (saddletail)	*Lutjanus malabaricus*	140,170	140,311
Shark, blacktip	*Carcharhinus* spp.	52,033	100,544
Shark, bronze whaler (dusky whaler)	*Carcharhinus obscurus*	212,072	334,806
Shark, 'golden' (copper whaler)	*Carcharhinus brachyurus*	6,165	9,801
Shark, eastern school	*Galeorhinus galeus*	32,745	52,062
Shark, grey reef	*Carcharhinus amblyrhynchos*	4,355	6,926
Shark, gummy	*Mustelus antarcticus*	158,207	251,695
Shark, hammerhead	Sphyrnidae	40,477	64,383
Shark, lemon	*Negaprion acutidens*	9,590	15,250
Shark, mako (shortfin)	*Isurus oxyrinchus*	1,705	2,123
Shark, other		142,619	224,293
Shark, pencil	*Hypogaleus hyugaensis*	1,139	1,810
Shark, pigeye	*Carcharhinus amboinensis*	19,773	31,327
Shark, silky	*Carcharhinus falciformis*	365	581
Shark, silvertip	*Carcharhinus albimarginatus*	750	1,193
Shark, spinner (long-nose grey)	*Carcharhinus brevipinna*	430	685
Shark, spot tail	*Carcharhinus sorrah*	1,672	2,663
Shark, thickskin (sandbar)	*Carcharhinus plumbeus*	154,877	245,705
Shark, tiger	*Galeocerdo cuvier*	36,052	50,542
Shark, whiskery	*Furgaleus macki*	120,167	179,887
Shark, wobbegong	Orectolobidae	27,567	43,745
Shovelnose (fiddler rays)	Rhinobatidae, Rhynchobatidae	2,447	8,153
Skates and rays, other		13,535	25,793
Snapper, bullnose (variegated emperor)	*Lethrinus* sp.2 (undescribed)	1,311	1,311
Snapper, frypan	*Argyrops spinifer*	46,104	46,104
Snapper, goldband (jobfish)	*Pristipomoides multidens*	144,205	145,637
Snapper, long nose	*Lethrinus olivaceus*	20,664	21,380
Snapper, north-west	Lethrinidae	95,570	109,013
Snapper, north-west (large)	*Lethrinus nebulosus*	31,884	31,888
Snapper, north-west (small)	*Lethrinus lentjan, L. choerorhynchus* etc.	216,644	216,644
Snapper, pink	*Pagrus auratus*	823,941	833,539
Snapper, Queen	*Nemadactylus valenciennesi*	40,234	45,494
Snapper, red (swallowtail)	*Lutjanus erythropterus*	337,229	337,230
Sole	*Ammotretis rostratus*	1,938	1,938
Sprat, blue	*Spratelloides robustus*	17,685	17,685

APPENDIX 3 Table of catches from fishers' statutory monthly production returns for 2000/01

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (KG)	LIVE WEIGHT (KG)
FISH (cont.)			
Sweep	*Scorpis aequipinnis*	1,780	2,018
Sweetlip	Haemulidae	81,414	83,369
Tailor	*Pomatomus saltatrix*	53,558	53,558
Threadfin bream (butterfish)	Nemipteridae	220,082	220,082
Threadfin salmon	Polynemidae	6,499	7,539
Threadfin salmon, giant (king)	*Eleutheronema tetradactylum*	106,303	114,812
Trevalla, deepsea	*Hyperoglyphe antarctica*	17,389	17,391
Trevally, golden	*Gnathanodon speciosus*	33,301	33,321
Trevally, other (skippy)	Carangidae	213,198	214,157
Trevally, skipjack	*Pseudocaranx dentex*	5,956	6,141
Trout, coral	*Plectropomus maculatus*	24,727	25,057
Tuna, northern bluefin	*Thunnus tonggol*	973	973
Tuna, other	Scombridae	11,173	11,507
Tuna, skipjack (striped)	*Katsuwonus pelamis*	1,367	1,548
Tuna, yellowfin	*Thunnus albacares*	2,816	2,971
Tuskfish, bluebone	*Choerodon* spp.	17,373	17,401
Veilfin	*Metavelifer multiradiatus*	653	653
Whitebait	*Hyperlophus vittatus*	223,746	223,746
Whiting, golden-lined	*Sillago analis*	1,420	1,420
Whiting, King George	*Sillaginodes punctata*	29,170	29,198
Whiting, other	Sillaginidae	1,985	1,985
Whiting, western sand	*Sillago schomburgkii*	196,745	197,013
Other fish varieties		151,059	166,442
Total fish		**13,725,187**	**14,687,744**
CRABS			
Crab, king	*Pseudocarcinus gigas*	13,264	13,264
Crab, mud	*Scylla serrata*	1,689	1,689
Crab, sand (blue swimmer, blue manna)	*Portunus pelagicus*	735,729	735,729
Crab, snow (Australian)	*Chaceon bicolor*	209,503	209,503
Crab, spiny	*Hypothalassia armata*	26,798	26,798
Other crabs		391	391
Total crabs		**987,374**	**987,374**
PRAWNS			
Prawn, banana	*Penaeus merguiensis*	253,527	253,527
Prawn, brown tiger	*Penaeus esculentus*	612,491	612,491
Prawn, coral	*Metapenaeopsis* spp.	298,851	298,851
Prawn, endeavour	*Metapenaeus endeavouri*	128,358	128,358
Prawn, western king	*Penaeus latisulcatus*	1,761,558	1,761,558
Other prawns	Penaeidae	870	870
Total prawns		**3,055,655**	**3,055,655**

APPENDIX 3 Table of catches from fishers' statutory monthly production returns for 2000/01

COMMON NAME	SCIENTIFIC NAME	LANDED WEIGHT (KG)	LIVE WEIGHT (KG)
ROCK LOBSTERS			
Bugs	Scyllaridae	21,797	27,699
Rock lobster, southern	*Jasus edwardsii*	79,582	79,582
Rock lobster, western	*Panulirus cygnus*	11,257,736	11,257,736
Other rock lobsters		12	12
Total rock lobsters		**11,359,127**	**11,365,029**
MOLLUSCS			
Abalone, brownlip	*Haliotis conicopora*	12,664	30,645
Abalone, greenlip	*Haliotis laevigata*	68,587	181,533
Abalone, Roe's	*Haliotis roei*	94,992	107,526
Cockles	*Katelysia* spp.	1,147	1,147
Cuttlefish	*Sepia* spp.	58,716	58,716
Mussel	*Mytilus edulis*	3,448	3,448
Octopus	*Octopus* spp.	103,633	194,385
Scallop, saucer	*Amusium balloti*	780,981	3,565,561
Squid	*Sepioteuthis* spp., *Loligo* spp.	48,275	48,280
Other molluscs		60	78
Total molluscs		**1,172,489**	**4,191,305**
OTHER CLASSES			
Beche-de-mer	Holothuridae	32,016	91,876
Total other classes		**32,016**	**91,876**
Grand Total		**30,331,848**	**34,378,983**

Reported Catches from Collectors' Licences for 2000/01

	QUANTITY	WEIGHT
Aquarium fish	193,608	
Specimen shells	20,138	
Hermit crabs	99,483	
Invertebrates	5,126	
Coral/living rock		2,393 kg