FISHERIES
WESTERN AUSTRALIA

State of the Fisheries Report

2000-2001

THE GOVERNMENT OF WESTERN AUSTRALIA

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 Fisheries WA for the financial year ending 30 June 2001.

Peter P Rogers
EXECUTIVE DIRECTOR

Edited by Dr J. W. Penn

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based at the WA Marine Research Laboratories

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Cover photographs:
(top) The Department of Fisheries' new 23m research vessel
Naturaliste*, constructed and launched in 2001.*
Photo courtesy Tenix Defence Pty Ltd (shipbuilders).
(bottom) Reef habitat at the Houtman Abrolhos Islands.
Photo: Clay Bryce

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Glossary of Acronyms

ADF	Aquaculture Development Fund
AFMA	Australian Fisheries Management Authority
AIMWTMF	Abrolhos Islands and Mid West Trawl Managed Fishery
AQIS	Australian Quarantine and Inspection Service
ATSIC	Aboriginal and Torres Strait Islander Commission
BRD	bycatch reduction device
CAES	catch and effort statistics
CALM	Conservation and Land Management, Department of
CPUE	catch per unit effort
DEPM	daily egg production method
ENA	extended nursery area
EPA	Environmental Protection Authority
ERA	environmental risk assessment
ERLMF	Esperance Rock Lobster Managed Fishery
ESD	ecologically sustainable development
FBL	fishing boat licence
FEMR	fisheries environmental management review
FHPA	fish habitat protection area
FRDC	Fisheries Research and Development Corporation
GAB	Great Australian Bight
GPS	global positioning system
GVP	gross value of production
IMP	interim management plan
IQF	individually quick frozen
ITE	individual transferable effort
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
LML	legal minimum length
MAC	management advisory committee
MOP	mother-of-pearl
MSC	Marine Stewardship Council
NDSMF	Northern Demersal Scalefish Managed Fishery
NPF	Northern Prawn Fishery
OAG	Office of the Auditor General
PIAC	Pearling Industry Advisory Committee
RFAC	Recreational Fishing Advisory Committee
RLIAC	Rock Lobster Industry Advisory Committee
RPA	reef protected area
SCEF	South Coast Estuarine Fishery
SRR	spawning stock-recruitment relationship
SWFRAC	South West Freshwater Research and Aquaculture Centre
TAC	Total allowable catch
TSC	Total sustainable catch
VFAS	Voluntary Fisheries Adjustment Scheme
VFLO	Voluntary Fisheries Liaison Officer
VMS	Vessel Monitoring System
WADGDLMAC	WA Demersal Gillnet and Demersal Longline Management Advisory Committee
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

Department of Fisheries Executive Director, Peter Rogers

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 aquaculture industries and the Department's Fish and Fish Habitat Protection Program is also provided.

In keeping with the Department's significant 2000/2001 initiative to begin implementation of ecologically sustainable development (ESD) principles in fisheries management, this year's *State of the Fisheries* has been extensively restructured. The document now reflects the nationally developed ESD reporting framework and provides, where available, assessments of the ESD performance of fisheries activities under Western Australian jurisdiction.

These reports for 2000/2001 indicate that the majority of the State's fish stocks are in a healthy condition, and although fully exploited are producing catches at sustainable levels. The exceptions to this in 2000/2001 continued to be the southern pilchard stocks which are now showing good signs of recovery from the exotic virus attack which occurred in 1998/99. The recovery of these severely depleted stocks has however been assisted by timely management action which resulted in low or zero quotas being set for the 2000 season.

While the overall status of our fish stocks reflects the Department's historical success in managing the major commercial fisheries and recreational activities, the continuing growth in population will inevitably require a more holistic approach to fisheries management and aquaculture development. This will require that the Department continue to undertake its extensive research and monitoring projects to ensure that there is a strong scientific basis underpinning our future integrated management initiatives. Similarly, the policy development and field management activities reported here are essential to ensure that all fishers understand the reasons for, and comply with, the controls necessary to sustain our fisheries resources in the future.

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

Director - Fisheries Research, Dr Jim Penn

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

For all of the fisheries resources management programs covered by this report to be successful, a high degree of cooperation is necessary between the users of the State's fish resources and the Department's Divisions of Fisheries Research and Fisheries Management Services. The level of cooperation and collaboration between fishers and Department of Fisheries staff is excellent, and continues to be a major factor in keeping the harvest from our fish stocks at sustainable levels. Of particular value is the contribution of all commercial vessels in providing monthly records of catches and fishing effort, and the completion of daily research logbooks and other voluntary records by about 500 skippers. These data are of great value in monitoring both the commercial fisheries and a variety of recreationally important fish stocks. The Department's Recreational Fisheries Program is also strongly supported by the Volunteer Fisheries Liaison Officers, who provide recreational fishing education, and together with recreational fishers contribute significant data to the recreational fisheries monitoring projects. Similarly, aquaculturists work actively with the Department's staff and support research and development programs to enhance their emerging industries. Data from all of these sources, together with fishery-independent research and monitoring projects, provide the scientific basis for fisheries management in Western Australia.

For this 2000/2001 edition of *State of the Fisheries*, the now bioregionally based document has again been significantly restructured to accommodate the national ecologically sustainable development (ESD) reporting and assessment processes foreshadowed last year. This restructuring now provides more comprehensive ESD-based status reports incorporating information under the following headings:

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

In relation to the important new 'ecosystem effects' section, the approach adopted has been to provide a high, medium, low or negligible 'risk' rating on the impact of fishing based on the Research Division's expert knowledge of the fishery, as a first step. This is in keeping with a formal ESD risk assessment process now under way for our major export fisheries, which will ultimately be used to meet the requirements of the Federal *Environmental Protection and Biodiversity Conservation Act 1999*.

Further refinements to the catch reporting in 2000/2001 include provision for the first time of data on the commercial catches, primarily of finfish, taken under 'wetline' fishing arrangements rather than under individual managed fisheries. Such catches are those taken by any Western Australian licensed fishing vessel, using methods such as handlining or droplining which are not subject to specific management regulation. These data, together with catches by vessels operating in specifically licensed fisheries, now provide a fully comprehensive reporting of all commercial catches in Western Australia.

In addition, the estimated recreational catch share in each managed commercial fishery has been included wherever relevant and comparable creel survey data are available. This additional information is in keeping with the needs of ESD reporting and is starting to provide the data which will be needed to support the Integrated Fisheries Management initiative now in progress.

The major purpose of this report, however, is to provide detailed information on the status of individual fisheries across the State which underpins key performance indicators (PIs) for the Department presented in the Annual Report to Parliament. These PIs relate particularly to the sustainability of the State's fish stocks and include measures of breeding stock levels and catch projections for all major commercial stocks. The more detailed individual fishery status reports also incorporate information on historical trends in catches and fishing activities. This information allows the reader to better assess the performance of the fisheries or industries covered, and provides a summary of information available

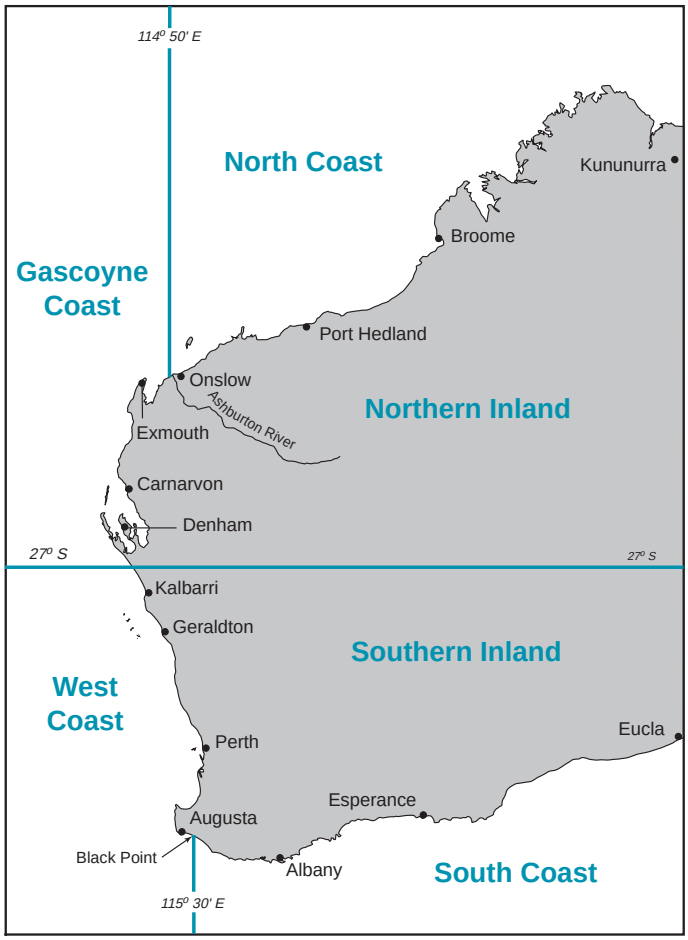
to the Office of the Auditor General, which provides an• independent third-party audit of the Department's PIs.•

State of the Fisheries, published each year as a companion• to the Department of Fisheries' Annual Report to• Parliament, has been produced annually since 1994/95,• and now provides an ongoing record of the performance• of the fisheries and fishing industries of Western Australia• for general reference purposes. The document is also• available on the Department of Fisheries website at• http://www.wa.gov.au/westfish/res/index.html.•

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 difficult task of compilation and copy-editing, and to my publications officer, Mrs Sandy Clarke, who has undertaken the layout and production of the volume.

Dr J.W. Penn
DIRECTOR - FISHERIES RESEARCH

Note: In July 2001, the name of the organisation changed from Fisheries WA to the Department of Fisheries, in line with Government policy. As this document reports on the year to 30 June 2001, prior to the change, the name 'Fisheries WA' has been retained throughout the body of the report.



BIOREGION 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 Fisheries WA head office in Perth as well as Regional Policy Officers in Albany, Fremantle, Geraldton, Carnarvon and Broome. Management of the major fishing activities is achieved through formal management plans declared under the *Fish Resources Management Act 1994,* while other forms of fishing activity are managed through a combination of controls derived from the *Fish Resources Management Regulations 1995,* orders under the Act 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, Fisheries WA 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 level of cost recovery operating at 100% of cash costs plus capital accruals in 2000/2001.

The remaining fisheries paid a contribution towards their management costs of 1.85% of their gross value of production (GVP). All fisheries also contribute to the Development and Better Interest Fund at a rate of 0.65% of their GVP.

A key development during 2000/2001 has been the formalisation by the Commonwealth Government of the requirement for Australian fisheries to have ecological sustainability certification in order to continue their export approval under Schedule 4 of the *Wildlife Protection (Regulation of Exports and Imports) Act 1982* beyond December 2003. This requirement will necessitate export fisheries developing documentation on their ecological status for review by Environment Australia and approval by the Commonwealth Minister for the Environment. Work on developing this documentation commenced during 2000/2001, and the five major cost-recovery fisheries (which are all important export fisheries) and a number of smaller export fisheries will finalise their documentation during 2001/02.

The *State of the Fisheries Report* for 2001 also contains, for the first time, a comprehensive report on the catch of Western Australia's 'wetline' fisheries. The holders of a fishing boat licence (FBL) in conjunction with a commercial fishing licence, irrespective of whether or not they have access to a managed fishery, are entitled to engage in a number of forms of fishing that are not otherwise prohibited. This is known as 'restricted access' or 'wetline' fishing (Crowe et al. 1999). Usual methods include handlining, droplining, trolling and hand-hauled netting, while less commonly used methods include drop netting, squid jigging, lift netting and diving. From 1984 onwards, those wishing to enter the commercial fishing industry could only do so by purchasing an existing FBL. Since 1984, the combined impact of this permanent 'cap' on the total number of registered fishing boats in Western Australia, together with a number of other management changes, has resulted in a reduction in the number of fishing boats without access to managed fish stocks. Although the catches of some sectors of the wetline fishery have been reported in previous years, this is the first year when the wetline catch is specifically reported for each bioregion. Defining and reporting on this component of the catch of the State's fisheries is an important step in the development and operation of the Integrated Fisheries Management strategy.

During 1999/2000, a total reported catch of 2068 tonnes of mostly finfish was attributed to wetline fishing, comprising 1176 tonnes (56%) from the west coast bioregion, 499 tonnes (24%) from the north coast, 306 tonnes (14%) from the Gascoyne and 136 tonnes (6%) from the south coast.

Key Achievements

During 2000/2001, the Commercial Fisheries Program updated management plans for a number of managed fisheries across the State. In addition, significant milestones were achieved in relation to ecologically sustainable development (ESD), resource sharing, implementation of new compliance technology and development of new fisheries, as follows:

- Completion of case study reports on the West Coast Rock Lobster and Marine Aquarium Managed Fisheries using the ESD framework developed for the Standing Committee on Fisheries and Aquaculture.
- Completion of an environmental risk assessment workshop and substantial preparation of an ecological risk assessment report as part of the ongoing Marine Stewardship Council (MSC) accreditation of the West Coast Rock Lobster Managed Fishery.
- Commencement of ecological sustainability reports to Environment Australia for west coast rock lobster, Shark Bay prawns, Shark Bay scallops, Shark Bay snapper, Exmouth Gulf prawns and abalone, for accreditation under Schedule 4 of the *Wildlife Protection (Regulation of Exports and Imports) Act 1982.*
- Completion of management plans and reports to Environment Australia for the extension of S.10(a) 'Controlled Specimens Declarations' under the *Wildlife Protection (Regulation of Imports and Exports) Act 1982* to maintain exports for deep-sea crabs, sygnathids, beche-de-mer and a number of specimen shell species.
- Progressing of voluntary resource-sharing discussions for the Demersal Gillnet and Demersal Longline (shark) Managed Fisheries and the Geographe Bay crab fishery.
- Amendment of the Cockburn Sound Crab Fishery Management Plan to give effect to the outcomes of the voluntary resource-sharing agreement, including a 50% reduction in crab pot entitlements for B-class licensees nominating as A-class licensees, the removal of gillnets as permitted gear and an increase in the minimum legal size for commercially caught crabs.
- Formal introduction of the Vessel Monitoring System (VMS) into the Abrolhos Islands and Mid West Trawl, Kimberley Prawn and Nickol Bay Prawn Fisheries, and Ministerial approval for implementation of the VMS in the Exmouth Gulf and Onslow Prawn Fisheries in 2002.
- Formation of a committee to advise the Executive Director on expressions of interest received under the policy on 'Developing New Fisheries in Western Australia', as a result of which a range of applications (mostly related to octopus and crabs) were dealt with and exemptions issued.
- Development of two further options for management of the mackerel fishery and completion of statewide consultation on the options.

Commercial Fisheries

West Coast Bioregion

Regional Management Overview

Commercial fishing in this bioregion is dominated by the< western rock lobster fishery, but also involves significant< fisheries for scallops, sharks, blue swimmer crabs,< pilchards, and coastal and estuarine finfish, many of< which are shared with the recreational sector.<

During 2000/2001 the West Coast Rock Lobster Managed< Fishery undertook the next step in the processes arising< from being awarded Marine Stewardship Council chain of< custody certification, which recognises the ecological< sustainability of its fishing and management operations.< This step involved holding an environmental risk< assessment workshop, from which an ecological risk< assessment report has been substantially prepared. <

There were also some significant changes to the< management arrangements for the West Coast Rock< Lobster Managed Fishery, including an amendment of the< management plan to provide for licence creation and< retirement. Other changes included Ministerial approval< for a one-season removal of the maximum size rule in< 2001/02, as the fishery moves into a low catch year for< that season. Ministerial approval was also received to< amend the management plan to implement the unitisation< of pot entitlements and to simplify the Big Bank boundaries.<

The successful outcomes produced from the 'Guidelines< for Voluntary Resource Sharing' process for the Cockburn< Sound Crab Managed Fishery were formally implemented< into the management plan for that fishery during< 2000/2001. Mediated meetings for the Geographe Bay< crab fishery and the 'shark' fishery under the resource-< sharing guidelines continued through the year. A< Fisheries Adjustment Committee for the South West Trawl< Managed Fishery provided a report to the Minister.<

The Abrolhos Islands and Mid West Trawl Managed< Fishery, which mainly fishes for scallops in the Abrolhos< Islands area, formally came under the VMS in the< 2000/2001 season.<

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 the fishing boat licence)< and boats which hold managed fishery licences < (e.g. west coast rock lobster) in addition to an FBL.< Mackerel are also taken by both groups, but the current< proposals for management of the mackerel resource will< leave only the take of mackerel south of Shark Bay within< the wetline fishery.<

There is also a take of fish by beach seining and near-< shore gillnetting using hand-hauled nets.<

Regional Compliance and Community Education Overview

Within the west coast bioregion, the major single focus for commercial fishery compliance monitoring is the West Coast Rock Lobster Managed Fishery. Compliance activities and outcomes for this fishery are reported separately on p. 6-7. In addition, there are a number of smaller fisheries which are covered to a lesser extent.

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

Unverified reports continue 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 which may have related to net rolling, but no further action was possible.

Overall, however, the level of compliance in these smaller commercial fisheries was generally good.

Further north, the Mid West regional office conducted a pre-season briefing for operators in the Abrolhos trawl fishery which was well attended. 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. VMS was introduced at the opening of the season and all vessels are 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.

Compliance monitoring was also carried out within the purse seine, shark and wetline fisheries, with no significant issues arising.

A dedicated two-man field operations team was established during 2000/2001 to enhance regional services delivery to the Abrolhos Islands reserve. Their work is reported in the Fish and Fish Habitat Protection section on p. 178-9.

Regional Research Overview

In addition to the research projects and activities noted in the research summary for each individual fishery, there has been a major focus during 2000/2001 on assessing the general wetline catch in each bioregion. This assessment, undertaken utilising the catch and effort statistics (CAES) database, indicates that over half (56%) of the wetline catch in 1999/2000 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 include West Australian dhufish (173 tonnes), pink snapper (158 tonnes), whitebait (151 tonnes), Australian herring (98 tonnes), sea mullet (69 tonnes), spangled emperor (68 tonnes), sweetlip emperor (63 tonnes), samsonfish (61 tonnes), baldchin groper (33 tonnes) and trevally (32 tonnes). Catches of dhufish,

pink snapper, emperor, and baldchin are the main product of the demersal scalefish operations reported on pp. 34-8, noting that catches of emperor are mostly from the Abrolhos. 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. 29-31).

West Coast Rock Lobster Managed Fishery

MANAGEMENT SUMMARY

Approximately 600 specialised rock lobster boats use about 57,000 pots to fish for rock lobster between Shark Bay and Augusta. The fishing season runs between 15 November and 30 June each year and most of the catch, which on a long-term basis averages around 10,500 tonnes per season, is exported to Asia.

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.

Breeding stock 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 are indeed 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 Fisheries WA 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 problem a management package designed to leave an additional 1,000 tonnes of lobsters in the water at the end of the season was implemented at the beginning of the 1993/94 season. The implementation of this package was preceded by two years of debate and consultation, with some preliminary measures being taken in the 1992/93 season. The core components of this management 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.

The above elements of this management package are still current to the end of the 2000/2001 season because they continue to be relevant by ensuring that the stock does not fall below the established biological reference point.

Following on from record catches of between 13,000 and 14,000 tonnes in the 1998/99 and 1999/2000 seasons, the catch in the 2000/2001 season dropped to just over 11,000 tonnes. Fluctuations of this magnitude are not abnormal, and simply reflect the size of puerulus settlement four years earlier, which is largely 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.

In anticipation of the below-average catch expected for the 2001/02 season, options were examined to increase the value of the catch without compromising sustainability. To achieve this goal the maximum size limit for females will be removed for the 2001/02 season before being reintroduced in the following season. It is estimated that the 'one-off' removal of the maximum size rule will allow for an additional 290 tonnes of lobster to be taken in the 2001/02 season. This measure has been assessed to be a very low risk from a stock sustainability perspective with the net decrease in egg production expected to be approximately 1%, while increasing the value of the catch without any additional costs.

Other management changes now approved by the Minister and set to come into effect with the commencement of the 2001/02 season are:

- individual numbering of pot entitlements within Fisheries WA's licensing register;
- the ability of those with access to 63 or more pot entitlements and a fishing boat licence to apply for a new managed fishery licence;
- the ability of fishermen to retain an inactive managed fishery licence by retaining an inactive fishing boat licence and one or more inactive pot entitlements; and
- provision for temporary pot transfers.

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. The first requirement was to conduct an environmental risk assessment (ERA). Fisheries WA has completed the assessment in conjunction with key stakeholder groups and will have produced the resultant document for public review towards the end of 2001.

The ERA identified 33 issues which could impact on ecological sustainability, with four classified as moderate risks and the remaining classified as low risks. The report will also outline recommendations and actions to address these moderate risks.

Commercial Fisheries

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. Specifically, the implementation of the *Environment Protection and Biodiversity Conservation Act 1999* and amendments to Schedule 4 of the *Wildlife Protection (Regulation of Exports and Imports) Act 1982* have resulted in very close examination of the operations of the fishery and its sustainability and environmental standards.

The rock lobster fishery will be the first Western Australian commercial fishery to submit the necessary documentation to Environment Australia to meet these new ecological sustainability tests. In addition, the evaluation of the fishery under the new ESD framework is becoming very much a part of rock lobster management. This will be evident when consideration of management options for the 2002/03 and 2003/04 seasons are presented in the context of ESD towards the end of 2001.

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 (RLIAC)
Annual RLIAC coastal tour
Joint industry–RLIAC meetings
Agency–industry meetings

COMPLIANCE AND COMMUNITY EDUCATION SUMMARY

Interface with the industry has continued to improve in 2000/2001. The first ever rock lobster compliance risk assessment workshop, held prior to the season opening, was attended by industry members and agency staff including Fisheries Officers. The aim of the workshop was to identify and target areas of non-compliance within the fishery. Whilst industry attendance numbers were smaller than expected, it produced clear results and has established a participative model for further development. One risk identified as a concern was the illegal sale into the restaurant trade.

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 regarding rule changes and obtain information on local compliance issues which can then be incorporated into the compliance planning process. Joint regional operations included checks on the Christmas trade in wholesale and retail outlets, roadside checkpoints near Lancelin, at-sea operations in the Abrolhos Islands, monitoring the 77 mm/76 mm gauge change, Easter roadside checkpoints and lower C Zone land and sea operations.

A mobile factory patrol (primarily to inspect landed catches of rock lobster at processing establishments) commenced late in the season to complement increased officer time in the field at sea and point of landing. The patrols, based in Fremantle and Geraldton, will travel at random throughout the fishery area and assist in maintaining a 3.8% catch inspection rate, which is judged to be the required level.

In the Metropolitan Region (principally Zone C), factory consignment compliance has been generally good. Minor infringement notices and warnings continue 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 an issue again this 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 have been about unauthorised pulling of pots. Complaints related to early pulling, or recreational fishers pulling commercial pots or cutting them off in high-density recreational fishing areas, 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 the A Zone prior to that area opening on 14 March. Operations were also conducted to ascertain whether vessels were pulling the 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.

The infringement notice system was in its fifth year of operation. There were 287 infringement warnings given, 52 infringement notices issued and 23 breach reports filed in the 2000/2001 season (West Coast Rock Lobster Table 1). Trends indicate a 100% increase in infringement warnings and a 25% increase in infringements issued for similar offences. Prosecution offences were primarily under-size and closed-water offences.

Overall the majority of fishers appear to be operating professionally with a sound attitude to sustainability of stock. Equity disputes relating to illegal pot pulling continue to be problematic and remain a key theme for targeted intervention.

Planning has commenced to implement a coastal tour by the Supervising Fisheries Officers, Mid West and Metropolitan Regions. The aim is to conduct a pre-season information session for deckhands and skippers, and to ensure consistency in messages and application of the law for fishers along the coast.

The western rock lobster compliance models have continued to show leadership on the national scene in terms of approach and industry participation. The strength of the industry commitment to compliance has been noted as a strong factor in support of the Marine Stewardship Council certification process. Presentations utilising new land and sea compliance data collection

WEST COAST ROCK LOBSTER TABLE 1

Summary of commercial rock lobster breaches, warnings and infringements for the years 1999/2000 and 2000/2001.

Offence Type	1999/2000 Breaches	1999/2000 Warnings	1999/2000 Infringements	2000/2001 Breaches	2000/2001 Warnings	2000/2001 Infringements
Closed season	0	0	0	1	0	0
Illegal gear	1	3	2	0	4	3
Obstruction	0	0	0	0	0	0
Processing	7	2	2	0	1	0
Records/Returns	0	0	0	0	2	7
Spawners	2	48	3	2	73	8
Under-size	11	96	33	8	186	26
Excess gear	4	0	0	1	0	0
Licence offence	1	0	0	1	7	7
Over-size	0	2	1	0	0	0
Closed waters	10	0	0	8	0	0
Other	2	4	0	4	14	1
Total	**38**	**155**	**41**	**23**	**287**	**52**

processes were made on the RLIAC coastal tour. Throughout the season, the RLIAC Compliance Subcommittee continued its planning in partnership with industry. New initiatives such as the Compliance Coordinator, mobile factory patrol, joint industry risk assessment and pre-season briefing continue to create new approaches to compliance in response to changing demands.

RESEARCH SUMMARY

Research activities continued to focus on forecasting future catch levels, monitoring of breeding stock levels, modelling and stock assessment. During the year, results from length-structured/age-structured simulation models assessing management options for maximising the value of the fishery were presented to industry. Researchers also attended the Sixth International Conference and Workshop on Lobster Biology and Management to present data for peer review on the impacts of individual elements of the management package introduced in 1993/94; western rock lobster migration; the prediction of recreational catches; and an assessment of environmental factors affecting commercial catch predictions. These data were also presented to industry.

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 1999/2000): 14,523 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 1999/2000 catch in the WCRLMF was forecast from puerulus settlement to be 13,500–14,500 tonnes. Processors' figures show the catch from the WCRLMF for the 1999/2000 season was 14,523 tonnes, 33.9% greater than the long-term average catch of 10,850 tonnes and 11.7% greater than the previous season's 13,009 tonnes. In 1999/2000, the catches in A Zone, B Zone and C Zone were 1,749 tonnes, 4,548 tonnes and 8,226 tonnes respectively, with A Zone 11.2% lower and B and C Zones 9.2% and 19.7% higher than the previous season. This was the fishery's second record catch in successive seasons.

Commercial Fisheries

In 1999/2000, a survey of recreational rock lobster fishers estimated that they caught approximately 750 tonnes, which was a 19.3% increase on the catch estimate for 1998/99 of 630 tonnes. The increase again was due to larger catches in the southern sector, adjacent to the Perth metropolitan area, reflecting the much higher abundance of lobsters available this season in C Zone.

The total catch of western rock lobster from this fishery (commercial and recreational) was approximately 15,270 tonnes, 12.0% higher than the previous season's catch of 13,630 tonnes.

Octopus may be caught in rock lobster pots, generally in shallow water (0–20 fathoms or 0–37 m), and catch rates of about 0.02–0.03 octopus per pot lift were recorded in voluntary research logbook data between 1992/93 and 1999/2000. This translates as an estimated 220,0000–300,000 octopus caught in all zones in each of the past eight seasons.

Fishing effort

The nominal fishing effort for 1999/2000 was 10.72 million pot lifts, 0.3% lower than the 10.75 million pot lifts for 1998/99 (West Coast Rock Lobster Figure 1). The nominal effort for the A, B and C Zones of the WCRLMF was 1.15 million, 3.9 million and 5.67 million pot lifts respectively, 5.7% less, 2.4% more and 0.9% less than the previous season's 1.22, 3.81 and 5.72 million pot lifts.

Effort equivalent to 0.55 million commercial pot lifts was used by the recreational fishery to land its catches. This was 5.8% higher than the 0.52 million pot lifts used in 1998/99.

The total effort used in the WCRLMF during 1999/2000 was 11.24 million pot lifts, 0.3% lower than the 11.27 million pot lifts made in 1998/99.

Catch rate

Due to the record abundance of rock lobsters on the grounds in 1999/2000, catch per unit of fishing effort increased substantially (12.4%) over the rate in 1998/99 (1.36 and 1.21 kg/pot lift respectively) (West Coast Rock Lobster Figure 2). Trends in catch rates show a 'cyclical' pattern due to environmental effects on puerulus settlement; however, the overall decline in catch rate (abundance) from the 1950s to the early 1990s (Rock Lobster Figure 2) was one of the contributory reasons for the introduction in 1993/94 of management arrangements designed to rebuild breeding stock levels. The catch rates in the past seven seasons have remained high due to the improved survival of lobsters, higher recruitment of lobsters in the last two years (from previous high puerulus settlements), and lower levels of fishing effort resulting from the management package introduced in 1993/94.

Recreational component: **5%**

See information in 'Landings' and 'Fishing effort' above, and the Recreational Western Rock Lobster Fishery Status Report (pp. 128-9).

Stock assessment completed: **Yes**

The stock remains fully exploited. The current management arrangements, introduced in 1993/94, have achieved their objective of rebuilding the breeding stock. The 18% pot reduction and minimum size increase to 77 mm carapace length (15 November to 31 January) have meant that a proportion of the 'whites' catch has been shifted through to the 'reds' fishery in each season since 1992/93. However, because of the geographic variation in the size distribution of lobsters (generally smaller lobsters in the north), this has had a greater impact in the northern regions than in the south. Greater overall survival meant that some lobsters grew to a larger size before contributing to the catches in each of those years, with greater recruitment to the breeding stock and a flow of product through to following seasons. Modelling suggests that the catch in 1999/2000 was 90.5% of the estimated catch that might have been achieved if the new regulations had not been implemented in 1993/94. This notwithstanding, successive record catches were taken in the past two seasons.

Under the management arrangements introduced in 1993/94, only 82% of each vessel's pot entitlement could be used for fishing. This reduced the number of pots being operated in the fishery to 56,910, and decreased the rate of exploitation of the stock. This reduced effort level has been maintained since 1993/94, and has had the secondary effect of 'encouraging' a reduction in fleet size as vessels purchase additional pot entitlements to improve their economic efficiency.

This industry restructuring continued during 1999/2000 when three vessels left the fishery, leaving a fleet of 593. Since latent effort has largely been removed from the fishery, pot reductions have proved to be an effective tool with which to manage fishing effort in the WCRLMF. Some effort 'creep' was evident between 1993/94 and 1998/99, but nominal effort levels since 1998/99 have remained relatively stable, so that 1999/2000 levels were 3% greater than the 10.38 million pot lifts of 1993/94 and 1994/95. Practically all of this movement occurred in C Zone, where a 9% increase in nominal effort was noted between 1993/94 and 1998/99. However, the huge catches of 1998/99 and 1999/2000 have seen a stabilisation of effort in C Zone, where 5.64 million, 5.72 million and 5.67 million pot lifts respectively were recorded in the three seasons from 1997/98 to 1999/2000. Although effort seems to have levelled out at a little over 10.7 million pot lifts, the lower catch seasons predicted for the next few years may generate increases in fishing effort above current levels. Effective fishing effort continues to increase through the improved use of sophisticated fish-finding and navigational technology. This is monitored and will be factored into stock assessments and future management advice.

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 indices show that there has been substantial and very significant growth of the breeding stock in response to the management package introduced for the 1993/94 season, which specifically aimed at improving egg production. Current indications from both sets of indices used to monitor the breeding stock are that egg production has now reached or is above the target levels set in 1993/94. Currently, egg production is assessed at 34% above the 1980/81 target level.

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

Projected catch next season (2000/2001): 11,200–12,400 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. Seasons 2000/2001 and 2001/02 are expected to produce commercial catches of around 11,200–12,400 tonnes and 9,500–10,500 tonnes respectively, the lower catches resulting from declining puerulus settlement following the large numbers of pueruli settling in 1995/96 and 1996/97 (West Coast Rock Lobster Figure 6). Forecast recreational catches indicate that total rock lobster landings (commercial and recreational) will be in the range of 11,800–13,000 tonnes in 2000/2001.

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 education has significantly reduced the at-sea discard rate of the bands. The second interaction is the drowning 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 very rare and are only reported to occur 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).

Turtles are rarely affected by lobster fishing. Anecdotal information suggests a very occasional entanglement of turtles in pot ropes (about one per year). Again the issue of the entanglement of, specifically, leatherback turtles was identified as a moderate risk by the ERA 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 interaction with fisheries (outside Western Australia) relates to bycatch from shrimp/prawn trawls without turtle exclusion devices, longlines, gillnets and shark nets. The indigenous harvest of leatherbacks in Indonesia and other south-east Asian countries and the poaching of eggs from nests in this region are also highly significant causes of mortality for this endangered species. By comparison, the occasional entanglement of a marine turtle in a pot rope, even assuming that all entanglements result in death, is unlikely to be a significant cause of mortality for any turtle species.

ECOSYSTEM EFFECTS

Food chain effects: Low

The legislated design of rock lobster pots, and the strict control of replacement pots, prevents 'ghost fishing' problems arising. In terms of ecosystem effects, the fishery is unlikely to cause significant 'food web' changes, as the sub-legal-sized lobsters and protected breeding stock components form a significant proportion of the biomass (> 50%) and remain relatively constant 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. Overall, the effect of the fishery on the wider ecosystem is assumed to be minimal. Notwithstanding this, and noting the magnitude of the fishery, a formal ecological risk assessment has been conducted as part of the Marine Stewardship Council accreditation and will formally document this assessment.

Commercial Fisheries

Habitat effects: **Low**

A study of human impacts (including rock lobster fishing) on the marine environments of the Abrolhos Islands is under way with funding from the Fisheries Research and Development Corporation (FRDC). This study estimated that potting might impact on between 0.1% and 0.2% of the surface area of fragile habitat 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 habitat is highly resistant to damage from rock lobster potting.

SOCIAL EFFECTS

The western rock lobster fishery is an important sector of Western Australia's economy, the current reporting season generating some $500 million of export income. Employment is seasonal, the fishing season covering seven and a half months from 15 November to 30 June. A total of 593 vessels and 1,625 people were engaged in fishing for rock lobster in 1999/2000. This equates to one skipper and an average of about 1.75 deckhands per vessel. During the year, 12 processing establishments engaged between 200 employees in the closed season and 1,100 employees in 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), Lancelin (1), Jurien (1), Cervantes (1), Dongara (1) and Geraldton (3). Rock lobster fishing is responsible for the establishment and survival of many towns along Western Australia's west coast from Mandurah to Kalbarri.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (1999/2000): **$390 million**

The price fishermen received for the western rock lobster in 1999/2000 was an estimated average of $27/kg in all zones of the fishery. This was a 33.3% increase on the $20.25/kg paid in 1998/99, and the first significant movement in price following three seasons of prices ranging between $19.25/kg and $20.25/kg. This substantial increase in price was due in large part to the devaluation of the Australian dollar against other currencies. The value of the record landed catch in the WCRLMF in 1999/2000 was approximately $390 million.

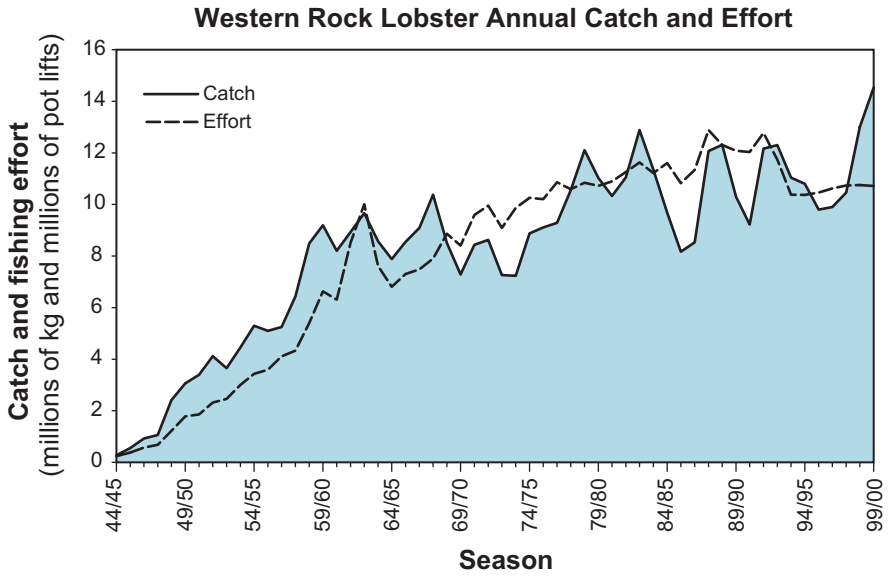
FISHERY GOVERNANCE

Acceptable catch range: **8,166–14,523 tonnes**

Between 1974/75 and 1999/2000, fishing effort levels exceeded 10 million pot lifts. During this 26-year period, catches ranged from 8,166 tonnes in 1985/86 to 14,523 tonnes in the current reporting year. The average catch has been 10,802 ± 628 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 26-year range.

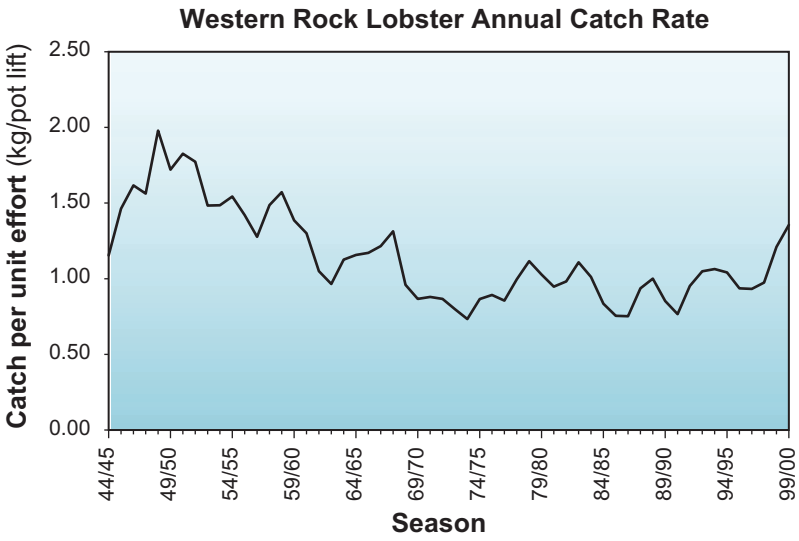
EXTERNAL FACTORS

The management package introduced in 1993/94 achieved its objectives of reducing the exploitation rate, increasing the breeding stock and allowing egg production to be maintained at or above the target levels. Catches peaked in 1999/2000, with the second successive season of record landings, and are expected to decline to average or above-average levels over the next few years. 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 increased again in 1999/2000, due primarily to forecasts of another record catch, a greater number of licences being issued (increase of 13% compared to 1998/99), and a high proportion of licensees actually undertaking some fishing activity (see Recreational Western Rock Lobster Fishery Status Report). Both Fisheries Western Australia and the rock lobster industry have been addressing issues raised by the Marine Stewardship Council to maintain the world's first MSC accreditation, and those arising from Commonwealth legislative requirements to ensure an ecologically sustainable fishery.



WEST COAST ROCK LOBSTER FIGURE 1

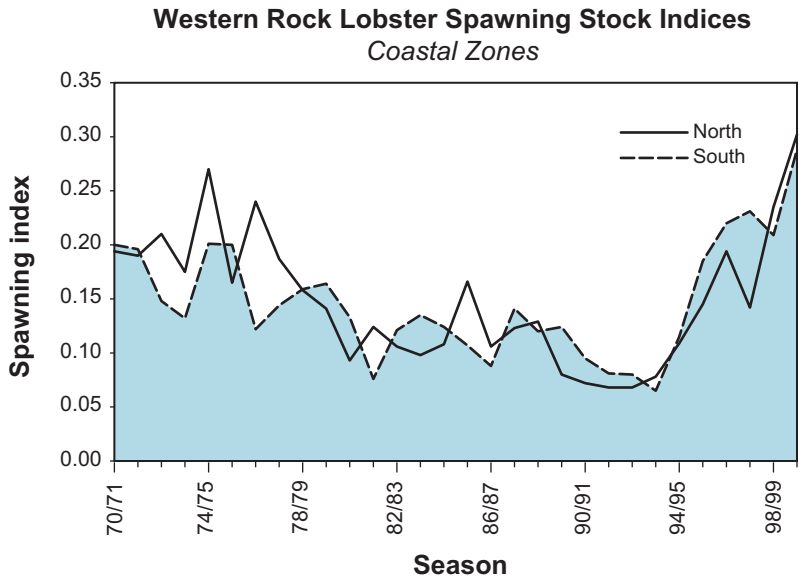
Annual catch and nominal fishing effort from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 1999/2000.



WEST COAST ROCK LOBSTER FIGURE 2

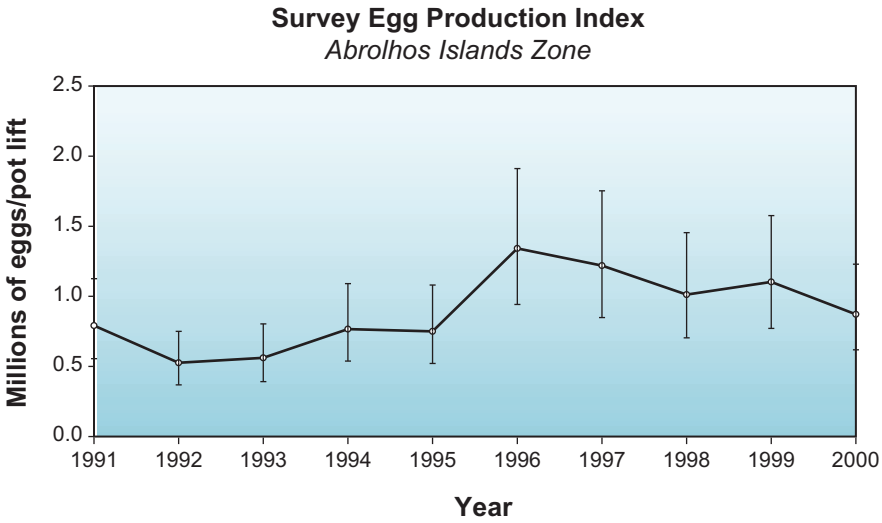
Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 1999/2000.

Commercial Fisheries



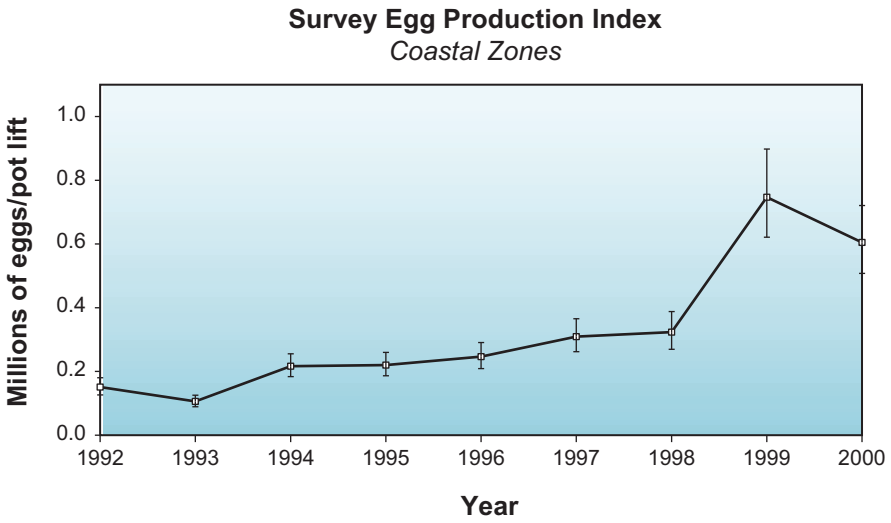
WEST COAST ROCK LOBSTER FIGURE 3

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.



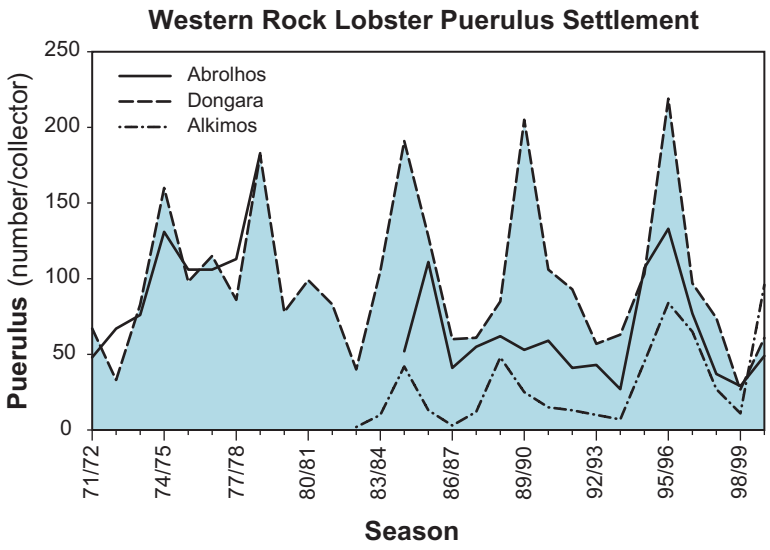
WEST COAST ROCK LOBSTER FIGURE 4

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).

Commercial Fisheries

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 and, in 2000/2001, 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.

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

The Vessel Monitoring System, a satellite tracking system used to monitor the movement of vessels within the waters of the fishery, was introduced into management arrangements for the AIMTMF in April 2001. VMS can also be used for electronic catch reporting, communication and emergency position reporting.

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

RESEARCH SUMMARY

Research monitoring of the scallop stocks in each fishery is undertaken utilising fishers' monthly return 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'.*

There are 17 boats licensed to fish for scallops in this limited entry fishery. However, 14 boats fished during the 2000 season. The permitted fishing area opened on 4 April and closed on 31 May 2000.

The Port Gregory trawl fishery operates as part of the AIMWTMF. The permitted fishing area opened on 1 March for prawns and 4 April for scallops, and was closed on 31 October 2000.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2000):
429 tonnes whole weight

Landings

The total landings for the 2000 season were ; 429 tonnes whole weight of scallops (Abrolhos Islands; Scallop Figure 1). No prawns were caught in the ; Port Gregory area.;

Fishing effort

A total of 1,281 trawl hours were recorded for the 2000 season.

Catch rate

378 kg/hr (whole weight).

Recreational component: **Nil**

Stock assessment complete: **Not assessed**

This fishery is highly variable, being dependent on sporadic recruitment which is 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 three years of surveys (1997–1999). Derivation of a more reliable survey abundance–catch relationship will require several more years of data.

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 (2001):
465–700 tonnes whole weight

Using the November 2000 survey data, the projected catch range for 2001 is likely to be 465–700 tonnes whole weight and may exceed the historically acceptable range of catches. During the survey, several areas indicated reasonable levels of recruitment and higher catches are expected in 2001 compared to 2000.

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 Fisheries WA 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 due to on-board processing during the short annual season. The estimated employment for the year 2000 was 180 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2000:
$2.3 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 $5.25/kg whole weight or $26.25/kg meat weight. Meat weight is approximately 20% of the whole weight.

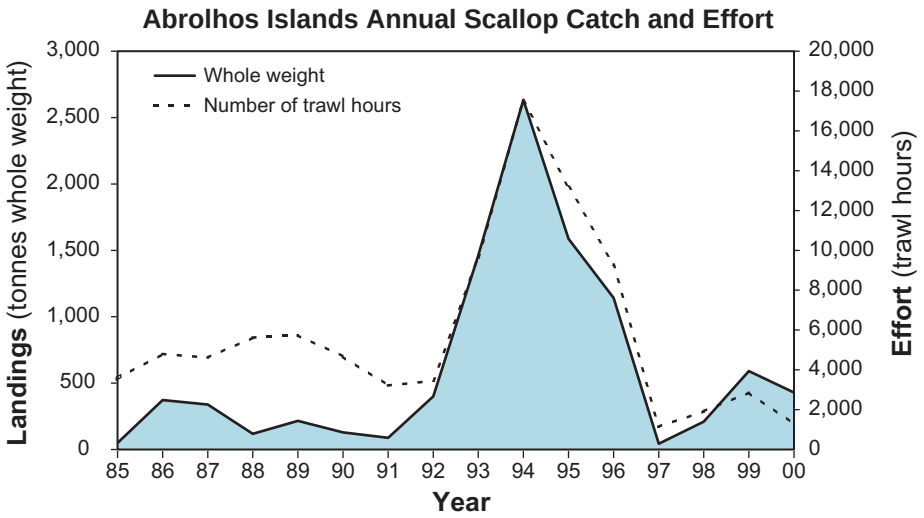
FISHERY GOVERNANCE

Acceptable catch range:
50–600 tonnes whole weight

Apart from the exceptional catches of the mid-1990s,; which were due to unusual environmental conditions increasing the success of recruitment, the catch range for this fishery 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.



ABROLHOS ISLANDS SCALLOP FIGURE 1

Annual scallop landings for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985–2000.

Commercial Fisheries

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 200m 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, B and D boats may fish all year round. Seasonal access to Zone C occurs between 1 July and 30 September. Seven boats operated in the fishery during 2000.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2000):
Prawns 32 tonnes
Scallops 23 tonnes whole weight

Landings

The total landings for the season were 32 tonnes of western king prawns and 23 tonnes whole weight of scallops. The fishery also lands a mixture of by-product, of which the most abundant species recorded were 12 tonnes of western sand whiting, 6 tonnes of blue swimmer crabs, 2 tonnes each of sole, squid, and mixed skates and rays, and 1 tonne each of flounder and red mullet.

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 2000 was 28 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2000:
Prawns $555,000
Scallops $120,000

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 $17.30/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 $5.25/kg whole weight or $26.25/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. The 2000 king prawn catch was significantly higher than in recent years, returning to the level of the mid-1990s.

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), while Condition 79 authorises demersal trawling for scallops within the Recherche Archipelago.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2000): 2,722 tonnes whole weight

Landings

The scallop catch of 2,722 tonnes whole weight was the highest recorded for this small fishery, with the previous highest catch being 138 tonnes whole weight in 1995. The south coast trawl fishery is principally a scallop fishery with only one licence holder reporting landings of mixed finfish, of which leatherjacket and redfish 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 2000 was 16 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): $14.3 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 2000 were very much higher than those seen in the fishery over the last 10 years, indicating a very strong settlement in the region.

Commercial Fisheries

West Coast Blue Swimmer Crab Fishery

MANAGEMENT SUMMARY

Blue swimmer crabs are found along the entire Western Australian coast and comprise the major proportion of inshore crab catches in Western Australia. 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. For the major fishery in Cockburn Sound, a review was carried out under the voluntary resource-sharing guidelines, resulting in amendments to the Cockburn Sound (Crab) Management Plan in 1999 and 2000 to incorporate the negotiated outcomes. These new management arrangements included an initial 20% 'across the board' crab pot reduction, an increase in the legal minimum size for crabs to 130 mm (for the commercial sector only), removal of gillnets as a permitted means of fishing, the introduction of a Fisheries Adjustment Scheme, and provision for non-transferable B Class licence holders to convert to A Class licences with a 50% reduction in crab pots. B Class licensees had until the commencement of the 2000/2001 fishing season to re-nominate as A Class licensees. These measures have seen the number of authorised crab pots reduced from 1,600 to 840. The daily permitted operating times have been adjusted to reflect the reduction and consolidation of pot numbers that has resulted from the recent management changes.

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

In the south and 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 in the latter half of 2000, after a Voluntary Fisheries Adjustment Scheme 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.

In past years there has been significant competition for access to blue swimmer crabs in south-west estuaries and south-west oceanic waters between some commercial and recreational fishers. However, the decline in the number of commercial fishermen in the estuaries and the introduction of specific arrangements for commercial crab fishing in Geographe Bay has reduced the friction between the two sectors.

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 recommendations have been the subject of further input at the request of the Minister, pending the development of a final position on crab fishery management arrangements.

Governing Legislation/Fishing Authority

Cockburn Sound (Crab) Management Plan 1995
Warnbro Sound (Crab) Management Plan 1995

Consultation Process

Agency–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 the Fisheries Research and Development Corporation, under the umbrella of the national collaborative blue swimmer crab research initiative. This research on the basic biology of crabs along the WA coast, gear–catchability relationships, recreational catch surveys, commercial catch monitoring, discard mortality estimation and stock assessment modelling will be completed in 2000/2001.
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, then 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 generally 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 crab 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 expired on 31 December 2000.

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 1999/2000): 673 tonnes

Landings

A commercial catch of 673 tonnes of blue swimmer crab was taken in 1999/2000, 17% up on the 577 tonnes caught in the 1998/99 season. Commercial catches in Cockburn Sound contributed 305 tonnes (28% increase), while other areas making a substantial contribution to total landings were the Peel/Harvey Estuary (60 tonnes, 8% decrease) and Shark Bay (182 tonnes, 38% 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 85% of the commercial catch, while the balance of the catch was taken mostly by trawling (8.1%), gillnetting (4.6%) and drop netting (0.5%). Fishing effort overall increased by 7.6% for traps while decreasing by 3% for trawling, 4.2% for gillnets and 2% for drop nets in the last year. This continues the trend from the mid-1990s towards use of purpose-designed crab traps in commercial crab fishing.

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, increased by 36% compared with the previous season. In the Peel/Harvey Estuary, catch rates remained the same for traps but increased by 34% for gillnets compared with the previous year. In Shark Bay, trap catch rates increased by 17.7%, whilst trawl catch rates decreased by 20.2%.

Recreational component: 40%

Recreational catches of blue swimmer crabs have been surveyed in the west coast bioregion, as reported in *State of the Fisheries 1999–2000*, and are estimated to be about 40% of the total catch. The recreational take was dominated by the catch from the Peel/Harvey Estuary.

Stock assessment completed: Preliminary assessment

A preliminary assessment has been made using catch rates for traps and gillnets. Trap catches show an increase between 1993/94 and 1997/98 and again in 1999/2000. The increases have been accompanied by an increase in overall effort. A slight decline in catches and catch rates was observed in 1998/99 (Blue Swimmer Crab Figure 3), but generally catch rates (kg/traplift) have remained relatively stable over the last eight years, with no trend evident at this stage.

Exploitation status: Not assessed

Breeding stock levels: Adequate

As the legal size at first capture 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.

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 trialled in Western Australian trawl fisheries, mainly to reduce the take of sharks and rays, which damage the quality of the target catch.

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

Commercial Fisheries

locations along the west coast from Geographe Bay in the south to Shark Bay in the north.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (1999/2000): $2.9 million

The catch was valued at approximately $2.9 million in 1999/2000, 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 last three years.

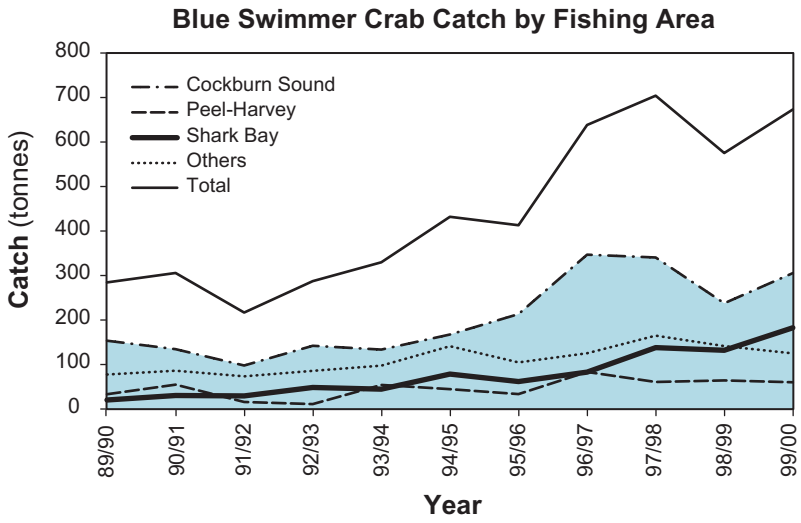
For the managed fishery in Cockburn Sound the commercially acceptable range for the current management regime is approximately 200–350 tonnes, based on catches in the last five years.

There is also interest in expanding the blue swimmer crab fishery into currently unexploited grounds in the north of the state such as Exmouth Gulf and Nickol Bay. Acceptable catch rates for these areas are not available as yet due to the lack of commercial fishery data.

EXTERNAL FACTORS

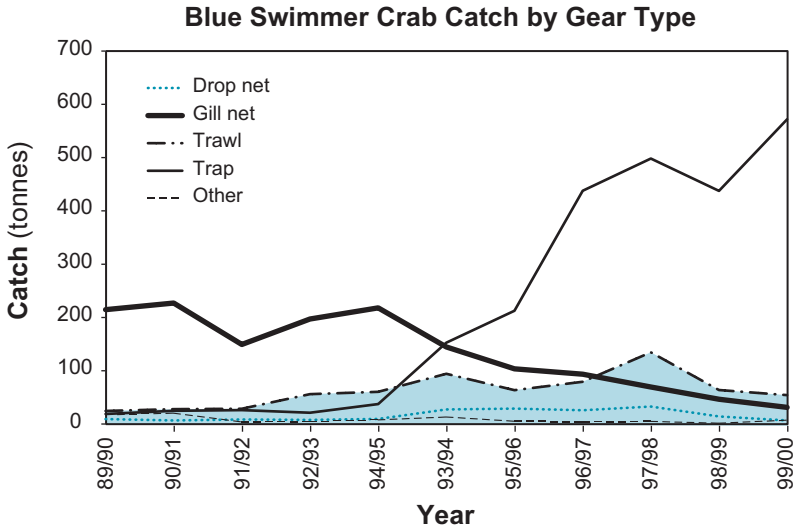
The commercial fishery has been expanding in the last few years as the main commercial sectors converted from set nets to dedicated crab traps, and there is still potential for future commercial expansion in areas not currently exploited. Currently, new commercial fishing grounds are being explored along 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 conflicts are 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 planned to review these arrangements in both Cockburn Sound and Geographe Bay.



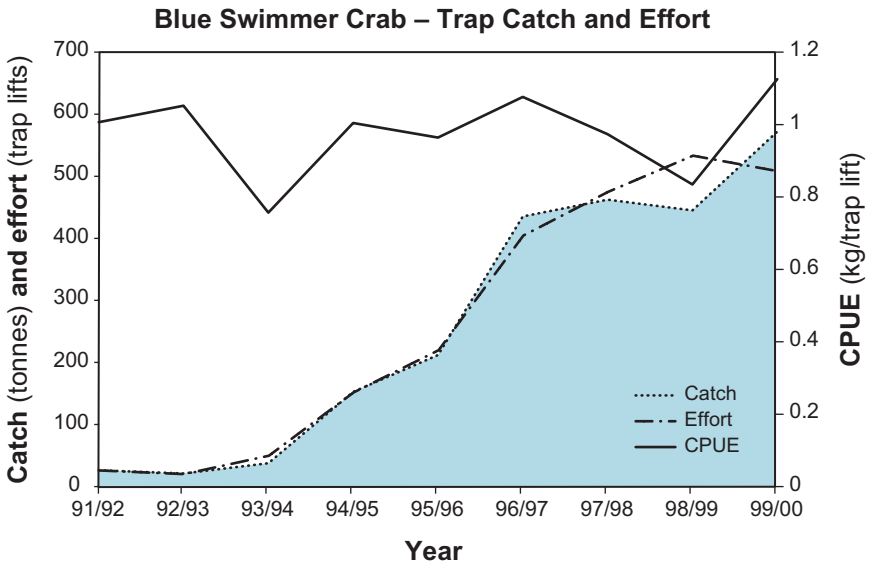
BLUE SWIMMER CRAB FIGURE 1

Commercial catch history for the blue swimmer crab *(Portunus pelagicus)* in Western Australia between 1989/90 and 1999/2000, indicating main areas of commercial fishing.



BLUE SWIMMER CRAB FIGURE 2

Blue swimmer crab catch taken by different gear types in Western Australia during the period 1989/90 to 1999/2000.



BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (kg), effort (trap lifts) and catch per unit effort (kg/trap lift) in Western Australia during the period 1991/92 to 1999/2000 using traps.

Commercial Fisheries

West Coast Estuarine Fisheries

MANAGEMENT SUMMARY

There are four 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)
- Leschenault Estuarine Fishery
- 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 basic level of commercial presence and production while encouraging a resource shift towards the recreational sector, a number of Voluntary Fisheries Adjustment Schemes (VFAS) have been run in the last five years. The outcome of these schemes has been a significant reduction in the number of commercial fishing units in these estuarine fisheries, with 7 fishing units being withdrawn in 2000/2001 (Peel/Harvey – 1, Leschenault – 6). The VFAS in the Leschenault Inlet has resulted in all commercial fishing units being removed. The number of fishing units remaining for each fishery as at 30 June 2001 is Swan/Canning – 4, Peel/Harvey – 8, Hardy Inlet – 1, Leschenault – 0.

Management of these fisheries continues under the policy directions set by the Integrated Fisheries Management Strategy (Fisheries WA 1999b). This paper proposes a target (or optimum) number of fishing units that should be attained in each fishery before transferability is considered.

In 2000/2001, there was continued industry and public consultation as part of the review of the west coast estuarine fisheries and development of the Integrated Fisheries Management Strategy. In support of these initiatives, a management paper is being prepared recommending specific management options for these fisheries. It is anticipated that this management paper will be released for further consultation with client groups and interested parties in 2001/02.

Governing Legislation/Fishing Authority

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

Consultation Process

Agency–industry meetings

RESEARCH SUMMARY

Research monitoring of fisheries and fish stocks in the west coast estuaries is primarily based on catch and effort statistics (CAES) returns provided by industry. These data are interpreted using the extensive scientific knowledge of the fish stocks in estuaries derived from research by Fisheries WA 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 – 9 units
Leschenault: level of access – 6 units
Hardy Inlet: level of access – 1 units

The levels of access listed above are as at April 2000. Unit holders in the four west coast estuaries are endorsed to fish a single west coast estuary system only.

The status of the fishery in each of the above estuaries is reviewed annually. Please note, where fewer than five fishers are actively involved in a particular fishery, the data are subject to the Fisheries WA 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, cobbler and whiting. These stocks are not subject to specific management plans, but are exploited as a part of the larger estuarine fishery.

Main fishing method

Gillnet/haul net.

RETAINED SPECIES

Commercial production (season 2000): 305 tonnes

Landings

The total landings of 305 tonnes from west coast estuaries include the following catches of key target species:

Sea mullet	88.8 tonnes
Blue swimmer crabs	73.0 tonnes
Yellow-eye mullet	48.3 tonnes
Western sand whiting	36.2 tonnes
Cobbler	5.0 tonnes
Tailor	9.6 tonnes
Perth herring	9.3 tonnes

Australian herring	8.5 tonnes
King George whiting	7.0 tonnes
Black bream	5.0 tonnes
Other species	14.3 tonnes

Swan/Canning: The 2000 catch was a further decrease from the 1999 catch figure and continued the overall decline in catches during the 1990s (actual figure not available as there were fewer than five operators). The catch from the Swan/Canning during 2000 was composed primarily of blue swimmer crab, sea mullet and Perth herring, with small quantities of black bream, Australian herring, 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. The total catch for 2000 of 192.1 tonnes was a decrease from the 1999 catch figures. While there was little variation in the catches during the early 1990s, there has been a dramatic decline since 1998. Approximately 62% of the finfish catch was comprised of sea mullet and yellow-eye mullet during 2000. Approximately 32% of the total 2000 catch was comprised of blue swimmer crabs.

Leschenault: The total catch for 2000 showed a decrease from the 1999 value (actual figure not available as there were fewer than five active operators). While the overall total catches over the past 25 years display a declining pattern, the catches during the past decade remained fairly stable until 1998 when they began to decline. Sea mullet and western sand whiting dominated the finfish catch. Approximately 1% of the total 2000 catch was comprised of blue swimmer crabs.

Hardy Inlet: The 2000 catch remained stable from 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, 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, the Peel/Harvey Estuary and the Hardy Inlet during 2000, with an insignificant quantity from the Leschenault Inlet. The reported catches from the Swan/Canning and Peel/Harvey Estuaries and Hardy Inlet showed an increase from the 1999 catches, while the reported catch from Leschenault Inlet declined from 1999.

Cobbler: Catches of cobbler were reported from all four estuaries during 2000. The reported catches of cobbler in the Swan/Canning Estuary have been declining from the late 1980s, with 2000 being the lowest on record. The 2000 catches in the Peel/Harvey Estuary have decreased to approximately half of the 1999 levels. In the Leschenault Inlet, the reported catch in 2000 continued to decline from mid-1990s values. There was a small catch reported from the Hardy Inlet for 2000.

King George whiting: King George whiting catches for 2000 were reported from the Swan/Canning and Peel/Harvey Estuaries, with the majority coming from Peel/Harvey. Total annual catches from these estuaries declined to half of the 1999 value, 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 four in 2000. There has been a 33% reduction in the number of fishing units from 1999.

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). There has been a decline in the mean monthly number of fishing units from approximately 40 in the early 1970s to the current level of nine boats actively fishing, and the number of units in 2000 has decreased by 26% from the previous year.

Leschenault: The general overall trend has been a decline in the mean monthly number of fishing units from approximately 10 in the 1970s to the current level of four units actively fishing in 2000.

Hardy Inlet: Fishing effort (mean monthly number of fishing units) in the Hardy Inlet has declined from three in the 1970s to the current level of only one unit operational in 2000, a decrease from two in 1999.

Catch rate

Swan/Canning: While the annual values of the catch per unit effort (CPUE) 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 followed the catches in this fishery. After a sharp decline in 1989 the CPUE has remained relatively stable during the past 10 years. The 2000 CPUE has decreased slightly from the 1999 values. 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, although it should be noted that it is significantly lower than the average catch rates experienced during the 10–year period between 1975 and 1985.

Leschenault: The overall trend since the late 1980s has been a stable catch rate, with some annual variation, generally following the fluctuations in catches. The 2000 CPUE has increased slightly from 1999 CPUE levels.

Commercial Fisheries

While targeted fishing effort is not reported, the general stability of the overall CPUE suggests the abundance of the suite of species which make up the overall catch has remained constant.

Hardy Inlet: Since the early 1990s the trend in the CPUE has generally followed the fluctuations in the catches. The 2000 CPUE has decreased slightly from the 1999 value.

Recreational component:
Overall percentage not assessed

Swan/Canning: A 1998/99 survey (Malseed and Sumner 2001) estimated the boat- and shore-based catch of the top five recreational finfish species in the Swan and Canning estuaries (tailor, whiting other than King George whiting, Australian herring, black bream and flathead) at about 3 tonnes. The commercial catches of the top five recreational species were of a similar magnitude to the recreational catches, but explicit data are not available for publication as fewer than five operators landed these species. This estimate of the recreational catch will be an under-estimate, as the survey covered only the estuary basin, excluding upstream areas where most of the black bream catch occurs. In addition to the finfish catch, recreational fishers also took about a quarter of the crab catch when surveyed in 1998/99.

Peel/Harvey: A 1998/99 survey (Malseed and Sumner, in press) estimated the boat- and shore-based recreational catch of key finfish species (Australian herring, tailor, King George whiting, whiting other than King George whiting, black bream and skipjack trevally) from the Peel/Harvey Estuary at 8 tonnes. This represents approximately 17% of the combined recreational and commercial take of these species in that year. These recreational finfish estimates can be regarded as the minimum taken, as the survey design focused on crab fishing times and locations. The recreational sector also took about 80% of the crab catch from the estuary in 1998/99.

Leschenault: Results from the recreational survey of the Leschenault Inlet in the 1998 calendar year (Malseed et al. 2000) indicated that boat- and shore-based catches of key recreational finfish species (tailor, King George whiting, whiting other than King George whiting and Australian herring) totalled less than one tonne. This represents about 9% of the combined recreational and commercial catch of these species in 1998. These figures represent minimum estimates of finfish taken recreationally from the Leschenault Inlet, noting that the focus of the survey was crabbing. The recreational sector took about 90% of the crabs in the survey year.

Stock assessment completed: **Yes**

Preliminary assessments have been completed for select targeted species only (black bream, cobbler and King George whiting).

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 *(Acanthopagrus butcheri)* 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.* No additional information is available.

Cobbler: Cobbler populations are genetically unique within each west coast estuary. A preliminary yield-per-recruit stock assessment was developed for the cobbler *(Cnidoglanis macrocephalus)* 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.* At this time, age structure information is not available to determine the current level of fishing mortality. Considerable research was conducted on the cobbler during the 1980s and early 1990s. From this work the current legal minimum length of 430 mm was set. Since that time there has been little research directed at this species. Cobbler catches have remained low during the 1990s, except for a peak in 1995. These low commercial catches reflect the lower number of fishers operating in the estuaries, but may also reflect a decline in the stock due to reduced availability/quality of estuarine habitat.

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 *(Sillaginodes punctata)* 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 1999 and 2000 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, with juveniles using estuaries and coastal waters as nursery habitats for the first few years of their life. Because the legal minimum length is considerably less. than the size at maturity, extra care needs to be taken to ensure overall fishing mortality does not exceed 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 which are susceptible to capture by the fishing gear used.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Low**

The operation of the 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 2000, there was an average of about 44 fishers operating in west coast estuarine fisheries.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000):
$0.91 million

FISHERY GOVERNANCE

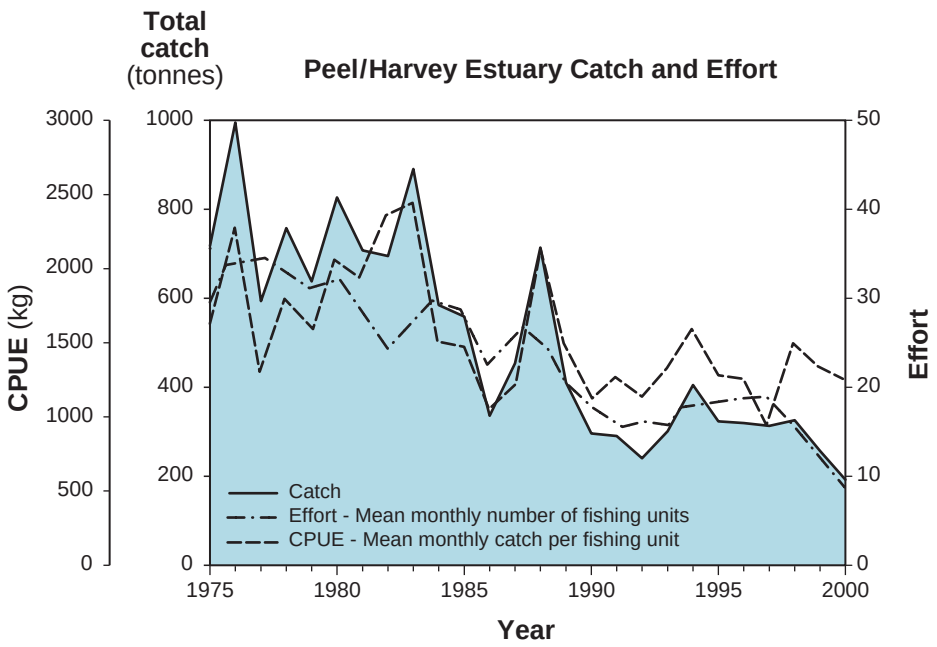
Acceptable catch range: **Not available**

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 2000 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 all three estuaries. These reduced levels of fishing activity as a result of voluntary buy-back of commercial access will almost certainly render these commercial catch and effort data sets less useful in assessing the status of estuarine species in future years. For example, this will be the last year of reporting of the Leschenault commercial catches, as all the fishing licences have now been bought back under the Voluntary Fisheries Adjustment Scheme.

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. Additional information to support this assessment process will be collected as a part of the FRDC-funded project to develop a methodology for a long-term annual index of recruitment for finfish species from south-western Western Australia.



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 1975–2000.

Commercial Fisheries

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: There are 11 licensees in this fishery. Small pelagic fish are taken primarily 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.

Continuation of beach access remains the main management issue relevant to this fishery, particularly where coastal developments restrict vehicle access.

Management of beach seining activities further south will be examined in a review of south-west beach seine access arrangements.

The major target species for these 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 Stocks, p. 18.

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

The catch of garfish and Australian herring has been rising steadily since the 1970s. The rate at which the catch of these two species is increasing is of some concern as they are both important recreational species.

Cockburn Sound (Mussel) Managed Fishery: There are two licensees with access to this fishery. Fishing activity in the wild capture fishery was 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 25 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 the scheme were surrendered.

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, garfish and Australian herring.

Commercial landings of King George whiting, western sand whiting, squid and octopus from Cockburn Sound have declined in recent years. Possible reasons may include environmental factors, fishing pressure and market-driven forces, or a combination of these factors. While Fisheries WA remains cautious about this trend, the underlying reasons for these declines are yet to be revealed.

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

Agency–industry meetings

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 which operate wholly and two managed fisheries which 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 gillnetting, crab netting (and potting), mussel diving and line and pot fisheries are all restricted to the waters of 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 2000 there were two licensees in the fish net fishery and 26 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. 29-31, 31-4, 158 and 18-21 respectively).

Main fishing method

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

RETAINED SPECIES

Commercial production (season 2000): 55.7 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 2000 catch represents a decline to 55.7 tonnes (Cockburn Sound Figure 1). The composition of the 2000 catch included over 20 finfish and elasmobranch species. Over 80% of the total catch was comprised of sea garfish, Australian herring (14.2 tonnes), pink snapper and sea mullet (2.8 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 2000 was 14.2 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 subsequently declined to 1,060 boat days for 2000.

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 2000 catch rate was 52.6 kg/boat day. The 2000 catch rate for Australian herring was 13.4 kg/boat day (Cockburn Sound Figure 2).

Recreational component: 45% (approx.)

A 12-month survey of boat-based recreational fishing in coastal waters from Augusta to Kalbarri was conducted during 1996/97 (Sumner and Williamson 1999). Catch and effort data collected as part of this survey identified the key recreational species in Cockburn Sound as Australian herring, King George whiting, other whiting, skipjack trevally, tailor and garfish. The estimated catch of these species was 39 tonnes. During the calendar year of 1997, the commercial catch of the same species in Cockburn Sound was approximately 45 tonnes. The recreational fishery therefore takes approximately 45% of the combined recreational and commercial catch of these key recreational finfish species. In addition, the recreational sector took about 5% of the crab catch from the area.

Stock assessment completed: Not assessed

Exploitation status: Not assessed

Breeding stock levels: Adequate for herring

See Australian Herring Stock Status Report, pp. 107-9.

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 2000, 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 22. Production supplies restaurant and retail sectors in the metropolitan area.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): $142,000

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

FISHERY GOVERNANCE

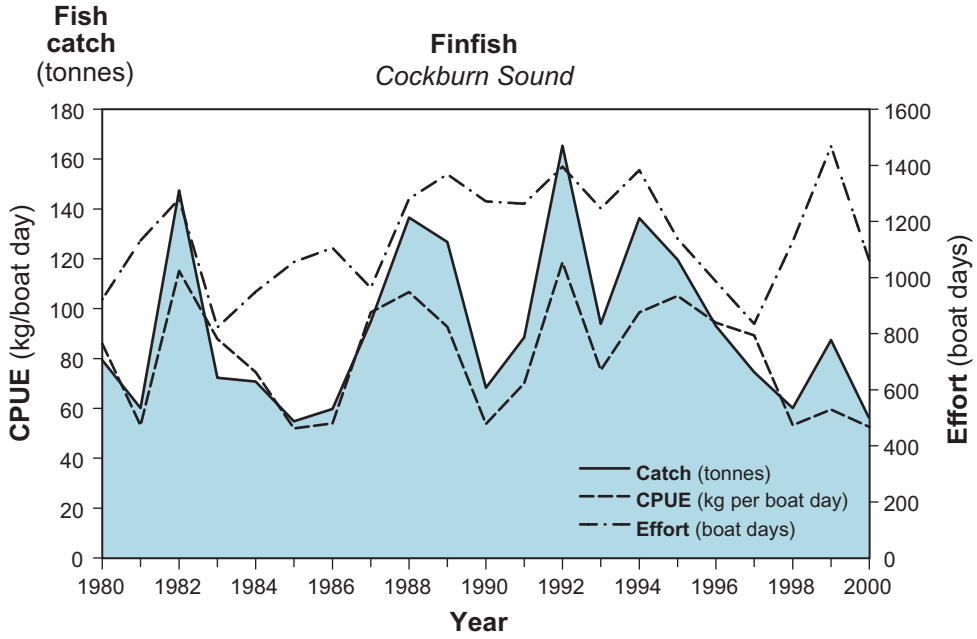
Acceptable catch range: 40–95 tonnes

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 within the acceptable catch range. Future annual catch values which fall outside of this range will be investigated. Where consecutive values occur outside of the range, management arrangements may need to be reviewed.

Commercial Fisheries

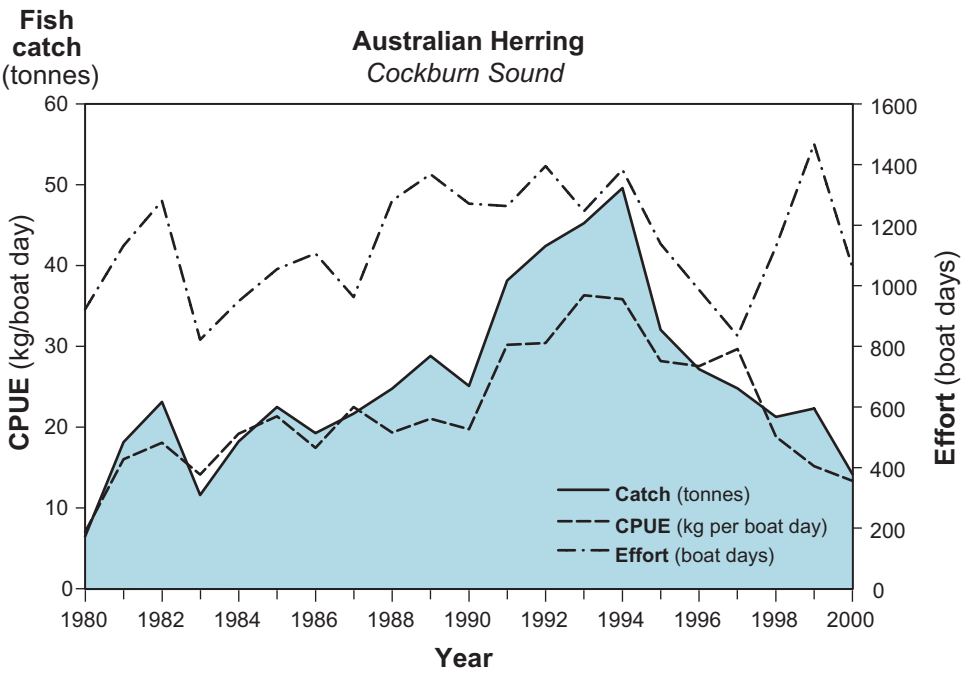
EXTERNAL FACTORS

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 1980–2000.



COCKBURN SOUND FIGURE 2

The annual catch, effort and catch per unit effort (CPUE) for Australian herring *(Arripis georgiana)* in the Cockburn Sound fisheries over the period 1980–2000.

West Coast Beach Bait (Fish Net) Managed Fishery Status Report

Prepared by 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 2000):
All species 336 tonnes
Whitebait 240 tonnes

Landings

The main target species in this fishery is whitebait, of which 240 tonnes were caught in the 2000 season. The catches of all other species landed in this fishery, which amounted to 96 tonnes, are shown in West Coast Beach Bait Tables 1 and 2. Sea mullet and Perth herring 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 are from the managed fishery, while Bunbury landings are from the south-west beach seine fishing.

Metropolitan: The catch of whitebait for the metropolitan region during 2000 was 32.1 tonnes, a major increase from the average of 20.3 tonnes over the previous three years (West Coast Beach Bait Figure 1).

Mandurah: The whitebait catch at Mandurah (33.6 tonnes) again narrowly exceeded that for the metropolitan region in 2000.

Bunbury: The Bunbury catch almost doubled this year to 174.8 tonnes from the 96 tonnes caught in 1999 (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 does 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, the abundance in the dominant Bunbury sector in 2000 was higher than in the previous year, as was also the case in the metropolitan and Mandurah sectors.

The 2000 catch was much as expected from the previously observed positive relationship between the Fremantle sea level (Leeuwin Current) and catch in the following year. That is, the high annual catch of whitebait expected in 2000 following a very strong Leeuwin Current during 1999 did eventuate.

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.

Projected catch next season (2001):
Whitebait 272–375 tonnes

The average monthly Leeuwin Current in 2000 was again very strong, only dropping slightly below the 1999 level which was the highest ever recorded. The Leeuwin Current/whitebait model suggests that the 2001 catch will be in the range 272–375 tonnes. (This range exceeds the acceptable catch range owing to the wide confidence limits around the regression model.)

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 pichards, 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.

Commercial Fisheries

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 60 fishermen and crew worked in the whitebait industry in 2000.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): $0.46 million

The price for whitebait was similar to that obtained in 1999, at an average of $1.80/kg. Total catch value was about $0.46 million.

FISHERY GOVERNANCE

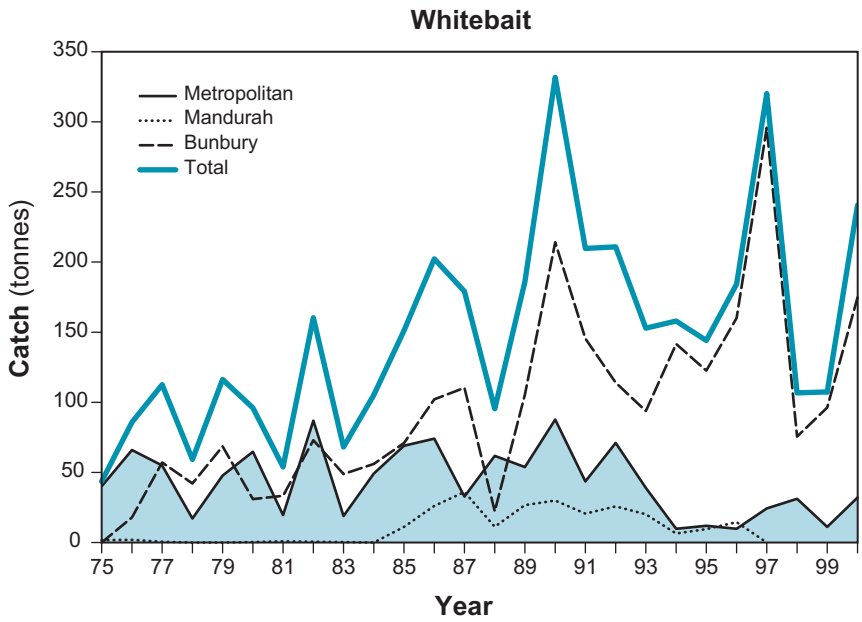
Acceptable catch range: Whitebait 106–331 tonnes

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 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 2000.

WEST COAST BEACH BAIT TABLE 1

Catches in 2000 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.

Anchovy	
Garfish, sea	
Herring, Perth	
Mullet, sea	
Mullet, yellow-eye	
Others	
Total	**1.0)**

WEST COAST BEACH BAIT TABLE 2

Catches in 2000 of retained species other than whitebait from the south-west beach seining sector.

Garfish, sea	
Herring, Australian	
Mullet, sea	
Mullet, yellow-eye	
Sprat, blue	
Whiting, western sand	
Others	
Total	

West Coast Purse Seine Managed Fishery

MANAGEMENT SUMMARY

This fishery is based 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. It is managed under the provisions of the West Coast Purse Seine Management Plan 1989. 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 throughout the west coast 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. The possibility of a further outbreak represents a real threat to the industry.

In response to concerns for the fishery, the Minister for Fisheries announced in March 2000 that the maximum quantity of pilchards that might be taken in the fishery for the 2000/2001 licensing period was to be 260 tonnes.

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 a 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.

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
Agency–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.

West Coast Purse Seine Managed Fishery Status Report

Prepared by 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.

Commercial Fisheries

Main fishing method

Purse seine net.

RETAINED SPECIES

Pilchard *(Sardinops sagax)* 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 *(Etrumeus teres)* are commonly caught, while small catches of anchovies *(Engraulis australis)* occur periodically.

Commercial production (season 2000): 624 tonnes

Landings

The combined catch of pilchards and sardinella for the managed fishery area and the developmental zone once again decreased from 1,103 tonnes in 1999 to 624 tonnes in 2000; this follows on from similarly sharp declines in 1997, 1998 and 1999 (West Coast Purse Seine Figure 1). Similarly, the contribution of pilchards to the combined catch decreased dramatically from 571 tonnes in 1999 to less than 14 tonnes. The decrease in pilchard abundance following the 1998/99 mortality event, coupled with a temporary closure of the pilchard fishery during the first half of the year, caused a switch in effort from pilchards to sardinella. This was reflected in the sardinella catch, which increased again from nearly 50% (532 tonnes) in 1999 to about 98% (610 tonnes) of the combined catch in 2000. In addition, when pilchard fishing resumed in the second half of the year this species was in low abundance at the traditional fishing grounds, and catches were largely composed of maray (traditionally a minor retained species), to the extent that more than 50 tonnes were landed for the year compared to less than 8 tonnes in 1999. There was also an increase in catch of anchovy to 5.8 tonnes (up from 83 kg in 1999).

Fishing effort

Eight vessels participated in the fishery in 2000 and together fished a total of 367 days. 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 no longer possible to estimate effort separately for the different species being targeted.

Catch rate

The estimated catch rate for all small pelagics was 1,700 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.

In early 1999, a second mass mortality event affecting only pilchards passed through the west coast stock after originating in South Australian waters and passing through the south coast of Western Australia. Pilchard mortalities were estimated to be much higher than in the initial disease event in 1995. As a result, a post-mortality biomass survey was considered necessary to estimate the size of the remaining stock.

A spawning biomass survey was therefore conducted in 2000. The spawning biomass was estimated to be 8,516 tonnes if a sex ratio of 73% was used, or 9,622 tonnes if the sex ratio was assumed to be 65% (see below). This result provides evidence that the stock is recovering strongly after the 1998/99 mass mortality. However, these estimates equate to a 60–80% increase from the 1999 estimate of 5,725 tonnes. Since an annual increase of 40% can be considered exceptional for a stock during times of very strong growth, the magnitude of increase appears to be too high for the west coast pilchard stock in a period of only one year, and may be indicative of poor estimation of adult parameters resulting from the low number of samples (n=4). The poor number of adult samples could be interpreted to mean that the estimates of adult parameters are not reliable, hence the two possible sex ratios presented above. However, examination of the relative changes in spawning biomass, as depicted by the changes in both proportion of sampling stations with pilchard eggs and the average egg density, support the estimated changes in spawning biomass. If portions of the west coast stock had been displaced during 1999 by unusually high water temperatures (either offshore, to deeper water or southwards), as suggested by some industry members, an increase in estimated biomass of 60–80% might be possible if this same portion had returned prior to the 2000 survey. This possibility is not contradicted by the age structure of the west coast pilchard catches. Assuming there has been strong recovery, availability to the fleet has remained very low.

Exploitation status: Fully exploited

Pilchards and sardinella are fully exploited.

Breeding stock levels: Depleted

See 'Stock assessment' above.

Projected catch (or effort) next season (2001): 100–720 tonnes

A notional TAC of 720 tonnes was based on an exploitation rate of 7.5% of the spawning biomass estimate obtained using a sex ratio of 65% female (i.e. 720 tonnes equals 7.5% of 9,622 tonnes). Given that stock may not be available to the fleet it is possible, however, that the catch may be much lower than the notional TAC. Thus it has been assumed that, if availability of the stock is reasonable, it should be possible to catch at least 100 tonnes.

NON-RETAINED SPECIES

Bycatch species impact: Low

This fishery targets specific schools of small pelagic fish

so bycatch is insignificant. Small pelagic fish which are sometimes caught but for which there are no stable markets for the quantities involved include yellowtail scad *(Trachurus novaezelandiae)* and blue mackerel *(Scomber australasicus)*. *Decapterus macrosoma*, a tropical scad, occurred apparently for the first time on the metropolitan purse seine grounds in 2000. This species represents an example of a non-retained small pelagic which may periodically occur on the lower west coast due to anomalous environmental conditions. Such infrequent occurrences would have negligible impact.

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.

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. 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. It should be noted, however, that in 'normal' circumstances the quota for pilchards is set at 10–15% of the spawning biomass, thus leaving 85–90% available to natural predators.

Habitat effects: **Negligible**

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

SOCIAL EFFECTS

The 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 6–12 people during 2000.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): **$0.5 million**

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 was $800/tonne.

FISHERY GOVERNANCE

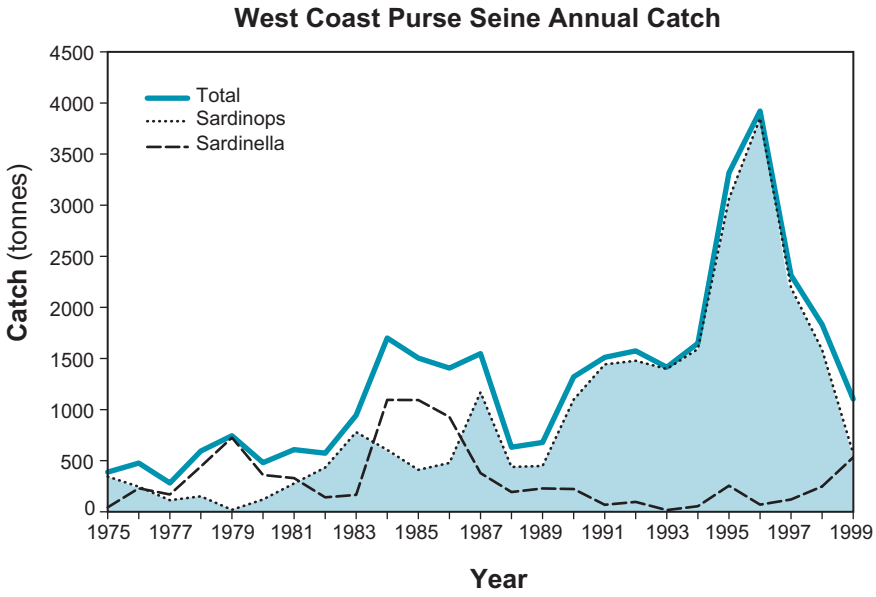
Acceptable catch (or effort) range: **Not available**

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 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 and has been delayed 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.

Commercial Fisheries



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 includes two of the three most important line-caught species of the wetline catch for the state, West Australian dhufish *(Glaucosoma hebraicum)* and pink snapper *(Pagrus auratus)*, as well as baldchin groper *(Choerodon rubescens)* and many other species. In addition to this fishery, these species are also caught in the demersal gillnet and longline fishery and by the recreational sector, including charter boats.

A common community concern that the wetline fishery has unrestricted access to a wide range of species led to a study of the fishing activity of wetliners published as Fisheries Management Paper no. 135 (Fisheries WA 2000a). 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. Most dhufish are caught in summer.

Around 466 boats of the wetline fleet took pink snapper between June 1992 and 1998, and 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. August, March and April recorded the highest catches of pink snapper.

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.

Governing Legislation/Fishing Authority

Fish Resources Management Regulations 1995
Fishing Boat Licence

RESEARCH SUMMARY

A detailed FRDC-funded research project on the biology of dhufish was completed at Murdoch University (Hesp and Potter 2000). This study determined the biological parameters of age, growth and reproduction, providing much of the scientific knowledge base for management (see 'Stock assessment'). A new FRDC-funded project commenced in 2000 by Fisheries WA will examine the mortality of under-size dhufish, snapper and, when possible, other species that are released after capture by line. The results of this project will provide an understanding of fishing mortality for the entire population and, together with CAES data, will be used to assess dhufish stocks.

Research on the life history of the baldchin groper at the Abrolhos Islands examined reproductive biology, age, growth and mortality (Nardi 1999). Baldchin groper can live up to 20 years or longer, and individuals will change sex from female to male mostly between the ages of 8 and 12 years. Spawning occurs from early spring to mid-summer. Size at first sexual maturity is estimated at 29 cm total length; however, this species changes sex from female to male at around 40–45 cm (Nardi 1999). The legal minimum length is 40 cm at age 9 years.

Although the Gascoyne bioregional component of the pink snapper stocks has been researched extensively, there has been little research on the species on the mid-west and lower west coast. Research on the biology of the breaksea cod was begun in 2001 by an honours student at Curtin University. Stock assessments of these species are planned as biological information becomes available. Until stock assessments are completed, monitoring of the fishery will continue to be undertaken annually using CAES data. This monitoring data is used to provide this status report.

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. For convenience, the fishing activities are assessed within the boundaries of the west coast bioregion, i.e. in waters south of latitude 27° S and west of longitude 115°30' E. During 1999/2000, 77 'wetline only' vessels operated in the west coast bioregion using handline and dropline. A further 165 vessels that were licensed in other fisheries also carried out wetline activities in the bioregion.

Main fishing method

Handline and dropline.

RETAINED SPECIES

Commercial production (season 2000): 768 tonnes

Landings

During 1999/2000, 242 boats wetlined for demersal finfish with 197, 181 and 134 boats catching dhufish, pink snapper and baldchin groper respectively. With landings of 173 tonnes of dhufish, 158 tonnes of pink snapper and 33 tonnes of baldchin groper, these three species comprised almost half of the total catch. Other major species in the catch are from the northern area of the west coast bioregion and include coral trouts (11 tonnes) and two lethrinid species, *Lethrinus nebulosus* and *Lethrinus miniatus*, reported as spangled emperor, sweetlip emperor, sweetlips and nor-west snapper (129 tonnes).

Demersal scalefish catches from other fisheries are not included here, however the scalefish catch accounted for 16% of the total catch of the West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery (WCDGDLIMF) in 1999/2000. This scalefish catch was dominated by dhufish (17.7 tonnes), followed by pink snapper (10.2 tonnes). For a full status report on the WCDGDLIMF, see pp. 113-18.

Dhufish: In general, catches of dhufish along the west coast over the last 10 years reflect trends in fishing effort (West Coast Demersal Scalefish Figure 1). Dhufish catch peaked in 1997/98 at 196 tonnes when effort was highest; the current year's catch of 173 tonnes is still higher than the 10-year average of 152 tonnes. Peak catches for the current year were recorded in December 1999 and January and May 2000.

Baldchin groper: Both catch and catch rate for the baldchin groper have been consistent over the last 10 years (West Coast Demersal Scalefish Figure 2). The baldchin groper catch in 1999/2000, at 33 tonnes, was higher than the 10-year average of 31.5 tonnes. Catches of baldchin groper are similar throughout the year, but the highest recorded catch for the current year was in April 2000.

Pink snapper: The pink snapper catch in 1999/2000 was 158 tonnes, and catches in the last three years have been below the 10-year average of 204 tonnes (West Coast Demersal Scalefish Figure 3). Snapper catches, however, now appear to be on the rise, as the current year's catch was slightly higher than in the previous year, and recently fishers have reported an abundance of small snapper off the west coast. The snapper fishery is renowned for its high variability in catch due to natural annual fluctuations in recruitment to the stock. Peak catches for the current year were recorded in November 1999 and May 2000.

Fishing effort

Throughout 1999/2000, 242 boats fished a total of 9,701 days in the west coast demersal scalefish fishery. This was similar to the previous year's level of effort.

Catch rate

In this multi-species fishery, catch rates of individual species are not a direct reflection of abundance because effort targeted at each species is not available.

Commercial Fisheries

To estimate catch rates for dhufish and baldchin groper, both catch and fishing effort on boats that targeted these species were examined in two regions, Geraldton and Perth. The fishing boats that landed the most fish in the last nine years were identified, and 10 boats with consistent records were used to estimate the catch rates. Rates were calculated for dhufish in both regions and for baldchin groper in the Geraldton region (West Coast Demersal Scalefish Figures 1 and 2). Catch rates of snapper were averaged over the entire fleet that caught the species along the west coast (West Coast Demersal Scalefish Figure 3).

Dhufish: For dhufish at Perth and Geraldton, CPUE has increased almost threefold since 1991/92 (West Coast Demersal Scalefish Figure 1). CPUE in the Perth region peaked at 40 kg/day in 1994/95 and 1998/99, and in Geraldton at 36.5 kg/day in 1998/99. This increase in catch rates may in part be explained by the introduction and use of the global positioning system (GPS), which was installed on these boats gradually over a three-year period starting in 1991/92. After installation, fishing efficiency on boats increased as new productive fishing sites were found and plotted on GPS. Now, however, five years after its installation on the last boat, improvements in catch rate due to GPS can be expected to level off. Comparing catch rates in the two regions, it can be seen that CPUE varies more among boats in Perth and generally is higher than on boats in Geraldton.

Baldchin groper: For baldchin groper at Geraldton, CPUE jumped from 10 kg/day in 1993/94 to 16 kg/day in 1994/95, which was the highest CPUE for the last nine years (West Coast Demersal Scalefish Figure 2). The gradual introduction of GPS to boats since 1991/92 does not appear to have had the same degree of impact on the catch rates of baldchin groper as it did for dhufish. Catches and catch rates for baldchin groper are the least variable of the major species in the west coast demersal scalefish fishery.

Pink snapper: In contrast to the other two species, the general catch rates of pink snapper for the whole west coast ranged widely, from 18.6 kg/day to 49.3 kg/day for the same period (West Coast Demersal Scalefish Figure 3). The current year's catch rate for snapper is 22 kg/day.

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

The recreational catch of the west coast was estimated from boat ramp surveys in 1996/97 (Sumner and Williamson 1999), giving estimated catches for dhufish, pink snapper and baldchin groper of 132, 27 and 23 tonnes respectively. Since this survey did not include estimates of the recreational catch from the Abrolhos Islands, the recreational catch of this species is most likely an under-estimate. Based on the survey data, the estimated recreational catch shares in 1996/97 were dhufish 46%, snapper 10.5% and baldchin groper 44%, giving an overall recreational share of the total catch of the three key target species of about 30%.

Stock assessment completed: **Yes**

A preliminary stock assessment has been undertaken for dhufish, the main species in the west coast demersal scalefish fishery. Nardi (1999) described the biology of the baldchin groper from the Abrolhos Islands. South of the managed Shark Bay snapper fishery, knowledge of the biology of the west coast pink snapper is limited.

Dhufish: Hesp and Potter (2000) have provided recent biological information for dhufish. Using the above data source, yield-per-recruit analysis suggests that maximum yield would be gained from dhufish stocks if fishing began at age 10 years. The legal minimum length (LML) for dhufish is 50 cm, which equates to an age of around 6 years for males or 7 years for females. Both sexes mature at between 2 and 5 years of age. At present, the sustainability of dhufish stocks on the west coast is uncertain because the degree of protection of under-size fish is unknown. Some under-size fish can be caught at 30 cm; however, both their catchability at this size and the level of mortality after they are released is currently unknown. Research into the survival of released under-size dhufish and pink snapper is under way, and will provide estimates of short-term survival (up to 4 days after capture). Problems associated with barotrauma caused by bringing these benthic-dwelling fishes up from the deep are considered to be the major factor influencing release mortality, and therefore survival rates from various capture depths will be compared. A more formal stock assessment on the dhufish will be carried out when the causes of fishing mortality are better understood.

Exploitation status: **Unknown**

Breeding stock levels: **Not assessed**

For dhufish, the preliminary stock assessment indicates that the species spawns for three years before reaching legal size. Thus at the existing LML when females are 7 years old, calculations on egg production suggest that 40% of the females present before fishing will remain unexploited in dhufish populations. Although baldchin groper mature at around 29 cm, this species changes sex from female to male at around 40–45 cm (Nardi 1999). Thus, the existing LML of 40 cm suggests that few of the males in the population are protected from fishing.
At present there are no indications of insufficient breeding stock from the catch or catch rates of dhufish and baldchin groper, but the breeding stock level has not been measured directly for any of the three species in the west coast demersal scalefish fishery. The variation in snapper catch most likely reflects natural recruitment variability in the population

NON-RETAINED SPECIES

Bycatch species impact: **Low**

As targeting demersal fishes using baited lines is a highly selective fishing method, bycatch comprises only a small proportion of the catch. Typically, bycatch includes small numbers of inedible species (e.g. silver toadfish) or small fish (e.g. wrasses), which are discarded.

Protected species interaction: **Negligible**

ECOSYSTEM EFFECTS

Food chain effects: **Low**

Effects on the food chain are considered to be negligible, as each of the three main species is at the upper end of the

chain and each targets different prey types. Although all three species are carnivores, dhufish mainly eat other finfish and baldchin groper target shellfish, whereas pink snapper eat a wide variety of prey types. For these reasons, the ecological impact of the fishery is considered to be minimal.

Habitat effects: **Negligible**

The method of targeting demersal fishes using baited lines has little impact on the benthic environment.

SOCIAL EFFECTS

Employment in this fishery is difficult to measure, as the many boats in the wetline fleet are also associated with other licensed fisheries. A rough average of all boats in this fishery suggests that in 1999/2000 242 boats fished an average of 6 weeks and employed approximately 500 people.

ECONOMIC EFFECTS

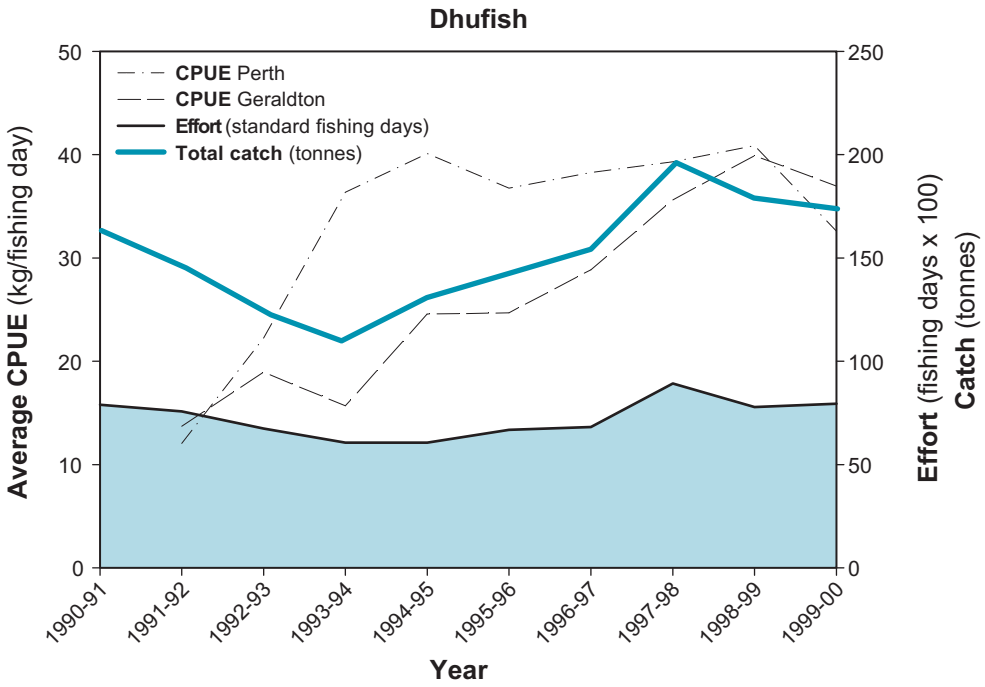
Estimated annual value (to fishers) for year (1999/2000): **$3.68 million**

The estimated value of the fishery in 1999/2000 includes all species caught by handlines and droplines on the west coast of Western Australia. More than 94 species or groups of seafood were recorded as catch and sold for an estimated $3.68 million. The highest-valued catch was dhufish at 42% of the total value, followed by pink snapper (19%), baldchin groper (5%), and nor-west snapper, sweetlip emperor, coral trout and spangled emperor in descending order of value. Catch of all other species represented less than 20% of the value of this fishery. In 1999/2000 dhufish, pink snapper and baldchin groper sold on average for $9/kg, $4.50/kg and $6/kg respectively. Of all species in the fishery, coral trout commanded the highest average price of $9.92/kg.

FISHERY GOVERNANCE

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

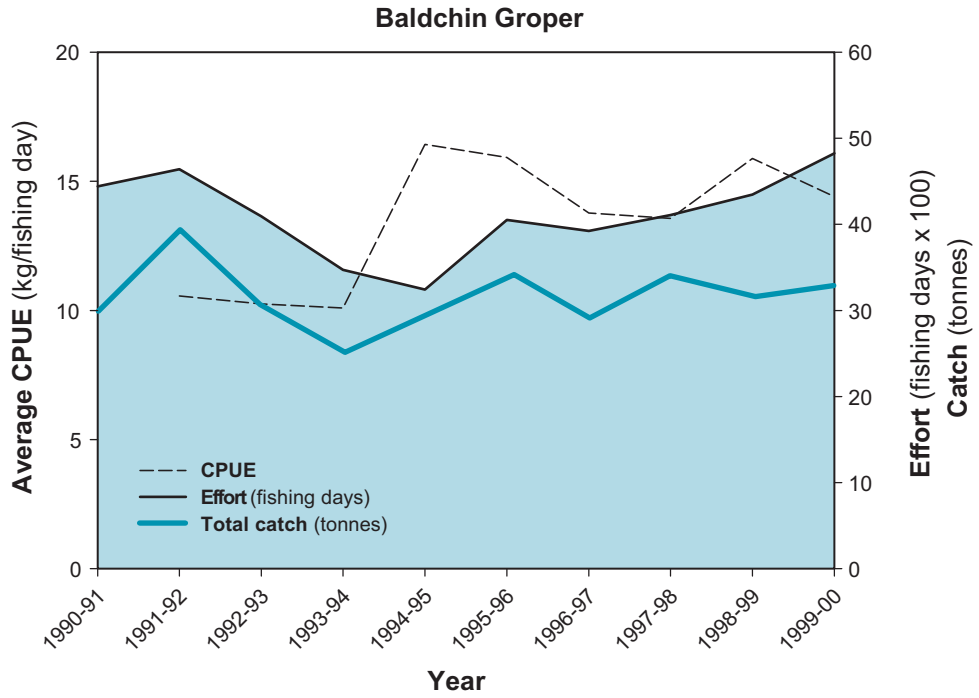
Using 80% confidence limits around a 10-year mean to 1999/2000, the acceptable catch range is calculated to be 125–179 tonnes for dhufish, 153–254 tonnes for pink snapper and 27.5–35.5 tonnes for baldchin groper. As the fishery for these species is not under a formal management arrangement, the catch may move outside this range if a higher proportion of the State's fishing fleet, particularly 'wetline only' vessels, move into this bioregion.



WEST COAST DEMERSAL SCALEFISH FIGURE 1

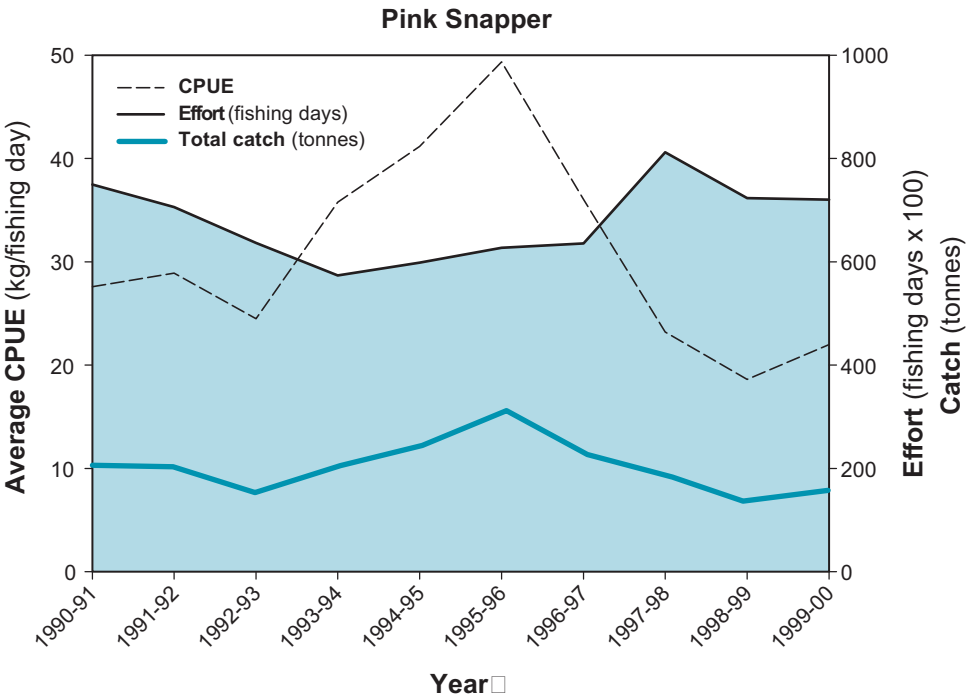
Annual catch and effort for dhufish in the west coast demersal scalefish fishery over the period 1990/91 to 1999/2000. Catch per unit effort (CPUE, kg/standard fishing day) for is shown for dhufish caught by 10 boats in the Perth region and 10 boats in the Geraldton region over the period 1991/92 to 1999/2000.

Commercial Fisheries



WEST COAST DEMERSAL SCALEFISH FIGURE 2

Annual catch and effort for baldchin groper in the west coast demersal scalefish fishery over the period 1990/91 to 1999/2000. Annual catch per unit effort (CPUE, kg/standard fishing day) is shown for baldchin groper caught by 10 fishing boats in the Geraldton region over the period 1991/92 to 1999/2000.



WEST COAST DEMERSAL SCALEFISH FIGURE 3

Annual catch, effort and catch per unit effort (CPUE, kg/standard fishing day) for pink snapper in the west coast demersal scalefish fishery over the period 1990/91 to 1999/2000.

Gascoyne Coast Bioregion

Regional Management Overview

The Gascoyne coast bioregion is home to the State's major trawl fisheries for prawns and scallops in Shark Bay and Exmouth Gulf. In addition, the region supports the important Shark Bay snapper and beach seine fisheries, which provide most of the pink snapper and whiting catch for the State. A fishery for blue swimmer crabs, primarily based in Carnarvon, is also developing.

The major change in the Gascoyne bioregion over the past 12 months was the introduction of new management arrangements in the Shark Bay Snapper Managed Fishery. Changes are embodied in the Shark Bay Snapper Fishery Management Plan Amendment 2000. These changes have modernised the management arrangements by moving them to a fully unitised, output-managed framework.

Trialling of bycatch reduction devices (BRDs) continued in the Shark Bay and Exmouth Gulf Prawn Managed Fisheries, with full BRD implementation anticipated for the Shark Bay Prawn Managed Fishery in the 2002 season. The bycatch action plan for the Shark Bay Prawn Managed Fishery was approved by the Minister for Fisheries for release for public consultation, and work commenced on bycatch action plans for the Exmouth Gulf Prawn and Shark Bay Scallop Managed Fisheries. BRD trials also commenced with the Shark Bay Scallop Managed Fishery.

Ministerial approval was received for the Exmouth Gulf Prawn Managed Fishery to formally adopt the Vessel Monitoring System in 2002.

The wetline fishery in the Gascoyne 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 emperors and baldchin groper, 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 are also taken by 'wetliners' as well as by operators 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

The compliance program focuses on ensuring that industry adheres to the various input controls, which include size limits, fishing gear types and closed/nursery areas. Fisheries Officers from Denham, Carnarvon and Exmouth conduct routine inspections including land patrols, sea patrols and aerial surveillance to ensure compliance with the management arrangements. They also conduct education sessions prior to fishing seasons with masters and relevant support staff of individual industries.

The Shark Bay prawn and scallop fleet consists of 41 licensed fishing vessels, though numbers can fluctuate due to licensee commitments elsewhere in the State. Compliance within the fleet was further enhanced in 2000/2001 with the implementation of the Vessel Monitoring System. The VMS uses satellites to relay real-time information regarding a vessel's position, and records past movements. A total of 21 warnings were issued to vessels in 2000/2001 for VMS-related offences. Four prosecutions are currently pending relating to fishing in closed waters.

VMS is currently being trialled within the Exmouth Gulf Prawn Managed Fishery, with full implementation scheduled to take place for the 2002 season.

The Shark Bay Snapper Managed Fishery is one of only three fisheries in the State to be managed on a quota-based system (output controls). Fisheries Officers conducted routine inspections of 'unloads' of pink snapper to confirm weights of fish. Other inspections carried out consisted of licence checks (commercial fisherman's licence, fishing boat licence and managed fishery licence), and gear checks to ensure fishing gear and equipment met management specifications.

Regional Research Overview

In addition to the research projects and activities noted in the research summary for each individual fishery, there has been a major focus during 2000/2001 on assessing the general wetline catch in each bioregion. This assessment, undertaken utilising the CAES database, indicates that around 14% of the State's wetline catch was reported from the Gascoyne coast bioregion during 1999/2000. The top ten species include Spanish mackerel (53 tonnes), other mackerel (35 tonnes), sea mullet (33 tonnes), spangled emperor (28 tonnes), western sand whiting (18 tonnes), sweetlip emperor (17 tonnes), red emperor (12 tonnes), unspecified trevally (12 tonnes) and tailor (11 tonnes). An interim management plan is currently being developed for the troll fishery for mackerel, details of which are reported under the north coast bioregion (pp. 82-6). Most other demersal species are taken by vessels targeting pink snapper in the region's oceanic managed fishery for that species (see pp. 53-5). Most of the mullet and whiting catches were reported from the area between the northern boundary of the beach seine fishery and Carnarvon.

Commercial Fisheries

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 Shark Bay Prawn Managed 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 2001 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. The fishery is continuing with its trialling of bycatch reduction devices during the 2001 season, using a BRD in one of the two nets. Trials with two BRDs will commence in late 2001.

The 2001 fishing season commenced on 14 March and is scheduled to close on 28 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 is soft-shelled and therefore less marketable. Permanent nursery area closures within the fishery protect tiger prawn breeding stocks and prevent the fishing of small prawns.

Cooperative management of the fishery is achieved through the provision of advice by the Shark Bay Prawn Management Advisory Committee. The advice provided allows for the management arrangements to be better tailored for achieving the maximum economic return from the prawn resource as well as maintaining sustainability of the fishery and ensuring cost-effective management.

Governing Legislation/Fishing Authority

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

Consultation Process

Shark Bay Prawn Management Advisory Committee
Agency–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 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.

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 2000 season, which opened on 13 March and closed on 4 November.

A recruitment survey within the closed area south of the Carnarvon/Peron Line and extended nursery area (ENA) was used to determine the extent of the ENA to be opened. The entire ENA was opened together with the Carnarvon/Peron Line on 27 April. The ENA was closed to fishing on 1 August to protect juvenile king prawns.

Denham Sound was closed to trawling from 1 May and reopened on 1 August. The Torbay Line within Denham Sound opened on 1 August and remained open until the end of the season (4 November).

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2000): 2,250 tonnes

Landings

The total landings of major penaeids for the 2000 season were 2,250 tonnes, comprising 1,555 tonnes of king prawns, 689 tonnes of tiger prawns and 6 tonnes of endeavour prawns. There were also 152 tonnes of minor penaeids (coral prawns) landed.

King prawn landings for 2000 were 12% higher than the five-year average (Shark Bay Prawn Figure 2). This may

be due to higher than average catch rates of king prawns at the start of the fishing season, after heavy rainfall and water runoff from the Gascoyne and Wooramel Rivers during early March apparently increased their vulnerability to trawling.

Tiger prawn landings were 6% higher than the five-year average but within the expected catch range (400–700 tonnes) for this species. The average catch of tiger prawns has been 514 tonnes since the inception of the closure to early seasonal fishing inside the Carnarvon/Peron line, whereas the average catch for the previous 10 years (1980–1989) had been 303 tonnes.

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 2000 totalled 120 tonnes whole weight. All Shark Bay Prawn Managed Fishery boats have Shark Bay Scallop Managed Fishery Class B licences.

By-product landings were 43 tonnes of blue swimmer crab, 19 tonnes of squid, 13 tonnes of cuttlefish, 19 tonnes of tuna (wetlining), 2 tonnes of kingfish and a small quantity of other miscellaneous finfish species.

Fishing effort

Effort recorded in the 2000 daily logbooks for the fleet showed nominal effort as 52,049 hours, which was a reduction of 5,264 hours when compared with the last five years' average effort (57,313 hours). Fishing effort is being monitored with the aim of reducing ineffective trawl hours whilst maintaining high catch levels, thus reducing overall effort to improve economic efficiency within the prawn trawl fleet.

Catch rate

Catch rates of 29.9 kg/hr for king prawns and 13.2 kg/hr for tiger prawns were recorded for the 2000 season. King prawn catch rates were similar to last year, whereas the average tiger prawn catch rate was 24% up from last year. Tiger prawn catch rates were exceptionally high in the beginning of the fishing season, possibly as a result of the high water flow into the bay with the flooding of the Gascoyne and Wooramel Rivers in early March, moving tiger prawns out on to the fishing ground earlier than usual.

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 incorporated 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. The tiger prawn closure area introduced during the 1996 season was again implemented from 1 July to 4 November (Shark Bay Prawn Figure 1).

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 variations, 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 been employed to increase the survival of these spawning stocks. 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. Tiger prawn catches have returned to the levels achieved in the 1970s, in the range of 400–700 tonnes. Changes in the efficiency of the fishing fleet must 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

Commercial Fisheries

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 2002/03 should 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 2000 was 135 skippers and crew. There are also prawn processing and support staff employed at Carnarvon and Fremantle.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): $42.7 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 higher than in 1999 and average ex-boat prices were as follows:

King prawns	$17.30/kg
Tiger prawns	$22.90/kg
Endeavour prawns	$12.90/kg
Coral prawns	$4.70/kg

FISHERY GOVERNANCE

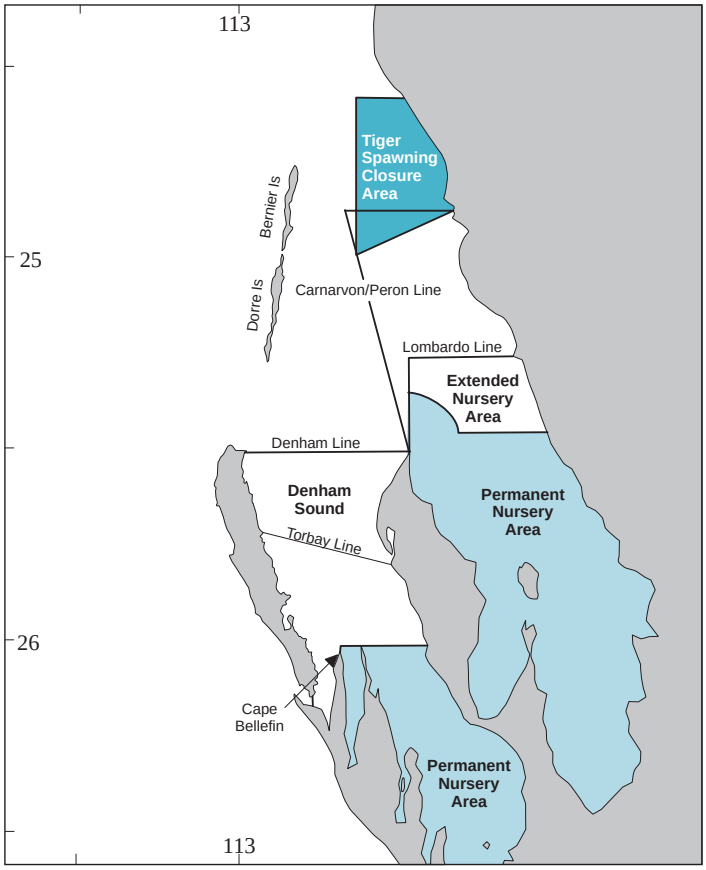
Acceptable catch range: **1,501–2,330 tonnes**

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 (1990/91), 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. The Leeuwin Current index continues to be high, which would indicate that the catch of king prawns will be maintained at the higher end of the range during the 2001 season.

EXTERNAL FACTORS

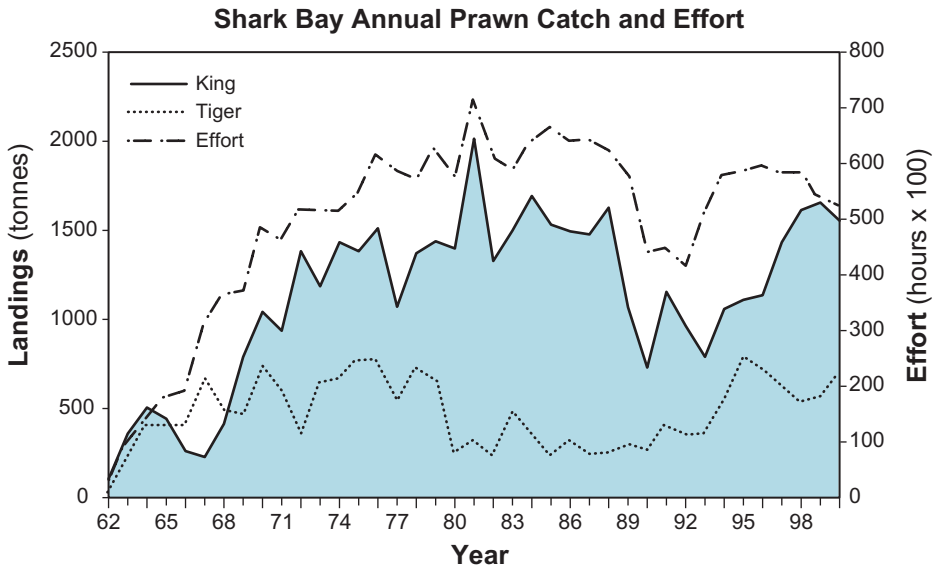
The catches of prawns in Shark Bay are particularly stable compared with other penaeid fisheries. The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment. A relationship between current strength (as measured by Fremantle sea level) and king prawn catches has been identified and is being refined as a method for improving catch forecasts.

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, 1962–2000.

Commercial Fisheries

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 2001 fishing season commenced on 10 April and is proposed to close in early November. Within the main fishing period, there are various subsidiary area openings and closures which are aimed at maximising the long-term yield from the fishery, particularly of tiger prawns. These closures also protect breeding stocks as well as maximising the catch of larger prawns suitable for export.

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 is soft-shelled and therefore less marketable.

Management controls also include limited entry and gear restrictions as well as controls on vessel size and power. Licensees in the Exmouth Gulf Prawn Managed 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). Trials with bycatch reduction gear are in progress in the fishery in the 2001 season.

Cooperative management of the fishery is achieved through the provision of advice by the Exmouth Gulf Prawn Management Advisory Committee. The advice provided allows for the management arrangements to be better tailored for achieving the maximum economic return from the prawn resource as well as maintaining sustainability of the fishery and ensuring cost-effective management.

Governing Legislation/Fishing Authority

Exmouth Gulf Prawn Management Plan 1989
Exmouth Gulf Prawn Managed Fishery Licence

Consultation Process

Exmouth Gulf Prawn Management Advisory Committee
Agency–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.

During the past year, collaborative research has been undertaken 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.

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 2000 season, two fewer than in 1999. All boats towed 4.5 fathom quad gear (four nets). The fleet headrope length has been adjusted so as not to exceed previous effort levels, and 6 fathoms of headrope were unused.

The fleet commenced fishing on 2 April in Area A (predominantly king prawn grounds), but moved to Area B (predominantly tiger prawn grounds) on 6 April due to the small size of the king prawns. During the season, Area B was fished for several periods (6-19 April, 12-15 May, 29–30 May and 27 June). On each occasion when the catch rate of tiger prawns from Area B fell below the sustainable threshold level (16 kg/hr), the prawn fleet voluntarily ceased fishing in this area. On 12 June, a restricted portion of Area B was opened for one night for banana prawn fishing. On 28 June, Area B closed to fishing at a catch rate of 10.2 kg/hr. Area C north of the A-line opened on 28 May and remained open until the closure of the season. Fishing ceased in all areas on 5 November. The season officially closed at 8.00 a.m. on 11 November.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2000): 565 tonnes

Landings

The total annual prawn landings from Exmouth Gulf for the 2000 season were 565 tonnes, a decrease of 51% on

the five-year mean of 1,027 tonnes and down 62% on last year's combined landings of 1,467 tonnes. Lower than average catches were achieved for all major prawn species, with 299 tonnes of king prawns, 82 tonnes of tiger prawns and 122 tonnes of endeavour prawns landed (Exmouth Gulf Prawn Figure 2). The king and tiger prawn catches were the lowest since 1981 and 1983 respectively. However, the banana prawn catch of 62 tonnes was the highest catch recorded for this species (Exmouth Gulf Prawn Figure 2).

Recorded landings of by-product were 59 tonnes of coral prawns, 10 tonnes of squid, 2 tonnes of cuttlefish, 6 tonnes of blue swimmer crab, 4 tonnes of shark and small quantities (less than one tonne each) of bugs, octopus and finfish species including mackerel and cobia.

Fishing effort

Total nominal effort for the 2000 season was 27,415 hours. Two boats were removed from the fishery to compensate for the full introduction of quad gear for this season, with 6 fathoms less of overall headrope towed in the fishery during 2000. The comparable effort in twin-gear terms was 33,380 hours, which was slightly lower than in 1999. The lower effort for 2000 reflected the lower stock abundance and the decision to cease fishing on 5 November, six days earlier than the nominated closing date of 11 November.

Catch rate

Catch rates for king and tiger prawns were low. The catch rates in twin-gear terms, after adjusting for changes in configuration from twin to quad gear, were 9 kg/hr for king prawns, 2.5 kg/hr for tiger prawns and 3.6 kg/hr for endeavour prawns.

Recreational component: **Nil**

Stock assessment complete: **Yes**

The king and tiger prawn stocks are fully exploited. For tiger prawns, this assessment is supported by the recent indices of recruitment and spawning stock with respect to the accepted SRR. The SRR and the environment are not examined in Exmouth Gulf for the king prawn stock; however, examination of catch trends continues to support evaluations.

The king prawn stock was slightly below the range normally predicted for this fishery. This may be attributed to the redistribution of the stock into areas not normally trawled as a result of the strong impact of Cyclone Steve during March 2000.

The tiger prawn stock during 2000 was low, with very little recruitment to the fishery being evident despite good breeding stock in 1999. Most of the prawns surveyed during the recruitment period in 2000 were residual stock (larger individuals). The longer-term impacts of Cyclone Vance (March 1999) on nursery habitats appear to have had a negative effect on tiger prawn recruitment in 2000. Inshore sampling by CSIRO in late 1999 found very low numbers of juvenile tiger prawns, indicating low settlement/survival rates in nursery areas. The level of the tiger prawn stock was monitored very closely during May and June 2000 using daily logbook data. Fishing ceased in the tiger prawn area before the abundance of tiger prawns was severely reduced. After closure to commercial fishing, surveys of spawning stock levels were conducted using two commercial boats which indicated that the spawning stock was below the threshold level of 16 kg/hr (in twin-gear terms).

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

King prawn breeding stocks continue to be adequate. However, low recruitment levels and continuing concerns about tiger prawn stocks necessitated the close monitoring of catch rates in Areas B and C during 2000. Fishing in these areas was restricted to only 19 nights to ensure that average catch rates did not fall much below the ideal cutoff level of 16 kg/hr. This catch rate has been determined from historical data as that needed to ensure a full breeding stock remains in spring of that year.

Standardised spawning surveys were again conducted in August, September and October of 2000, and indicated catch rates for tiger prawns averaging 10.3 kg/hr in the area. This was lower than the ideal catch rate level, but still considered reasonable given the very low recruitment which was available.

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 commenced in 2000 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 to 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

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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 2000 was 52 skippers and crew. Processing and support staff are also based in Exmouth Gulf and Fremantle.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2000: $9.6 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	$17.30/kg
Tiger prawns	$22.90/kg
Endeavour prawns	$12.90/kg
Coral prawns	$4.70/kg

FISHERY GOVERNANCE

Acceptable catch range: 771–1,276 tonnes

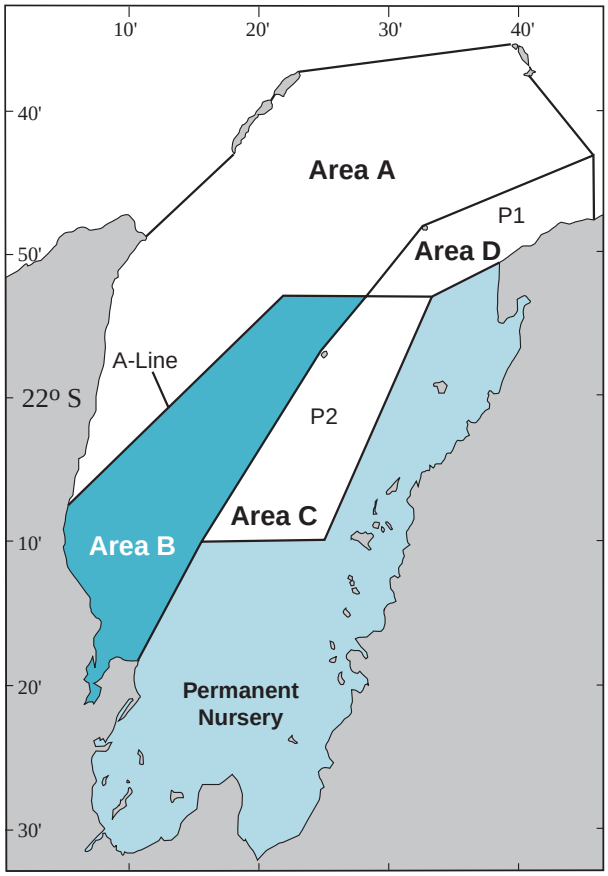
Under current fishing effort levels, the acceptable catch range for major penaeids is that of the late 1990s (771–1,276 tonnes). Acceptable catch ranges for individual species are king prawns 350–500 tonnes, tiger prawns 250–550 tonnes and endeavour prawns 120–300 tonnes (noting that maximum or minimum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

Several factors have contributed to the lower than average season in the Exmouth Gulf prawn fishery in 2000. The tiger prawn catch was well below the acceptable range for the species, king prawns slightly below, and endeavour prawns at the lower end of the acceptable range, while conversely the banana prawn catch was the highest recorded from the fishery. These perturbations have been driven by the impact of cyclone events in the summers of 1998/99 and particularly 1999/2000, and are reminiscent of the situation that existed in the 1960s when cyclone frequency was at a similar level.

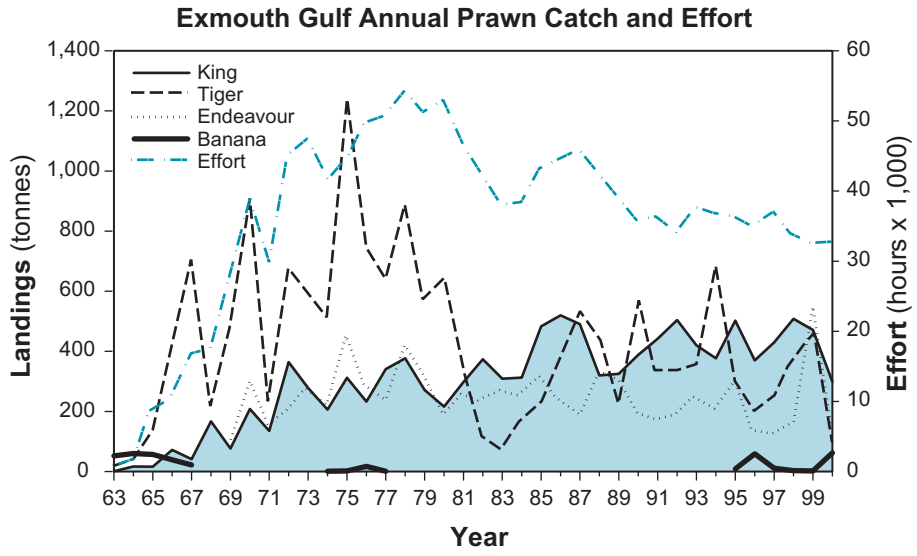
The very low tiger prawn catch was, however, also due in part to the management controls which ensured that sufficient tiger prawns were left to become the spawning stock for 2000. Secondly, the need to close the tiger prawn grounds early to protect the breeding stock significantly reduced access to the endeavour prawn stock and to a lesser extent the king prawn stock, resulting in a low total catch for the 2000 season.

Two boats were removed from the fishery and the remaining 13 boats moved to quad trawl gear in 2000 under an Exemption. This change permitted the Exmouth Gulf fleet to gain in efficiency by having fewer trawlers and lower fuel usage overall while maintaining its catching ability. This is part of an approved 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, 1963–2000.

Commercial Fisheries

Shark Bay Scallop Managed Fishery

MANAGEMENT SUMMARY

The Shark Bay Scallop Managed Fishery is historically Western Australia's most valuable scallop fishery, based on the take of southern saucer scallop *(Amusium balloti)*. 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, whilst 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 2001 scallop fishing season commenced on 28 April and is scheduled to close 28 October, the same day as the Shark Bay Prawn Managed Fishery. Other management measures include limited entry, area closures, gear controls and crew limits.

Catch in this fishery varies widely depending on the strength of recruitment, 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).

A cooperative approach to the development of management strategies in this fishery is achieved through the Shark Bay Scallop Management Advisory Committee, which includes representatives from both the Shark Bay Scallop and Shark Bay Prawn Managed Fisheries.

Bycatch reduction device trials are being undertaken during the 2001 season.

Governing Legislation/Fishing Authority

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

Consultation Process

Shark Bay Scallop Management Advisory Committee
Agency–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 a catch forecast to be provided annually.

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 2000 scallop season commenced on 3 May and officially closed on 4 November. However, trawling for scallop by Class A boats had ceased by the end of June because of poor quality and small meat size.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2000):
1,345 tonnes whole weight

Landings

The total scallop catch for this fishery was 1,345 tonnes whole weight. The Class A fleet (all 14 boats fished in 2000) caught 1,220.5 tonnes whole weight or 90.7% of the total catch, with the Class B fleet taking 124.5 tonnes whole weight (Shark Bay Scallop Figure 1). Low quantities of by-product (less than one tonne each of bugs, blue swimmer crabs and cuttlefish) were recorded for the Class A fleet during 2000.

Fishing effort

The total effort recorded by the Class A boats in 2000 was 9,893 hours, the lowest recorded since 1991. This was because the scallop boats did not fish beyond the end of June, when the remaining scallops showed small meat size and poor condition.

Catch rate

A mean catch per unit effort of 123 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 in 1999 was at the low end of the range, as measured using the data from the November scallop survey. This level of recruitment was reflected in the catch taken in 2000; however, the catch projection was not realised because the small meat size of the scallops produced a lower than expected ratio of total meat to whole weight. The fishing effort was also 21% lower than the previous year. The remaining stock from the 2000 season may be beneficial for the scallop industry as it should provide additional catch of the residual scallops in 2001.

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

The management arrangements for the fishery over past years have ensured that some spawning has occurred each year before the bulk of the stock has been taken. Annual variations in recruitment seem to be dominated by environmental factors that are believed to be correlated inversely with the strength of the Leeuwin Current.

Projected catch next season (2001):
1,000–1,700 tonnes whole weight

The catch projection range for the 2001 season is approximately 1,000–1,700 tonnes whole weight, based on the November 2000 survey which indicated that recruitment was lower than last year but residual stock was higher due to the lower level of fishing in 2000.

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 2000, preliminary grid trials to minimise the capture of large animals were undertaken on commercial boats.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

The ecosystem impacts of saucer scallop fisheries are unlikely to be significant, taking into account the typically high annual variation in abundance of the species and the high natural mortality associated with short life-cycles and natural death in the third year of life.

Habitat effects: **Low**

The scallop fleet operates over a limited portion of the licensed fishing area, primarily in the oceanic centre section of Shark Bay. Fishing is concentrated on a small sector (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 2000 was 182 skippers and crew. There are also processing and support staff employed at Carnarvon, Fremantle and Geraldton.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2000:
$7.1 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 $5.25/kg whole weight or $26.25/kg meat weight. Meat weight is 20% of whole weight.

FISHERY GOVERNANCE

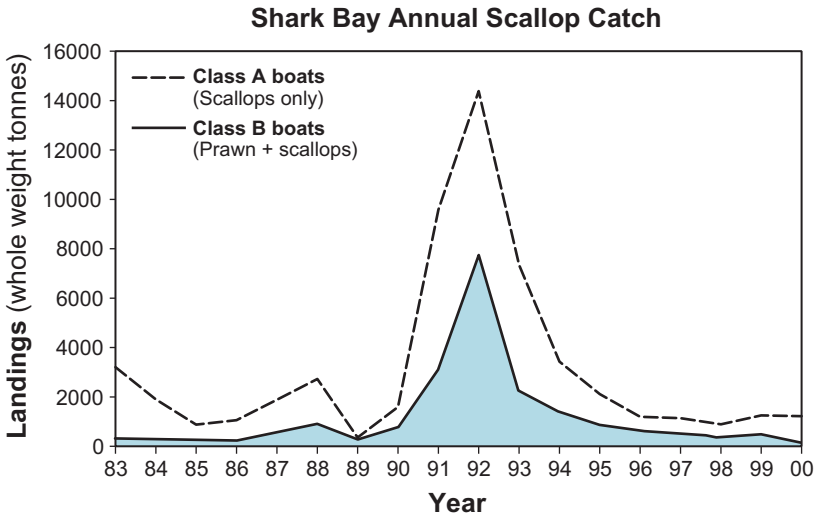
Acceptable catch range:
1,250–3,000 tonnes whole weight

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 artificially high catches of the early 1990s (Shark Bay Scallop Figure 1), apparently created by an unprecedented three years of El Niño conditions. The expected catch for next season is based on a pre-season survey, as indicated above.

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 and 2000 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 low catch for the 2000 season was expected; however, it was further reduced by the small meat size of the scallops and the resultant lower fishing effort. 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.

Commercial Fisheries



SHARK BAY SCALLOP FIGURE 1

Annual scallop landings by fleet for the Shark Bay Scallop Managed Fishery, 1983–2000.

Shark Bay Beach Seine and Mesh Net Managed Fishery

MANAGEMENT SUMMARY

This fishery operates in the waters of Shark Bay and takes a mixed catch of whiting, mullet, tailor and yellowfin bream. Entry to the fishery is limited, with restricted, family-only transfers and gear limitations. A unit in the fishery comprises one primary vessel, a maximum of three netting dinghies and a maximum team size of three fishers. Most of the catch is marketed through the fish processing factory in Denham. Effort is driven by market needs as opposed to fish availability, with catches conforming to commercially acceptable size limits which are above the legal minimum size for species concerned.

Governing Legislation/Fishing Authority

Shark Bay Beach Seine and Mesh Net Management Plan 1994

Shark Bay Beach Seine and Mesh Net Managed Fishery Licence

Consultation Process

Agency–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 2000, 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 2000):
All finfish 300.1 tonnes
Whiting 126.6 tonnes

Landings

Whiting is the main target species in Shark Bay, although the overall catch consists primarily of two species of whiting, 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 2000 were 126.6 tonnes of whiting. Landings have increased over the 1999 catch and are similar to the 1997 catch of 122 tonnes. The current catch is the highest reported between 1989 and the present. The 2000 total catch for the Shark Bay beach seine and haul net fishery of 300.1 tonnes has increased from the 1999 reported catch and is slightly lower than the 1997 catch of 325 tonnes, which was at the highest level reported during the past 10 years (Shark Bay Beach Seine Figure 2). Among the landings of other species from this fishery, mullet (106.1 tonnes) ranked second to whiting, followed by tailor (38.9 tonnes) and bream (8.7 tonnes). There were 19.8 tonnes of fish of other species.

Fishing effort

During 2000, there was an average of seven boats fishing per month, expending a total 1,187 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 2000.

Catch rate

CPUE (based on nominal effort) for the whiting fishery has increased during the past 10 years, with only minor annual fluctuations. The present CPUE is 106.7 kg/boat day for the whiting fishery, which is a slight increase over 1999. The increase in catch rate of whiting during the 1990s may be related to increased efficiency following the introduction of jet boats (Shark Bay Beach Seine Figure 1). The CPUE for the overall Shark Bay beach seine and haul net fishery increased steadily between 1989 and 1995. After 1997, there was a gradual decline in the CPUE values, until the current season saw an increase to 252.8 kg/boat day (all species) (Shark Bay Beach Seine Figure 2).

Recreational component: **< 5%**

The Gascoyne Recreational Fishing Survey conducted in 1998/99 (Sumner et al., in press) estimated a catch of approximately 100 tonnes by shore- and boat-based recreational fishers from the inner gulfs of Shark Bay, consisting mainly of pink snapper, black snapper (grass emperor), narrow-barred Spanish mackerel, spangled emperor and tailor. Smaller quantities of baldchin groper, whiting species, western butterfish, mullets and Queensland school mackerel are included in this total. The commercial catch for the same area in the calendar year of 1998 was about 250 tonnes; however, it was dominated by whiting, mullet, tailor and bream, most of which were not major components of the recreational take. Less than 2 tonnes of pink snapper was taken by the commercial fishery. The recreational catch of the main commercial species was approximately 4% of the combined recreational and commercial catch of these species. For more details on the Gascoyne Recreational Fishing Survey, see pp. 135-42.

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). A more detailed evaluation of the current status of the fishery cannot be achieved with the data currently available, however the increasing trend in CPUE resulting from the reduced effort levels during the early 1990s indicates that the stock is being fished within its productive capacity.

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 its 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 2000, the average number of fishers in the Shark. Bay Beach Seine and Mesh Net Fishery was 18.8. Fishing and associated local processing is one of the. major sources of employment for the Denham community.

Commercial Fisheries

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000):
All finfish $911,000
Whiting $490,000

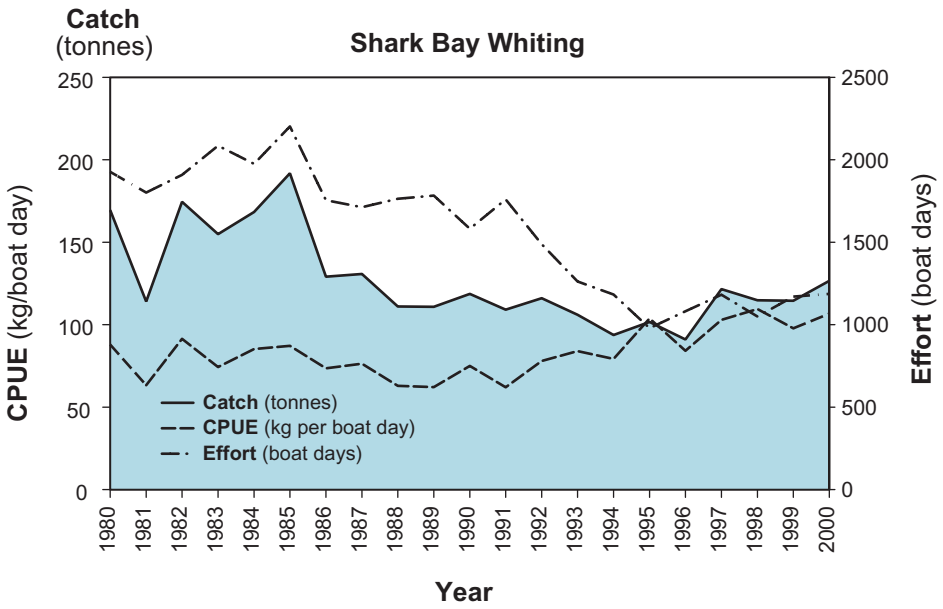
FISHERY GOVERNANCE

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 values occur outside of the range, changes to the management arrangements may need to be considered.

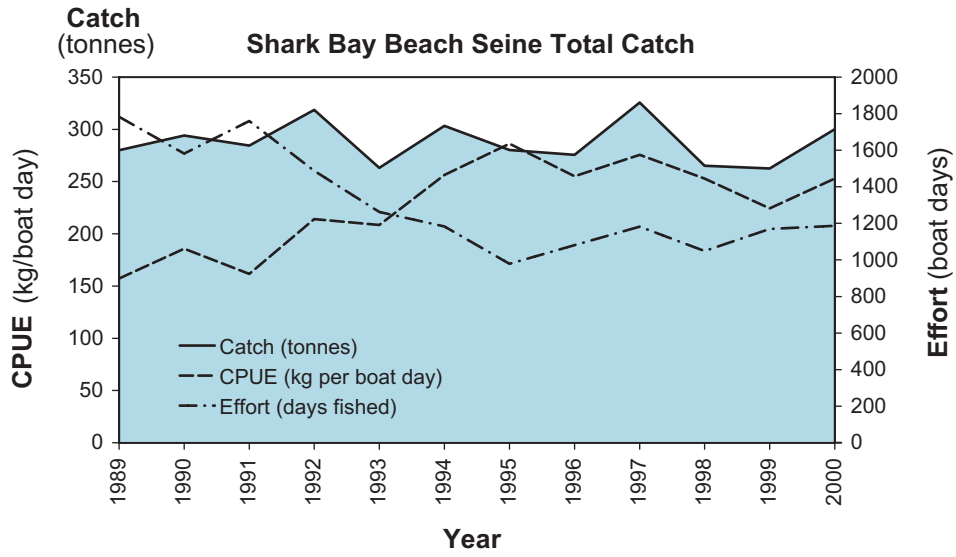
EXTERNAL FACTORS

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 1989–2000.



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 1989–2000.

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 amendment simplifies the complex management and administrative arrangements previously in place while providing more flexibility for both industry and Fisheries WA.

Governing Legislation/Fishing Authority

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

Consultation Process

Agency–industry meeting

RESEARCH SUMMARY

Detailed research on the offshore snapper fishery was undertaken during the 1980s and provides the scientific knowledge base for management. A new 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 M. Moran

FISHERY DESCRIPTION

Boundaries and access

The Shark Bay Snapper Managed Fishery operates in the waters of the Indian Ocean between latitudes 23°34' S and 26°30' S and in the waters of Shark Bay north of Cape Inscription. There are 24 licences, but some boats have several managed fishery licences aggregated on one fishing boat licence. Shark Bay prawn and scallop trawlers are also permitted to catch up to one tonne of snapper per year. Catches of snapper in the peak fishing season (May–August) have been subject to individual quotas, while gear controls applied in the off-peak season. The peak season catch in 2000 was 393 tonnes and the off-peak catch was 95 tonnes. Commencing with 2001, the whole year's catch will be subject to individual quotas.

Main fishing method

Mechanised handline.

Commercial Fisheries

RETAINED SPECIES

Commercial production (season 2000): 488 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 2000 were slightly higher than the previous year, at 488 tonnes compared with 450 tonnes in 1999. Catches are generally limited more by market capacity than availability of fish. The snapper fishery also took 106 tonnes of other finfish species 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 2000 was 845 standard June–July line boat days compared with 712 days in 1999 and 984 days in 1998.

Catch rate

The catch per line boat day of the managed fishery licensed boats for the peak months (June–July) was 578 kg in 2000, close to the the average for the 1990s of 593 kg/boat day, compared with 632 kg/boat day in 1999 (Shark Bay Snapper Figure 1).

Recreational component: 4% (approx.)

The Gascoyne Recreational Fishing Survey, conducted between April 1998 and March 1999 (Sumner et al., in press), 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 5.7 tonnes from a total charter catch of 32 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. 139-41.

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 new 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.

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 discarding of unwanted 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 insignificant 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

Seven boats fished both peak and off-peak seasons (about nine months) with an average crew of three. This rose during the peak season (four months) to a total of 13 boats with an average crew of five.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): $2.7 million

The value of the pink snapper taken by the fishery in 2000 was $2.24 million, while other scalefish species added a further $0.45 million.

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 June–July line boat days. It is expected that the new management arrangements will facilitate utilisation of latent effort, e.g. from the Shark Bay prawn and scallop trawler fleet.

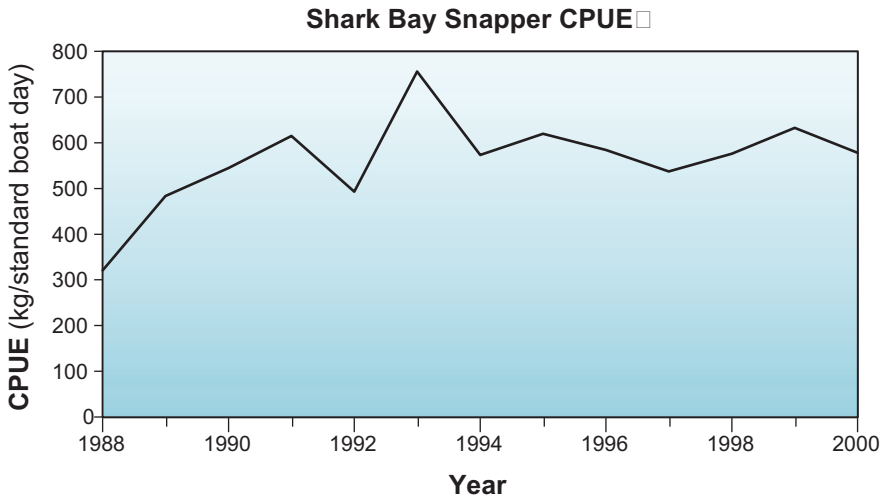
EXTERNAL FACTORS

Japanese demand for snapper has been declining in recent years and efforts have been made to explore other overseas and Eastern States markets.

SHARK BAY SNAPPER TABLE 1

Catches in the year 2000 by Shark Bay Snapper Managed 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. 82-6).

Species	Tonnes
Mulloway	20.7
Cod, various species	12.1
Trevally, various	9.3
Sweetlip emperor	8.4
Spangled emperor	6.0
Red emperor	5.7
Baldchin groper	3.0
Pearl perch	2.5
Blue-spot emperor	2.0
Tailor	1.9
Sea perch, various	1.7
Flagfish	1.6
Cobia	1.6
Dhufish	1.5
Blue-lined emperor	1.1
Shark, various	1.0
Scalefish, other	13.4
TOTAL	106.0



SHARK BAY SNAPPER FIGURE 1

Catch per unit effort by year from 1988 to 2000 for the Shark Bay Snapper Managed Fishery. Units are kg whole weight of pink snapper per standard boat day. As catchability varies markedly throughout the year, peaking in June and July, the CPUE for line fishing in June and July is used as the index of abundance.

Commercial Fisheries

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. A new management plan for the Northern Demersal Scalefish Fishery was introduced on 1 January 2001, moving the fishery from interim managed to fully managed status. All three fisheries operate under individual transferable effort management arrangements, monitored by the Vessel Monitoring System.

There were some significant changes to the management arrangements for the Onslow and Nickol Bay Prawn Managed Fisheries and the inter-relationships of the Nickol Bay Prawn Managed Fishery with the Pilbara Fish Trawl Interim Managed Fishery. Ministerial approval was received to amend the management plan for the fish trawl fishery to remove the link between it and the prawn fishery. Once this change is effected it will require the latent effort issue in the Nickol Bay Prawn Managed Fishery to be further considered. Ministerial approval was also received to provide for an amendment to the management plan for the Onslow Prawn Managed Fishery which will allow Onslow Area 3 licences to become fully transferable.

The Kimberley Prawn Managed Fishery formally adopted the Vessel Monitoring System for the commencement of the 2001 season, with the Nickol Bay Prawn Managed Fishery expected to come under the VMS later in the year. Ministerial approval was also received to bring the Onslow Prawn Managed Fishery under the VMS in 2002.

A resource management agreement (the 'Barramundi Accord') was developed for the barramundi resources of the Kimberley. Fisheries WA, together with Kimberley gillnet and barramundi licensees and representatives of other interested groups, developed and signed off on an agreement which will assist in sustainable management of the stock and reduce conflict between user groups. The 'Accord' now has to be approved by the Minister and given effect through a number of changes to management arrangements for the Kimberley Gillnet and Barramundi Managed Fishery and to recreational fishery controls.

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

- Mackerel (primarily by trolling);
- Beach seining and near-shore gillnetting;
- Demersal line fishing (Pilbara line fishery).

Commercial fishing for Spanish mackerel *(Scomberomorus commerson)* operates mainly between May and October between Geraldton and the Northern Territory border. Limited catches are also made through summer by fishers operating in the Pilbara region. The main method for capturing Spanish mackerel is by trolling baits and lures, with up to seven lines trolled at a time. Baits and lures drifted or cast from an anchored or drifting boat are also used to target mackerel, whilst incidental catches may occur when using handlines and droplines.

Owing to concerns from both industry and Government over increased catches and preliminary assessments which suggest that the species could be over-fished, an interim management plan is currently under discussion. Following extensive consultation during 2000/2001, and receipt of a large number of submissions on proposed options, it is anticipated that the fishery will move to interim managed status in 2002. In the interim, the minimum legal size for Spanish mackerel has recently been increased to 90 cm to correspond more closely to age at sexual maturity. Research data on Spanish mackerel fishing are reported on pp. 82-6.

There is also a take of fish throughout the region by beach seining and near-shore gillnetting using hand-hauled nets, which is not subject to any dedicated management plan. The exception to this is the Kimberley Gillnet and Barramundi Managed Fishery, reported on pp. 67-70.

The activities of the demersal line fishery, which takes demersal finfish, are reported in the Pilbara Demersal Finfish Fisheries Status Report on pp. 75-81.

Regional Compliance and Community Education Overview

The Pilbara Fish Trawl, Northern Demersal Scalefish and Kimberley Prawn Managed Fisheries were monitored through the use of VMS, which operates through client stations at the Karratha and Broome District Offices. In addition, Fisheries Officers from both of these locations carried out numerous land-based and sea patrols to inspect the catches of licensees in these and the region's other small prawn fisheries.

Compliance activities directed at the remaining fisheries were at a low level due to limited resources coupled with the extensive geographical area and small number of licensees involved. However, resource-sharing issues related mainly to barramundi fishing are leading to an increased demand for compliance activities, especially in the lower Ord River, Roebuck Bay and the Pilbara.

Regional Research Overview

In addition to the research projects and activities noted in the research summary for each individual fishery, there has been a major focus during 2000/2001 on assessing the general wetline catch in each bioregion. This assessment, undertaken utilising the CAES database, indicates that around a quarter (25%) of the State's wetline catch during 1999/2000 was reported from this bioregion, which includes waters off both the Kimberley and Pilbara coasts. The top ten species include Spanish mackerel (250 tonnes), threadfin (72 tonnes), other mackerel (25 tonnes), unspecified shark (20 tonnes), spangled emperor (17 tonnes), unspecified trevally (8 tonnes), blacktip shark (6 tonnes), cod (5 tonnes), red emperor (4 tonnes) and mulloway (black jew)(4 tonnes). An interim management plan is currently being developed for the troll fishery for mackerel, details of which are reported on pp. 82-6. 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 2001 fishing season commenced on 1 March and will end on 15 November. Within the main fishing period, a number of fishing area openings and closures allow access to tiger prawn and banana prawn stocks at appropriate times.

A significant number of boats have access to this fishery, as most Exmouth Gulf prawn vessels have access to Area 2 and most Nickol Bay prawn vessels have access to Area 3. Management controls include limited entry, gear restrictions and controls on replacement boat size. The Onslow Prawn Fishery Management Plan has recently been amended to increase the transferability of some licence categories.

Governing Legislation/Fishing Authority

Onslow Prawn Fishery Management Plan 1991
Onslow Prawn Managed Fishery Licence

Consultation Process

Agency–industry meeting

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 2000 season the areas were open during the following periods:

Area 1	2 April-11 November
Area 2	2 April-11 November
Area 3	1 March-15 November
Fortescue Nursery	1 May-11 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 2000 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 2000): 87 tonnes

Landings

The total landings of major penaeids for the 2000 season were 87 tonnes, including 12 tonnes of king prawns, 18 tonnes of tiger prawns, 6 tonnes of endeavour prawns and 51 tonnes of banana prawns (Onslow Prawn Figure 2). King prawn catches were 33% lower than the five-year average, which may have been due to effects of cyclonic activity and heavy rain during March 2000. This may have dispersed king prawns further offshore away from areas where they are normally caught, reducing the catchability for this season. Conversely, rainfall-dependent banana prawns provided a higher catch this season, up 144% on the five-year average.

Recorded landings of by-product species included 4 tonnes of coral prawns, 11 tonnes of bugs and less than one tonne each of black tiger prawns, squid, blue swimmer crabs, shark and mixed finfish species.

Fishing effort

Not assessed.

Catch rate

Not assessed.

Recreational component: Nil

Stock assessment complete: Not assessed

The catches during 2000 were below average for king prawns, middle of the range for tiger prawns, and in the low end of the range for endeavour prawns. Banana prawn catches were among the highest recorded since 1990. Further work is under way to assess the relationship between summer rainfall and catches from Area 1, which includes the Ashburton River estuary, a nursery area for this species.

Commercial Fisheries

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.

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.

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 2000 was 12–15 skippers and crew, with up to 10 people involved in local processing.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2000: **$1.5 million**

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices received by vessels fishing along the northern coast in 2000 were as follows:

King prawns	$17.30/kg
Tiger prawns	$22.90/kg
Endeavour prawns	$12.90/kg
Banana prawns	$15.40/kg
Coral prawns	$4.70/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:

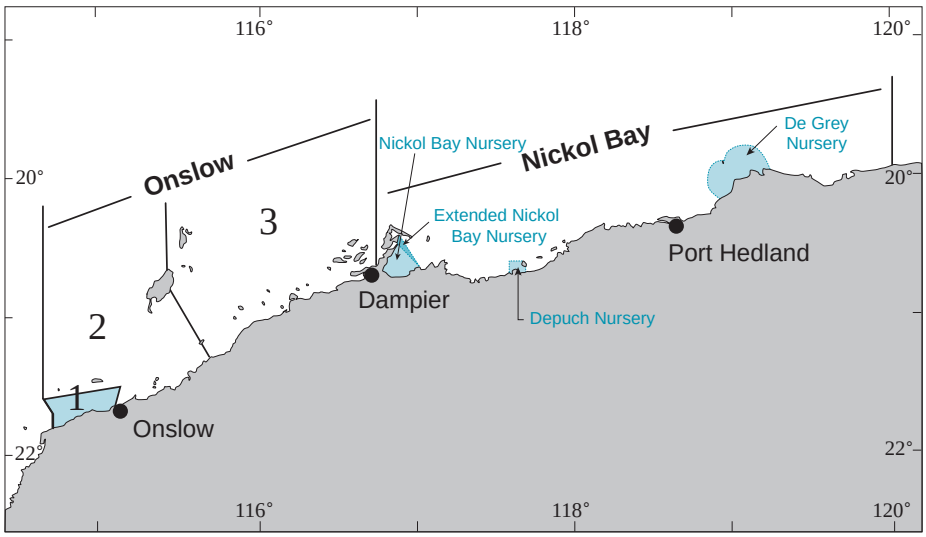
King prawns	10–55 tonnes
Tiger prawns	5–40 tonnes
Endeavour prawns	5–20 tonnes
Banana prawns	2–90 tonnes

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

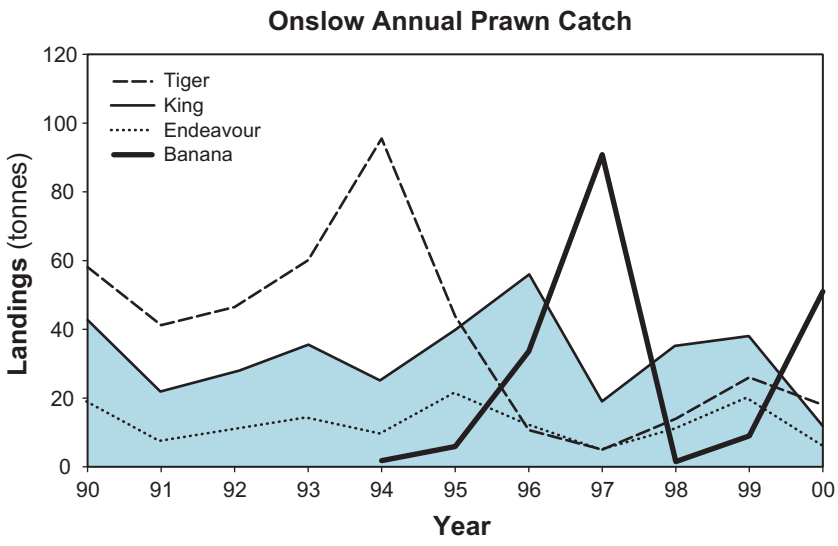
The catches taken are from a number of separate nursery areas and are highly variable from year to year. This is particularly the case for the rainfall-dependent banana prawn, which was the dominant species caught during 2000.

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 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 Onlsow and Nickol Bay Prawn Managed Fisheries.



ONSLOW PRAWN FIGURE 2

Annual landings for the Onslow Prawn Managed Fishery, 1990–2000.

Commercial Fisheries

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 occurring in inshore areas. Management controls for the NBPMF are based on limited entry, seasonal and area closures, gear controls and restrictions on boat size. A number of the Nickol Bay prawn trawlers also operate in the Pilbara Fish Trawl Interim Managed Fishery and the Onslow Prawn Managed Fishery. However, following industry consultation, Ministerial approval was received to amend the management plan for the fish trawl fishery to remove the link between it and the NBPMF. Once this change is effected it will require the latent effort issue in the NBPMF to be further considered.

In 2001, the main fishing grounds opened on 1 May and will close on 15 November. Within the main fishing period, fishing area openings and closures allow access to tiger and banana prawn stocks at appropriate times.

Governing Legislation/Fishing Authority

Nickol Bay Prawn Fishery Management Plan 1991
Nickol Bay Prawn Managed Fishery Licence

Consultation Process

Agency–industry meeting

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 2000 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 2000.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2000): 512 tonnes

Landings

The banana prawn landings of 467 tonnes for the 2000 season (Nickol Bay Prawn Figure 1) fell within the range of 300–500 tonnes projected on the basis of the high rainfall in the 1999/2000 summer period.

Other prawn landings for the 2000 season totalled 45 tonnes, comprising 31 tonnes of king prawns, 13 tonnes of tiger prawns and 1 tonne of endeavour prawns (Nickol Bay Prawn Figure 1).

Recorded by-product species for 2000 were 1 tonne of black tiger prawns, 3 tonnes of coral prawns, 4 tonnes of bugs, 2 tonnes of blue swimmer crabs, 1.5 tonnes of shark and less than one tonne each of squid and mixed finfish species.

Fishing effort

Not assessed.

Catch rate

Not assessed.

Recreational component: Nil

Stock assessment complete: Not assessed

A relationship exists between the summer rainfall (December–March) and the catch of banana prawns in the same year. This relationship is assessed annually (Nickol Bay Prawn Figure 2). Other prawn stocks are insufficient to carry out a formal stock assessment.

Exploitation status: Not assessed

Breeding stock levels: Not assessed

Projected catch next season (2001): Banana prawns 80–190 tonnes

Adjusting the forecast of banana prawns for the 183 mm of rain during the 2000/2001 summer period provides a catch projection of between 80 and 190 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.

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 2000 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 2000: **$8 million**

Ex-vessel prices for prawns vary depending on the grade of the product and the market forces operating at any one time. Generally, average prices received by vessels fishing along the northern coast in 2000 were as follows:

Banana prawns	$15.40/kg
King prawns	$17.30/kg
Tiger prawns	$22.90/kg
Endeavour prawns	$12.90/kg
Coral prawns	$4.70/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.

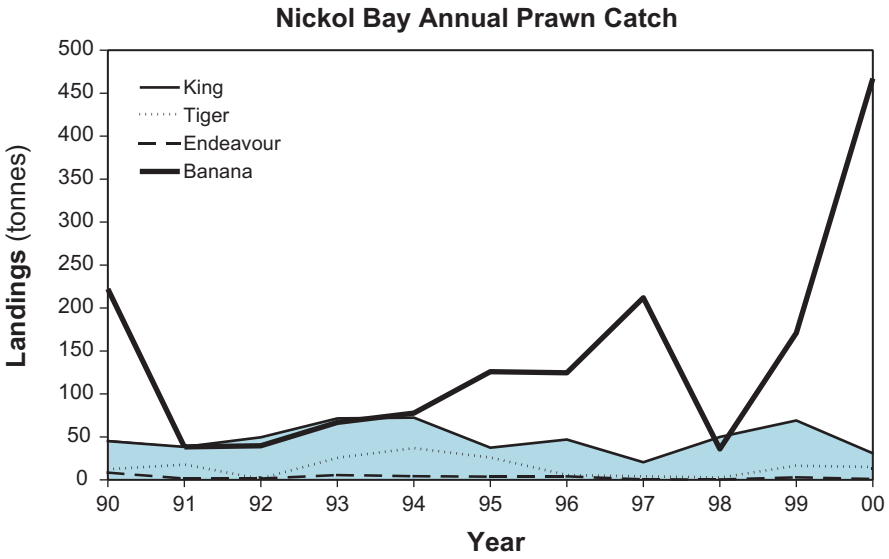
EXTERNAL FACTORS

Minimum catch monitoring is completed for minor fisheries such as the Nickol Bay Prawn Managed Fishery.

The majority of boats in the prawn fleet of Nickol Bay are also licensed to fish finfish stocks offshore (the Pilbara Fish Trawl Fishery). Some also 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 Pilbara Fish Trawl Fishery has led to time quotas and other restrictions. The impacts of these restrictions and of falling finfish catches have forced some of the fishing effort back into the Nickol Bay Prawn Managed Fishery.

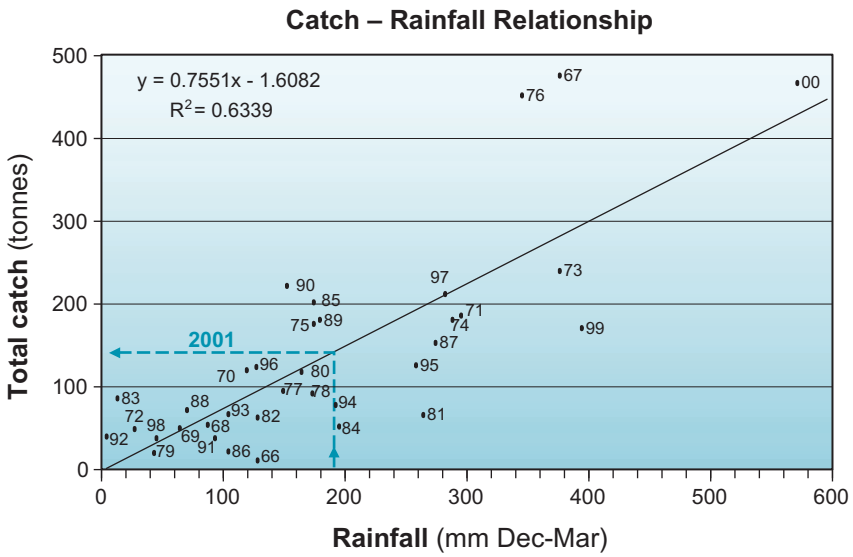
Banana prawns usually dominate the catch from Nickol Bay. The catch of this species is positively correlated with rainfall in the months December to March. The record catches of banana prawns in 2000 were anticipated because of high rainfall (572 mm) during this critical period. With only 183 mm of rainfall recorded for this same period during 2000/2001 lower landings (80–190 tonnes) of banana prawns are forecast for 2001. The king prawn catches were below the five-year average but within the acceptable range for this species. The distribution of the king prawn stock appears to have been affected by freshwater inflow from cyclonic activity during the summer period (December to March). The high rainfall during the 2000 season would have dispersed the king prawns further offshore, away from where they would normally be caught, thus reducing their catchability for this season. It is anticipated that the king prawn catches should return to acceptable catch range in 2001 provided environmental conditions are favourable (less rainfall).

Commercial Fisheries



NICKOL BAY PRAWN FIGURE 1

Annual landings for the Nickol Bay Prawn Managed Fishery, 1990–2000.



NICKOL BAY PRAWN FIGURE 2

Relationship between banana prawn landings and rainfall between December and March for the years 1966–2000.

Broome Prawn Managed Fishery

MANAGEMENT SUMMARY

The Broome Prawn Managed Fishery is a small fishery which operates in July–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). The management plan, which came into effect in 1999, includes a provision for licensees to be directed to instal bycatch reduction devices if required.

Governing Legislation/Fishing Authority

Broome Prawn Fishery Management Plan 1999
Broome Prawn Managed Fishery Licence

Consultation Process

Agency–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 has resulted in some ongoing modifications to the management arrangements.

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 2000 fishing season on 1 June and closed on 7 August.

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 2000): 159 tonnes

Landings

The total landings for the 2000 season were 159 tonnes, including 76 tonnes of king prawns and 83 tonnes of coral prawns (Broome Prawn Figure 1) for 54 days fished. King prawn landings for 2000 were 8% lower than the five-year average (83 tonnes) whereas the catch of coral prawns was the highest total catch recorded to date.

Fishing effort

Nominal effort recorded in the daily research logbooks for the fleet was 2,957 hours.

Catch rate

A catch rate of 25.8 kg/hr for king prawns and 28 kg/hr for coral prawns was recorded. The catch rates of king prawns for June (28.9 kg/hr) were similar to those seen in 1999, but rates were lower in July (21.8 kg/hr) compared to the corresponding period in 1999.

Recreational component: Nil

Stock assessment complete: Yes

A more sophisticated Delury depletion analysis incorporating lunar effects was carried out on the 2000 logbook data to quantify the standing stock of king prawns in the Broome fishery. From this analysis, a standing stock of approximately 190 tonnes was estimated. This indicates that approximately 40% of the stock was taken by fishing, utilising the 2,957 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 unfished 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 stopped. This stock could continue to breed. In addition, some females may have spawned prior to capture. These data indicate that the king prawn stock is well above the level of 20% of virgin biomass generally considered to be sufficient to sustain a fishery.

Commercial Fisheries

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 minimal.

Protected species interaction: **Low**

The fishery operates in relatively deep water, and this fact, combined with the short season 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 gazetted fishing area was surveyed by the 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

Estimated employment for the year 2000 was 20 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2000: $1.7 million

Ex-vessel prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, prices received by boats for 2000 were as follows:

King prawns	$17.30/kg
Coral prawns	$4.70/kg

FISHERY GOVERNANCE

Acceptable catch range: King prawns 35–170 tonnes

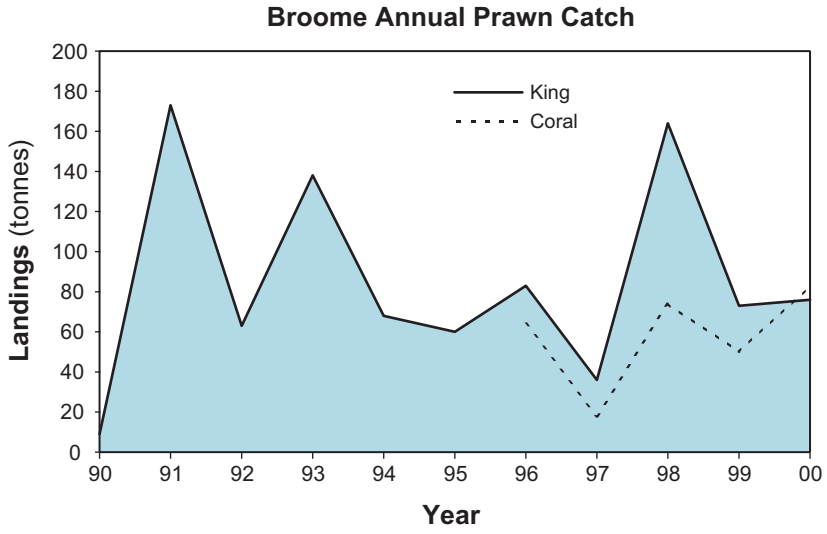
Under current effort levels and previous environmental conditions, the acceptable range for the king prawn catch, based on the catches of the 1990s, is 35–170 tonnes.

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 (approximately eight weeks) coincides with the king prawn recruitment and catchability, which is influenced by the lunar period. Historically, the timing of this fishery has been set by calendar to coincide with the NPF mid-season closure (six weeks) rather than the appropriate lunar period. Consequently, the timing of the fishing period has not always been optimal for exploiting the king prawn stock.

This fishery has benefited from advice from Fisheries WA relating to the timing of the fishing season. The catch of king prawns is affected by the lunar phase, with lower catches occurring around the full moon. By bringing the timing of the season in line with lunar period, fishing efficiency has been maximised. This achieves the best catch rates available during the fishing period while keeping the season generally in line with the NPF mid-season closure.

This fishery is valuable, despite its short season, because it allows approximately eight 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, 1990–2000.

Kimberley Prawn Managed Fishery

MANAGEMENT SUMMARY

The Kimberley Prawn Managed Fishery operates off the north of the State adjacent to the Commonwealth-managed 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. VMS was also introduced into the fishery during 2001.

Governing Legislation/Fishing Authority

Kimberley Prawn Fishery Management Plan 1993
Kimberley Prawn Fishery Managed Fishery Licence

Consultation Process

Agency–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 (AFMA) 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 DESCRIPTION

Boundaries and access

The boundaries of this fishery are *'all Western Australian waters of the Indian Ocean lying east of 123°45' east longitude and west of 126°58' east longitude'.*

Seasonal dates for the Kimberley Prawn Managed Fishery are aligned with those of the adjacent Northern Prawn Fishery. Consequently, the 2000 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 8 November.

Although a total of 134 boats had access to the Kimberley Prawn Managed Fishery under various licensing arrangements, only 25 boats operated in the fishery during the 2000 season.

Main fishing method

Otter trawl.

RETAINED SPECIES

Commercial production (season 2000): 236 tonnes

Commercial Fisheries

Landings

The total landings for the 2000 season were 236 tonnes, including 201 tonnes of banana prawns, 23 tonnes of tiger prawns, and 7 tonnes of endeavour prawns (Kimberley Prawn Figure 1).

The banana prawn catch was below the range expected (275–525 tonnes) using the preliminary relationship between summer rainfall (December to March) and catches. The estimate has a wide range because of highly variable catches due to environmental conditions (summer rainfall), the extensive coastline, the topography of the coastline, and large tidal fluctuations. The tiger prawn catch was within the expected range for these species (15–40 tonnes) whilst endeavour prawns were just below the expected range (11–80 tonnes).

Recorded by-products were 2 tonnes of bugs and less than one tonne of squid.

Fishing effort

Not assessed.

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 2001 was 348 mm at Derby and 571 mm at Kalumburu, which indicates that banana prawn catches for 2001 should be in the range of 200–350 tonnes. Investigations on refining rainfall–catch relationships are continuing.

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

Projected catch next season (2001):
Banana prawns 200–350 tonnes

The projected catch for 2001 based on the rainfall–catch relationship is 200–350 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. Only one turtle was recorded (AFMA records) as being captured in the Kimberley fishery during 2000, and this was returned to the sea alive.

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 2000 was 100 skippers and crew.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year 2000:
$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 2000 were as follows:

Banana prawns	$15.40/kg
Tiger prawns	$22.90/kg
Endeavour prawns	$12.90/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

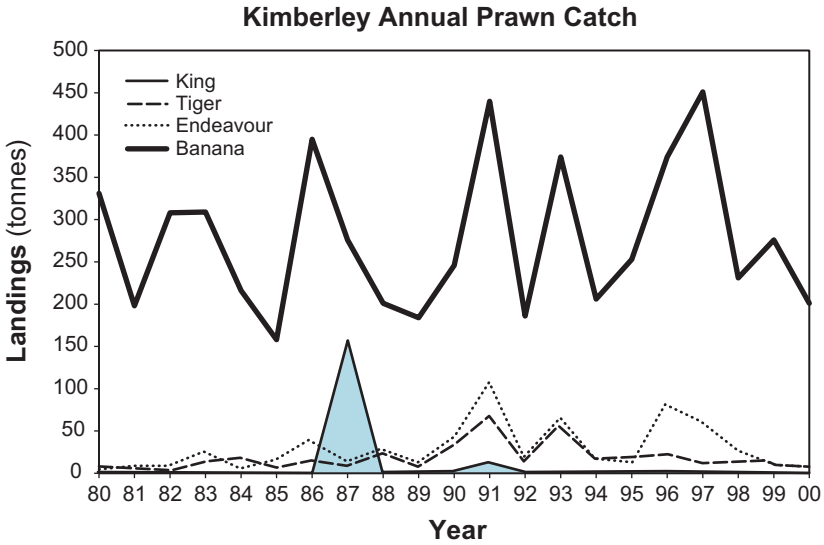
Note the overall acceptable range for all species combined is different from the aggregate of the individual species ranges shown, as the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species in the same year.

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.



KIMBERLEY PRAWN FIGURE 1

Annual landings for the Kimberley Prawn Managed Fishery, 1980–2000.

Kimberley Gillnet and Barramundi Managed Fishery

MANAGEMENT SUMMARY

The Kimberley Gillnet and Barramundi Managed Fishery extends from the WA/NT border to the top of Eighty Mile Beach, south of Broome (latitude 19° S). It encompasses the taking of 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, the Fitzroy River, Roebuck Bay and 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.

In March 2000, a working group consisting of commercial, recreational and charter boat representatives as well as Fisheries WA research and management officers was formed to consider future management arrangements for the barramundi resource. A number of recommendations were developed for both the commercial and recreational exploitation of barramundi. These recommendations included extensive areas closed to commercial fishing around major town sites and recreationally important fishing locations, and a total netting ban north of Beadon Creek near Onslow.

Amendments to existing bag and size limits have also been recommended. The main elements of this 'Barramundi Accord' have been supported by the Minister for Fisheries, and legislation is being drafted to implement the new arrangements.

Governing Legislation/Fishing Authority

Kimberley Gillnet and Barramundi Fishery Management Plan 1989

Kimberley Gillnet and Barramundi Managed Fishery Licence

Consultation Process

Agency–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.

Commercial Fisheries

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 1999/2000. (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 1999–2000):
All species 147 tonnes
Barramundi 44.5 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 44.5 tonnes for 1999/2000 (Kimberley Gillnet Figure 1). This catch of barramundi was greater than those of the previous three years, reflecting an increase in abundance, noting that effort has been in an overall downward trend over recent years.

The 1999/2000 landings of threadfin salmon, at 90.8 tonnes, were once again far higher than those of barramundi. These two main species comprised 92% of the total catch. There were reported landings of 18 other species, including 3 tonnes each of elasmobranchs (sharks and rays) and cod.

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 1999/2000, the total effort across the four prescribed fishing areas was 1,355 units. This total effort is slightly higher than last year, but lower than in the previous 10 years (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 down from last year, which was the highest in the past 12 years (Kimberley Gillnet Figure 1).

Recreational component: **Not assessed**

At this time there are no available figures on recreational catch and effort in this area.

Stock assessment completed: **Yes**

A boot-strapped biomass dynamics model was used to estimate biomass for the barramundi assemblage for each of the four principal fishing areas. The information for each of the four models uses commercial catch and effort data and an estimated recreational catch and participation level (=effort) based on a percentage of the 1999 commercial catch for the fishing area, and a rate of annual increase in recreational participation that is similar to the statewide increase. There remains a high degree of uncertainty around the results because the data to verify a number of assumptions inherent in the models, are not available.

The Cambridge Gulf fishery model and the Kimberley coast fishery model predict that at current commercial effort levels, the catch will be sustainable for the next 10 years in these areas. The estimated biomass remains above 50% of the virgin biomass and the stocks appear to be under-exploited, noting however that Cambridge Gulf has been at much lower levels over the past 20 years and has only just started to recover to acceptable levels. For both the Broome coast and King Sound sectors, the predicted future biomass falls between 20% and 50% of the estimated virgin biomass. In the Broome region the prediction is that the biomass will continue to decline. Management changes are being introduced to address this issue. For the King Sound fishery, large confidence intervals around the annual estimates indicate greater uncertainty. However, reference to historical catch and effort trends and our understanding of how the fishery operates indicate that fishing at current levels in this area is sustainable.

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, with some local depletion approaching the critical level of 20% of virgin biomass in the Broome region.

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 saw 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: **Not assessed**

SOCIAL EFFECTS

The Kimberley Gillnet and Barramundi Managed Fishery involved an average of about 23 fishers in 1999/2000. There was additional employment through local processors and distribution networks.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (1999–2000): **All species $861,000**
Barramundi $424,000

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 future annual catch values which fall outside of this range will be investigated. Where consecutive values occur outside of the range, management changes may need to be considered.

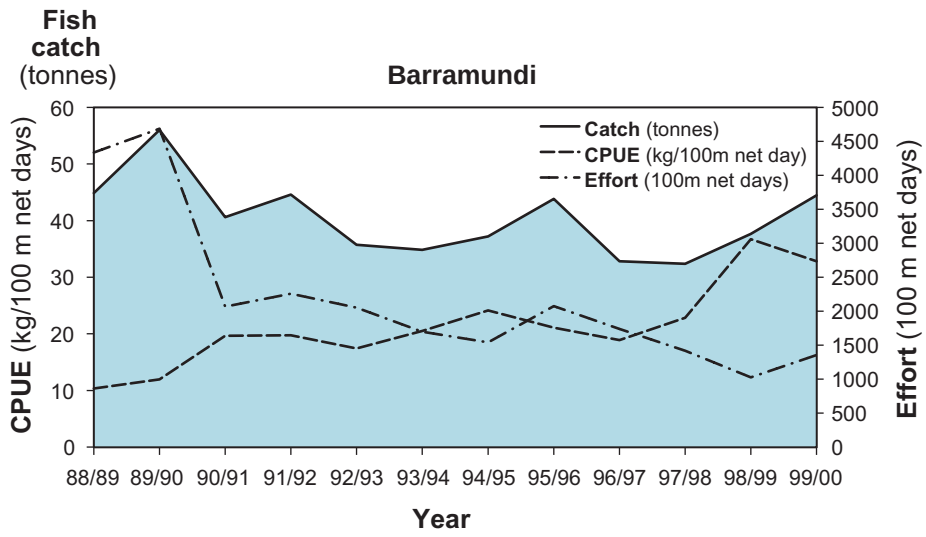
EXTERNAL FACTORS

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 is a current issue. However, recent and anticipated levels of commercial fishing by existing operators pose no threat to the viability of the resource. At current levels of fishing it is unlikely that the abundance of fish is being significantly impacted by the commercial sector.

The stock assessment models developed for the barramundi fisheries cannot be improved without the allocation of more resources to the gathering of the data necessary to test the model assumptions and to evaluate the effects of proposed management changes.

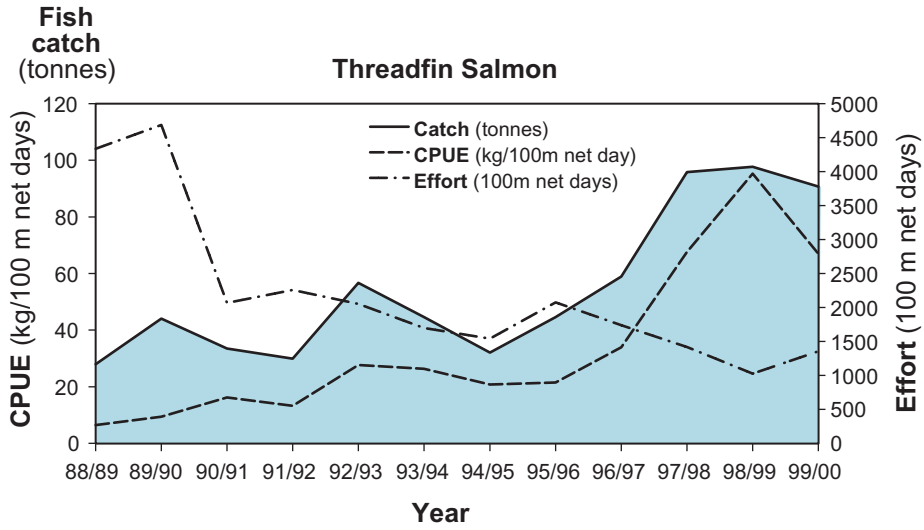
Since 1995/96 the catch of threadfin salmon has been considerable, making it the major focus of this fishery in recent years (Kimberley Gillnet Figure 2). As such, priority needs to be given to basic research on these stocks.



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 1999/2000.

Commercial Fisheries



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 1999/2000.

Northern Demersal Scalefish Managed Fishery

MANAGEMENT SUMMARY

The Northern Demersal Scalefish Managed Fishery (NDSMF) operates off the north-west coast of Australia in the waters east of 120° E longitude. Commercial catches are dominated by tropical snappers (which include red emperor), the emperors or nor-west snappers (which include goldband snapper), and the cods or gropers.

The Northern Demersal Scalefish Fishery Management Plan 2000 was developed and legislated during 2000 and commenced on 1 January 2001. This plan superseded the Northern Demersal Scalefish Fishery Interim Management Plan 1997 and converted the NDSMF to managed fishery status. The Northern Demersal Scalefish Management Advisory Committee, NDSMF licensees and Fisheries WA have worked co-operatively to ensure that the new management arrangements are simple, enforceable, flexible and cost-effective.

The fishery is managed by way of a series of input controls including individual transferable effort allocations, gear restrictions and area closures. In addition, a nominal total sustainable catch (TSC) is allocated on an annual basis. In 2000, the TSC was 800 tonnes of demersal scalefish.

With the exception of one case, all the objection tribunals pertinent to the NDSMF have been resolved. There are presently three licensees authorised to fish in Area 1 of the fishery and 11 licensees authorised to fish in Area 2.

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

A major three-year research project to assess the status of the major fish stocks which contribute to this fishery was completed in 2000. The information gathered is now being analysed to reassess the sustainable yield. Ongoing monitoring of this fishery is being undertaken using both CAES data and VMS records.

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

Northern Demersal Scalefish Fishery Status Report

Prepared by S. Newman

FISHERY DESCRIPTION

Boundaries and access

The waters of the 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.

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 which approximates as closely as possible the 30 m bathymetric contour.

Access to the NDSMF is currently limited to 11 licences under an individual transferable effort quota system. This allows the effort quota to be operated by a lesser number of vessels. For example, during 2000, seven vessels 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 2000): 470 tonnes

Landings

The reported catch in the NDSMF rose steadily in the period from 1992 to 1996 (Northern Demersal Scalefish Table 1 and Figure 2). However, catches have declined from 1997 through to 2000. In the three years since the implementation of management controls, the reported catch has ranged between 470 and 580 tonnes. The 2000 catch of demersal scalefish in the NDSMF is the lowest catch return of the last nine years. In particular, the trap catch in 2000 was down considerably on 1999 and on historical levels (Northern Demersal Scalefish Table 1, Northern Demersal Scalefish Figure 2). The trap and line fishery in the NDSMF principally targets red emperor *(Lutjanus sebae)* and goldband snapper *(Pristipomoides multidens)* with many species of snappers *(Lutjanidae)*, emperors *(Lethrinidae)* and cods *(Serranidae)* comprising a large component of the landed by-product. A breakdown of the landed catch in the NDSMF in 2000 is provided in Northern Demersal Scalefish Table 2. A number of operators within the NDSMF are also involved in other fishing activities in the region, such as trolling for Spanish mackerel. 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. 82-6.

Fishing effort

The fish trap effort (in boat days fished) within the NDSMF has on average been declining since 1992. The fish trap effort in 2000 was down from that recorded in 1999, but was marginally higher than the 1998 level (Northern Demersal Scalefish Table 1). As has been the case in both 1998 and 1999, a large proportion of the effort allocated to both line and trap vessels in the fishery remained unutilised in 2000. The line effort recorded in 2000 was down on that recorded in 1999, but was higher than the 1998 line effort (Northern Demersal Scalefish Table 1). Line vessels operating within the NDSMF in recent years have struggled to be economically viable and most have looked to convert to trap fishing methods. This limited viability is the reason for the heavily reduced line effort evident for the period 1998–2000 (Northern Demersal Scalefish Table 1).

Catch rate

Catch per unit effort for trap vessels in the NDSMF increased in 1998, reflecting increases in efficiency as fishers sought to maximise their catch return from each day fished as the fishery came under full management, with consequent limitation on the available fishing effort. Since 1998, CPUE for trap vessels has declined to average historic levels.

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 expended in Area 1. However, the magnitude of this effort and the catch taken is still to be quantified.

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 adopted in order to constrain harvest rates until a stock assessment of the key target species could be completed. 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. Decision rules have been developed to manage variations in catch around the target TSC. The outcome from this effort determination process for the 2001 fishing season is noted in the 'Acceptable catch range' section below.

A major three-year FRDC-funded research project was completed in 2000. The primary objective of this research project was to undertake a formal assessment of the key demersal finfish species in the NDSMF, red emperor and goldband snapper. Goldband snapper live to at least 30 years. Growth parameters for the goldband snapper are L_∞ = 598 mm, K = 0.187 yr^{-1}, t_0 = -0.173 (r^2 = 0.76). The instantaneous rate of natural mortality (M) was estimated to be in the range 0.104–0.139. Total instantaneous mortality rate (Z) estimates generated from catch-at-age data for goldband snapper, taking into account fishing effort levels were 0.65 for 1995/96, 0.87 for 1996/97 and 0.76 for 1997/98. In 1999 fishers increasingly targeted goldband snapper and this is likely to have affected their catchability, and thus influenced the mortality estimates derived from catch-at-age information. This result is to be investigated further. The above mortality estimates were used to calculate exploitation rates. They ranged from 0.79 to 0.84 in the period from 1995/96 through to 1997/98. These rates of exploitation for the NDSMF population of goldband snapper are considered to be above the optimum.

Commercial Fisheries

Red emperor were found to live to at least 34 years. There was significant differential growth between sexes, with male fish reaching a larger size at age than female fish. Growth parameters for males were L_{∞} = 628 mm, K = 0.151 yr^{-1}, t_0 = -0.595, and for females L_{∞} = 483 mm, K = 0.271 yr^{-1}, t_0 = 0.065. Slow growth in length was evident for both sexes. The instantaneous rate of natural mortality (M) was estimated to be in the range 0.104–0.122. The instantaneous rate of total mortality (Z) estimated from catch-at-age data for red emperor was 0.32 for 1997/98 and 0.28 for 1998/99. These results yield exploitation rates for the NDSMF population of red emperor of 0.63 in 1997/98 and 0.57 in 1998/99, which may also be above the optimum.

These results indicate that the fishery is fully exploited and is likely to be operating above optimum levels for the key species. Furthermore, the TSC has not been achieved in recent years, which raises the question of whether the 800 tonne TSC is sustainable or achievable in the long term.

The results from the stock assessment work will be used to undertake a review of the appropriateness of the current target sustainable catch prior to the 2002 fishing year. Part of the review process will involve attempting to improve the spatial resolution of the targeted effort used for stock assessment. The present stock assessment approach has looked at the fishery in its entirety. The next step in this process is to look at areas within the fishery to determine whether greater spatial resolution of the targeted catch and effort data is possible.

Exploitation status: **Fully exploited**

Key species are exploited above optimum levels.

Breeding stock levels: **Declining**

The length at maturity for goldband snapper was estimated to be 473 mm fork length (552 mm total length) for females and 470 mm fork length (549 mm total length) for males, corresponding to an age at maturity of 8.2 years for females and 8 years for males. As it is impractical to return under-size fish (due to decompression injuries), there is currently no legal minimum size for goldband snapper within the fishery, and all fish landed are sent to market. The length frequency distribution of more than 4,500 goldband snapper of both sexes sampled over the last five years indicates that a large proportion of the harvested population consists of immature fish. For male goldband snapper, 23% of fish sampled were below the size at maturity, while for females 41% were below the size at maturity. Furthermore, there has been a significant decline in the mean length and weight of goldband snapper landed in the period from 1995 to 1999. These results indicate that the breeding stock level of goldband snapper in the NDSMF is declining.

However, given the vulnerability of goldband snapper to swim bladder over-expansion injuries (meaning that goldband snapper caught below the size at maturity are already dead or moribund), the introduction of minimum size regulations is unlikely to have the desired effect of returning these immature fish to the breeding stock. Fishery managers and fishers will thus need to consider management measures other than those dealing with effort reductions. Such measures may include spatial area closures designed to protect a portion of the spawning stock biomass from fishing.

The length at maturity for red emperor was estimated to be 429 mm fork length (461 mm total length) for females and 457 mm fork length (491 mm total length) for males, corresponding to an age at maturity of 8.2 years for females and 8 years for males. The current legal minimum size for red emperor is 410 mm total length. This is below the size at maturity for red emperor in waters of the NDSMF. In addition, there has been a significant decline in the mean length and weight of red emperor landed in the period from 1997 to 1999. The breeding stock level of red emperor in the NDSMF is considered to be declining even at the lower effort levels expended since the introduction of formal management.

Careful monitoring of the breeding stock level of red emperor and goldband snapper in the NDSMF is required on an ongoing basis.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

As a result of the marketability of most species caught, there is a limited quantity of by-catch in this fishery. The most common by-catch 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, 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

Seven vessels fished in the 2000 fishing season with an average crew level of 3 people per vessel, indicating that 21 people were directly employed in the NDSMF.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): $2.63 million

The NDSMF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery landed a total of 470 tonnes of demersal scalefish in 2000, for a catch value of over $2.63 million. This value is lower than that reported in 1999 owing to the lower catch. However, the average price received by fishers in 2000 was much improved on the prices achieved in 1999.

FISHERY GOVERNANCE

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

For the year 2001, the total allowable effort has been set at 1,320 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, a three-year research project to reassess the long-term sustainable catch level is expected to indicate that a reduction in the TSC is needed. This is in keeping with the inability of the fleet to achieve the 800-tonne TSC in the past four years.

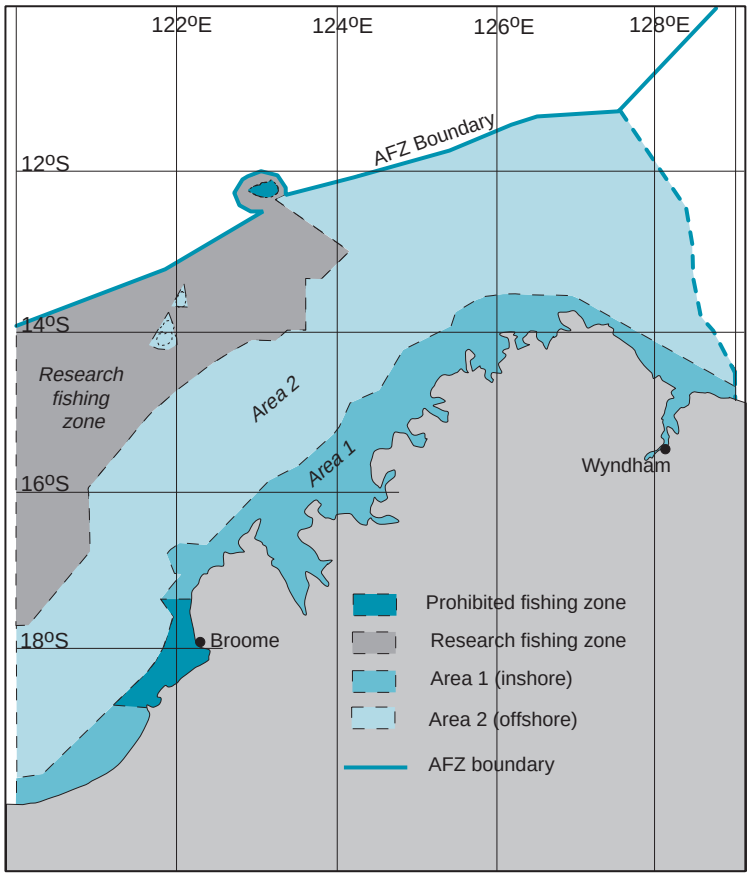
EXTERNAL FACTORS

The current assessment of the status of the key species, in association with a declining catch rate in 2000, is likely to confirm that the current TSC needs to be revised downwards in future years.

There has also been reduced line effort in the period from 1998 to 2000, probably reflecting the reduced viability of line fishers presently in the NDSMF. Under the management plan which took effect on 1 January 2001, licensees can now chose either fish traps or lines on a trip-by-trip basis. Hence, the low level of line fishing effort in the NDSMF is expected to continue.

Recreational fishing pressure in the Broome region is considered to be increasing, and potentially involves thousands of anglers per year. A recreational creel survey was undertaken between December 1999 and November 2000 to determine the magnitude and composition of the recreational fishing catch between Exmouth and Broome. Results from this survey should become available in 2002 to assess the degree of overlap between the two sectors.

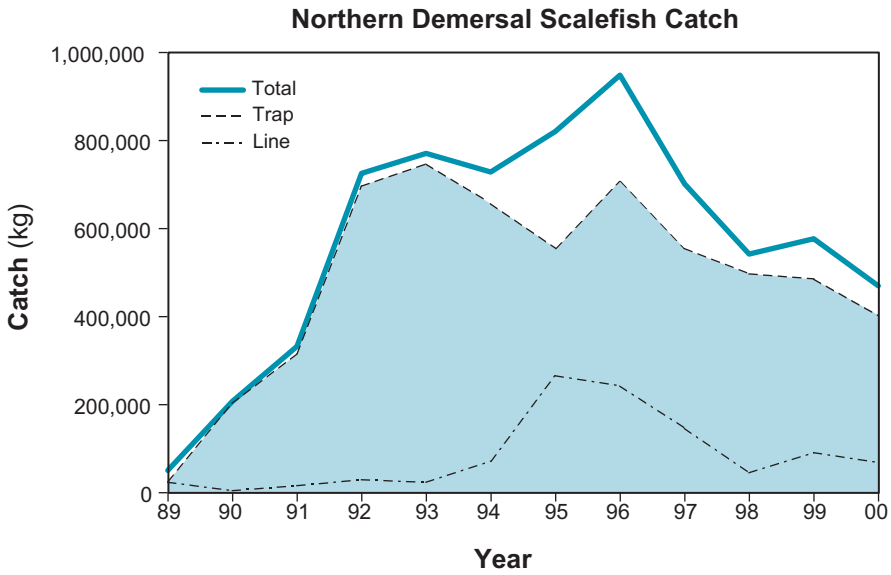
The future catch from the NDSMF may also involve the stocks from waters greater than 200 m depth. This area of the fishery is available as a research fishing zone and fishers have the option to explore the deeper waters, though to date industry has shown little interest in doing so. However, the resources of this sub-region are unlikely to be substantial. Given the even lower production potential of deeper-slope reef fish, the sustainable catch from this zone is likely to be quite low.



NORTHERN DEMERSAL SCALEFISH FIGURE 1

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

Commercial Fisheries



NORTHERN DEMERSAL SCALEFISH FIGURE 2

Catches of demersal finfish in the NDSMF by line and trap, 1989–2000.

NORTHERN DEMERSAL SCALEFISH TABLE 1

Catches of demersal finfish by line and trap in the NDSMF, 1989–2000. 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		Fish trap		Total catch (kg)
		Catch (kg)	Effort* (block days)**	Catch (kg)	Effort (block days)**	
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	79	497,154	869#	542,017
1999	1,716	91,045	228	485,918	971#	576,963
2000	1,562	68,543	148	401,487	890#	470,080

* 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 2000.

Species group	Line		Fish trap		Total catch
	Tonnes	%	Tonnes	%	Tonnes
Red emperor	3.1	0.7	85.7	18.2	88.8
Goldband snapper	48.2	10.3	136.8	29.1	185.0
Cod	4.4	0.9	70.3	15.0	74.7
Spangled emperor	-	-	11.4	2.4	11.4
Scarlet perch	6.0	1.3	16.8	3.6	22.8
Red snapper	2.2	0.5	5.2	1.1	7.4
Other species	4.7	1.0	75.3	16.0	80.0
All demersal finfish	68.6	14.6	401.5	85.4	470.1

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 smaller proportion taken by fish traps and line. Both the Pilbara Fish Trawl Interim Managed Fishery and the Pilbara Trap Managed Fishery operate under individual transferable effort (ITE) 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 effort limitations. Since the fishery came 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 and Rankin cod) at sustainable levels. Eleven licences currently exist to operate in the fishery, with a total of 29,568 trawl units allocated. Unit values for 2001 reflect values between 0.6 and 1.1 trawl hours per unit, dependent on the zones being fished.

The new 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 do not have access to specific 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

Agency–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 the deeper areas adjacent to the existing trawl grounds have been completed under a separate FRDC-funded project.

The following status report, which provides a synthesis of the data from the fishery, utilises the results of this earlier research and some ongoing monitoring.

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 allocation of transferable trap units 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

Commercial Fisheries

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 depth contour. 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. The allocated effort quota is transferable and monitored by VMS.

In addition, some wetline fishing occurs in the areas of the trawl and trap fisheries. Planning for limiting access by the general wetline fleet began with the release of a discussion paper in November 1997.

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 line fishing and trapping being relatively minor components.

RETAINED SPECIES

Commercial production (season 2000):

Trawl 2,075 tonnes
Trap 257 tonnes
Line 59 tonnes

Landings

Catch of the major species for 2000 is shown in Pilbara Table 1. The catches by different fishing methods for the years 1985 to 2000 are shown in Pilbara Table 2 and illustrated in Pilbara Figure 2.

Demersal scalefish catch by trawl, trap and line was 1,995 tonnes, 257 tonnes, and 59 tonnes respectively.

The 2000 trawl fishery demersal scalefish catch had a similar species composition to that in 1999, with the catch of most of the major species decreasing and red snapper increasing. The major target species landed (with 1999 catch in brackets) were blue spot emperor 401 tonnes (445 tonnes), red snapper 252 tonnes (230 tonnes), red emperor 68 tonnes (78 tonnes), flagfish 166 tonnes (189 tonnes), threadfin bream 187 tonnes (217 tonnes), goldband snapper 75 tonnes (82 tonnes), scarlet perch 65 tonnes (72 tonnes) and Rankin cod 25 tonnes (34 tonnes). The main by-product species were shark 52 tonnes, bugs 5 tonnes, and cuttlefish 23 tonnes.

The trap fishery catch decreased from 351 tonnes in 1999 to 257 tonnes in 2000 due to the introduction of effort quota. Major species taken by trap fishing in 2000 (1999 figures in brackets) were red emperor 40 tonnes (55 tonnes), blue spot emperor 39 tonnes (27 tonnes), goldband snapper 30 tonnes (38 tonnes), Rankin cod 27 tonnes (52 tonnes), and red snapper 27 tonnes (22 tonnes). There is no by-product in this fishery.

Demersal scalefish catches by line fishing were slightly higher at 59 tonnes (50 tonnes in 1999), comprising mainly spangled emperor 18 tonnes (12 tonnes in 1999), Rankin cod 5 tonnes (5 tonnes) and red emperor 7 tonnes (6 tonnes). In addition, 187 tonnes of sharks and rays (which includes the North Coast Shark Fishery catch) and 103 tonnes of mackerel were caught in the Pilbara. The shark catch is reported in more detail in the North Coast Shark Fisheries Status Report (pp. 87-8), and the mackerel catch in the Spanish Mackerel Stocks Status Report (pp. 82-6).

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 2000 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 from 1998 to 2000 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 2000 of 17% in Area 2 and 10% in Area 4 (compared with 12% and 5% in 1999). There was no trawling in Area 6, the research zone, in 2000. The 2001 effort allocation will be redistributed in 2001 to reduce effort in Area 1, the most heavily exploited area.

Five trap boats using between 10 and 12 traps reported 518 days fishing in statutory monthly returns in 2000, compared with 842 days in 1999. 5,867 trap units (days multiplied by number of traps) were allocated in 2000 and 5,000 units were used. This equates to 505.6 days fished with an average of 11.6 traps per day.

In 2000, line fishers reported operating for 500 days, compared with 453 days in 1999. This effort does not include trolling, which is reported in the Spanish mackerel report (pp. 82-6). Line fishing in the Pilbara is still unrestricted and under 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. In Area 1 of the trawl fishery, the catch rate for red emperor is stabilising at a low level, while in Areas 2 and 3 it is increasing. Rankin cod and blue spot emperor catch rates increased in all areas of the trawl fishery. No decline in catch rates is evident for flagfish or rosy threadfin bream. However, the efficiency of the fish trawl fleet has probably continued to increase as skippers become more experienced and electronic equipment is used to target fish. This expected efficiency increase means that the observed catch rates are likely to be biased upwards in future years.

Catch rates for the trap fishery and line fishing (based on the reported number of days fished) were slightly higher

in 2000 than 1999, apparently due to the increasing skill of operators.

Recreational component: **Not assessed**

Stock assessment completed: **Yes**

Red emperor and blue spot emperor were used as indicators of long-lived and short-lived species.

Trawl fishery: The effort reduction introduced in 1999 appears have arrested the decline in the catch rates. An age-structured model (using biological information, age structure, catch from 1989 to 2000 and catch rates from 1993 to 2000) was used to assess the red emperor and blue spot emperor stocks in Areas 1 to 5. The assessment criterion was that 'the spawning biomass should not decrease below 25% of the estimated virgin level in the fishing area'.

The virgin biomass, with upper and lower confidence values, was determined using trawl, trap, line, and charter catches and the effort levels adopted in 2001 (Pilbara Table 4) were projected into the future. The assessment indicated that the lower estimate of the spawning biomass of red emperor in Area 1 declined to 17% of the virgin level in 1998 and would stabilise at a low level of 16% after 2001. In Area 2, the lower estimated spawning biomass was 25% of the virgin level in 1998, and then increased, with an expected value of 30% in 2006. In Area 3, which is closed to fishing, the biomass fell to 30% of the virgin level in 1998 and is expected to rise to 58% of the virgin level by 2006. Overall, in the western half of the fishery (Areas 1, 2, and 3), the lower estimate of spawning stock reached a minimum of 25% of the virgin level and would be expected to rise to 35% by 2006.

Blue spot emperor spawning biomass would be expected to decline in Area 1 for the next few years, but then remain steady at a level above the assessment criteria. There was no indication of decline for this species in Areas 2 or 3. For both red emperor and blue spot emperor, there was insufficient information for an assessment to be made in Areas 4 or 5. On the basis of this modelling, the 2000 effort allocation was continued into 2001.

Trap fishery: The effort quota introduced in 2000 reduced catches to a level below the recommended cap of 300 tonnes. In the portion of the trap fishery west of 116° E the catch rates of red emperor are still decreasing, and although the data is very limited, there appears to be serious growth over-fishing in this area.

Line fishing: The line catch was low in 2000, but there is some concern that it consists mainly of a few species vulnerable to line fishing (e.g. Rankin cod, red emperor and spangled emperor).

Exploitation status: **Fully exploited**

Breeding stock levels: **Adequate**

Breeding stocks of the short-lived species have been assessed as adequate in the fishing area overall. The spawning biomass of red emperor was estimated to have fallen below the reference point in Area 1 in the period 1997–2000. However, this represents a local depletion, as Area 1 consists of only one-eighth of the area where this species occurs in the Pilbara fishery. The overall recovery of the spawning stocks in Areas 1, 2, and 3 of the trawl fishery is expected following the 1999 effort reductions and the 2001 effort redistribution. Careful ongoing monitoring is required to ensure compliance with effort reductions in order to maintain satisfactory breeding stock levels of the long-lived species within the fishing zone.

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 finfish. 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, is not expected to be great, but needs to be assessed further. Sea snakes are occasionally captured in the fish trawl nets but are returned alive to the sea in most cases. There is no turtle catch in the trap, line or fish trawl fishery,

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, a higher standing stock is maintained, although all sectors selectively harvest the larger individuals of many of the top-end predators. Overall the fishery is likely to have only a moderate impact on the food chain of the North West Shelf outside 50 m.

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 in 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

Commercial Fisheries

(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 18 fishers were employed during 2000 on Pilbara trawl fishing vessels, and 9 fishers in the trap fishery. The level of employment in line fishing is not assessed.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): $8.5 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 12 months. The trawl fish catch is dominated by lower-valued species such as blue spot emperor and threadfin bream, and the value is $7 million. The trap and line catches are dominated by the valuable species such as red emperor and jobfish, and the values are approximately $1.2 million and $0.3 million respectively.

The catches from these fisheries dominate the Western Australian metropolitan markets and support the local fish processing sector.

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 last seven years. 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 in 2001 indicates a catch range of 1,900–2,200 tonnes for trawl and 150–300 tonnes for trap.

EXTERNAL FACTORS

There was a slight increase in catch and effort for line fishing in 2000. Conversely, catch and effort decreased in the trap fishery due to effort quota introduction, and in the trawl fishery due to unused effort quota by some vessels.

In 1999 and 2000 there has been noticeable recovery of red emperor stocks, and it is anticipated that similar recovery will occur for other long-lived species. In Area 1 of the trawl fishery, the decline in the red emperor stock appears to have been arrested, albeit at a low level. The stocks of red emperor in the portion of the trap fishery west of the trawl fishery appear to be over-exploited, and the same may be true of other long-lived species in this area.

The smaller species such as flagfish and threadfin bream are probably under-exploited. Development of fishing methods which increase catches of these species without increasing catches of the large, long-lived species could increase the economic return from the fishery.

Research is needed to obtain more detailed information on habitat distribution, recovery times and the importance of habitat to recruitment in order to assist future decisions on redistribution of trawl effort.

In the deep-water zone (100–200 m depth), the fish species are concentrated between the depths of 100 m and 140 m and are likely to be highly vulnerable to over-fishing. Industry surveys monitored by the Research Division suggest that stocks in this zone are limited and if fishing is to be allowed in this area, it should be very limited.

The area available for fishers has decreased over recent years due to exclusion areas for gas pipeline and facilities. This is not 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 2000.

	Fish trawl catch		Trap catch		Line catch		Total catch
	tonnes	%	tonnes	%	tonnes	%	tonnes
Red emperor	68	59%	40	35%	7	6%	115
Rankin cod	25	44%	27	47%	5	9%	57
Scarlet perch	65	76%	18	21%	2	3%	85
Red snapper	252	90%	27	10%	2	0%	281
Goldband snapper	75	67%	30	27%	6	6%	111
Spangled emperor	27	39%	25	42%	18	26%	70
Blue spot emperor	401	91%	39	9%	-	-	440
Flagfish	166	98%	3	2%	-	-	169
Threadfin bream	187	100%	0		-	-	187
Frypan snapper	45	98%	1	2%	-	-	46
Other demersal scalefish	684	91%	47	6%	2	3%	750
All demersal scalefish	1,995	86%	257	11%	59	3%	2,311
Shark and ray	52	22%	0		187	78%	239
Other by-product	28		0		0		28

PILBARA TABLE 2

Summary of reported commercial catches (tonnes) of demersal scalefish by line, trap and trawl in the Pilbara fishery as well as shark catch by all methods, scombrid catch by trolling and charter catch.

Year	Demersal scalefish				Troll	Shark	Charter
	Line	Trap	Trawl	Total			
1985	180	168	-	348	132	22	-
1986	65	113	-	178	97	25	-
1987	67	192	3	262	119	19	-
1988	136	243	3	382	79	24	-
1989	104	457	124	685	116	29	-
1990	157	407	421	985	209	57	-
1991	107	119	754	980	196	132	3
1992	63	148	1,413	1,624	125	273	7
1993	67	178	1,724	1,969	160	143	7
1994	79	207	2,506	2,792	144	144	12
1995	95	222	2,821	3,138	131	67	15
1996	136	302	3,201	3,639	119	123	33
1997	109	234	2,630	2,973	152	96	22
1998	78	250	2,512	2,840	121	333	36
1999	50	371	2,136	2,419	113	232	47
2000	59	257	1,995	2,314	130	244	27

Commercial Fisheries

PILBARA TABLE 3

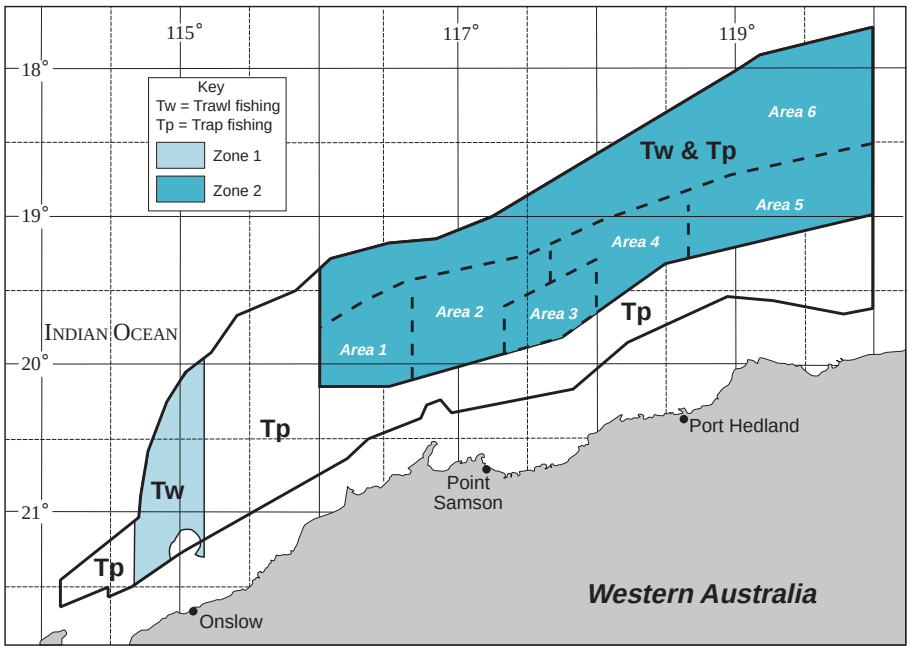
Summary of effort in the Pilbara fishery. The trap, line and trawl effort (days) is from monthly catch and effort returns. The trawl effort (hours) is nominal effort from operators' logbook data.

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

PILBARA TABLE 4

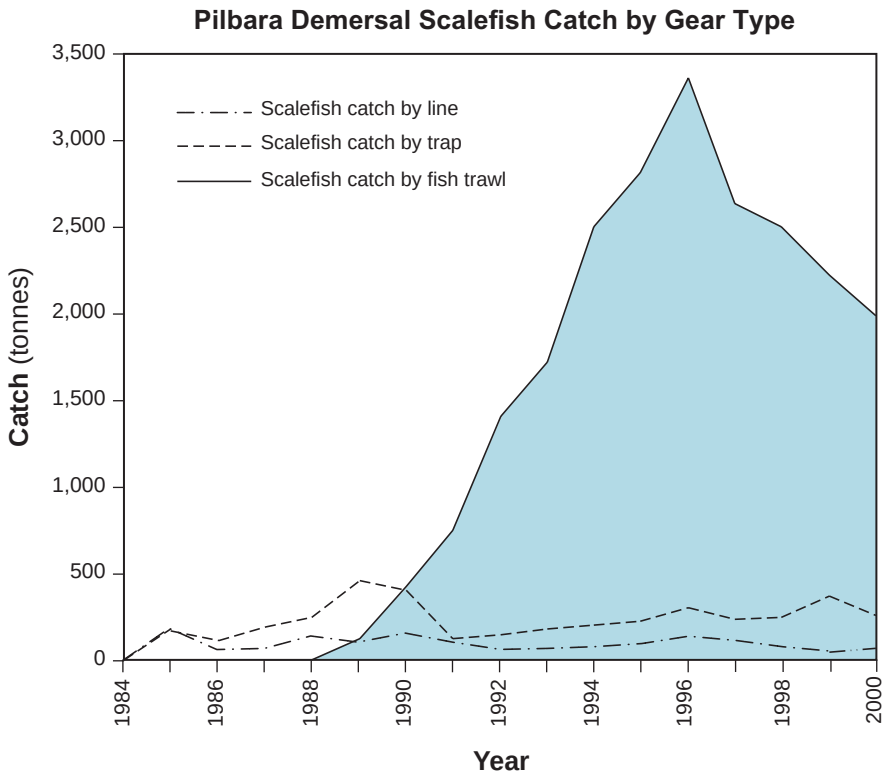
The number of hours allocated, the number of hours used and the percentage of the allocation used in each area of the Pilbara trawl fishery (and, for 2000, in the Pilbara trap fishery).

		Area 1	Area 2	Area 3	Area 4	Area 5	Total
1998	time allocation	17136	3,360	0	3,360	5,712	29,568
TRAWL	time used	15,076	3,842	0	3,736	4,955	27,609
	% of time used	88%	114%	-	111%	87%	93%
1999	time allocation	11,481	3,360	0	3,057	5,198	23,096
TRAWL	time used	10,237	3,767	0	3,213	4,973	22,190
	% of time used	89%	112%	-	105%	96%	96%
2000	time allocation	11481	3360	0	3057	5198	23096
TRAWL	time used	9438	3928	0	3358	4476	21199
	% of time used	82%	117%	-	110%	86%	92%
2000	time allocation			0			524
TRAP	time used			0			507
	% of time used			-			97%



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.



PILBARA FIGURE 2

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

Commercial Fisheries

Spanish Mackerel Fishery

MANAGEMENT SUMMARY

Fishing for Spanish mackerel *(Scomberomorus commerson)*, under the general wetline access available to all Western Australian licensed commercial fishing boats, was reported by 68 boats during 2000 (18% of the total wetline fleet for the year). Most of these catches were made opportunistically by boats operating within other fisheries, and at present there are only about 10 boats which specifically target mackerel. Owing to concerns over increased catches and anecdotal evidence to suggest that the species may be in danger of over-fishing, an interim management plan (IMP) is currently in preparation. This plan will restrict the mackerel fishery to boats which meet certain fishing history and catch criteria, with two separate options proposed for managing the fishery. The first of these is a low-cost, simple alternative with stricter criteria and fewer boats in the fishery. Subject to ongoing review of the fishery, these boats would have unlimited access to designated sectors of the fishery. Under the second option, the fishery would contain more boats with restrictions to fishing effort based on previous catch histories. This option would require the use of VMS technology. The IMP has involved significant consultation with industry and is unlikely to be instigated during the 2001 season. In addition to the IMP, the capture of Spanish mackerel by commercial and recreational fishers is subject to a minimum legal size of 90 cm total length. A recreational bag limit of four fish per angler per day is also in place.

Governing Legislation/Fishing Authority

Fish Resources Management Regulations 1995
Fishing Boat Licence

RESEARCH SUMMARY

In 1998, a joint WA/NT/Qld FRDC-funded research project to determine the stock structure of Spanish mackerel in these States commenced, using genetic markers, stable isotope ratios and parasitic fauna. This project is due for completion in 2001. In 1999 a second FRDC-funded project began, aimed at determining the status of Spanish mackerel stocks in Western Australian waters. The main focus of this research is the gathering of biological information on Spanish mackerel. A preliminary evaluation of the status of Spanish mackerel stocks has been undertaken using the CAES records provided by industry to Fisheries WA, and from interviews with industry. This information has been required for the IMP. Results from the stock assessment should be available at the conclusion of the current project in June 2002.

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

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 NT 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. On rare occasions (including 2001), fishers also report small catches as far south as Albany.

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. The extent of these movements has important stock and management implications, and will be clarified at the end of the stock structure project.

Spanish mackerel fishing was previously reported under three sectors based on overall catches, fishing methods and likely boundaries of the IMP. However, as a result of ongoing consultation with industry over the IMP, the fishery is now reported in four sectors, with resultant changes to the boundaries between them.

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 NT 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), crews number 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.

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 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 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, and this sector may remain within the general wetline fishery following implementation of the IMP.

Main fishing method

Trolling.

RETAINED SPECIES

Landings

Commercial production (season 2000): 304.7 tonnes

Spanish mackerel *(Scomberomorus commerson)* is the target species and may comprise 95% of the catch. Grey mackerel *(S. semifasciatus)* is the dominant by-product, particularly in the Gascoyne and west coast sectors where it is sometimes captured in large numbers. However, 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, spotted and shark mackerel, wahoo, cobia, blue- and yellowfin tuna, 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 total catch of 304.7 tonnes of Spanish mackerel in 2000 comprised 118.3 tonnes from the Kimberley sector, 103.4 tonnes from the Pilbara, 68.1 tonnes from the Gascoyne and 14.9 tonnes from the west coast. (It should be noted that the catch figures expressed here may differ from those given in previous reports owing to the changes in sector boundaries, the introduction of a new sector, and the use of an improved conversion factor for filleted to whole weight – previously 3, now 1.6.)

Annual catches in the Kimberley sector rose slowly between 1979 and 1990, before a significant increase in catches from 45.4 tonnes in 1990 to 160.7 tonnes in 1991 when two of the four main present-day operators entered the fishery (Spanish Mackerel Figure 1 and Table 1). Between 1991 and 1998 the trend in catches increased slightly in this sector, with a peak of 198.2 tonnes in 1997. However catches have dropped in subsequent years to 118.3 tonnes in 2000. Catches within the Pilbara sector have been steadily rising from a low in 1988 of 47.1 tonnes, following a period of high catches that peaked in 1984 at 136.9 tonnes. In 2000, 103.4 tonnes were caught in this sector. Catch trends in the Gascoyne sector are similar to those in the Pilbara, with a steady increase in recent years from a low of 8.7 tonnes in 1992. This low followed a period of high catches during the 1980s which peaked in 1987 at 110.6 tonnes. In 2000 the catches in this sector were 68.1 tonnes. Catches in the west coast sector are minor, averaging about 10 tonnes per year with 14.9 tonnes caught in 2000. Catches in this sector have ranged from 1.7 tonnes in 1981 to 20.4 tonnes in 1989.

The 2000 catch in the Kimberley sector gives cause for concern because it was below the acceptable catch range provided last year (150–200 tonnes), and continues the downward trend in catches since 1998 (Spanish Mackerel Figure 1). Continuation of this trend in 2001 would create serious concern over the status of the stocks; however, this seems unlikely because catch rates in this sector still remain relatively high (Spanish Mackerel Figure 2), and the pattern of fish abundance during 2000 was considered unusual by fishers. Catches in the Pilbara sector during 2000 were slightly above the acceptable catch range for that year, again due in part to the unusual pattern of mackerel abundance along the coast. The 2000 Pilbara catches continue a rising trend that sees them approaching the peak catches of the mid-1980s, which are considered unsustainable (Spanish Mackerel Figure 1). Catches in the Gascoyne sector during 2000 were within the projected catch range (noting that the change in boundaries and the addition of the west coast sector makes comparisons less valid).

Annual catches of other species of mackerel, including the grey or broad-barred mackerel *(Scomberomorus semifasciatus)*, school mackerel *(S. queenslandicus)*, spotted mackerel *(S. munroi)* and shark mackerel *(Grammatorcynus bicarinatus)*, 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 becoming more targeted in the Gascoyne sector and will be reported as a separate species in 2002. (Catches of grey, school and spotted mackerel are now recorded separately in the CAES database.) School and shark mackerel species make up approximately 7% each of the 'other mackerel' catch. Annual fluctuations in the catch of other mackerel are thus mainly due to variability in the capture of grey mackerel. Catches of other mackerel in the Kimberley and Pilbara show particular year-to-year variability. In 2000, the catches of 14.3 tonnes in the Kimberley sector were at their lowest level since 1989, coinciding with decreased catches of Spanish mackerel, whilst in the Pilbara sector catches improved from 7.9 tonnes in 1999 to 27.1 tonnes in 2000. Catches of other mackerel in the Gascoyne sector have generally been on the increase despite periods of low catches in the 1980s and early 1990s. In 2000, catches within this sector reached 29.2 tonnes. The increase in catches of other mackerel in the Gascoyne sector since 1992 mirrors increases in catches of Spanish mackerel. Catches of other mackerel peaked in the west coast sector in 1989 at 37.1 tonnes, but have since dropped and remained at a low level since 1993. Only 4 tonnes were captured in this sector in 2000. Note that landed weights of other mackerel species are converted to whole weights using the same conversion factors used for Spanish mackerel.

Fishing effort

The annual number of boats recording catches of Spanish mackerel has varied substantially since 1980, from 4 to 20 boats in the Kimberley sector (7 in 2000), 17 to 53 boats in the Pilbara sector (17 in 2000), 13 to 56 boats in the Gascoyne sector (26 in 2000), and 10 to 39 boats in the west coast sector (32 in 2000). Note that the number of boats within each sector differs from that given in 1999 because of changes to sector boundaries and the addition of the fourth sector.

Commercial Fisheries

The unit of effort used in analysis of catch rate is the 'fishing day'. This is not considered the most accurate measure of effort given the variation in number of hooks trolled and number of hours fished per day by the mackerel fleet. It is nevertheless the most reliable measure of effort until a more appropriate means of determining fishing effort is put into use. Monthly patterns of fishing effort are similar to those for catches: 70.3% of the annual fishing effort (days per month in which Spanish mackerel were captured) by all vessels within the Kimberley sector for the period 1990-1999 (data pooled) was expended between June and October, with a peak of 16.2% in August. In the Pilbara sector for the same period, 68.9% of effort occurred from June to October (peak of 19.7% in August), whilst in the Gascoyne and west coast sectors 72.4% of effort occurred between April and August (peak of 17.7% in July).

Annual trends in effort and catch are also similar in the Kimberley sector, where total fishing days varied from 92 in 1982 to 921 in 1994. Between 1979 and 1990 the average was fairly steady at 262 days/year, with a jump in 1991 and a fairly steady average of 789 days/year between 1991 and 1997. Since 1997 total fishing days have declined to 367 days in 2000. In the Pilbara sector, fishing effort peaked in 1984 at 1,960 total fishing days before a downward trend to 1,443 days in 1997. Since 1997 the drop in fishing effort has been more dramatic, with a total of 552 fishing days for this sector in 2000. Effort in the Gascoyne sector reached peaks of 2,476 and 2,087 fishing days in 1985 and 1987 respectively, followed by a steep decline to 335 fishing days in 1991. Since 1991 total fishing days rose steadily to 1,265 in 1999 before dropping to 868 in 2000. The annual number of fishing days in the west coast sector reached a peak in 1988 of 1,148 before dropping and remaining between 330 and 746 from 1989 to 2000. In 2000 the total of fishing days in this sector was 545. It should be noted that the large differences in fishing days between sectors reflect the number of vessels recording mackerel catches in each sector rather than the intensity of fishing effort. For instance, the few mackerel fishing vessels in the Kimberley sector focus almost exclusively on mackerel but have a relatively low combined total of fishing days. In contrast, most of the Gascoyne fleet do not target mackerel and may only catch a small number of them per day; nevertheless, their combined tally of days on which mackerel were caught is relatively high.

Catch rate

Analysis of catch per unit effort is complicated by the fact that many fishers who catch Spanish mackerel do not normally target them, and thus the effort they expend in doing so is likely to be combined with the effort spent catching other species. The catch rate of vessels known to target Spanish mackerel is therefore used to estimate catch rates of all vessels in the fishery in the following analysis. Catch rates (kg/day) in the Kimberley sector since 1989 have fluctuated markedly but exhibit an increasing trend peaking in 1998 at 440 kg/day (Spanish Mackerel Figure 2). Catch rates in this sector have since dropped to 351 kg/day in 2000. In the Pilbara, catch rates remained fairly steady between 1990 and 1996 at about 155 kg/day, but have risen in consecutive years to a high of 294 kg/day in 2000. Catch rates in the Gascoyne sector reached a low of just 6 kg/day in 1992 during the period when catches for this sector were also at a low point, but have since increased to a high of 155 kg/day in 2000. Catch and effort data for vessels known to target Spanish mackerel in the west coast sector is too limited to provide meaningful statistics for this sector.

Recreational component: **40–44% (approx.)**

Recreational survey data are only available for the west coast in 1996/97 (Sumner and Williamson 1999) and the Gascoyne in 1998/99 (Sumner et al., in press). For the west coast in 1996/97, the recreational take was estimated to be about 44% of the total catch of Spanish mackerel and related species, while for the Gascoyne in 1998/99, the recreational share was estimated at 40%.

A recreational survey of the north coast in 2000/2001 will provide information on these more remote areas where the recreational catch share is expected to be lower than for the Gascoyne and west coast.

Stock assessment completed: **Not assessed**

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

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 do not impact on the habitat.

SOCIAL EFFECTS

Approximately 72 people were employed in the Spanish mackerel fishery during the 2000 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 (2000):
Spanish mackerel $1.9 million
Other mackerel $0.37 million

Overall ex-vessel prices for Spanish mackerel ($6.27/kg) and other mackerel (approximately $5/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 broad due to incomplete knowledge of the status of mackerel stocks. They are based on historic catch trends and take into account previous fishing pressure. This is particularly relevant in the Kimberley, where accumulated stocks of larger, older fish are likely to have supported high initial catches during the 1990s.

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 2001 season. Ongoing cooperation between Fisheries WA research staff and mackerel fishers will be essential under the IMP to ensure information needed to monitor the status of the fishery is obtained.

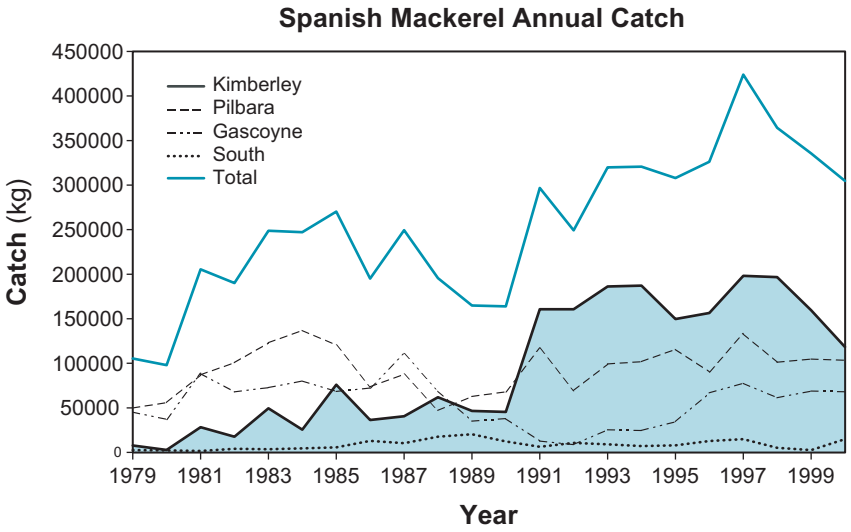
The recreational fishery for Spanish mackerel also requires assessment as this is a growing sector which takes a significant proportion of the mackerel catch. Such an assessment will need to examine the usefulness of current minimum size limits and bag limits, since research fishing and tagging experience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

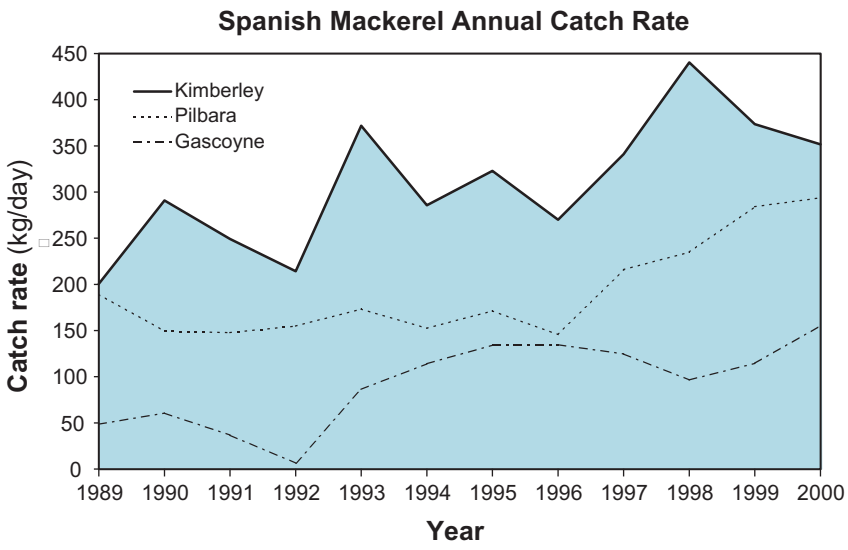
Year	Spanish mackerel (tonnes)					Other mackerel (tonnes)				
	Kimberley	Pilbara	Gascoyne	South	Total	Kimberley	Pilbara	Gascoyne	South	Total
1980	2.8	56.0	36.9	2.2	97.9	0.0	8.6	2.1	0.0	10.8
1981	28.3	68.7	88.5	1.7	187.2	1.9	0.4	0.1	0.1	2.5
1982	17.6	100.7	67.8	4.0	190.1	3.3	3.6	11.8	1.2	19.9
1983	49.5	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	118.3	103.4	68.1	14.9	304.7	14.3	27.1	29.2	4.0	74.6

Commercial Fisheries



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 catching Spanish mackerel. Effort data was based on those vessels known to target the species.

North Coast Shark Fisheries

MANAGEMENT SUMMARY

The taking of shark by longline and gillnet between 123°45' E and the WA/NT border is controlled by a Western Australian and Commonwealth Joint Authority. This sector is officially titled the Joint Authority Northern Shark Fishery (JANSF).

The Western Australian-controlled sector of the north coast 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 to 123°45' E with longline, and from 114°06' E to the WA/NT border with dropline. This sector is referred to in this report as the WA North Coast Shark Fishery (WANCSF).

There is a lack of knowledge regarding the dynamics of the target 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 Fisheries WA is part of a cooperative approach to shark research by a number of agencies across northern Australia that includes 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

Agency–industry meeting

RESEARCH SUMMARY

Research to monitor the status of the northern shark stocks has been undertaken as an extension of the south and west coast shark research project. A three-year research project partly funded by the FRDC began in July 2000 and will provide an improved understanding of these fisheries and of northern shark stocks generally. The following status report has been prepared based on CAES data from industry and a general knowledge of tropical shark stocks from the scientific literature.

North Coast Shark Fisheries Status Report

Prepared by R. McAuley and R. Lenanton

FISHERY DESCRIPTION

Boundaries and access

The management boundaries of the north coast shark fisheries depend upon the type of gear used. Western Australia manages dropline fishing for shark from longitude 114°06' E to the WA/NT border (129° E) and longline fishing for shark 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.

Main fishing method

Shark dropline and shark longline.

RETAINED SPECIES

Commercial production (season 1999/2000): 103 tonnes

Landings

This total shark catch of 103 tonnes comprised 101 tonnes from the WANCSF and 2 tonnes from the JANSF. In 1999/2000, the WANCSF also retained 6 tonnes of finfish species.

Sharks are also caught by other user groups apart from the two dedicated fisheries. During 1999/2000, vessels licensed in other managed fisheries operating in the same overall area (i.e. between North West Cape and the WA/NT border) reported catches of shark and ray totalling 77 tonnes. A further 'wetline' catch of 22 tonnes of shark and ray was taken by vessels without access to managed fisheries.

Fishing effort

There are 13 vessels with specific licensed access to these stocks, eight of which were active in 1999/2000. Effort is not reported this year as the accuracy of CAES returns from the northern shark fisheries cannot be ascertained until research staff have had the opportunity to assess reporting procedures. However, there does appear to have been a reduction in effort during 1999/2000. Given the escalation of shark-fin prices and the subsequent introduction of additional full-time vessels in the northern shark fisheries, this is considered to be a temporary and artificially low level of effort.

Catch rate

See 'Fishing effort' above.

Recreational component: **Not assessed**

Stock assessment completed: **Not assessed**

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.

Protected species interaction: **Negligible**

The WANCSF between North West Cape and Koolan Island is only permitted to utilise longlines and droplines,

Commercial Fisheries

which have negligible interaction with endangered species. The JANSF, when operating more than 12 nautical miles from the coast, is permitted to utilise gillnets, and therefore has the potential to interact with dolphins and turtles. However, little fishing is undertaken in this sector (2% of the catch), with the result that such interactions are insignificant.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The physical impact of dropline and longline on the seabed is minimal.

SOCIAL EFFECTS

Estimated employment in the WANCSF during 2000 was 20 fishers. Employment levels in the JANSF are not known.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (1999/2000): **$0.4 million**

The value of the combined catch from the two managed sectors was approximately $0.4 million (including estimated value of shark fins). During the 1999/2000 season, shark fins were worth 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.

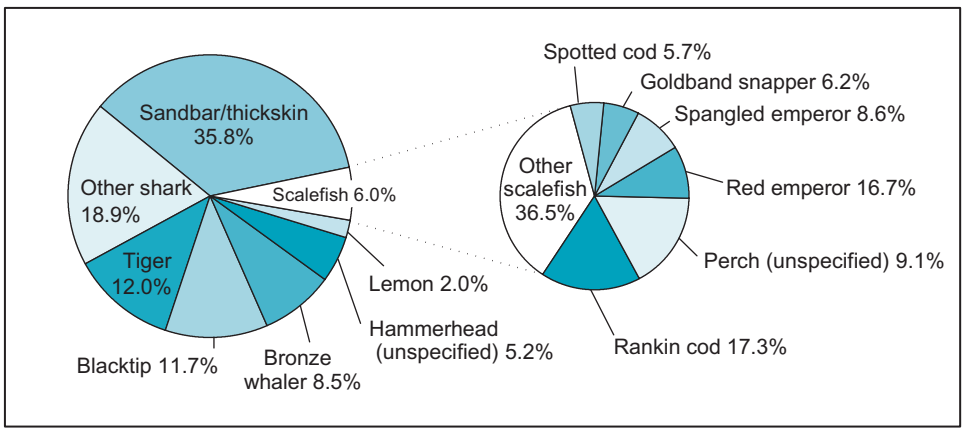
FISHERY GOVERNANCE

Acceptable catch range: **Not assessed**

EXTERNAL FACTORS

A large portion of the shark catch from the State's northern bioregion is taken by vessels fishing for other target species. This factor, in addition to the multi-species nature of the tropical shark fisheries, makes formal stock assessment processes particularly difficult. However, a new research project funded in part by the FRDC, aimed at conducting a stock assessment of the sandbar (thickskin) shark *Carcharhinus plumbeus*, will improve understanding of several northern shark stocks as well as providing a clearer picture of the shark catch by other fisheries.

North Coast Shark Catch Composition



NORTH COAST SHARK FIGURE 1

Combined WA North Coast Shark Fishery and Joint Authority Northern Shark Fishery catch species composition.

South Coast Bioregion

Regional Management Overview

Management arrangements in the South Coast Purse Seine Managed Fishery continue to be dominated by the after-effects of the 1998/99 mortality event, believed to be caused by a Herpesvirus. At this stage the stocks in the western zones of the fishery have not rebuilt sufficiently to allow for commercial exploitation. Quotas for 2000/2001 in the Albany and Bremer Bay areas remained at zero (although there are small research quotas to allow for research sampling). The quota in the Esperance area was originally set at 1,060 tonnes, but later raised on a pro rata basis to 1,300 tonnes when the season was extended to 30 June.

The review of the South Coast Estuarine Fishery was completed in 2000 and Ministerial approval of the outcomes was received. A Voluntary Fisheries Adjustment Scheme was established to facilitate a voluntary reduction in the number of participants ahead of the implementation of the approved outcomes. A VFAS was also established to remove herring G-trap entitlements and five entitlements were removed.

Some changes have been made to the management arrangements for the Esperance Rock Lobster Managed Fishery. In addition, following successful negotiations with Environment Australia, a new 'Controlled Specimens Declaration' was granted under the *Wildlife Protection (Regulation of Imports and Exports) Act 1982* for spiny, giant and snow crabs.

The abalone fishery is one of the major fisheries of the area, taking predominantly greenlip and brownlip abalone on the south coast, while Roe's abalone is taken mostly on the west coast . The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery is another important fishery of the region. This fishery, and its west coast counterpart, have been engaged in a strict process of effort reduction and exploitation rate control to rebuild the biomass of the major shark stocks. The first five-year program of effort reduction will be completed in 2001 and a new program will have to be developed for 2002 onwards.

There was a significant catch in the south coast scallop fishery during 2000/2001 (reported under Minor Scallop Fisheries in the west coast bioregion, p. 17), following an unusually high level of recruitment to the fishery. A high level of variation in recruitment is normal for scallop fisheries and it is likely that this fishery will return to more normal catch levels in future years.

The 'wetline' fishery in the south coast bioregion is composed primarily of inshore gillnetting and beach-seining sectors.

Regional Compliance and Community Education Overview

On the south coast, the major compliance issues relate to abalone. The commercial abalone fishery continues to require a high level of compliance activity, with reports of breaches in 2000/2001 of management rules relating to annual quota management, non-completion of catch and disposal records, and the unlicensed take and sale of abalone.

Poaching activity by unlicensed operators running illegal commercial operations continues to be a significant issue within this fishery. These operations extend to the illegal take and shipment of abalone to overseas and interstate markets. The Serious Offences Unit was again used this year to target this particular problem. Two major prosecutions of unlicensed commercial-level operators are currently under way, and high-level 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.

The development of a uniform national approach to compliance monitoring of the abalone industry by fisheries agencies around Australia will also assist in addressing this problem. A National Docketing System is now in place for all other abalone-producing states, and Western Australia is continuing to develop a similar audit and monitoring system.

In addition to the cases of unlicensed operation reported above, three prosecutions were initiated for commercial abalone offences during 2000/2001, and one other matter is currently under consideration.

Funding of the compliance program for the commercial abalone fishery remains a major management issue and resulted in 'response only' field compliance being provided for the last six weeks of the quota season. The abalone fishery is in the high-risk category for non-compliance, and the resourcing of the compliance program needs to be resolved.

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 continues in certain areas of the fishery. Community and industry liaison by Fisheries Officers has assisted each sector to develop a better understanding of the other sectors' concerns and needs.

Compliance within the South Coast Estuarine Fishery continues to be generally good. 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. Fisheries Officers monitor licences, gear restrictions, closed-water areas, fish size limits and setting and retrieval limits in this fishery.

There is a high level of compliance activities in the seasonal Western Australian salmon fishery. Inspections for this shore-based fishery include beach inspections for block nets, checking commercial licences, and monitoring of penning time periods and compliance with designated fishing zone boundaries.

Commercial Fisheries

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

Compliance activities in the Australian herring fishery concentrate on the period of time each day for which nets may be set. There were no major compliance problems and no significant conflicts reported for this beach-based fishery for 2000/2001.

In the South Coast Purse Seine Managed Fishery, the closures and associated regional effects required more time to be spent on liaison with fishers, processors and the general community, rather than specific monitoring and enforcement work.

Fisheries Officers undertake compliance monitoring and inspections in a number of minor commercial fisheries in this bioregion. No major compliance issues have been encountered in these fisheries during 2000/2001.

A total of 8 infringement/warning notices were issued and 4 prosecutions were initiated during 2000/2001 for commercial fisheries offences (excluding abalone) in the south coast bioregion.

Regional Research Overview

In addition to the research projects and activities noted in the research summary for each individual fishery, there has been a major focus during 2000/2001 on assessing the general wetline catch in each bioregion. This assessment, undertaken utilising the CAES database, indicates that only 6% of the wetline catch was reported from the south coast bioregion during 1999/2000. The top ten species include redfish (28 tonnes), pink snapper (17 tonnes), samsonfish (14 tonnes), squid (12 tonnes), Australian herring (10 tonnes), hapuku (7 tonnes), queen snapper (6 tonnes) and deepsea trevalla (4 tonnes).

South Coast Rock Lobster Fisheries

MANAGEMENT SUMMARY

Esperance Rock Lobster Managed Fishery: The Esperance Rock Lobster Managed Fishery has 11 vessels which operate 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.

There were significant changes in the management arrangements for the Esperance Rock Lobster Managed Fishery, with the removal of the requirement for mandatory pot reductions on transfer and the introduction of a process to allow the Executive Director to vary the season dates. Following successful negotiations with Environment Australia, a new 'Controlled Specimens Declaration' was granted under the *Wildlife Protection (Regulation of Imports and Exports) Act 1982* for spiny, giant and snow crabs.

Other south coast rock lobster fishing endorsements: In addition to the Esperance fishery, southern rock lobster and deep-sea crabs are also taken by vessels authorised to fish for lobsters on the south coast outside the Esperance managed fishery zone. These vessels operate in two zones, catching predominantly southern rock lobster, although catches of western rock lobster, *Panulirus cygnus*, are also taken in the western part of the fishery, particularly in the area adjacent to the Windy Harbour/Augusta Rock Lobster Managed Fishery.

Effort in the areas adjacent to the Esperance fishery is controlled by a limitation on the number of licences issued and constraints on the number of rock lobster pots that a boat may carry. However, the fluctuating nature of recruitment into the fishery and scarcity of favourable rock lobster habitat mean that this fishery tends to be exploited on an opportunistic basis in accordance with variations in available stock. The fishery does not lend itself 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.

Deep-sea crab stocks are thinly spread over the fishing grounds but exploitation rates are increasing. This is likely to result in catches that fluctuate widely from season to season, as fishable stocks are rapidly fished down in times of abundance, and then rebound following periods where the scarcity of legal-size specimens makes it less economic to target them.

Windy Harbour/Augusta Rock Lobster Managed Fishery: There are only two licensees in this fishery and the public disclosure of total catch data would breach the confidentiality requirements of the *Fish Resources Management Act 1994* by allowing the catch of an individual fisherman to be identified. Accordingly, this catch data is included in the published total catch data of the West Coast Rock Lobster Managed Fishery. Both western and southern rock lobsters, together with small quantities of deep-sea crabs, are taken from this fishery. The fishery is located where the southern limits of the main population of western rock lobster and the western limits of the range of southern rock lobster meet.

Governing Legislation/Fishing Authority

Esperance

Esperance Rock Lobster Management Plan 1987
Esperance Rock Lobster Managed Fishery Licence

Other south coast endorsements

Fish Resources Management Regulations 1995
Regulation Licence granted under Regulations 125 and 126

Windy Harbour/Augusta

Windy Harbour/Augusta Rock Lobster Management Plan 1987
Windy Harbour/Augusta Rock Lobster Managed Fishery Licence

Consultation Process

Agency–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 Fisheries 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 1999/2000, 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 1999/2000, 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 have been asked to show cause why their related rock lobster pot entitlements should not be cancelled. While the agency's intention is to reduce the number of pot entitlements as the opportunity arises, it is recognised that the Albany/GAB zones will never be a significant rock lobster fishery and will be best managed as an adjunct to fishers' other diverse operations.

Main fishing method

Rock lobster pots.

RETAINED SPECIES

Commercial production (season 1999/2000): 69 tonnes

Landings

A catch of 38 tonnes of southern rock lobsters was taken in the ERLMF in 1999/2000, a decrease of 5% on the catch taken in the 1998/99 season (40 tonnes). The combined catch for the GAB and Albany southern rock lobster fishery zones in 1999/2000 was 31 tonnes, a decrease of 14% on the 1998/99 figure (36 tonnes). Catches in the Albany zone increased from 6 to 8 tonnes, but in the GAB zone of the fishery catches decreased from 29 to 23 tonnes. As a by-product of the rock lobster fishery, 3 tonnes of giant crabs and 14 tonnes of champagne crabs were landed in the Albany zone and 2 tonnes of giant crabs in the ERLMF.

Fishing effort

The ERLMF experienced a 20% decrease in nominal fishing effort levels, from 52,600 pot lifts in 1998/99 to 42,000 pot lifts in 1999/2000. Total effort for the Albany and GAB zones in the 1999/2000 season was 90,500 pot lifts, a decrease of 1,200 pot lifts (1%) on the previous season's 91,700 pot lifts. Fishing effort increased in the Albany zone, from 21,600 pot lifts in 1998/99 to 33,700 pot lifts in 1999/2000, and decreased in the GAB zone, from 70,000 pot lifts in 1998/99 to 56,800 pot lifts in 1999/2000. 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 1999/2000 season in the ERLMF increased by 18%, from 0.76 kg/pot lift in 1998/99 to 0.90 kg/pot lift in 1999/2000. The combined catch per unit of fishing effort for the GAB and Albany zones in the 1999/2000 season was 0.34 kg/pot lift, a 13% decrease from the 0.39 kg/pot lift for the 1998/99 season. Catch rates decreased from the 1998/99 value in the Albany sector by 21%, from 0.29 to 0.23 kg/pot lift, and in the GAB by 2%, from 0.42 to 0.41 kg/pot lift.

Recreational component: Not assessed

Stock assessment completed: Yes

Indications from production modelling 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 western and eastern zones are not suited to southern lobster colonisation. The survey of fishers showed that the western and eastern 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). Model outputs show that the ERLMF fishery is sustainable at current annual catch levels of around 40 tonnes, but not at the 60 tonne levels that were experienced in the early to late 1990s. The fact that the current effort in this fishery remains similar to that during the period of 60 tonne catches means that if latent effort is utilised in the future, localised depletion will be likely to result.

Commercial Fisheries

Stock assessments for the GAB and Albany zones show that sustainable yields in both zones are small, and at the fishing levels of recent years, both areas have been rapidly depleted. Should the rates of exploitation that have been experienced in recent times persist in the future, they will probably lead to lobster fishing in the GAB and Albany zones becoming uneconomic. Unsustainable fishing pressure in the neighbouring zones should not affect the ERLMF, as recruitment to the south coast fishery overall is not considered to be dependent on egg production from Western Australian waters.

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. Most of the fishers have other forms of employment outside of the commercial rock lobster fishing season.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (1999/2000): **$1.8 million**

The beach value of the fishery was about $1.8 million in 1999/2000, based on a beach price of $26/kg.

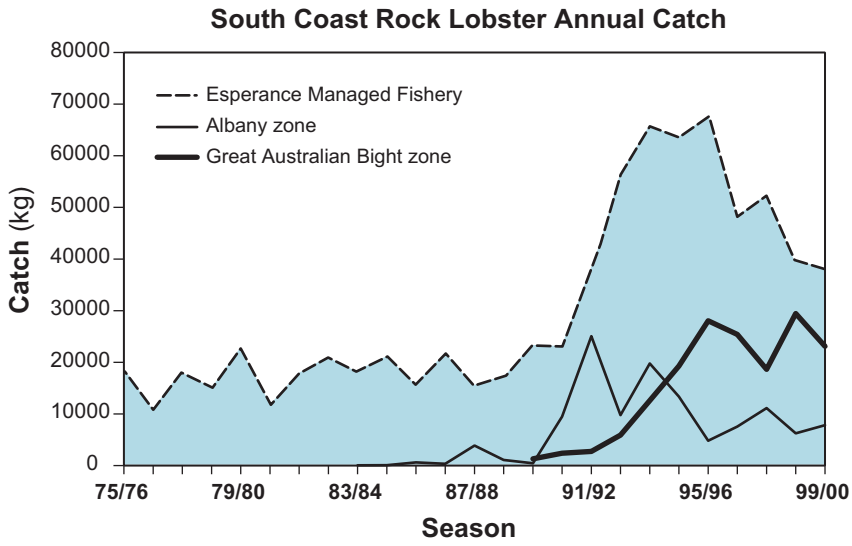
FISHERY GOVERNANCE

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 eastern and western 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 the agency has therefore adopted a policy whereby it will reduce the number of pot entitlements as the opportunity arises and manage the fishery as an adjunct to fishers' other activities.



SOUTH COAST ROCK LOBSTER FIGURE 1

Seasonal catches of southern rock lobster by management area, 1975/76 to 1999/2000.

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 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. Each February, total allowable catches are determined for each area in the fishery. The set number of units in each area is then assigned a unit value based on the number of units in that area. 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).

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.

There are 42 current abalone licences. This includes 15 greenlip/brownlip abalone licences, with the remainder endorsed to take Roe's abalone. There are a total of 13,800 greenlip units, 2,300 brownlip units and 25,180 Roe's abalone units in the fishery. During 2000/2001, fishermen were entitled to catch nearly 116 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 quantity (for greenlip/brownlip only), the date and location of collection and the personal details of the diver are all recorded and used to assist in research, compliance and management matters.

Governing Legislation/Fishing Authority

Abalone Management Plan 1992
Abalone Managed Fishery Licence

Consultation Process

Abalone Management Advisory Committee
Agency–industry meetings

RESEARCH SUMMARY

The 2000 quota period represents the second full season of abalone fishing under new management arrangements. Prior to 1999 the Abalone Managed Fishery was divided into three zones. For the 1999 and 2000 fishing seasons fishing was 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).

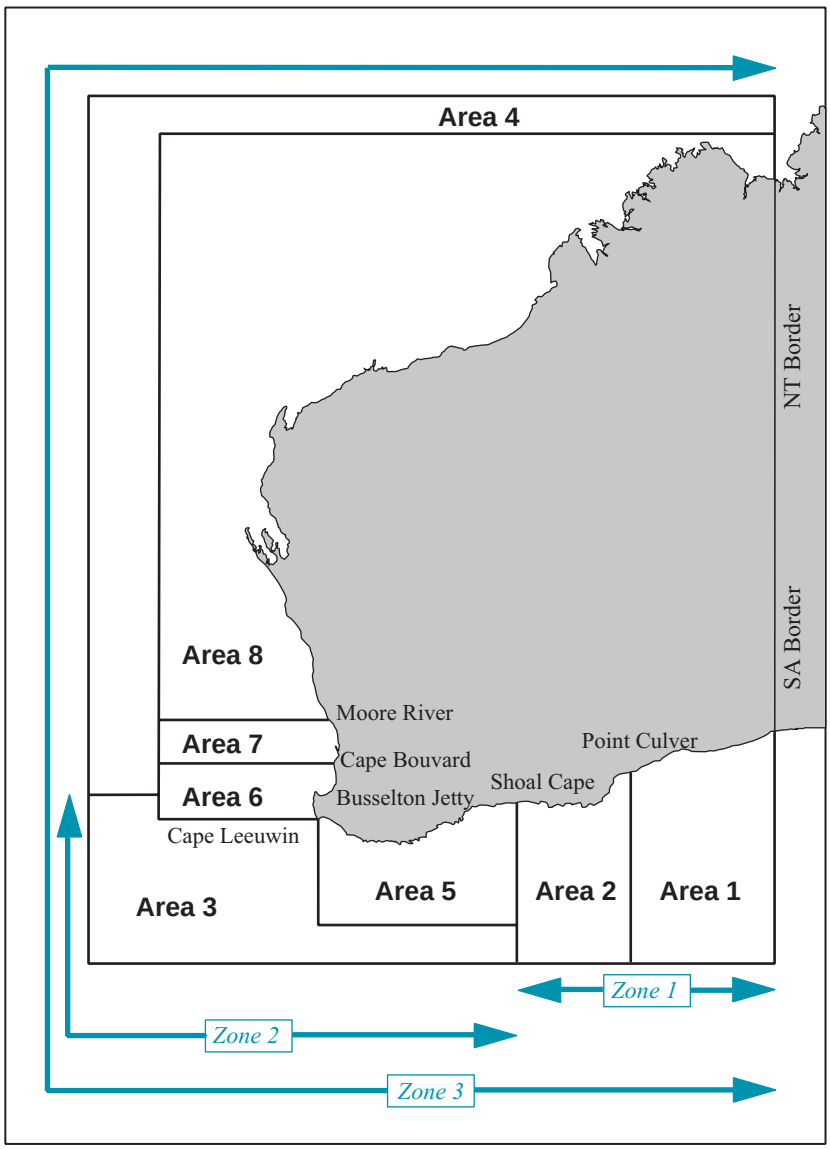
Commercial Fisheries

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 1999 and 2000 catch rates with historical data.

The introduction of individual quotas for greenlip and brownlip abalone is a new initiative within the management plan. Previously brownlip abalone, which have a lower value than greenlip abalone, were usually caught as incidental catch while fishing greenlip abalone. The separate quotas have the advantage that fisheries managers will be able to manipulate quotas more accurately to reflect changes in the abundance of particular abalone stocks.

Basic research monitoring for the eight abalone catch areas is undertaken annually utilising industry data from the daily catch records, information from processors, fishers' monthly returns and data collected during specific research projects. In each of the eight areas, the fishing effort required to achieve the catch is examined annually to ensure that the quota level is sustainable. The quota period for all areas for the last two seasons of the Abalone Managed Fishery was 1 April to 31 March in the following year. (For simplicity, data will be reported against the quota period for the year in which it began. For example, for the 2000/2001 quota period, data will be reported as taken in the 2000 season.)

The approximate value of the Western Australian commercial abalone fishery in 2000 was $19 million. The following status reports utilise the research findings for the greenlip, brownlip and Roe's fisheries from the eight fishing areas.



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 K. Friedman 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. The quota period for all areas was 1 April 2000 to 31 March 2001.

Main fishing method

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

RETAINED SPECIES

Commercial production (season 2000):
Greenlip 189.84 tonnes whole weight
Brownlip 33.53 tonnes whole weight

Landings

Catches are currently controlled by quotas, with the TAC for the 2000 quota year being 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 189.84 tonnes whole weight (71 tonnes meat weight) and brownlip catch was 33.53 tonnes whole weight (13 tonnes meat weight) for the 2000 season (Abalone Table 1).

Fishing effort

Total effort for 2000 was 1,173 days fished for greenlip and brownlip abalone, which was similar to 1999 and within the projected effort range of 1,100–1,520 days.

Catch rate

In 2000 the catch rate was 195.7 kg whole weight per diver day (72.1 kg meat weight per diver day).

Recreational component (2000): 21% (estimate)

Based on recreational telephone surveys, recreational fishing accounted for an estimated 21% of the combined commercial and recreational catch of greenlip and brownlip abalone in 2000. See Recreational Abalone Fishery Status Report, pp. 130-34.

Stock assessment completed: Yes

Presently greenlip and brownlip abalone stocks are assessed by analysing industry data from the daily catch records, information from processors, fishers' monthly returns and data collected during specific research projects.

Industry has collaborated with Fisheries WA to develop strategies for the sustainable harvesting of stunted populations of abalone. 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 200 kg fished annually since 1994. In 2000, industry divers and Fisheries WA researchers carried out exploratory fishing at Twilight Cove to determine the distribution and density of the stocks and obtain data needed for the development of a new strategy for sustainable fishing of these particular stocks. The survey revealed that less than 5% of stocks were of legal size (140 mm+) and that stocks reaching legal size were localised to small areas.

In Area 2, the recent improvement in average meat weights of non-stunted greenlip stocks recorded in 1999 has not been sustained this season. In 2000 the average greenlip meat weight reverted to 177 g, a decrease of just over 10 g from the previous season's average when controlled harvesting of stunted stocks relieved fishing pressure (and effort) from traditionally fished stocks. The Area 2 catch rate for greenlip abalone was 54.63 kg/day in 2000. In addition to decreasing average meat weights, fishing 10% more abalone (by weight) from traditional stocks than in 1999 also saw catch rates decrease by 9 kg/day. Although lower than last season by 4 g, the generally consistent average meat weight of brownlip abalone in Area 2 does not indicate any present cause for concern.

Area 3 has utilised a combination of temporary quota reductions and closures/openings of the most productive locations in the recent past as controls to direct effort. In addition, raising minimum size limits (by industry agreement) has increased the average meat weight of greenlip abalone substantially since 1997. In 2000, the average meat weight for greenlip abalone was 231 g, the highest average recorded in the 1990s. During the season the catch of greenlip from traditionally fished grounds was decreased 3.75% by fishing 1.5 tonnes of 'stunted stock' 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 2 tonnes for the 2000 season to allow divers to target new areas for brownlip abalone. Average meat weights and diver catch records indicate that this approach has been partially effective. The average meat weight for brownlip abalone in 2000 was 274.5 g, the highest since 1995.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

The literature lists greenlip abalone as maturing between 70 and 90 mm shell length (2–4 years of age), and brownlip abalone maturing at between 90 and 130 mm shell length. However, maturity in abalone is generally related to age and not size. Despite growth varying markedly between fast-growing and stunted stocks in Western Australia, the minimum legal size limit is considered adequate. 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 (other than stunted stocks), whereas within fast-growing areas of Area 3, fishers take abalone over 153 mm shell length (5.5–7 years of age).

A new finer-scale reporting system initiated by Fisheries WA researchers in 2000 is giving a clearer picture of

Commercial Fisheries

stock utilisation and spatial variations in catches which was difficult to assess from the previous 10 x 10 mile grid reporting system. The new system will allow greater protection of breeding stocks by helping to identify and limit serial depletion of sub-stocks.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

Divers have the ability to target abalone of choice (species, sizes and quality of abalone) and do not inadvertently harvest bycatch in their normal fishing activities.

Protected species interaction: **Negligible**

The only 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 deterrence 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 (2000): $13.38 million

The estimated average wholesale price was $163/kg meat weight for greenlip and $132.50/kg meat weight for brownlip abalone. On the basis of the average prices, the greenlip and brownlip abalone fishery was worth approximately $13.38 million. These prices were significantly higher than last year's values of $120/kg meat weight and $110/kg meat weight for greenlip and brownlip abalone respectively.

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 2001 quotas for greenlip abalone (194.67 tonnes whole weight) and brownlip abalone (34.87 tonnes whole weight) should be taken within the five-year range (1994–1998) of 1,110–1,520 diver days. The effort recorded in 2000, at 1,173 days, was at the lower end of 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, the season's mean kg/day catch rates should not fall significantly below the average presented.

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.

A new industry catch reporting system, which is on a finer scale than previous systems, has been initiated by Fisheries WA for all greenlip/brownlip abalone fishing areas in the 2000 season. This data will enable 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 2001. In addition, Fisheries WA in collaboration with the industry is developing 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	229,309	1,173

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. 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 K. Friedman, A. Hancock and F. Fabris

FISHERY DESCRIPTION

Boundaries and access

The Roe's abalone fishery includes Areas 1, 2, 5, 6, 7 and 8 and extends from Steep Point (Shark Bay) in the north to the SA/WA border.

Main fishing method

Diving. 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 2000): 107.7 tonnes whole weight

Landings

Catches are currently controlled by quotas, with the TAC for the 2000 quota year being 115.9 tonnes whole weight for Roe's abalone. The catch of 107.7 tonnes whole weight for the 2000 season (Abalone Table 2) was lower than the TAC as some stock in remote locations remained unfished and there was a voluntary 4 tonne reduction in catch from Area 8 due to concerns over the size of the quota.

Fishing effort

Total effort in 2000 was 755 diver days, which was similar to 1999 and within the projected effort range of 750–950 days. Note that the full quota was not taken.

Catch rate

The Roe's abalone catch rate in 2000 was 142.63 kg whole weight per diver day.

Recreational component: 32% (estimate)

The recreational catch estimates for 2000 were approximately 32% of the total Roe's abalone catch. See Recreational Abalone Fishery Status Report, pp. 130-34.

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 is no process for assessing average meat weights within this fishery.

The population structure has now been assessed through genetic analysis (gel electrophoresis). Results demonstrate moderate levels of connection (gene flow) between populations throughout the species distribution, hence Roe's stocks can be examined on a State scale. Statewide connection occurs despite mixing within each generation occurring on a smaller scale of < 13 km. This means that, although there is gene flow across the complete range of Roe's abalone, the majority of recruitment occurs as a local event on continuous reef complexes; therefore most fisheries management and research occurs on a smaller scale by Area.

In general, assessment of Roe's stocks using daily catch records is limited to reviewing catch per unit effort (CPUE) and movement of catch and effort within the

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10 x 10 mile grid reporting system. In general these catch statistics describe a well-managed stock, as the catch was fished in two less days than was the case last year and within the acceptable catch and effort range projected last season. However, comparative assessments of changes in catches from particular locations beyond gross catch weight, e.g. 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. In 2001/2002 Fisheries WA will be working with industry to institute the development of a system which is able to monitor changes in the average meat weight or grade of catch from particular locations.

In 1999 there was some concern at the condition of the commercial stocks at specific locations at the margins of the fishery. In Area 1 there was evidence of localised depletion of Roe's abalone in the vicinity of the launch area at Twilight Cove (first 10 km east of cliffs). This concern has been somewhat allayed by an increase in the legal minimum size limit for Area 1 from 60 mm to 75 mm shell length. 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 setting for 1999 and 2000 was too high, despite a reduction in quota in 2000. The abundance of legal-sized Roe's abalone in this area has declined due to localised depletion of abalone caused by inappropriate distribution of fishing effort by less experienced fishers (on a spatial scale smaller than previously reported). In addition, some natural losses have occurred as a result of environmental factors outside of the control of the commercial fishery, for example in shallow water areas where unusually hot weather coincided with extreme low tides. In 1999, fishers in Area 8 instituted a voluntary reduction of 6 tonnes from their 30 tonne TAC. Despite arguing for a 20 tonne TAC for 2000, fishers again instituted a voluntary reduction of 4 tonnes during the season following concerns that the quota was still too high. For the 2001 season, a further reduction in quota is planned to improve the abundance of legal-sized abalone, and industry operators have traded quota units to ensure that only divers experienced in fishing these remote colonies 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.

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, 26 vessels fish for Roe's abalone, employing approximately 50 people. 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 (2000): $5.9 million

The estimated average price was about $55/kg whole weight for Roe's abalone. On the basis of the average price the fishery was worth approximately $5.9 million. The price of Roe's abalone was significantly lower last year, at $35/kg whole weight.

FISHERY GOVERNANCE

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

As a consequence of management changes in 1999, such as the removal of the daily catch limits in Area 7, the historical effort data set from the metropolitan area (Area 7) is no longer comparable with present-day effort recordings. A new estimation of the acceptable effort range for Area 7 has been calculated for this report by varying the average 1999 and 2000 catch rate (first two

years of new management arrangements) by the mean annual variation of catch rate recorded within other areas of the fishery between 1994 and 1998 (± 16.5%). With the inclusion of this variation in catch rate for Area 7, the full quota for the Roe's abalone fishery in 2001 (107.9 tonnes whole weight) should be achieved in 725–929 days of fishing. Although effort in number of days fished may vary due to variations in total catch in the more remote parts of the fishery, the season's mean kg/day catch rates should not fall significantly below 142.63 kg whole weight Roe's abalone per diver day.

EXTERNAL FACTORS

The 1999 quota period saw several major management changes within the metropolitan area (Area 7). The 100 kg maximum daily limit was removed, along with the restricted two-month fishing season; subsequently effort was greatly reduced due to larger daily catch rates and decreased diver days in the water. A new catch reporting system, which is on a finer scale than previous systems, has been initiated by Fisheries WA, with industry support, for all Roe's abalone fishing areas in the 2000 season. This will permit improved monitoring of the exploitation rates in the fishery.

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 days$^{\Delta}$
1990	105,000	117,558	1114
1991	101,000	110,334	1005
1992	105,000	112,275	942
1993	128,000	116,390	1058
1994	125,960	119,849	1146
1995	125,960	115,218	1206
1996	125,960	122,065	1176
1997	126,790	119,080	970
1998	93,960*	86,530	799
1999	119,900+	108,278	757
2000	115,900+	107,683	755

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 quota for 2000 in response to concerns over the low abundance of legal-sized abalone.

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 in 2000.
3. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar year.

Commercial Fisheries

South Coast Estuarine Fishery

MANAGEMENT SUMMARY

Consultation for the review of the South Coast Estuarine. Fishery was completed in 2000 and the new management. arrangements for the fishery have been approved.. Development of the new legislation is under way and it is. anticipated that the new management plan for the fishery. will be in place at the beginning of 2002..

The new arrangements will not result in dramatic changes. to the fishery, but will define permitted fishing methods,. with limits. 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 1 April 2001, with the negotiation. phase to be completed by 31 December. Prior to the. recent VFAS there were 27 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

Fishing Boat Licence Condition 19.
Commercial Fishing Licence Condition 17.
Various orders under Section 43 of the *Fish Resources Management Act 1994* (closed waters and permitted gear)

Consultation Process

Agency–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 Fisheries WA 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, Parrys Inlet, Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Culham Inlet, Oldfield Inlet, Torradup Inlet, Stokes Inlet and Jerdacuttup. The level of access stood at 31 fishing units in April 2000.

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 comprises many finfish species. This report presents specific data for three of the most important estuarine fish stocks, namely black bream, cobbler and King George whiting.

Main fishing method

Gillnet/haul net.

RETAINED SPECIES

Commercial production (season 2000): 252 tonnes

Landings

The total reported landings of 252 tonnes from the south coast estuaries incorporate molluscs and crustaceans as well as finfish, and include the following catches of key target species:

Cobbler	62.0 tonnes
Black bream	30.0 tonnes
Australian herring	28.5 tonnes
Sea mullet	21.8 tonnes
King George whiting	19.4 tonnes

The reported catch from south coast estuaries shows a stable history between 1993 and 1997, with an increase in catches reported in 1998 followed by a decline in 1999. The reported 2000 catch figure has decreased from the 1999 levels (South Coast Estuarine Figure 1). In 2000, higher catches were reported from Princess Royal Harbour, Gordon Inlet and Beaufort Inlet, which each showed an increase of more than 1 tonne over 1999 levels. Decreased catches compared to the previous year were recorded from Oyster Harbour, Wilson Inlet, Broke Inlet and Stokes Inlet. The 2000 reported catches were similar to the 1999 catches for Irwin Inlet and Oldfield Inlet. Catches were reported from the Jerdacuttup Lakes, Culham Inlet, Hamersley Inlet and Torradup Inlet during 2000 after several years without fishing activity. There was no fishing reported in Parrys 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 cobbler, King George whiting, sea mullet, Australian herring and black bream.

Black bream: In 2000, the reported catches of black bream in south coast estuaries increased from 1999 levels (South Coast Estuarine Figure 2). The greatest catches in 2000 were reported from Beaufort Inlet, Stokes Inlet, Gordon Inlet and Wilson Inlet.

Cobbler: During 2000, the catch was concentrated in three south coast embayments/estuaries, namely Wilson Inlet, Oyster Harbour and Princess Royal Harbour, with the highest catches (76%) 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 2000 catches from Wilson Inlet decreased by 9 tonnes from the 1999 catch (South Coast Estuarine Figure 3).

King George whiting: During 2000, the majority of catches were reported from Wilson and Irwin Inlets. The King George whiting catch from Wilson Inlet for 2000 continued to decline from the high 1998 level but was still above the catch 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 is reflected for the overall King George whiting catch from 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 difficult to determine targeted effort from this measure.

Since 1992, the fishing effort in the SCEF has declined (South Coast Estuarine Figure 1). In particular, Wilson Inlet and Oyster Harbour are reporting effort declines for 2000 compared to the previous year.

Catch rate

CPUE has closely followed the trend in catches overall in south coast estuaries. The catch rate reported for the south coast estuaries in 2000 was similar to 1999 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 *(Acanthopagrus butcheri)* 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*. However, assessments for other south coast estuarine stocks are unavailable at this time.

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 being harvested sustainably.

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 which, although at the maximum end of the historical range, has been relatively steady during the 1990s. This indicates that the stock is being fished sustainably.

Exploitation status: **Fully exploited**

Breeding stock levels: **Not assessed**

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*. Since 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: Between 1997 and 1999, the Wilson Inlet catch of King George whiting surpassed the catch in other Western Australian estuaries. These high commercial catches of King George whiting from the inlet indicate a successful 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 interact with these fisheries.

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 38 fishers during the 2000 fishing season.

Commercial Fisheries

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): $1.06 million

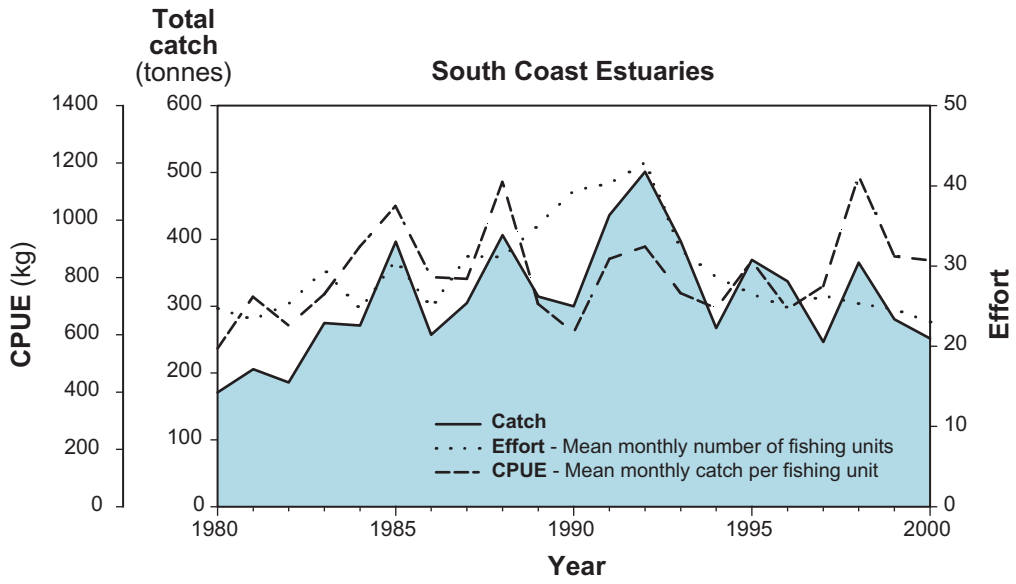
FISHERY GOVERNANCE

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.

EXTERNAL FACTORS

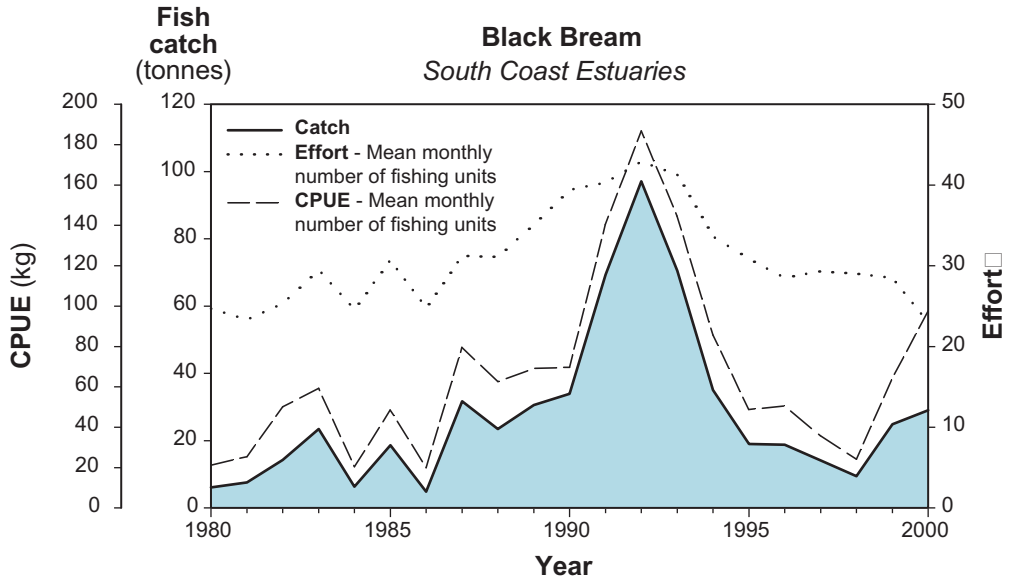
Variation in fish abundance in these south coast estuarine stocks is largely driven by environmental influences on recruitment. In the South Coast Estuarine Fishery this is further complicated by the natural closure of some estuaries and the need for human intervention to breach estuarine bars, mostly for a range of reasons related to estuarine amenity coupled with ecosystem 'health'. These factors, which are outside the control of Fisheries WA, often have a dominant influence on the catch and effort from year to year.



SOUTH COAST ESTUARINE FIGURE 1

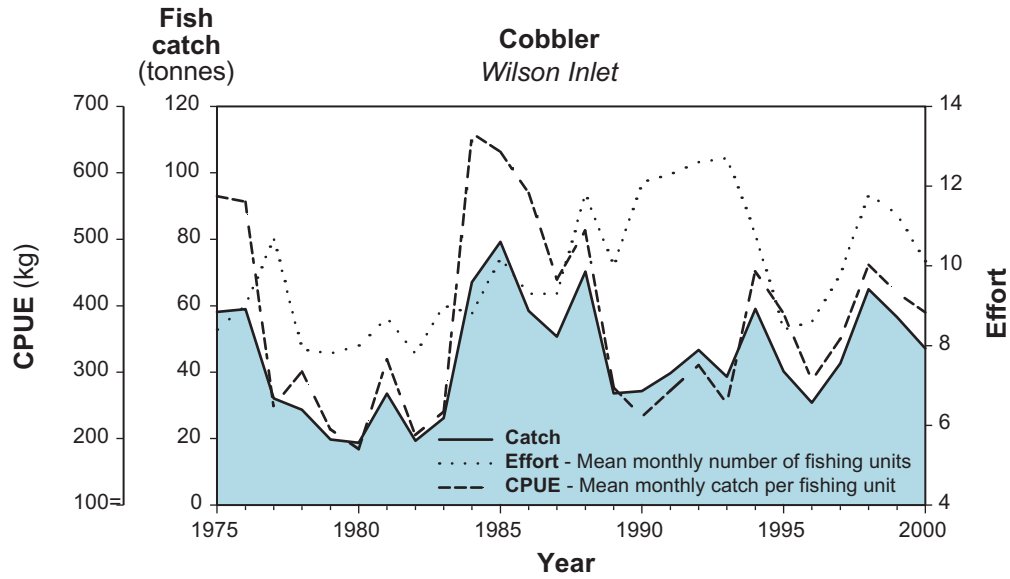
The annual catch, effort and catch per unit effort (CPUE) for the South Coast Estuarine Fishery over the period 1980–2000.

Note that prior to 1993, the south coast estuarine catch figures included King George Sound, which was not strictly 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

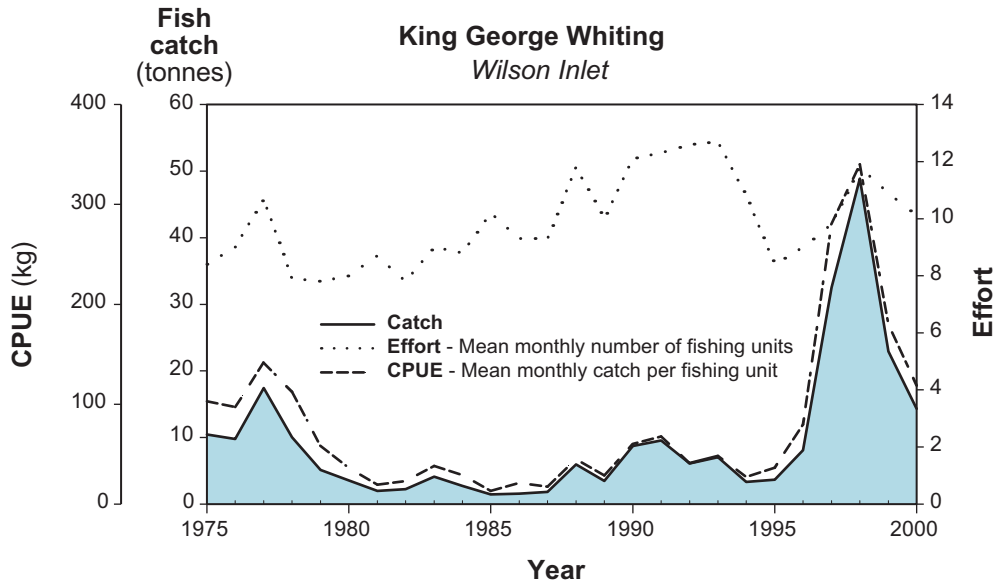
The annual catch, effort and catch per unit effort (CPUE) for the black bream *(Acanthopagrus butcheri)* fishery in south coast estuaries over the period 1980–2000.



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 1974–2000.

Commercial Fisheries



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 1974–2000.

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, by fishing teams using a beach seine net from small boats. Salmon may also be taken outside this period, particularly on the south coast.

There are two managed salmon fisheries:

- The South Coast Salmon Managed Fishery permits authorisation holders to operate from specifically 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 through priority of netting rules.

Market price and transport costs play a major role in reducing the profitability of this fishery, and many industry members are investigating ways of improving fish handling and value-adding techniques to improve the profit margin. This subject will be listed for discussion at this year's annual meeting of the Australian Salmon and Herring Industry Advisory Committee.

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
Agency–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 April 2000, 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'*. 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.

Main fishing method

Beach seine.

RETAINED SPECIES

Commercial production (season 2000): 2,283 tonnes

Landings

The total State catch for the year was 2,283 tonnes, which was about 500 tonnes more than the previous year (Salmon Figure 1). The 2000 south coast commercial catch of Australian salmon was 2,282.6 tonnes. This catch was taken from the designated salmon beaches, with a minor catch component from the estuaries. Between March and May 2000, the south coast catch of salmon was 2,136 tonnes. There were 133 tonnes caught in the 'back run' between June and December. The January and February catch was 13 tonnes, which would have been part of the back run from 1999.

The highest proportion of the 2000 south coast catch (1,459 tonnes or 63.9%) was taken from the central sector of the fishery (east of Albany to Cape Riche). A total of 570 tonnes (25%) was taken in the western region of the fishery (west of Albany to Windy Harbour). Fewer fish (254 tonnes or 11.1%) were taken from the eastern sector of the fishery (from Cape Riche to the east).

The south-west and west coast catch for 2000 totalled less than 1 tonne, apparently due to limited migration to the west coast which is usually related to a strong Leeuwin Current.

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 2000, the average catch per fishing team was 126.8 tonnes for the south coast, and effectively zero for the west coast where less than 1 tonne was taken overall.

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 very low commercial west coast catch in 2000, there would have been little 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*. Before an accurate determination of the status of the stock can be completed more complex analyses are needed to account for the environmental impacts on recruitment. However, there are insufficient resources available to progress this aspect of the research.

Exploitation status: Fully exploited

Breeding stock levels: Adequate

Current commercial catches indicate 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 nature of the fishery. Any further 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 on prey species. Overall, the ecological impact of the fishery is assessed as low.

Habitat effects: Negligible

No habitat impacts occur as the fishery operates seine nets only on sandy surf beaches.

Commercial Fisheries

SOCIAL EFFECTS

The south coast fishery involved an average of about 67 fishers and the south-west and west coast fishery involved an average of about 13 fishers during the 2000 fishing season.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000): $1.14 million

The south coast catch in 2000 was received by five processors: Albany Bait Producers, Princess Royal Seafoods, Allerton's Bait Supply, Bremer Bay Fish Processors and Bevan's Fish Supplies.

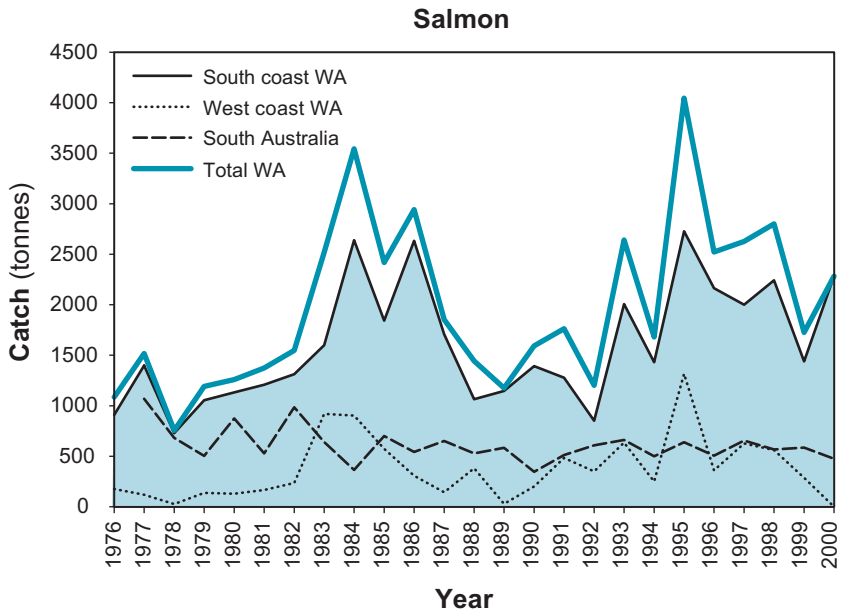
FISHERY GOVERNANCE

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.

EXTERNAL FACTORS

The minimal catch of Australian salmon from the west coast during 2000 is thought to be associated with the behaviour and strength of the southward-flowing Leeuwin Current, which was relatively high during the autumn period of 2000. It is believed that the salmon avoid the warmer waters and remain offshore where they are not vulnerable to commercial and recreational fishing gear.



SALMON FIGURE 1

Australian salmon catches for South Australia and Western Australia for the period 1976 to 2000. 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.

Herring trap nets may only be used by specific endorsement holders on individually assigned south coast beaches. There is a closed season (10 February to 25 March each year) which coincides with the peak salmon season along the south coast. Herring caught in Cockburn Sound are managed under the Cockburn Sound (Fish Net) Managed Fishery. Apart from these restrictions, herring may 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.

Herring is also a very important recreational fishing resource. In recognition of this, the South Coast Herring Fishery Voluntary Fisheries Adjustment Scheme was introduced for the period February 1998 to 30 June 2000. In this process, fishermen were able to offer the surrender of their herring trap endorsement to the scheme and be compensated by a negotiated amount. This scheme removed a total of 10 endorsements.

Governing Legislation/Fishing Authority

Fisheries Notice no. 478 (Section 43 order)
Condition 42 on Fishing Boat Licence

Consultation Process

Australian Salmon and Herring Advisory Committee
Agency–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 are 13 licensed fishing teams (most of whom are also Australian salmon fishers) permitted to take herring using 'G' trap nets set on 12 nominated south coast beaches. 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 and beach seine.

RETAINED SPECIES

Commercial production (season 2000):
State 818 tonnes
South coast 705 tonnes

Landings

The total catch of Australian herring for the State in 2000 was 818 tonnes, an increase of approximately 53 tonnes from the 1999 catch (Herring Figure 1). The south coast catch was 705 tonnes, which comprised 86% of the total State catch. The south coast landings included 676 tonnes from the ocean (668 tonnes from trap nets and 8 tonnes from other gear) and 28.5 tonnes from estuaries and embayments. The south coast catch to the end of May 2000 (traditionally the end of the trap net fishing season) was 686 tonnes, or 97% of the annual south coast catch. The west coast catch was 113 tonnes and included 35.2 tonnes from the ocean, 8.5 tonnes from estuaries and 69.6 tonnes from embayments (Geographe Bay and Cockburn Sound).

Fishing effort

There are 13 south coast fishing teams with access to the trap net fishery. These fishers exert targeted effort on Australian herring. However, most licensed commercial fishers are permitted to take Australian herring in any Western Australian waters under their basic fishing boat licence wetline entitlement.

Catch rate

The average catch per south coast trap net fishing team during 2000 was 54.2 tonnes, which is an increase from 1999 levels.

Recreational component: Approx. 10% (south coast)

Recreational catch and effort figures are not available for 2000. 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. The Australian herring populations in all regions appear to be at satisfactory levels, and above a prudent biological limit reference

Commercial Fisheries

point of 40% of the total virgin biomass (Quinn and Deriso 1999, p. 474). Further analyses are continuing to improve model estimates and to reduce uncertainty around some of the results of the model.

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. Increasingly, evidence suggests that the influence of factors other than fishing may be largely responsible for fluctuations in the catch and, therefore, breeding stock levels (see 'External Factors').

NON-RETAINED SPECIES

Bycatch species impact: **Low**

The main south coast fishery operates primarily through fixed trap nets on 12 beaches which are manned daily during the short 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 interaction with protected species.

ECOSYSTEM EFFECTS

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

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

SOCIAL EFFECTS

The south coast trap net fishery involved an average of 41.5 fishers during 2000. Additional employment is created in the processing and distribution networks and retail fish sales sectors.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000):
$0.27 million

This estimate is for the south coast trap net fishery only

FISHERY GOVERNANCE

Acceptable catch range:
South coast 450–1,200 tonnes

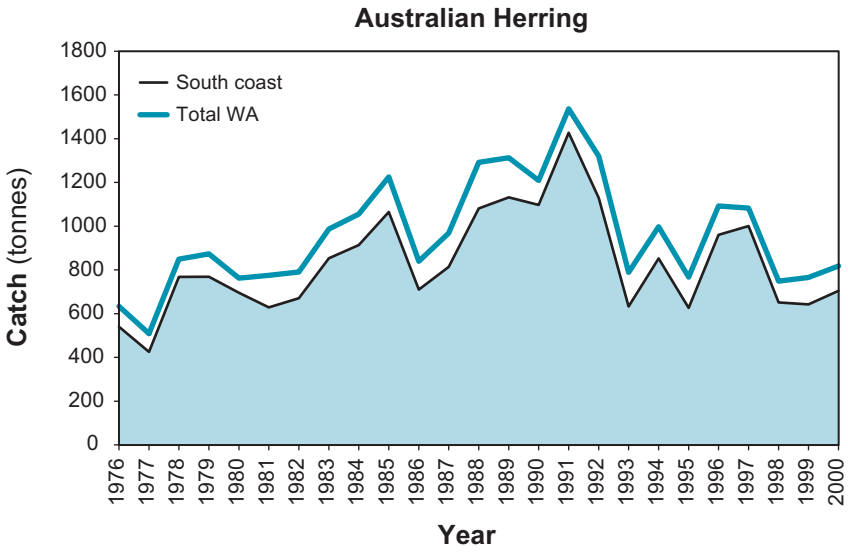
The acceptable catch range for the south coast Australian herring trap net fishery under the current management regime is 450–1,200 tonnes (rounded to the nearest 50 tonnes). This projection is derived by double exponential smoothed forecasting of the past annual catches to 1998 and the variation of 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.

EXTERNAL FACTORS

As is the case with salmon, a proportion of the Australian herring 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).

At present an FRDC-funded research project is focused on the development of a juvenile index of recruitment for Australian herring that may be used to predict to future catches. This research will be completed by 2002. A second FRDC-funded research project is using time-series analysis of historic commercial catches of Australian herring to predict future catches and is also due for completion by the end of 2002.



HERRING FIGURE 1

Catches of Australian herring from the south coast and the total Western Australian catch for the period 1976 to 2000.

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 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.

Commercial fishing is controlled by the setting of total allowable catches (TACs) that represent the combination of transferable quota units within each of the five zones. With the exception of Zone 4 (Esperance region), TACs were reduced to zero for the 2000/2001 season to allow continued rebuilding of the stock. The TAC for Esperance was initially set at 1,060 tonnes, but was increased to 1,300 tonnes (for a 15-month period) following a change to the end date of the season, which was extended by three months to 30 June 2001. The season for the South Coast Purse Seine Managed Fishery will now run 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

Consultative Process

Purse Seine Management Advisory Committee
Agency–industry meetings

RESEARCH SUMMARY

Data for setting catch quotas is derived from fishery-independent spawning biomass surveys, quota returns and biological monitoring of the catch composition.

Research during 2001 will focus on fishery-independent spawning biomass surveys, which will continue for the next five years as part of an FRDC-funded project to examine regrowth of the pilchard stocks in Western Australia. Detailed monitoring of catches will continue. Biomass surveys and analysis of catches together allow the annual review of stocks in each major zone and compilation of the following status report.

Commercial Fisheries

South Coast Purse Seine Managed Fishery Status Report

Prepared by 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 boundaries of the Bremer Bay zone are Cape Knob and Point Charles. The boundaries of the Esperance zone are Point Charles and the WA/SA border. A further zone between Cape Leeuwin and Cape D'Entrecasteaux exists, but, to date, has not been significantly fished.

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 2000): 988 tonnes

Landings

Pilchard *(Sardinops sagax)* is typically the dominant species in this fishery, and the only species subject to TACs; smaller quantities of maray *(Etrumeus teres)* and anchovy *(Engraulis australis)* are also retained. Yellowtail scad *(Trachurus novaezelandiae)* are sometimes retained, but market demand is limited and catches are normally only retained when pilchards are scarce.

Using data from the quota returns, the catch of pilchards *(Sardinops sagax)* on the south coast in 2000 was 988 tonnes, with all but 5 tonnes of this from the Esperance zone (South Coast Purse Seine Figure 1). Five tonnes were caught at Bremer Bay as part of the 1999/2000 quota, and no commercial landings were made at Albany. Note that annual TACs for these latter two regions were set at 0 tonnes for the 2000/2001 season.

(In future, following the change in the season dates, catches will be reported by financial year rather than calendar year, to match the quota period.)

Fishing effort

Albany zone: Following the 1998/99 pilchard mortality event, the fishery was set a TAC of 0 tonnes for the period 1 April 2000–31 March 2001.

Bremer Bay zone: As for Albany.

Esperance zone: The recorded number of CAES days in 2000 was about 453, 28% greater than in 1999.

Catch rate

Albany zone: Not applicable.

Bremer Bay zone: Not applicable.

Esperance zone: The 2000 catch rate of 2,171 kg/day, an increase on the 1999 catch rate of 1,224 kg/day, represents a return to the catch rates recorded in 1996 and 1997 (~1,940 kg/day). 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. Estimates of quantities of pilchards killed in the 1998/99 mass mortality indicate that 70% of the stock died. The assessment model predicts that in 2001 there will be a small increase in pilchard biomass at Albany, a small decrease at Bremer Bay and a substantial increase at Esperance. The marginal changes at Albany and Bremer Bay indicate that the recovery of the stocks in these regions has initially been slow. Egg surveys during 1999 indicated that the Albany stock is still less than 10% of the size of the virgin stock, while the Bremer Bay stock is still around the 20% level. In contrast, the model data indicate that the biomass in Esperance is growing quickly, with an increase from 41.3% to 56.4 % of virgin biomass. During 2000, some recruitment was recorded within each zone, with pilchards less than 4 years old dominating the catch. At Esperance, where sample sizes were comparable to those in past years, recruitment was very strong. Smaller sample sizes at both Bremer Bay and Albany preclude comments on the magnitude of recruitment. However, the data clearly show that recruitment to these regions has occurred. Thus, although it is clear that recruitment has occurred to both Bremer Bay and Albany, whether this has been at levels sufficient to produce a significant change in stock size cannot be determined at this time. The slow rate of recovery suggested by the model for Albany and Bremer Bay can be partly explained by the age structure of pilchards in each region. The loss of older age classes translates as a decrease in average weight of fish and a concomitant decrease in egg production; these factors explain the initially poor levels of recovery predicted for Albany and Bremer Bay. Given that the age structure at Esperance is similar to that in the other two south coast regions, in that it is dominated by fish less than 4 years old, the model prediction of a rapid recovery at Esperance may be somewhat unrealistic. The age structure of the catch indicates that a substantial proportion of the stock consists of fish spawned after the 1998/99 mass mortality. Thus, a large number of pilchards that have contributed to the recovery of the stock at Esperance were too young to reproduce; the stock thus missed out on the 'compounding effect' of allowing at least some egg production prior to capture.

Albany zone: The assessment model indicated that the biomass at Albany has been declining since 1994 and, as of December 1998, was at its lowest recorded level. Following the mass mortality, the stock was considered to be critically low and in a severely depressed state. There has been no unequivocal evidence to indicate that substantial recruitment has occurred in the Albany region,

which is a prerequisite for recovery of the stock. Thus, the model indicates that the stock is still at a very low level.

Bremer Bay zone: As with the Albany stock, the integrated model indicated that the Bremer Bay stock had been declining since the mid-1990s. Following the 1998/99 mass mortality, the Bremer Bay stock appeared to be severely depressed. Research samples collected in 2000 have shown high proportions of recruit-aged (1- to 2-year-old) pilchards in the Bremer Bay region. However, the numbers of samples collected were insufficient to allow determination of the magnitude of this apparent influx of recruits.

Esperance zone: As in 1999, Esperance again had a high level of recruitment in 2000. The relatively stable nature of the biomass at Esperance can be attributed both to fewer years of poor recruitment than in the other south coast regions, and to a history of much lower exploitation rates. The reasonable catch rates at Esperance were reflected in the strong production of nearly 1,000 tonnes. Current exploitation rates are less than 10% of the spawning biomass and appear to be sustainable. However, because there continue to be uncertainties over the level of interchange of pre-recruit-aged pilchards between the south coast zones, the level of exploitation at Esperance will likewise continue to be kept at a precautionary level. No significant change to the TAC is expected for 2001.

Exploitation status:
Overall south coast stock fully exploited

Breeding stock levels: **Depleted**

Breeding stock for the entire south coast pilchard population decreased by approximately 70% due to the disease event in the first two months of 1999. Estimates of vulnerable biomass (which closely reflects spawning biomass) at the end of 2000 were derived from the integrated model and are as follows: Albany 1,051 tonnes (630–1,607 tonnes), Bremer Bay 3,301 tonnes (2,784–5,202 tonnes), Esperance 22,563 tonnes (12,315–43,214 tonnes). The total estimated spawning biomass across the south coast was 26,915 tonnes, which represents 35% of the virgin biomass, a small increase from the previous year's level of 28%. Although the breeding stock levels at Albany and Bremer Bay remain depleted, for the south coast as a whole the breeding stock appears to be recovering.

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**

Several species of seabirds, pinnipeds, cetaceans and protected sharks are attracted to schools of pilchards and other small pelagic fish, but there is currently no evidence to indicate any interaction between these and the purse seine industry.

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. 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. It should be noted, however, that in 'normal' circumstances the quota for pilchards is set at 10–15% of the spawning biomass, thus leaving 85–90% available to natural predators.

Habitat effects: **Negligible**

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

SOCIAL EFFECTS

The 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 on pilchards have shut down for extended periods. These effects were felt mainly in the Albany and Bremer Bay regions. In Esperance, where an economically significant TAC has remained, there were five vessels working in 2000, employing approximately 15 staff (skipper and crew). The catch from these was directed through two factories, which in turn employed approximately 10–20 casual staff as well as 6 full-time staff, including the owners.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000):
$0.84 million

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 2000 was $0.84 million (988.5 tonnes at an average price of $850/tonne), marginally higher than last year's $0.7 million.

FISHERY GOVERNANCE

Acceptable catch (or effort) range:
Effort not available

The south coast purse seine fishery is still in a state of flux owing to implementation of measures to protect the stock following the 1998/99 virus epidemic. The resulting changes in the way the fleets operate in each region have been significant, particularly at Albany and Bremer Bay where fishers have been requested to modify

Commercial Fisheries

their 'normal' fishing patterns so as to ensure continuity in supply of samples for research purposes. In effect, the quotas set for Albany and Bremer Bay in 2001/02 are 'research' quotas to ensure the stock rebuilding process can be monitored. For these reasons, a projection of the effort level required to land the TAC at each region is not available.

The quotas for the 2001/02 season are as follows:

South coast total	1,175–1,350 tonnes
Albany zone	50–100 tonnes
Bremer Bay zone	100–200 tonnes
Esperance zone	1,000–1,200 tonnes

EXTERNAL FACTORS

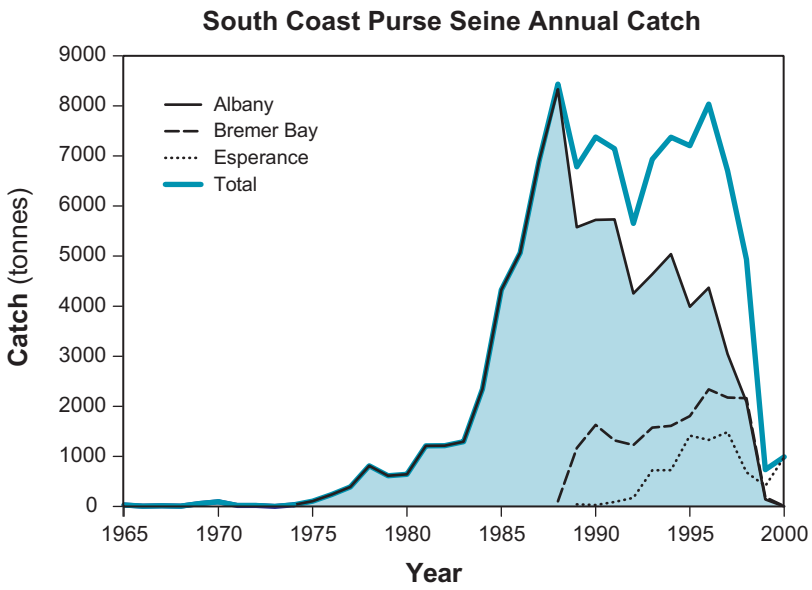
Following the loss of stock due to the mass mortality event, serious concerns about the sustainability of pilchard stocks in Western Australia have continued. In particular, these concerns led to TACs of zero tonnes for Albany and Bremer Bay during the 2000/2001 quota season (1 April 2000 – 31 March 2001). 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. Although the stock is likely to recover, the rebuilding process is expected to be relatively slow and the future viability of the fleet is in question. The short- and medium-term viability of the purse seine fisheries off southern Western Australia currently remains a problem. The gap left in the angling bait market by the decreased volume of Western Australian pilchards has been filled by *Sardinops sagax* imported from overseas, which presents a degree of disease risk to the local pilchard stocks.

Environmental factors such as Leeuwin Current flow possibly associated with global warming 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.

SOUTH COAST PURSE SEINE TABLE 1

Processing details (in tonnes) from Albany, Bremer Bay and Esperance for 2000.

Product	Albany	Bremer Bay	Esperance	Total south coast
Trays	0	5.0	830.5	835.5 (84.5%)
IQF	0	0	122.6	122.6 (12.4%)
Pet/tuna food	0	0	30.5	30.5 (3.1%)
Total	0	5.0	983.6	988.6



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 (as far north as Shark Bay) through two complementary management plans, described below.

The threat of over-exploitation and the potential for activation of latent effort remain important issues in both the southern and western fisheries. Also of concern is the ability of fishers outside of the two managed fisheries to take sharks by wetlining, pot hooks and other methods, as well as the latent effort in these other fisheries. High demand for shark fins has led to reports of increased activity and targeting of sharks by wetliners (i.e. wetline fishery operators).

Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF): During 1997, the Minister for Fisheries approved the implementation of a five-year management package, beginning in 1997/98, which included phased effort reductions for this fishery. This package was developed by the WA Demersal Gillnet and Demersal Longline Fishery Management Advisory Committee (WADGDLFMAC) in response to an identified need to restore and maintain targeted shark stocks at 40% of their virgin biomass. In the 1999/2000 season, the fishery implemented the third phase of scheduled effort reductions. The results of scientific monitoring indicate that the reductions made to date have not increased the spawning biomass of the whiskery shark stock. A review of the current five-year management package is expected to be completed during 2001/2002, with another package to be implemented after consultation with industry.

In response to concerns regarding the at-sea 'finning' of sharks by both State and Commonwealth commercial fishing sectors, regulations were introduced under the *Fish Resources Management Act 1994* to prohibit the removal of fins from sharks and the discarding of the associated carcass at sea. The new regulations permit the removal of gut and head at sea, but all other parts of the sharks must be retained and brought ashore.

Having developed good stock assessment models, Fisheries WA will continue to monitor the effectiveness of management arrangements in the fishery in close association with the WADGDLFMAC.

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 unit stock 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 south coast fishery also apply to the west coast fishery, and the declaration of a management plan was an important part of the management of the key species throughout their distribution.

Fisheries WA plans to progress management of this fishery from interim managed fishery status to managed fishery status upon completion of what has been a lengthy objections process.

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 Managed Fishery Licence

Consultation Process

Western Australian Demersal Gillnet and Demersal Longline Fisheries Management Advisory Committee
Agency–industry meetings

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, has provided a detailed basis for managing the fishery. The extensive information from these studies has been incorporated in two FRDC final reports, and the data sets incorporated into the Fisheries WA research data records. A new 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. When management was introduced a net length was set at 600 m, but periodic effort reductions had brought this down to 378 m by 1998/99. During the 1999/2000 season, units were further

Commercial Fisheries

reduced to 270 m of 20-mesh drop net or 324 m of 15-mesh drop net. The financial effects of net-length reductions, aimed at reducing effort directed at whiskery sharks, were partly offset by southern fishery operators being permitted to use 20-mesh drop nets, which increased their catch rates of other shark species. In the 1999/2000 season there were 57 JASDGDLF licences, of which 35 were active.

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 between Steep Point (26°30' S) and North-West Cape has been prohibited since 1993 to protect breeding stocks of whaler sharks. Under this 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 being delayed by a number of legal challenges to the proposed unit allocation. Access to the WCDGDLIMF during 1999/2000 was limited to 26 licences which had powered net drum endorsements, and productive catch returns were received from 15 vessels.

Main fishing method

Demersal gillnet

RETAINED SPECIES

Commercial production (season 1999/2000):
All sharks 1,257 tonnes
Key species 785 tonnes

Landings

The total shark catch of 1,257 tonnes from these fisheries comprised 829 tonnes from the JASDGDLF and 428 tonnes from the WCDGDLIMF, made up as follows:

JASDGDLF:

Whiskery shark†	159 tonnes
Dusky whaler†	250 tonnes
Gummy shark†	240 tonnes
Other shark	180 tonnes
Total shark	829 tonnes

WCDGDLIMF:

Whiskery shark†	51 tonnes
Dusky whaler†	85 tonnes
Other shark*	209 tonnes
Total shark	428 tonnes

† Original key target species subject to stock assessment.
* This 'other shark' catch includes 139 tonnes of sandbar (thickskin) shark. This species was not previously reported separately, but is now 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 comprised of finfish species which are retained for sale. In 1999/2000, scalefish landings totalled 134 tonnes in the JASDGDLF and 82 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 Figures 1-3.

Sharks are also caught by other user groups apart from the two dedicated fisheries, and these catches are reported here for the first time because of their importance to an understanding of the true exploitation rates. During 1999/2000, vessels licensed in other managed fisheries operating in the same overall area (i.e. between North West Cape and the SA border) reported catches of shark and ray totalling 87.5 tonnes. A further 'wetline' catch of 26.5 tonnes of shark and ray was taken by vessels without access to managed fisheries.

Fishing effort

JASDGDLF:	169,116 kilometre gillnet hours
WCDGDLIMF:	113,649 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 5).

Catch rate

See 'Stock assessment' below.

Recreational component: < 5%

The estimated recreational catch between Augusta and Kalbarri, from a Fisheries WA 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, namely whiskery shark *(Furgaleus macki)*, dusky whaler *(Carcharhinus obscurus)* and gummy shark *(Mustelus antarcticus)*. Owing to changes in the target species of the west coast fishery, the procedure that determines the species composition of the southern and west coast demersal gillnet shark catch was modified this year and catches have been recalculated from 1994/95 onwards. As a result of these changes, the catches of these species are estimated to be slightly lower than previously reported. A summary of the results of the stock assessments follows.

Whiskery shark: Total whiskery shark landings increased by 13% in 1999/2000 to 210 tonnes, which was within the 'acceptable catch range' forecast last year. The catch rate of the species remained relatively stable over the last 12 months. Whiskery shark catch fell by 8% in Zone 2 of the JASDGDLF, due mainly to a significant decline in fishing effort. Despite a reduction in nominal effort, whiskery shark landings increased by 15% in Zone 1. Overall there was a 7% increase in whiskery shark catch in the JASDGDLF and 25% in the WCDGDLF, where there was also a noticeable decline in nominal effort. Catch rates of whiskery sharks decreased substantially during the late 1970s and early 1980s but since the late

1980s have declined only slowly and have stabilised in recent years. Estimates of the current level of total biomass (relative to the virgin level) range from 3% to 40%, with the best estimate at 26%. At this level of biomass, the whiskery shark stock is considered to be exploited above the optimum level, and at current levels of fishing effort has a less than 7% probability of achieving the biomass target (40% of virgin) set by the WADGDLFMAC by 2010.

Dusky whaler: At 335 tonnes, the total catch of dusky whalers in 1999/2000 was 7% less than that of the previous year and was below the acceptable catch range forecast last year, due to an over-estimate of the acceptable catch range in last year's report. Whilst dusky shark catches in Zone 1 of the JASDGDLF increased by 3%, catches in Zone 2 and the WCDGDLF declined by 9% and 20% respectively. Catch rates were calculated to have risen by 10% in Zone 1 and fallen by 3% in Zone 2 and 14% in the WCDGDLF. Given that Zone 1 is the main area of dusky whaler recruitment, these regional catch rate figures suggest that recruitment continues at a reasonable level. However, although the weight of sharks landed in Zone 1 increased slightly during 1999/2000, the catch was reported by fishers to be made up of fewer, larger individuals, supporting their views that recruitment over the last three years has been low. This lower level of recruitment may indicate a reduction in the breeding stock of mature females, and is a cause for concern, noting that there appears to be an unreported catch of these animals in the offshore Commonwealth-managed longline fisheries.

Gummy shark: The total catch of gummy sharks in 1999/2000 was 240 tonnes, 22% lower than in the previous year and slightly below last year's 'acceptable catch range', however this range is considered to have been over-estimated in last year's report. A significant reduction in effort in Zone 2 of the JASDGDLF, where most gummy shark is caught, is thought to account for most of this reduction in catch. A 25% decline in gummy shark catch rate is, however, of some concern, although it is too early to say whether this is likely to be a trend. The previously stable catch rates and the results of previous stock assessments indicate that the stock is likely to be above the target level. However, given the fall in the catch rate and the imminent conclusion of the five-year management cycle, a new stock assessment needs to be conducted as soon as possible. The results of the 1998 assessment, the most recent available, estimated that the current level of biomass (relative to 1975) ranged from 23% to 60%, with the best estimate at 42.7%. At this level, the stock was considered to be just above the target level set by the WADGDLMAC, and fully exploited. The effort targeted at gummy shark in 1999/2000 was calculated to be 65% of 1993/94 level, on which the last stock assessment was based. At this level of effort, it was calculated that there is a 72% probability that the gummy shark biomass target will be met in 2010.

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, but causing some over-exploitation of the whiskery shark stock.

Breeding stock levels: **Adequate**

Current fishing levels are permitting the maintenance of adequate breeding stock levels of dusky whaler and gummy shark, but are causing a gradual decline in breeding stock levels of whiskery shark.

NON-RETAINED SPECIES

Bycatch species impact: **Low**

There is some discarded bycatch of unsaleable species of sharks, rays and scalefish, but this is considered to be of relatively minor impact to those stocks.

Protected species interaction: **Not assessed**

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 target species' habitat. 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. The physical impact of the gear on the bottom is minimal.

SOCIAL EFFECTS

Estimated employment during 1999/2000 in the JASDGDLF was 50 skippers and crew, and in the WCDGDLIMF 20.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (1999/2000): **$5.1 million**

JASDGDLF:	$2.7 million (shark and scalefish)
JASDGDLF:	$850,000 (shark fins)
WCDGDLIMF:	$1.2 million (shark and scalefish)
WCDGDLIMF:	$350,000 (shark fins)

The value of the fisheries was similar to last year. The decline in total shark landings during the 1999/2000 season was offset by dramatic increases in the value of shark fins to between $25/kg and $120/kg, depending on fin size and species. As fishers are not able to record fin weights on their catch returns, an average of 3% of sharks' whole weight and a conservative price of $35/kg were used to estimate fin values. Categories of shark which do not have saleable fins were excluded from fin valuation.

FISHERY GOVERNANCE

Acceptable catch range: **Key species 725–975 tonnes**

Acceptable catch ranges for the key species are as follows:

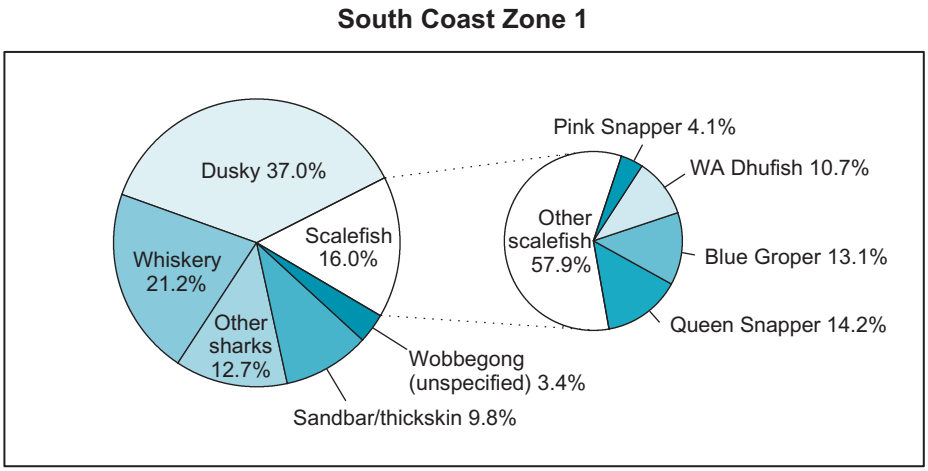
Whiskery shark	175–225 tonnes
Dusky whaler	300–400 tonnes
Gummy shark	250–350 tonnes

These acceptable ranges are based on the revised catches for the last 10 years, and hence are lower than previously shown.

Commercial Fisheries

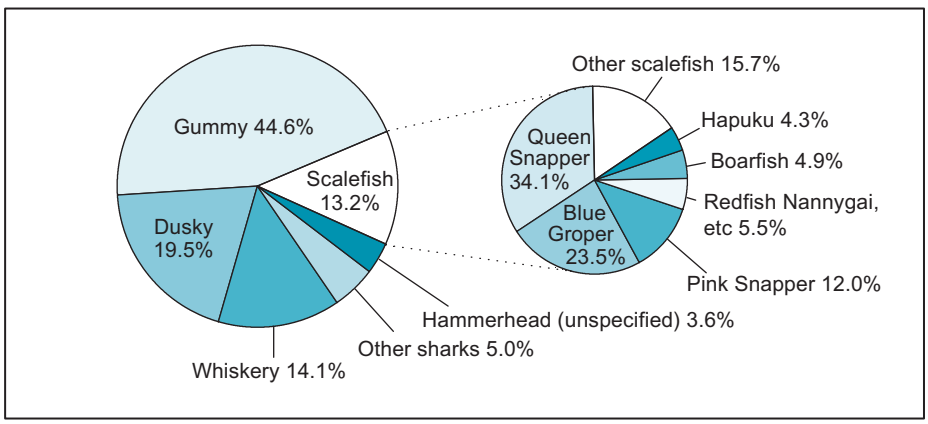
EXTERNAL FACTORS

The current level of exploitation of dusky whaler sharks appears to be sustainable provided the exploitation of mature animals does not exceed 4% annually. However, continued anecdotal evidence suggests that significant numbers of large dusky whaler sharks are now being taken by other user groups, including Commonwealth-managed tuna longlining vessels, illegal foreign vessels and WA-licensed fishing vessels operating under their general 'wetlining' access. There is also anecdotal evidence that recruitment may be declining in recent years. There is thus an urgent need to quantify the take of sharks by the non-WA vessels, determine the size and age structure of the overall catch and update our estimates of the exploitation rate of juveniles taken in the target fisheries, in order to provide a basis to determine the true current exploitation rate of the dusky whaler stock.



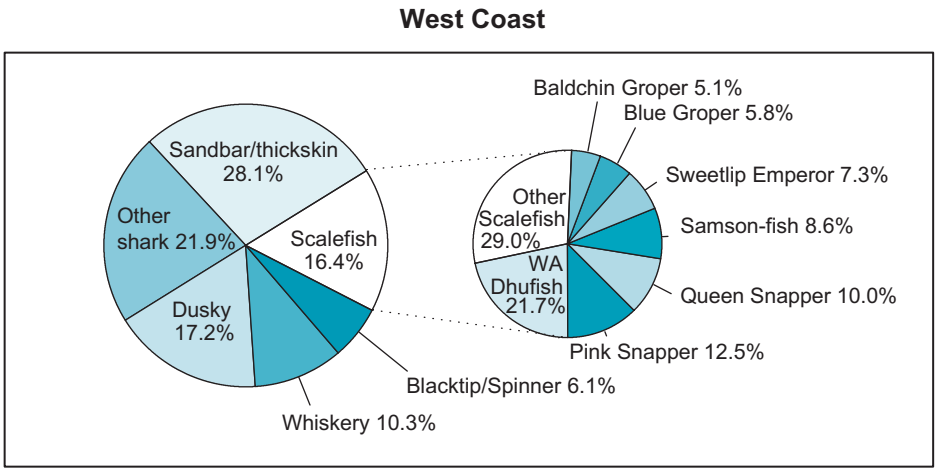
DEMERSAL GILLNET AND LONGLINE FIGURE 1

Joint Authority Southern Demersal Gillnet and Demersal Longline Interim Managed Fishery Zone 1 catch species composition for 1999/2000.



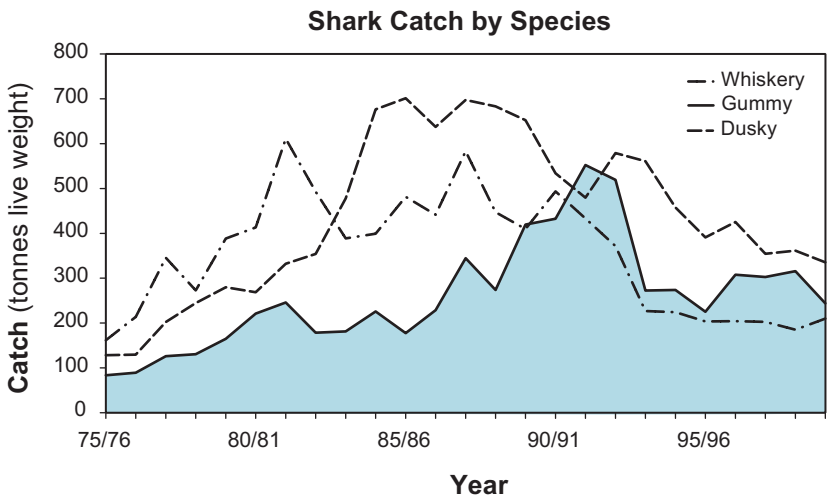
DEMERSAL GILLNET AND LONGLINE FIGURE 2

Joint Authority Southern Demersal Gillnet and Demersal Longline Interim Managed Fishery Zone 2 catch species composition for 1999/2000.



DEMERSAL GILLNET AND LONGLINE FIGURE 3

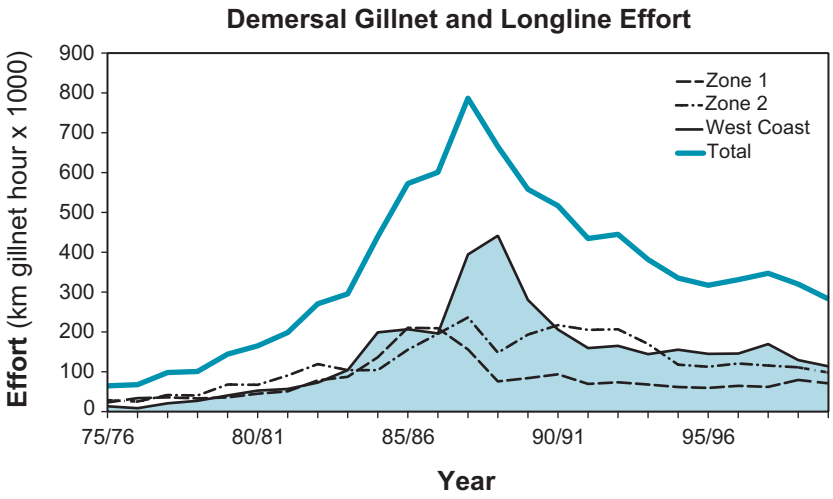
West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery catch species composition for 1999/2000.



DEMERSAL GILLNET AND LONGLINE FIGURE 4

Combined annual catches of key target shark species from the JASDGDLF and WCDGDLF.

Commercial Fisheries



DEMERSAL GILLNET AND LONGLINE FIGURE 5

Historical effort in the JASDGDLF and WCDGDLF.

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

There is limited compliance monitoring activity in this fishery, and compliance continues to be a low priority. There were no compliance problems encountered during 2000/2001.

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 catfish (silver cobbler) 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 are currently in the process of developing an industry Code of Conduct. The code will specify the accepted means of operation in the fishery, as well as outlining contingency procedures for circumstances when fishing gear has been lost or abandoned. The code will be implemented during 2001.

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 42 on Fishing Boat Licence

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 1999/2000 there were six licensees who had access to the Lake Argyle catfish fishery.

Main fishing method

Gillnet.

RETAINED SPECIES

Commercial production (season 1999/2000): 230.5 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. Since 1993/94 there has been a trend towards increasing catches in this fishery, with the current catch being the highest on record (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 during 1999/2000 was 10,788 units, which is slightly lower than the previous year (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. During the past five years the CPUE has remained fairly constant at this lower level (Lake Argyle Catfish Figure 1).

Recreational component: Not assessed

Stock assessment completed: Yes

This year, a process error model and an observational error model have replaced the biomass dynamics model. The process error model has forecast an estimate of the catch for 2000/2001 of 193 tonnes. The results of this model indicate that the fishery is either fully fished or slightly over-fished. The alternative observational error model predicts a lower catch for 2000/2001 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

Commercial Fisheries

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: **Not assessed**

SOCIAL EFFECTS

During 1999/2000, 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 (1999–2000): **$0.61 million**

FISHERY GOVERNANCE

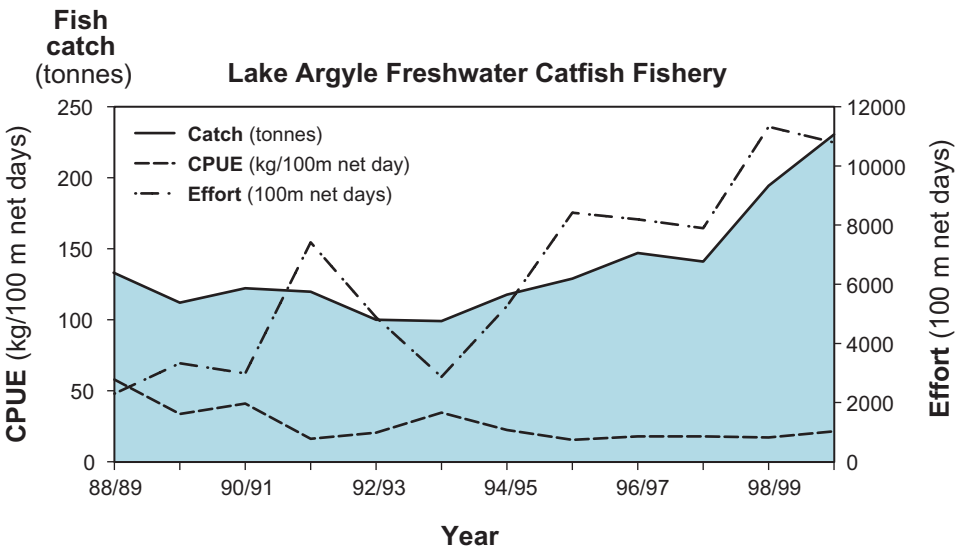
Acceptable catch range: **100–140 tonnes**

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 1998/99 annual catch figure of 194 tonnes and the 1999/2000 catch of 230.5 tonnes are above the upper limit of the catch projection and the sustainable; level of catch determined by the observational and; process models. This increased level of catch reflects the; dramatic increase in effort between 1997/98 and the; present (Lake Argyle Figure 1). Under this scenario,; management action may need to be considered to ensure; the sustainability of this resource.;

EXTERNAL FACTORS

An annual research report was made available for the; annual management meeting with operators in Kununurra; in April 2000. At that time the present high catch levels were presented to the fishers with the concerns about the continuation of fishing at this high level.

With the introduction of licence transferability, the unused ('latent') effort 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 may be 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 1988/89 to 1999/2000.

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. Because these species are not being targeted as a food product, there is not the same incentive as in other commercial fisheries to maximise catches, and no species has been identified as being at risk of over-exploitation at current levels of fishing. 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 for the number of licences issued, boat replacement size, the permitted means of capture and fishing gear. Other legislation imposes constraints on the areas in which commercial collecting of marine aquarium species can be undertaken. Fishing activities are targeted and relatively low in volume, and have limited effect on fish populations.

There are reporting requirements to Environment Australia in relation to the commercial harvest of syngnathids to maintain the 'Controlled Specimens Declaration' which allows these species to be exported. In addition, the Marine Aquarium Managed Fishery is being assessed as a case study as part of the national project to develop ESD reporting arrangements for all fishing activities.

Governing Legislation/Fishing Authority

Marine Aquarium Fishery Management Plan 1995
Marine Aquarium Managed Fishery Licence

Consultation Process

Agency-industry meeting

RESEARCH SUMMARY

Production from this fishery is monitored by way of a statutory record completed by each fisher, which is recorded in a database held in the Fisheries Research Division.

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 broad range of specimen shell species along the entire Western Australian coastline, except where there are specific closures, for example within marine parks or aquatic reserves.

The management plan establishes the legislative controls for the number of licences issued, boat replacement size, permitted means of capture and fishing gear.

There are also reporting requirements to Environment Australia to maintain the 'Controlled Species Declaration' for eight of the species taken by the fishery, which allows them to be exported.

Governing Legislation/Fishing Authority

Specimen Shell Management Plan 1995
Specimen Shell Managed Fishery Licence

Consultation Process

Agency-industry meeting

RESEARCH SUMMARY

Production from this fishery is monitored by way of a statutory record completed by each fisher, which is recorded in a database held in the Fisheries Research Division.

Recreational Fisheries

Recreational Fisheries

General Overview

The Recreational Fisheries Program is responsible for the management of Western Australia's recreational 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 (RFAC) 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.

Revenue raised from licence fees is credited directly to the Recreational Fishing Fund to support recreational fisheries management, research and community education activities. Licence fees contributed approximately $1.7 million of the total operating costs of $10.3 million for the Recreational Fisheries Program.

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, abalone and marron.

Recreational fishing activity occurs in four main zones: creeks and estuaries, shore-based fishing, inshore marine fishing in waters generally within the inshore reef system or three nautical miles of the coast, and an offshore fishery which targets demersal fish and pelagics such as billfish and tunas.

Recreational catch and target species in each region vary significantly, as does the fishing pressure.

Threats and Opportunities

Western Australia's recreational fisheries are a major community asset, and contribute in excess of $570 million a year to the State's economy.

Since 1987 participation in recreational fishing of all kinds has more than doubled from 284,000 people to about 640,000 people a year, or from 27% to 37% of the population over 4 years old. The most recent survey (Baharthah and Sumner 2001) showed that 213,000 (one-third) are regular fishers who go fishing on more than 10 days a year, while 427,000 (two-thirds) fish for 10 or fewer days per year. The estimated fishing effort has also risen from an estimated 3 million fishing days to 10 million fishing days, with the typical recreational fisher spending 6 days a year fishing. The most avid 30% of recreational fishers contribute 80% of fishing effort.

In the State's licensed recreational fisheries a total of 66,069 people obtained licences in 2000/2001, as follows:

Marron	22,460 licences
Rock lobster	36,820 licences
Abalone	18,713 licences
Netting	17,297 licences
South west freshwater angling	15,795 licences

Of these, 11,254 people took out all categories of licence available. (All licence figures are given as at 30 June 2001.)

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 recreational fisheries 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 fishery enhancement opportunities provided through the developing aquaculture industry, particularly for inland and some estuarine habitats.

Recreational Fisheries Management

A key outcome of the strategic planning process jointly carried out by Fisheries WA's Recreational Fisheries Program and the Recreational Fishing Advisory Committee is the development of four regional marine 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.

Key elements in each strategy include the clear identification of those fish species, stocks and areas of most importance for recreational fishing, and the development of a set of 'fishing quality' indicators against which each plan can be reviewed.

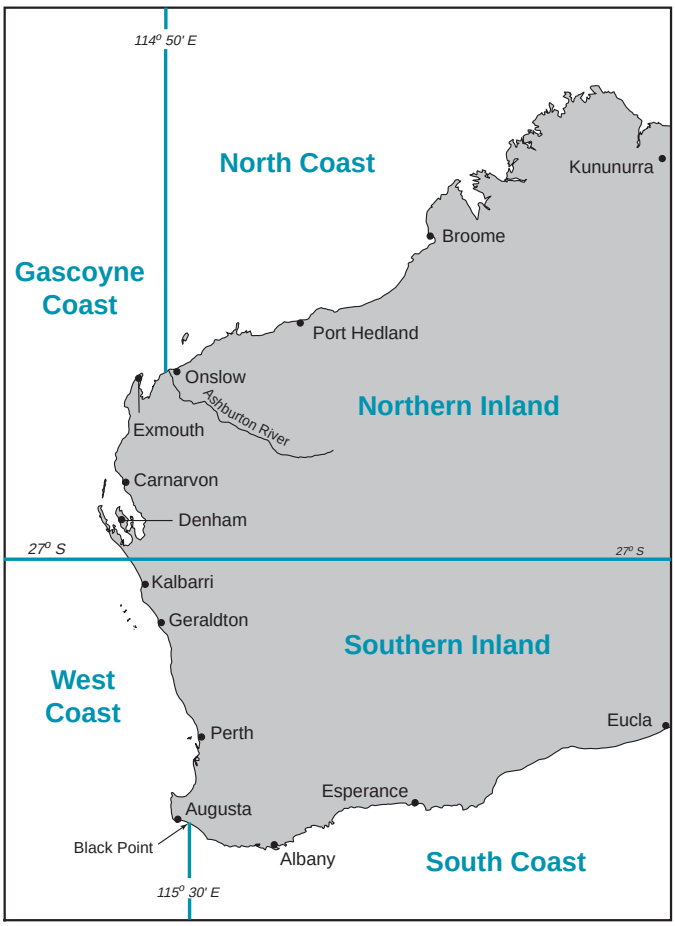
Each regional strategy is being developed by a community-based working group comprising fishing, conservation and tourism interests and will include recommendations for a detailed research and management program specific to that region.

This process has commenced with the Gascoyne and west coast regions and reviews of the north and south coast regions will commence in 2001/02.

A major review of charter fishing and associated ecotourism was undertaken by an industry-based working group established by the Minister for Fisheries. Their final report was released in November 1998 (Fisheries WA 1998).

A charter licensing and management framework has been developed to regulate the industry across the four biogeographic regions. At this stage 282 applications for fishing and aquatic ecotour licences have been received and are undergoing assessment against selection criteria set out in Ministerial Policy Guidelines.

Upon the issue of licences, operators will be required to submit catch returns, which will provide information on the impacts of this sector in each bioregion.



RECREATIONAL FISHERIES FIGURE 1

Map showing Western Australia's major biogeographical regions.

Recreational Fisheries

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 450,000 anglers fishing an estimated five million fishing days a year. Within this region the metropolitan coastal waters between Yanchep and Mandurah attract about 310,000 fishers, generating an estimated 4 million fishing days a year (Baharthah and Sumner 2000). 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 is also significant and 99 aquatic tour licence applications have been received for the west coast bioregion, with a further 82 'multi-zone' applications (operators seeking access to the west coast and one or more other regions).

Major species in the shore and inshore boat catch include Australian herring, whiting (several species including King George whiting), skipjack trevally, blue swimmer (manna) crabs, tailor, garfish and squid, while dhufish, pink snapper and baldchin groper 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, cobbler, tailor, mulloway, flathead, flounder and a suite of marine species.

King and river prawns also provide a highly seasonal and variable fishery in the Swan/Canning and Peel/Harvey estuaries.

Blue swimmer crabs are the target of WA's largest recreational fishery, with over 80,000 participants. Major fishing areas include the Peel/Harvey Inlet, 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.

There are licensed recreational fisheries for rock lobster and abalone. The recreational rock lobster fishery is concentrated in inshore regions, in depths of less than 20 m, with most fishing activity around the Perth metropolitan area and Geraldton. Fishing controls include gear restrictions, bag and size limits and protection of breeding females. In addition, a restricted fishing season operates between 15 November and 30 June and a recreational rock lobster licence is required.

Recreational fishing for Roe's abalone *(Haliotis roei)* takes place mainly on the inshore reef platforms between Geraldton and Augusta during the early spring and summer months when tide and weather conditions allow easy access to the reefs. South of Cape Naturaliste, the larger species of greenlip and brownlip abalone *(Haliotis laevigata* and *Haliotis conicopora)* are also taken in deeper water, with most fishing activity occurring from Hamelin Bay round to the south coast. Fishing controls include licensing, closed seasons, closed waters, possession and size limits and gear controls. The Perth metropolitan and Greenough recreational abalone season commenced on Sunday 5 November 2000 and continued each Sunday only from 7.00 a.m. to 8.30 a.m. until 10 December. A recreational abalone licence is required to take abalone.

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 nearshore waters, and competition for the available resource with the commercial wetline and demersal gillnet fleet, the commercial crab fleet and the commercial estuarine fishery.

Additional requests have also been made in recent times for specific management controls for the proposed Jurien Bay Marine Park, Abrolhos Islands Fish Habitat Protection Area, prawn drag netting in Peel/Harvey and Leschenault Inlets, and crabs in Cockburn Sound and Geographe Bay.

A review of recreational fisheries management arrangements for the west coast is currently under way. A discussion paper (Fisheries Management Paper no. 139) prepared by a community-based working group was released in June 2000 for public comment (Fisheries WA 2000c). Over 1,200 submissions were received on the discussion paper. Following consideration of public submissions, a final report was prepared by the working group and is currently being considered by the Minister for Fisheries.

Regional Compliance and Community Education Overview

Recreational fishing compliance and education in the west coast bioregion was carried out by Fisheries Officers stationed in Geraldton, Dongara, Jurien Bay, Lancelin, Hillarys, Fremantle, Mandurah, Bunbury and Busselton, with the assistance of Volunteer Fisheries Liaison Officers (VFLOs) in major coastal centres.

A total of 26,279 hours of activity by Fisheries Officers were applied to coastal boating and land-based fishing and to overseeing netting by recreational fishers. Approximately 12,430 of these hours were applied in the greater metropolitan area between Mandurah and Lancelin, while the mid-west (Jurien–Kalbarri) accounted for 5,447 hours and the south-west (Bunbury–Augusta) 8,402 hours.

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 open 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 extremely well

supported by the recreational fishing community, and there were few signs of fishers targeting snapper during the closed season.

Metropolitan Fisheries Officers contacted 14,500 fishers in both a compliance and educational role throughout the year, detecting 396 offences. A significant number of these were detected in the rock lobster, abalone, crab, and marine finfish fisheries.

In the mid-west several major apprehensions occurred for possession of large numbers of rock lobster and rock lobster tails, possession of large quantities of under-size finfish, and exceeding bag limits. Reports also indicate an increased incidence of recreational fish sales and interference with fishing gear, mainly lobster pots. This increase may have resulted from the upgraded Fishwatch system, which facilitates improved regional reporting of alleged offences.

Approximately 400 Fishwatch reports on illegal activity were received during the year. Approximately 30% of 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.

The VFLO program involves 77 volunteers in the Perth area, 37 in Mandurah, 34 in Geraldton and the mid-west and 29 in Bunbury and Busselton. VFLOs reported 13,500 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 was noted which can largely be attributed to the presence and educational role of the VFLOs.

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 attended the Abrolhos Islands and conducted liaison activities for the second year in a row.

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.

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 Fisheries WA researchers and others in collaboration with postgraduate students, mainly of Murdoch University. These studies have provided biological data on herring, whiting (including King George whiting), blue swimmer crabs, prawns, tailor, cobbler, black bream and other minor species. For west coast offshore boat angling species – whiting (other than King George whiting), wrasse and groper (various species), Western Australian dhufish and snapper – some biological data is also available from previous Fisheries WA 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).

A 12-month survey of recreational boat-based fishing from Augusta to Kalbarri was completed in 1997 (Sumner and Williamson 1999). This survey estimated the recreational catch and fishing effort for the region. The main marine species caught by boat-based fishers are (in order of number caught) whiting species (other than King George whiting) (564,000), Australian herring (425,000), blue swimmer crabs (255,000), skipjack trevally (123,000), King George whiting (94,000), squid (88,000), southern sea garfish (79,000), various species of wrasse and groper (66,000) and Western Australian dhufish (29,000). The size of the recreational catch for many of these species was of a similar magnitude to the commercial catch. These findings have highlighted the importance of proper management for recreational fisheries.

A survey of recreational fishing in the Leschenault Estuary was completed in 1998 (Malseed et al. 2000). Similar surveys of the Swan-Canning and Peel-Harvey

Recreational Fisheries

estuaries focusing mainly on the recreational catch of blue swimmer crabs were completed in 1999 (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 datasets from the commercial CAES database, will provide the core information necessary for management of the most important recreational fish stocks in future.

A new research project on maximising the survival of under-size west coast reef fish began in August 2000, with funding from FRDC. Short-term caging experiments are testing the effects of hook types, venting fish to release air from their swim bladders, and the 'simple' and 'shotline' methods of release, on the survival of dhufish caught from three depths (< 20 m, 25–35 m and > 40 m). This work will ultimately be used to review the regulations relating to deep-water species and to educate fishers, both recreational and commercial, on fish release methods.

Recreational Rock Lobster Fishery

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.

Licensed Recreational Rock Lobster Fishery Status Report

Prepared by R. Melville-Smith and A. Thomson

FISHERY DESCRIPTION

Boundaries and access

The recreational rock lobster fishery operates on a statewide basis and encompasses the take of all rock lobster species; however, fishing is concentrated on western rock lobsters in inshore regions in depths of less than 20 m between North West Cape and Augusta. The Perth metropolitan region and Geraldton experience the greatest fishing activity. A recreational rock lobster licence is required to take lobsters, and in the 1999/2000 season 36,906 licences were sold. The 1999/2000 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 1999/2000): 747 tonnes (estimate)

The recreational catch of western rock lobster for 1999/2000 was estimated at 747 tonnes, with 561 tonnes by potting and 186 tonnes by diving. Comparative catch estimates for 1998/99 were 457 tonnes by potting and 169 tonnes by diving.

Fishing effort

36,906 people purchased licences to fish for lobsters, but only an estimated 29,420 utilised their licence. The average pot and diving fishers (excluding all those who held a licence but failed to use it) used their licences on 34 and 11 days respectively during the 1999/2000 fishing season. Potters and divers fished on average 38 and 16 days respectively in the 1998/99 fishing season.

Catch rate

The average pot and diving catches were 1.7 and 2.5 lobsters per person per fishing day in the 1999/2000 fishing season. In the 1998/99 fishing season potters and divers caught 1.4 and 1.8 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. 7-13).

Exploitation status: Fully exploited

See the commercial fishery status report.

Breeding stock levels: Adequate

See the commercial fishery status report.

Projected catch next season (2001): 650–750 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, licence 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 in 2000/2001. Based on declining settlement indices in 1996/97 and 1997/98, it is predicted that if the number of licences used remains at a similar level to the 1999/2000 season, the recreational rock lobster catch will decrease to around 695 tonnes in 2000/2001, and will further decline in 2001/02 to about 600 tonnes before improving in 2002/03 to about 700 tonnes (Recreational Rock Lobster Figure 1).

NON-RETAINED SPECIES

See commercial fishery status report.

ECOSYSTEM EFFECTS

See commercial fishery status report.

SOCIAL EFFECTS

With approximately 30,000 people taking approximately 1.5 million individual lobsters annually, this fishery represents a major recreational activity and provides a significant social benefit to the Western Australian community.

ECONOMIC EFFECTS

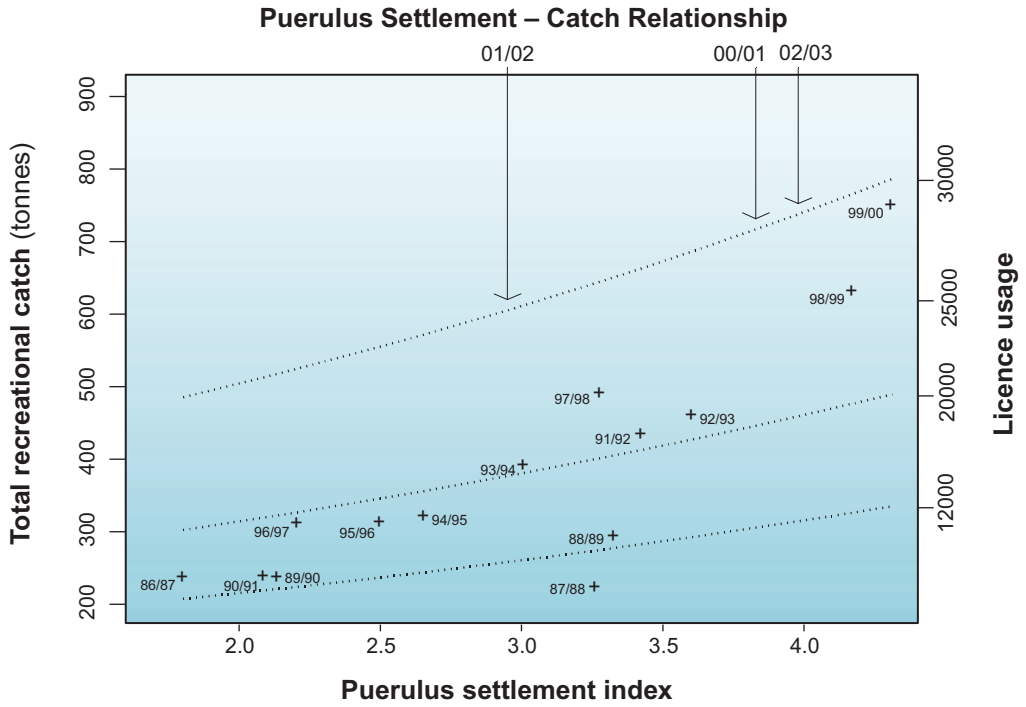
The direct value of the recreational catch in the 1999/2000 season was about $17 million, however this represents only a minor proportion of the economic activity generated by this sector through the use of boats, fishing gear etc.

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

The relationship between puerulus settlement at Alkimos and recreational catch at three different levels of recreational licence usage (see usage figues on the right side of the graph). Along the upper horizontal axis are arrows indicating the level of puerulus settlement corresponding to future seasons. The most likely catch prediction scenarios correspond to licence usage rates similar to those in the 1999/2000 season (i.e. approximately 30,000).

Recreational Fisheries

Recreational Abalone Fishery

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 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.

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. In previous volumes of State of the Fisheries only preliminary catch and effort estimates for the Perth Roe's fishery were reported, and these have now been revised based on the above surveys. 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 (postcode) from the licensing database. The field survey results are based on an analysis of head counts and interview data from recreational fishery participants during the 1997–2000 seasons.

Licensed Recreational Abalone Fishery Status Report

Prepared by B. Hancock, T. Baharthah, N. Sumner and K. Friedman

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 2000 Perth and Greenough season ran from 5 November to 10 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 SA 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: **Roe's Perth fishery 32 tonnes**
Roe's rest of State 20 tonnes
Greenlip 47 tonnes
Brownlip 12 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). Measurements of the mean weight of recreationally caught abalone are available only for the Perth Roe's recreational fishery for the 1999 and 2000 seasons. 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 33.7 tonnes and 30.2 tonnes for the Perth fishery were derived from telephone and field surveys respectively. Based on these estimates, the catch for the Perth fishery has decreased by about 33% from 1999 (30.9% and 34.1% for telephone and field surveys respectively). This has been predominantly driven by a decrease of 26% in the mean weight of abalone taken (119.5 g and 91.3 g for 1999 and 2000 respectively). Estimates of Roe's catch in the other areas of the fishery (28.8 tonnes in 1999 and 19.5 tonnes in 2000) were estimated using telephone surveys stratified by recreational abalone and umbrella licence holders (Recreational Abalone Table 2).

The recreational catch of greenlip and brownlip abalone was predominantly taken from the south coast fishery. The greenlip catch has risen on the south and west coasts by 39% and 14% respectively (Recreational Abalone Table 2). The brownlip recreational catch has increased on the south coast by 6% and decreased on the west coast by 41% (Recreational Abalone Table 2).

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. This type of mortality was estimated at 5–20% of the retained catch from the Perth recreational fishery in surveys conducted in 1997. This information is not available from the west and south coast regions, but is assumed to be lower for greenlip and brownlip abalone fishing as these species are not taken from within the surf zone (while fishing the reeftop).

Fishing effort

The total recreational fishing effort during 2000 in the Perth fishery was estimated at 21,767 fisher days from the telephone survey or 19,800 fisher days from the field survey. This represents decreases of 6.7% and 10.3% from the 1999 estimates for the telephone and field surveys respectively.

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. Effort recorded by fisher days for the south coast and west coast recreational fisheries was 12,966 and 9,820 fisher days respectively. This represents decreases of 20% and 4% compared to effort recorded in 1999.

Catch rate

The catch rate during the Perth season was estimated at 17 and 16.7 abalone per fisher day by the telephone and field surveys respectively, a decrease of 3.7% over the 1999 figures indicated by the telephone survey and a decrease of 4% for the field survey.

Commercial share: **Roe's 68% (estimate)**
Greenlip/brownlip 79% (estimate)

The commercial fishers in the Perth Roe's abalone fishery have caught their quota of 36 tonnes in recent years. This was about 53% of the combined recreational and commercial catch in 2000, an increase from approximately 45% in 1999 as a result of the decrease in estimated recreational catch in 2000. For the State as a whole, the commercial Roe's abalone catch share was estimated at 68%.

For greenlip and brownlip abalone the commercial catches were 189.8 tonnes and 33.5 tonnes respectively. These catches represent 79% of the estimated total take of these two species statewide.

Stock assessment completed: **Yes**

For the Perth fishery, size distributions and densities were measured from each of six reef platforms between Penguin Island and Burns Beach. 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. All abalone seen within a quadrat were counted and measured. These surveys were conducted in January and February 2001 (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).

Preliminary estimates of post-season densities after the 2000 recreational season were highest at Burns Beach with 155 abalone/m^2, with the other locations ranging from 87 to 97 abalone/m^2. At sites north of Penguin Island, these figures have remained fairly stable during the last three years, with fluctuations in total densities being influenced by the strength of post-settlement recruitment. These densities can be compared to an average figure of 95 abalone/m^2 in Waterman's reserve, an unfished site, however the variation between transects indicates that the changes over time at a site are more informative. The mean densities of legal-sized abalone at the end of the fishing season vary among sites (Recreational Abalone Table 3) but most sites had good abundance of legal-sized abalone during the 2001 survey compared to previous years.

Examination of the density of different year classes of Roe's abalone in the future may permit the assessment of annual variation in settlement, and the strength of cohorts reaching legal size in subsequent seasons. This projection requires a sound knowledge of the growth of sub-legal size classes, which is currently being analysed.

Penguin Island was opened to fishing for the November and December 2000 season. This is the first time that Penguin Island has been opened since 1995. The increasing abalone density at the indicator site, along with an increase in the percentage of abalone above legal size, supports the view that the abalone population had recovered sufficiently to support recreational fishing.

West and south coast stock assessments are based on catch and effort data from the commercial fishery (see commercial status report, pp. 93-9).

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 and eastern south coast fisheries 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.

Projected catch next season (2001):
Roe's Perth fishery 34–46 tonnes
Roe's rest of State 20–29 tonnes
Greenlip 36–47 tonnes
Brownlip abalone12–15 tonnes

Based on the recent history of the Perth fishery (1997–2000), the catch for the 2001 season would be expected to lie within the range 323,200–383,600 abalone. This estimate is taken from the range of field survey estimates (1997–1999, Recreational Abalone Figure 1). Assuming a catch weight intermediate between the mean abalone weights measured for the 1999 and 2000 seasons, these catches in number of abalone would describe a catch range of 34–46 tonnes.

Estimates for the other recreational fisheries are taken from the range of results originating from the telephone survey (1999 and 2000, Recreational Abalone Table 2).

NON-RETAINED SPECIES

See commercial fishery status report, pp. 93-9.

ECOSYSTEM EFFECTS

Habitat effects: **Low**

See commercial fishery status report, pp. 93-9.

SOCIAL EFFECTS

Over 18,000 licences were issued that would have allowed fishers to participate in the recreational abalone

Recreational Fisheries

fishery. The telephone survey estimated 6,200 of these licence holders actively fished during the 2000 season, mainly in the Perth fishery. This fishery provides a major social benefit to the sectors of the community who 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 Effort (days)	Catch rate	Catch (number)	Catch (tonnes)	Field Survey 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**

RECREATIONAL ABALONE TABLE 2

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

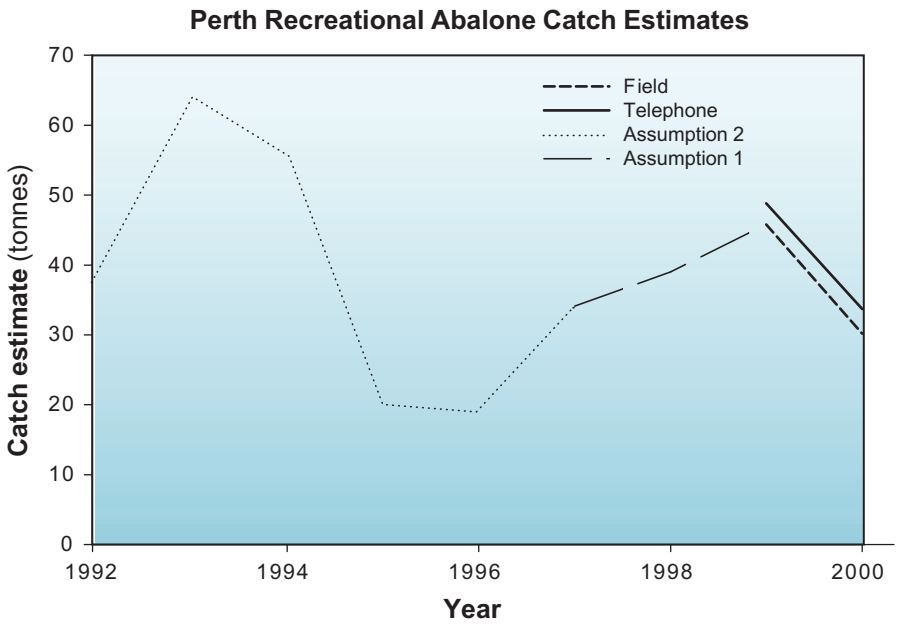
Year	Effort[1] (days)	Roe's abalone Catch rate	Roe's abalone Catch (number)	Roe's abalone Catch[2] (tonnes)	Greenlip abalone Catch rate	Greenlip abalone Catch (number)	Greenlip abalone Catch[3] (tonnes)	Brownlip abalone Catch rate	Brownlip abalone Catch (number)	Brownlip abalone Catch[4] (tonnes)
West 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**
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**

1. Effort is estimated for all species combined.
2. Mean whole weight for Roe's abalone is assumed to be 0.091 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 platform.

Year	Bailey Street		Mettams Pool		Beaumaris		Burns Beach		Waterman's		Penguin Island	
	Total	60+	Total	60+	Total	60+	Total	60+	Total	60+	Total	60+
1999	88	25	90	35	92	45	127	45	106	36	80	26
2000	86	21	88	27	86	47	137	46	84	45	96	30
2001	**87**	**28**	**90**	**25**	**88**	**50**	**155**	**56**	**95**	**45**	**97**	**29**



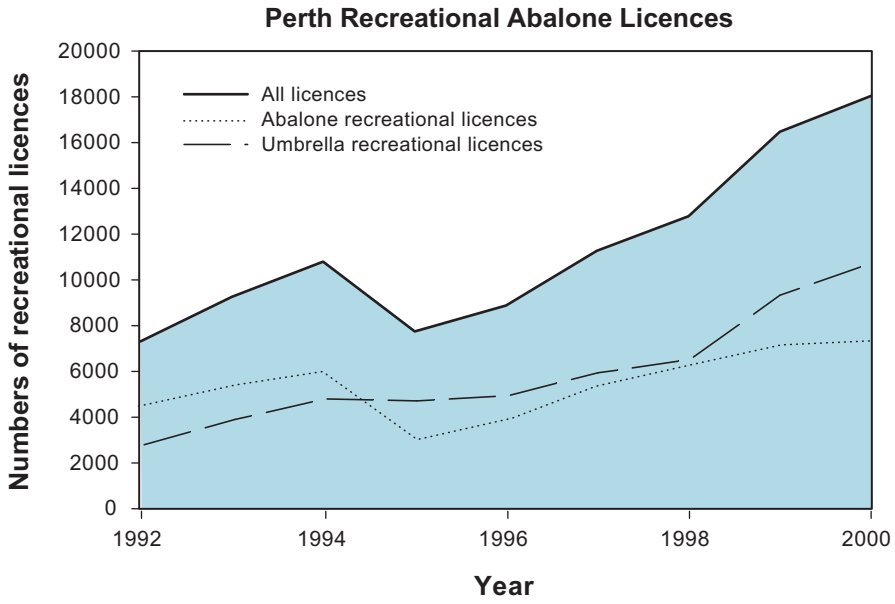
RECREATIONAL ABALONE FIGURE 1

Catch estimates for the Perth recreational abalone fishery for the period 1992 to 2000, 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 Fisheries



RECREATIONAL ABALONE FIGURE 2

The number of licences issued in the Perth recreational abalone fishery, by licence type, for the period 1992 to 2000.

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 1997–2000. Since 1995 permissible fishing hours per season day have been 1.5 (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).

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 6% of the State's fishers or 40,000 fishers a year (Baharthah and Sumner 2001).

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., in press) has confirmed that the Gascoyne is a major focus of recreational fishing, with 243,000 fisher days being recorded over the survey period. The majority of fishers came from Perth (44%) or rural WA (34%), with 13% being based locally and the remainder (9%) from the Eastern States. Detailed catch results from this survey will be found in the following pages.

Charter activity, although not covered in the 1998/99 survey, is also significant, with 35 aquatic tour licence applications received for the Gascoyne coast bioregion, plus a further 71 'multi-zone' applications from operators seeking access to the Gascoyne and one or more other regions. A logbook system is being introduced which will provide catch data from this sector, and is expected to show that significant catches are taken.

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 two pink snapper 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 four and a limit of two 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 two 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 been more effective in protecting pink snapper stocks, and have reduced the recreational catch in the western gulf.

A review of recreational fisheries management arrangements for the Gascoyne bioregion is currently under way. A discussion paper (Fisheries WA 1999a) 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

Compliance and education programs for the Gascoyne are delivered through Fisheries WA offices in Denham, Carnarvon and Exmouth.

Regional Services staff undertook 7,469 hours of activities in the Gascoyne bioregion during 2000/2001. These hours were divided between rock lobster, net fishing, marine boat- and shore-based angling, and support for Recreational Fishing Advisory Committees and the Volunteer Fisheries Liaison Officer program.

Indicators of compliance levels include data collected during research creel surveys, data from VFLO observations, patrol contact sheets and reports completed by Fisheries Officers, and reports from members of the public.

As a result of Fisheries patrols, a total of 21 prosecutions, 13 infringement notices and 20 infringement warnings were given out in 2000/2001 for a variety of recreational fishing offences relating to under-size fish, illegal gear and catches in excess of bag limits.

Areas considered at highest risk of non-compliance included new regulations for pink snapper in Shark Bay, the take of under-size spangled emperor, and illegal netting.

Anecdotal information and reports from Fisheries Officers also indicated increased illegal activity in the recreational net fishery. This resembles patterns of non-compliance from the previous year.

Fishwatch reports indicated that the major area of public concern was illegal netting in Bush Bay just south of Carnarvon.

The 1998/1999 Gascoyne Recreational Fishing Survey (Sumner et al., in press) indicated a high level of compliance in the region, with very few (< 4%) of anglers keeping under-size fish or exceeding bag limits.

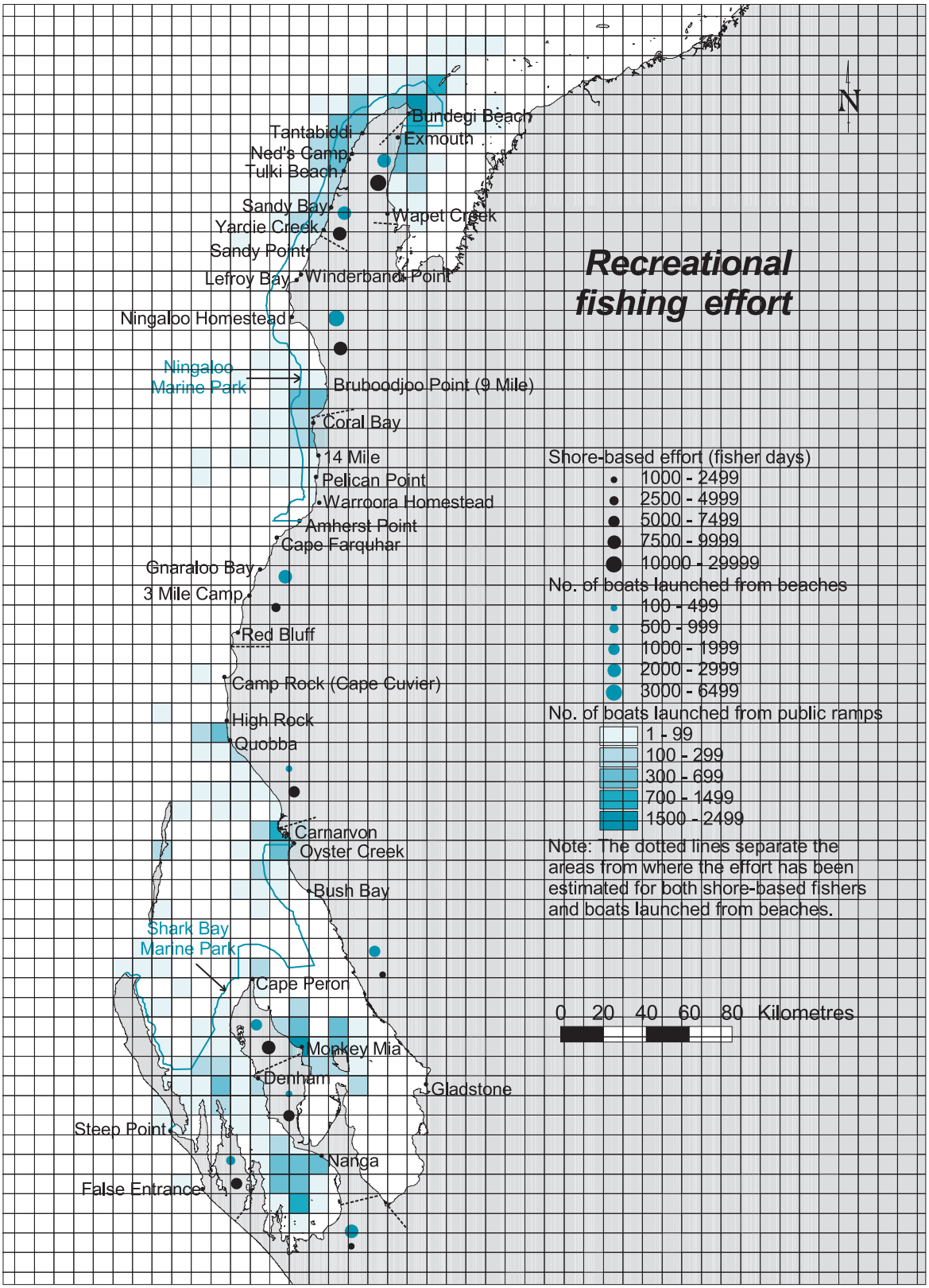
The highest levels of non-compliance with fishing regulations occurred in the Carnarvon and Point Quobba areas of the region (17% and 13% of those interviewed respectively).

Other areas including Exmouth, Coral Bay and Denham all recorded low levels of non-compliance with the fishing regulations (between 3% and 4%).

The VFLO program was launched in Exmouth and Carnarvon in 1994, with the combined centres fielding a total of 10 volunteers in 2000/2001. VFLOs reported 373 contacts and 161 interviews during the year. Recruitment and training is ongoing, with the volunteer program to be launched in Denham by the end of 2001.

Fisheries Officers together with VFLOs have placed a greater emphasis on community education as a key strategy for combating non-compliance in recreational fishing. Gascoyne regional staff attend and present information in a variety of forums throughout the year, including school talks, sporting club presentations and community expos.

Recreational Fisheries



GASCOYNE RECREATIONAL FISHING FIGURE 1

Spatial distribution of recreational fishing effort in 1998/99.

Both Fisheries Officers and VFLOs were involved extensively in the Shark Bay area during 2000/2001 to educate the public on the new fishing management arrangements for the inner bay stocks of pink snapper. Fisheries Officers conducted high-profile sea and land patrols to raise awareness of the new management strategies.

Regional Research Overview

Scientific information to underpin management of recreationally important fish stocks in this bioregion in the past has been provided primarily from historical Fisheries WA biological research conducted on commercial fisheries. This research has covered pink snapper, emperors (Lethrinid species) and whiting. Biological information is currently being collected on tailor and on Spanish mackerel.

Owing to the increasing recreational pressure on inner Shark Bay fish stocks, two dedicated studies are being carried out to provide specific information on the status of the inner bay pink snapper and black snapper stocks. 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., in press). The survey estimated the recreational catch and fishing effort for the region (as summarised below), providing 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 2000/2001. The results from this latter study will become available during 2002.

Gascoyne Recreational Fishing Survey

RESEARCH SUMMARY

Prepared by N. Sumner

A 12-month creel survey of recreational boat-based and shore-based fishing in the Gascoyne region of Western Australia was conducted between April 1998 and March 1999 (Sumner et al., in press). In summary, the total annual recreational fishing effort for the Gascoyne region in 1998/99 was 243,000 fisher days. This comprised 113,000 fisher days by boats launched from public ramps, 53,000 fisher days by boats launched from beaches and 77,000 days by shore-based fishers (Gascoyne Recreational Fishing Figure 1). 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 this data will be provided in future years.

The total recreational 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. (For simplicity, the catch 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 weight caught), which together comprised 86% of the total catch by weight, were as follows.

Spangled emperor

Spangled emperor is an important species for recreational and commercial fishers. The estimated recreational catch for the region was 30,000 fish kept (79 tonnes). From the survey results, a further 3,000 fish were estimated to have been eaten by sharks. The commercial catch from the region for the same period was 81 tonnes. Spangled emperor was predominantly (95%) caught by boat-based fishers. Most of the catch was taken from within the Ningaloo Marine Park (76%). Most fish kept were between 410 and 529 mm in length. A small number of fish kept by anglers were below the minimum size limit at the time of 410 mm.

Pink snapper

Pink snapper was predominantly (99%) caught by boat-based fishers. The estimated recreational catch for the region during 1998/99 was 28,000 fish kept (79 tonnes). A further 600 fish were estimated to have been eaten by sharks. Most of the recreational catch was taken from Shark Bay (73%). Almost half of the recreational catch from the Gascoyne region (38 tonnes, or 48% by weight) was from the western gulf stock. The eastern gulf was closed to pink snapper fishing for most of the period when the survey was conducted. For this reason, the recreational catch of pink snapper for previous years was likely to have been greater than the catch estimated for 1998/99.

Spanish mackerel and other mackerel species

Spanish mackerel (narrow-barred) was predominantly caught by boat-based fishers (75%). The estimated recreational catch for the region was 8,000 fish kept (47 tonnes). A further 600 fish were estimated to have been eaten by sharks. The commercial catch for the combined west coast and Gascoyne regions during 1998 was 67 tonnes (Mackie 2000). This may be compared to a recreational catch of 59 tonnes from the same regions. The most common size class for fish kept was 950–999 mm. A small number of fish kept by anglers were below the minimum size limit at the time of 750 mm. Large fish of up to 1,600 mm were caught on occasions. A stock assessment of the fishery is presently under way.

Recreational fishers also caught 8 tonnes of other mackerel species. These were predominantly Queensland

Recreational Fisheries

school mackerel (2,000 fish kept) and shark mackerel (1,900 fish kept). The commercial catch for the same period was 40 tonnes (Mackie 2000).

Black snapper (grass emperor)

Black snapper, also known as grass emperor, is predominantly a recreationally caught species. The estimated recreational catch for the region was 33,000 fish kept (34 tonnes). Black snapper was predominantly (99%) caught by boat-based fishers. Most of the catch was taken from Shark Bay (76%). The most common size class for fish kept was 300–319 mm. Large fish of up to 660 mm were caught on occasions.

Golden trevally

Golden trevally is predominantly a recreationally caught species. The estimated recreational catch for the region was 6,000 fish kept (20 tonnes). The commercial catch from the region for the same period was 1 tonne. Golden trevally was predominantly (63%) caught by boat-based fishers. Most of the catch was taken from within the Ningaloo Marine Park (74%). There was no minimum size for this species at the time of the survey.

Sweetlip emperor

Sweetlip emperor is an important species for recreational and commercial fishers. The estimated recreational catch for the region was 13,000 fish kept (16 tonnes). The commercial catch from the region for the same period was 14 tonnes. Sweetlip emperor was predominantly (99%) caught by boat-based fishers. Most of the catch was taken from within the Ningaloo Marine Park (79%). Most fish kept were just above the minimum size limit of 280 mm at the time. Large fish over 450 mm were caught on occasions.

Chinaman cod

Chinaman cod is predominantly a recreationally caught species. The estimated recreational catch for the region was 23,000 fish kept (10 tonnes gilled and gutted). The commercial catch from the region for the same period was 1 tonne. Chinaman cod was predominantly (99%) caught by boat-based fishers. Most of the catch was taken from within the Ningaloo Marine Park (85%). Most fish kept were between 281 and 340 mm in length. There was no minimum size for this species at the time of the survey.

Western yellow-fin bream

Western yellow-fin bream is an important species for recreational and commercial fishers. The estimated recreational catch for the region was 10,000 fish kept (5 tonnes). This is exceeded by the commercial catch for the region of 10 tonnes. Western yellow-fin bream was predominantly (99%) caught by shore-based fishers. Most of the catch was taken from Exmouth Gulf (92%).

Tailor

Tailor is an important species for recreational and commercial fishers. The estimated recreational catch for the region was 7,000 fish kept (5 tonnes). This is exceeded by the commercial catch for the region of 44 tonnes. Tailor was caught by boat-based (50%) and shore-based (50%) fishers. Most of the catch was taken from Shark Bay (87%).

Whiting species

Whiting is predominantly a commercial species with a catch of 115 tonnes from Shark Bay during 1998. The estimated recreational catch for the region was 34,000 fish kept (5 tonnes). Present catch levels are considered to be sustainable. Whiting species were predominantly caught by shore-based fishers (88%). Most of the catch was taken from Shark Bay (64%). There was no minimum size for this species at the time of the survey.

Inner Shark Bay Recreational Fishery

RESEARCH SUMMARY

Research to support the management of Shark Bay pink snapper *(Pagrus auratus)* 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 *(Lethrinus laticaudis)*, 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., in press) 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 (58 tonnes), black snapper (22 tonnes), Spanish mackerel (15 tonnes), spangled emperor (7 tonnes), tailor (4 tonnes), whiting species (3 tonnes), western butterfish (2 tonnes) and mullet species (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 2000/2001 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 2000/2001. 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 2000/2001.

Inner Shark Bay Pink Snapper Stocks Status Report

Prepared by G. Jackson

FISHERY DESCRIPTION

Boundaries and access

Separate stocks of pink snapper have been shown to inhabit the sheltered inner gulf waters of Shark Bay. The eastern stock is found in waters to the east of the Peron Peninsula and to the south of Cape Peron (the eastern gulf) (Gascoyne Recreational Fishing Figure 2). Two subpopulations of snapper are found in the western gulf, to the north (Denham Sound) and south (Freycinet Estuary) of a line running west from Goulet Bluff to Heirisson Prong. Although reproductively isolated from each other, these subpopulations are collectively known as the western stock. Research advice (stock assessment, recreational catch and effort) is provided on the basis of these divisions.

Both inner gulf snapper stocks have primarily become the target of recreational fisheries since about the 1980s. The eastern gulf snapper fishery is currently closed (since June 1998) to allow stock rebuilding. Bag/size limits and a seasonal spawning closure (Freycinet Estuary only) apply in the western gulf. Commercial snapper fishing in the inner gulfs is now limited to the 11 licensed fishing units of the Shark Bay Beach Seine and Mesh Net Managed Fishery, which are also subject to the current eastern gulf closure.

Main fishing method

Recreational: Rod and line.
Commercial: Handline, beach seine, haul net, gillnet.

RETAINED SPECIES

Recreational catch (season 2000):
Eastern gulf closed
Western gulf 25 tonnes (estimated)

Comprehensive data on recreational catches inside Shark Bay were lacking until recently.

A survey in 1983 indicated that recreational snapper catches were relatively low at that time, particularly in the eastern gulf. In 1998, based on results of the Gascoyne Recreational Fishing Survey (April 1998 – March 1999), the estimated catch of pink snapper in the eastern gulf was approximately 3 tonnes (for the period April to June only, prior to the fishery closure), and in the western gulf approximately 38 tonnes (Denham Sound approximately 12 tonnes, Freycinet Estuary approximately 26 tonnes). This survey indicated that 90% of all snapper caught in Denham Sound were released by fishers (assumed under-size) compared with 70% in the Freycinet Estuary, possibly indicating greater numbers of smaller/younger fish in the former area compared with the latter. In 2000 (May 2000 – April 2001), a second survey estimated the recreational catch of snapper in the western gulf to be approximately 25 tonnes (Denham Sound approximately 9 tonnes, Freycinet Estuary approximately 16 tonnes), with no catch in the eastern gulf because of the closure. During this period, 88% of all snapper caught in Denham Sound were released by fishers compared with 76% in the Freycinet Estuary.

Fishing effort

Results from the Gascoyne Recreational Fishing Survey indicated that approximately 49,000 fisher days were expended in the inner gulfs of Shark Bay in 1998 by boat fishers launching from public ramps (i.e. Nanga, Denham and Monkey Mia). The survey also indicated that the majority of pink snapper were caught by fishers in boats launched from the public ramps at Denham and Nanga, rather than by shore-based fishers or boats launched from beaches. Of this effort, approximately 80% was in the western gulf and 20% in the eastern gulf (closed to the take of pink snapper June 1998). A recreational survey in 2000 indicated that 35,000 days were expended by boat fishers launching from public ramps at Nanga, Denham and Monkey Mia, with approximately 70% of the total effort in the western gulf and 30% in the eastern gulf.

Commercial share: **Eastern gulf closed**
Western gulf 2 tonnes (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 approximately 9 tonnes in 1997 (eastern gulf 3 tonnes, western gulf 6 tonnes). In 2000, there was no catch in the eastern gulf (fishery closed) and approximately 2 tonnes in the western gulf.

Stock assessment completed: **Yes**

In the absence of a long time-series of recreational catch

Recreational Fisheries

and effort data for inner gulf snapper stocks, the assessment method adopted has been to directly assess the status of the spawning biomass and recruitment to each stock within the fishery. The 'daily egg production method' (DEPM) involves plankton surveys to sample snapper eggs (used to estimate 'average' egg production across area of spawning) and, combined with information on the spawning condition of adult females, has been used to back-caclulate the total biomass of spawning adults in each gulf. In addition, research trawl surveys (ongoing) and trap surveys (1998–2000) have been used to provide information on the abundance of 0+ age juvenile snapper in both gulfs.

Using results of DEPM surveys, the size of the spawning biomass in each year, 1997–2000, was estimated as follows:

1997:	
Eastern gulf	approximately 4 tonnes
Western gulf	Freycinet Estuary approximately 97 tonnes; no estimate for Denham Sound
1998:	
Eastern gulf	approximately 14 tonnes
Western gulf	approximately 95 tonnes* (Freycinet Estuary and Denham Sound)
1999:	
Eastern gulf	approximately 45 tonnes
Western gulf	approximately 36 tonnes* (Freycinet Estuary and Denham Sound)
2000:	
Eastern gulf	approximately 78 tonnes
Western gulf	approximately 94 tonnes (Freycinet Estuary and Denham Sound)

* DEPM surveys in 2000 located some previously unidentified spawning areas in the waters of northern Denham Sound. Using this additional information, spawning biomass of pink snapper in Denham Sound has been re-estimated for 1998 and 1999; revised estimates are presented here and differ slightly from those previously presented in the *State of the Fisheries Report 1999–2000.*

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 introduction of the current eastern gulf closure, management targets for rebuilding of the spawning biomass of both stocks were agreed at 100 tonnes and 200 tonnes for the eastern and western stocks respectively. The spawning biomass of each stock remains at a level below these targets.

In 2000, following experimental research trawls conducted in the Freycinet Estuary and trap surveys to identify habitat type preferred by juvenile snapper across both gulfs, estimates of absolute abundance of 0+ juveniles in the eastern gulf and Freycinet Estuary were possible for the first time (similar data unavailable for Denham Sound). With data now available since 1996, results appear to indicate that recruitment of 0+ snapper in the inner gulfs can be highly variable, particularly in the Freycinet Estuary. In the eastern gulf, 0+ juveniles were less abundant in 2000 than in 1999 (and 1998), although still more abundant than in 1996 and 1997. In contrast, in the Freycinet Estuary, the highest numbers of 0+ juveniles were recorded since trawl surveys commenced in 1996, indicating a significantly higher level of recruitment, approximately four times greater than in the previous highest year (1997). Research into factors causing this recruitment variability will be a future priority.

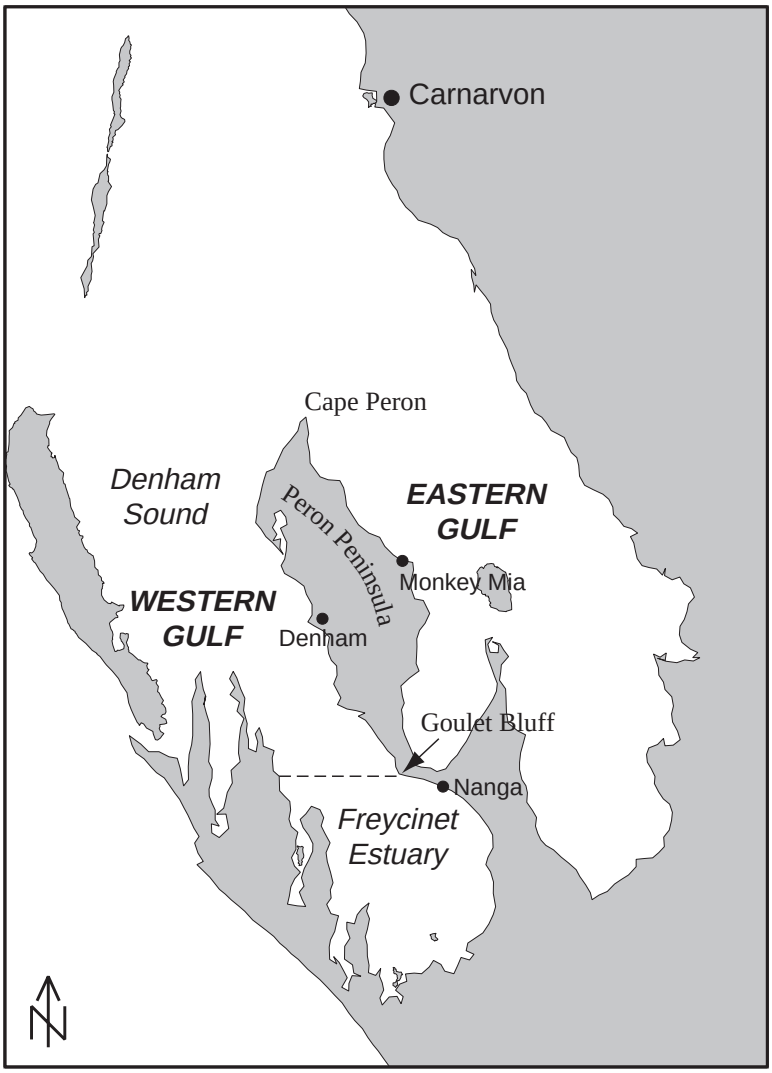
The overall assessment is that the eastern snapper breeding stock remains depleted but that rebuilding continues, while the western stock overall remains depleted, particularly in Freycinet Estuary, although significant recruitment to the breeding stock appears to have occurred in Denham Sound in 2000.

FISHERY GOVERNANCE

The management of the eastern stock through a total closure continues to appear appropriate for rebuilding; biomass estimates since 1998 are in agreement with earlier model estimates that indicated a high probability that the 100 tonne management target would be reached sometime between 2002 and 2003. Additional management measures to protect the western stock, including an increase in minimum legal size to 50 cm, further protection of larger fish (> 70 cm), a reduction of the individual bag limit to two fish per day and a seasonal closure (to protect spawning aggregations) in the Freycinet Estuary, were introduced in August 2000. These measures have achieved some success, particularly in the Freycinet area where the 2000 recreational snapper catch was 60% of that estimated in 1998. However, further measures such as the introduction of a possession limit may be necessary to accelerate stock rebuilding and ensure long-term sustainability in the western gulf.

EXTERNAL FACTORS

Comprehensive information on the inner gulf snapper stocks obtained since 1996 suggests that annual recruitment to these fisheries may be highly variable, very likely due to the effect of environmental factors on the survival of snapper larvae and post-settlement juveniles. Understanding these effects and the relationship between spawning stock biomass and juvenile recruitment will be 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 subsequent consequences for the recreational fishery in this area. Research projects currently under way, including bycatch reduction technology for prawn trawlers and stock structure of Denham Sound snapper, will provide information on the potential significance of prawn trawling on local snapper stocks.



GASCOYNE RECREATIONAL FISHING FIGURE 2

The recreational fishing areas of inner Shark Bay.

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, is under way to determine the level of stock separation of black snapper or grass emperor *(Lethrinus laticaudis)* in the gulfs of Shark Bay. Preliminary results indicate 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).

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 2000): 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., in press).

Recreational Fisheries

Fishing effort

Not assessed for 2000.

Commercial share: **1% (approx.)**

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 2000 commercial catch reported from the western and eastern gulfs was 0.4 tonnes or about 1% of the overall catch in Shark Bay.

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 fishers is 280 mm. Community support for an increase in the minimum legal size for black snapper is being considered under the current review of recreational fishing management arrangements in the region.

Oceanic Sector Recreational Fishery

RESEARCH SUMMARY

Estimates of the recreational catch and fishing effort for the oceanic sector of the Gascoyne region have been derived from the results of the 1998/99 Gascoyne Recreational Fishing Survey (Sumner et al., in press).

The oceanic sector comprises all areas of the Gascoyne region other than Shark Bay and the Ningaloo Marine Park. This includes the area between Shark Bay and the Ningaloo Marine Park (Carnarvon, Quobba Station and Gnaraloo Station), the area west of the Ningaloo Marine Park boundary, the Muiron Islands and most of Exmouth Gulf.

The total annual recreational fishing effort for the oceanic sector during 1998/99 (excluding the recreational charter operators who could not be surveyed) was estimated at 69,000 fisher days. The recorded effort comprised 24,000 fisher days by boats launched from public ramps at Carnarvon, Quobba and Exmouth, 9,000 fisher days by boats launched from beaches within the marine park and 36,000 days by shore-based fishers.

The most common species kept by all recreational fishers in the oceanic sector were (in order of estimated weight kept) pink snapper (38 tonnes), Spanish mackerel (17 tonnes), spangled emperor (13 tonnes), golden trevally (5 tonnes), western yellowfin bream (4 tonnes), black snapper (3 tonnes), sweetlip emperor (2 tonnes) and chinaman cod (2 tonnes gilled and gutted).

Commercial fishers predominantly target the oceanic stock of pink snapper. The commercial catch of Shark Bay oceanic stock during 1999 was 450 tonnes (Moran 2000). The oceanic stock is beyond the reach of many recreational fishing boats; however, charter boats operating from Denham also target this stock. The commercial oceanic stock quota-managed fishery may be close to fully exploited (Moran 2000). The number of recreational fishing boats and charter boats targeting the oceanic stock may increase in future years and should be monitored.

Ningaloo Recreational Fishery

RESEARCH SUMMARY

Estimates of the recreational catch and fishing effort for the Ningaloo area have been derived from the results of the 1998/99 Gascoyne Recreational Fishing Survey (Sumner et al., in press).

The Ningaloo Marine Park encompasses 260 kilometres of coastline down the west coast of North West Cape from Bundegi to Amherst Point. The marine park includes most of the Ningaloo Reef. There are eight sanctuary areas within the marine park where fishing is not permitted, and specific fishing regulations for the areas where fishing is permitted.

The total annual recreational fishing effort for the Ningaloo Marine Park during 1998/99 (excluding the recreational charter operators who could not be surveyed) was estimated at 85,000 fisher days. The recorded effort comprised 40,000 fisher days by boats launched from public ramps at Coral Bay, Tantabiddi, Bundegi and Exmouth, 26,000 fisher days by boats launched from beaches within the marine park and 19,000 days by shore-based fishers.

The most common species kept by all recreational fishers in the Ningaloo Marine Park were (in order of estimated weight kept) spangled emperor (60 tonnes), golden trevally (15 tonnes), sweetlip emperor (13 tonnes), black snapper (9 tonnes) and chinaman cod (8 tonnes gilled and gutted).

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 6% of the State's recreational anglers, or some 40,000 anglers per year generating 500,000 fishing days (Baharthah and Sumner 2000). Recreational fishing shows distinct seasonal peaks, with the highest number of visitors during the winter months.

Creek systems, mangroves and rivers, and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, sea perches such as mangrove jack, trevallies, sooty grunter, threadfin, mud crabs, and cods.

Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including many members of the demersal sea perch family (Lutjanidae) such as scarlet sea perch and red emperor, cods, coral and coronation trout, 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. A total of 74 aquatic tour licence applications have been received for the north coast bioregion, with a further 50 'multi-zone' applications (operators seeking access to the north coast and one or more other regions).

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 has developed a number of recommendations for both the commercial and recreational exploitation of the species, and legislation is being drafted to implement new management arrangements. 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 55 cm, a maximum size of 80 cm 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 2001/02.

Regional Compliance and Community Education Overview

Recreational fishing compliance and education in the northern region was carried out by Fisheries Officers stationed in Karratha and Broome, with the assistance of Volunteer Fisheries Liaison Officers from both centres.

A total of 4,829 hours of activity were applied by Fisheries Officers to coastal boating and land-based fishing and to overseeing netting by recreational fishers, with a total of 6,800 compliance and education contacts recorded.

As a result a total of 12 prosecutions, 7 infringement notices and 4 infringement warnings were given out in 2000/2001 for a variety of recreational fishing offences, the majority relating to illegal netting activity.

The areas assessed as being at highest risk of non-compliance with the management arrangements were recreational netting throughout the bioregion and barramundi regulations in the Ord River and West Kimberley, while a significant amount of public complaint about the take and landing of large quantities of filleted fish by anglers in the Onslow area was recorded.

Anecdotal information and reports from Fisheries Officers and Fishwatch indicated the major areas of public concern were illegal activities relating to net fishing in the Fitzroy River and other rivers and creeks, the take of under-size fish, and exceeding bag limits for barramundi.

A rationalisation of available resources in the northern bioregion enabled Fisheries Officers and VFLOs attached to the Broome and Karratha offices to increase service delivery to both compliance and community awareness programs across the bioregion.

A program of extended mobile patrols of up to 10 days' duration was introduced to service the requirements of the recreational fisheries program, especially in the East and West Kimberley during the dry season. These patrols were carried out to popular fishing destinations, with officers from Broome conducting regular patrols to the Fitzroy River catchment area, Derby region and Kununurra. Karratha-based officers conducted regular patrols of the Dampier Archipelago, Port Hedland and Eighty Mile Beach areas, plus monthly patrols to the Onslow district.

While on patrol, officers have also commenced a program of consultation with pastoralists, to assist them in managing the recreational fishing activities of visitors to their properties.

A creel survey of the Pilbara region and Broome conducted between December 1999 and November 2000 indicated a high level of compliance in the region, with very few (< 6%) of anglers keeping under-size fish or exceeding bag limits. The highest levels of non-compliance with fishing regulations occurred in the Onslow and Point Samson areas of the region (19% and 12% of those interviewed respectively). Other areas including Dampier, Karratha, Port Hedland and Broome all recorded low levels of non-compliance with the fishing regulations (between 2% and 8%).

The VFLO programs in Broome and the Pilbara, coordinated by officers from Fisheries WA, involved 17 volunteers who reported 35 contacts and 5 interviews during the year. Volunteers from these groups also

Recreational Fisheries

provided assistance in several community displays in Karratha and Port Hedland. A small VFLO group has been established at Derby in the West Kimberley which will work closely with Fisheries Officers and other VFLOs from Broome.

The West and East Kimberley and Pilbara Regional Recreational Fishing Advisory Committees were also provided with executive support by Fisheries WA staff.

Regional Research Overview

Scientific information to support recreationally fished stock management in the north coast bioregion has come largely from previous Fisheries WA 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, now in its second year, will generate more biological data on these important recreational species.

A major project which began in July 2000 will collect baseline data on the inshore finfish species targeted by recreational anglers across the northern 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 by all sectors for recreational stock management purposes, creel surveys of recreational catches are required. For this purpose, a 12-month 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. This survey will estimate the recreational catch and fishing effort for this bioregion. The results from this study will become available during 2002, and will be complemented by data from the National Recreational Fishing Survey undertaken during 2000/2001.

These data, integrated with the long-run commercial CAES databases and the current fishery-independent projects, will provide the basis for ongoing management of the most important recreational stocks in this region.

South Coast Bioregion

Regional Management Overview

Recreational fishing participation for the south coast of Western Australia, between Augusta and the WA/SA border, is estimated at around 25% of recreational anglers (Baharthah and Sumner 2000), or some 160,000 anglers per year generating 2 million fishing days.

At this stage 20 aquatic tour licence applications have been received for the south coast bioregion, with a further 14 ‘multi-zone’ applications (operators seeking access to the south coast and one or more other regions).

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, King George whiting and trevally, while shore fishing focuses on Western Australian salmon, herring, whiting and trevally. Boat fishing is concentrated near major population centres with the major target species being pink snapper, queen snapper, blue groper, shark, red snapper and samson fish.

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 six herring trap net licences, two salmon netting licences and eight 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.

Regional Compliance and Community Education Overview

Regional services staff undertook 2,937 hours of compliance and education activities in the south coast bioregion in 2000/2001. These hours were divided between abalone, rock lobster, marine boat- and shore-based angling and the estuarine netting fisheries.

The VFLO program involved 17 volunteers in the Albany and Denmark areas and 7 in Esperance. VFLOs reported 771 contacts and 61 interviews during the year.

Indicators of compliance levels include data collected from VFLO observations, patrol contact sheets and reports completed by Fisheries Officers, and reports from members of the public.

Areas of highest risk of non-compliance with the management arrangements were considered to be abalone, cockles, marine finfish and estuarine netting, while areas of greatest public complaint related to abalone poaching and exceeding bag limits and illegal sale of marine finfish. These corresponded to public concerns reported to Fishwatch.

Public contact exercises were supported by covert surveillance and focused investigations around specific

illegal activities, in particular illegal catches and sales of abalone and marine finfish.

As a result 24 letters of warning, 17 infringements and 15 prosecutions were initiated in the south coast region.

Community education activities conducted in the bioregion included attendance and presentations by Fisheries Officers and VFLOs at regional shows and festivals, primary and high schools and community groups, and direct contact with fishers in the field.

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 Fisheries WA 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 Fisheries WA with Murdoch University postgraduate students, particularly on recreationally important species in Wilson and Nornalup-Walpole inlets (e.g. Potter et al. 1993, Potter and Hyndes 1994).

These studies, supported by and utilising commercial fisheries catch information, have provided a good biological knowledge of the key species black bream, cobbler and King George whiting. Relevant abundance information and stock status for these recreational/commercial stocks are reported on pp. 100-104.

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, skipjack, yellowfin whiting, southern school whiting and King George whiting. Further survey work to estimate the impact of recreational fishing on key species on the south coast, originally planned for 2001/02, has been deferred to 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 and dusky whaler) which have been extensively researched under FRDC-funded projects (see p. 113).

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 surveys.

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 stock. For simplicity of reporting, these activities are reported under the north coast bioregion (p. 143), which covers the more significant estuarine breeding component of the barramundi stock.

Regional Research Overview

Scientific information for the management of northern freshwater species, particularly barramundi, has been provided by historical Fisheries WA 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. 68-70. In addition to barramundi, Lake Argyle catfish and cherabin (freshwater prawns) 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 being undertaken in 2000/2001.

Recreational Fisheries

Southern Inland Bioregion

Regional Management Overview

The major species fished recreationally in southern inland waters are native marron, trout stocked by Fisheries WA into public dams and rivers, and red-fin perch, an introduced, self-perpetuating exotic stock. The native freshwater cobbler is also taken in small numbers, as are black bream artificially stocked into some inland impoundments.

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 were first introduced in the 1990 season, and 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 fishing effort and improving the size of the marron caught.

Major concerns with the marron fishery relate to its ability to withstand the existing level of fishing pressure, particularly in low rainfall periods as has occurred during 2001.

Fishing for trout and other freshwater fish species (other than for 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.

Management controls include closed seasons and closed waters for trout spawning streams, bag and size limits and gear controls. These controls aim to protect juvenile fish and ensure the available catch is shared among anglers. The bag limit for trout is four, which is consistent with the community view of trout as a prized fish species, and also helps to distribute the stocked public resource to maximise community benefits.

A trout stocking committee, established in 1994 to maximise angler returns on fish available for stocking into public waterways, continued to operate successfully during 2000/2001. The committee consists of agency officers including the manager of the South West Freshwater Research and Aquaculture Centre (SWFRAC) in Pemberton, and representatives from RFAC, the WA Trout and Freshwater Angling Association and the general freshwater angling public.

Regional Compliance and Community Education Overview

Recreational fishing compliance and education in the southern inland bioregion was carried out by Fisheries Officers stationed in Geraldton, Fremantle, Mandurah, Bunbury, Busselton and Albany with the assistance of Volunteer Fisheries Liaison Officers based in major coastal centres. The statistics on Fisheries Officers' compliance work and VFLO contacts do not differentiate between coastal and inland activities. Consequently, their activities in the southern inland bioregion will have been incorporated in the statistics for the south and west coast bioregions.

In the marron fishery the highest risks of non-compliance with the management arrangements were illegal fishing before the season opening in January, use of illegal fishing gear, use of nets in recently declared 'snare-only' waters, illegal fishing in closed Water Corporation catchments, and complaints of illegal fishing on private property.

In the trout fishery a number of complaints were received regarding the use of bait in 'artificial lure only' waters, exceeding bag limits, and the take of fish prior to the season opening.

Regional Research Overview

Research for managing and enhancing the State's southern freshwater fisheries for marron and trout has been largely undertaken by Fisheries WA. In addition, collaborative university projects have provided data on red-fin perch and freshwater cobbler and their relationships to the small native freshwater species.

Recreational Marron 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 report on the recreational marron fishery and a supporting fisheries assessment document. The following status report is based on these research findings.

Licensed Recreational Marron Fishery Status Report

Prepared by B. Molony

FISHERY DESCRIPTION

Boundaries and access

The recreational marron fishery extends from the Hutt River north of Geraldton to waters near Esperance. There is a specific annual licence for the open season during January and February. In 2000 the season was open between 9 January and 29 February.

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 2000): 25 tonnes

An estimated total of 200,000 legal-sized marron (minimum of 25 tonnes) were taken in the 2000 season (1999: 158,000 marron, 19.7 tonnes; 1998: 206,000 marron, 25 tonnes) (Recreational Marron Figure 1).

Fishing effort

The number of licences issued for the 2000 season was 21,894, with an estimated 11,493 of these (unusually low at 53%) used to make one or more trips, at an estimated average of 3.6 trips/licence holder. (1999: 21,330 licences, with 13,899 (65%) used to make one or more trips.) A total of approximately 40,835 trips were made, comprising an estimated 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 2000 was estimated at 4.89 legal-sized marron per licence holder per night (1999: 3.84). The increase in the catch rate over that recorded for the 1999 season may be due to the lower overall participation rate, with more marron available for fewer fishers. However, information for the 2000 season was generated using a slightly different telephone survey technique which may have caused a minor bias in estimated catch rates. 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 patterns, 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 trip from the logbook and phone survey data. This number is then multiplied by the number of active licence holders.

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 may be an under-estimate as larger, and therefore heavier, marron are captured during the season. A second estimate of total catch is generated using the size and weight distributions of marron recorded by logbook holders.

The estimated number of trips (effort) to dams and rivers is calculated in a similar manner.

The status of the stock is 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 has been relatively stable during the 1990s.

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. Some breeding stocks are also protected in water supply dams not subject to fishing.

Projected catch next season (2001): Approx. 194,000 marron (24 tonnes)

Based on rainfall records during the year 2000, the catch for the 2001 season is likely to be similar to or slightly lower than the catch in 2000. Bureau of Meteorology data indicate that the rainfall during 2000 was approximately 95.18% of the long-term average. Based on this figure, the expected catch of marron is predicted to be approximately 194,000 animals. However, the relationship between rainfall and marron catches needs further analysis. 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). Thus slightly lower catches are expected during the 2001 marron season, from the fishery overall.

NON-RETAINED SPECIES

Bycatch species impact: Negligible

Recreational Fisheries

The marron fishery does capture small quantities of non-target species, principally gilgies *(Cherax quinquecarinatus* and *C. crassimanus)* and koonacs *(C. plejebus* and *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.

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.

SOCIAL EFFECTS

The marron fishery in the 2000 season involved approximately 11,500 licence holders and their families undertaking about 40,000 fishing trips, and provided a major recreational activity in regional areas of the south-west of the State.

ECONOMIC EFFECTS

The 'commercial' value of the 2000 season recreational marron catch was about $0.5 million (based on a price of $20/kg). In addition, the estimated 40,000 trips to 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 include changes in land practices (including clearing and water diversion), a reduction of access to large dams, salinisation of the upper reaches of many rivers, the spread of the competitive yabby and the impact of introduced predatory fishes (including red-fin and trout) – all issues outside the control of the Fisheries legislation. Illegal fishing, including fishing out of season, retention of under-size marron and retention of more marron than permitted by the daily bag limit, may also be having a significant impact. 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.

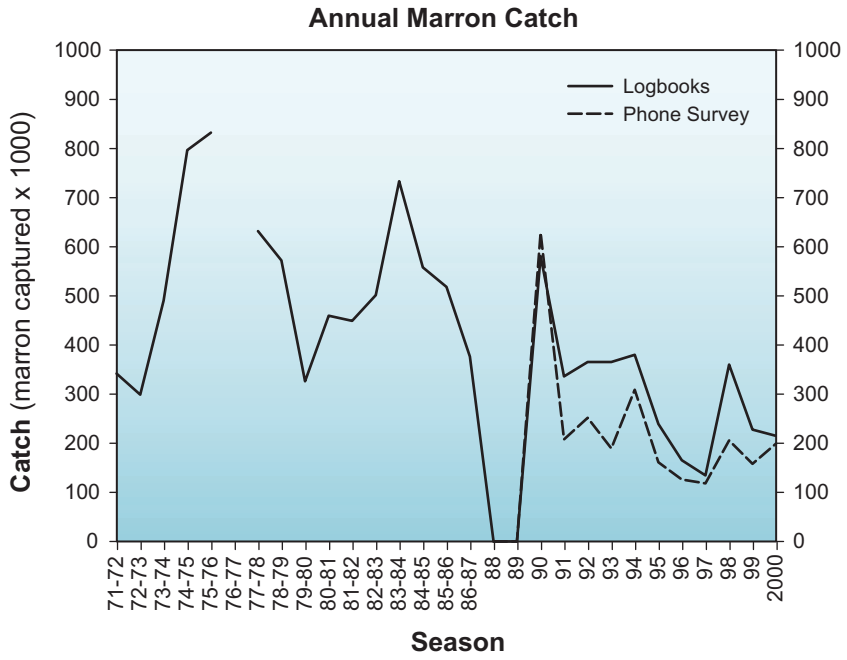
EXTERNAL FACTORS

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. 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 Waroona Dam. However, the Water Corporation is likely to refurbish Waroona Dam in the near future, which would include the complete draining of the dam for at least 18 months. Fisheries WA is working closely to ensure the refurbished dam provides a high-quality marron fishery once the dam is refilled.

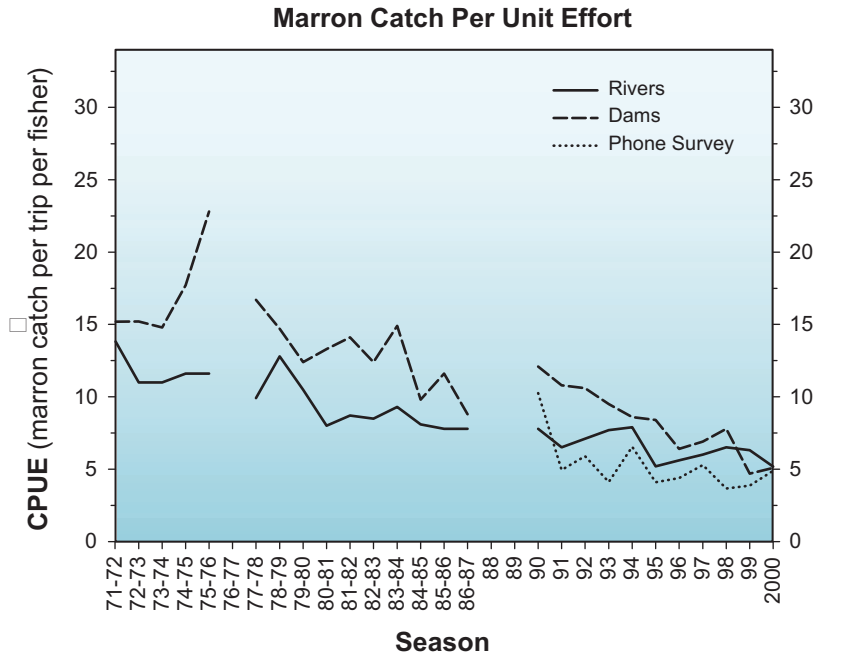
Introduced species also impact on the quality of marron fishing. The two major introduced species that impact on the marron fishery are yabbies and red-fin perch. Yabbies, a direct competitor and potentially serious threat to marron, have been recorded from a number of areas within the marron recreational fishery. 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 Fisheries WA.

Red-fin perch, which appear to predate heavily on small marron, have been illegally stocked into most rivers and irrigation dams in the south-west. Red-fin 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. The potential for increasing the marron survivorship rates and carrying capacity of water bodies by installing artificial structures is currently being investigated by Fisheries WA and should be considered, especially in the context of irrigation dams.



RECREATIONAL MARRON FIGURE 1

Total annual recreational marron catch, 1971 to 2000.



RECREATIONAL MARRON FIGURE 2

Catch per unit effort in the recreational marron fishery as recorded from logbook holders and from the telephone survey.

Recreational Fisheries

Recreational Freshwater Angling

RESEARCH SUMMARY

Fisheries WA Research Division projects on trout involve the production and distribution of trout fry, yearlings and excess broodstock to public waters. In addition, a number of research projects are currently being undertaken at the South West Freshwater Research and Aquaculture Centre, 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. 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 in several water bodies to reduce the predation rate of stocked fish, thus providing more angling opportunities. Genetic research into enhancing the quality of trout, particularly heat tolerance, from the agency's hatchery facility is also under way, comparing the tolerances of the SWFRAC strain, a natural strain and hybrids of rainbow trout. Finally, rainbow trout yearlings have been produced for use in inland saline waters. 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, red-fin 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. 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 but also provide some recreational fishing opportunities.

Main fishing method

Angling with rod and line.

RETAINED SPECIES

Recreational catch (season 2000): **Not assessed**

No catch or effort data were recorded for the fishery in the 1999/2000 season while improved survey methods were being designed and implemented. In the future, annual data will be collected via a new telephone survey.

The most recent survey data, for the 1998/99 season, gave an estimated catch of 34.1 tonnes (110,100 fish), comprising rainbow trout 6.8 tonnes (22,400 fish), brown trout 0.4 tonnes (1,300 fish), red-fin perch 26.0 tonnes (83,800 fish) and native catfish 0.8 tonnes (2,600 fish).

Fishing effort

Not assessed.

Catch rate

Not assessed.

Commercial share: **Nil**

There is no commercial fishery for these species.

Stock assessment completed: **No**

Enhanced rainbow and brown trout are produced at the SWFRAC and stocked into public waters as breeding by trout in south-west dams and rivers is negligible. A total of 550,000 rainbow trout fry and 25,000 brown trout fry from the SWFRAC were stocked into public waters during 1999. In addition, approximately 230,000 rainbow trout fry were sold to private dam owners for tourist fishing and private club fishing and 175,000 rainbow trout fry were sold to commercial producers. Older fish were also produced and sold from the SWFRAC during the year. Approximately 24,800 rainbow trout yearlings were produced and stocked into the public fishery, while 2,700 ex-broodstock rainbow trout entering their second and third years of life were also stocked into the recreational fishery for the 1999/2000 season.

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

Trout need stock enhancement by hatchery releases in most waters, as there is very little natural breeding due to high summer temperatures and limited nesting areas. Native cobbler are self-sustaining. Introduced red-fin 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 red-fin 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 red-fin perch. Red-fin consume trout, native fishes and crayfishes (including marron). Further, red-fin 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 red-fin by members of the public, although not recommended, occurs at high levels and may result in a decline of fishing quality. Fisheries WA encourages anglers to retain any red-fin caught, regardless of size.

Rainbow and brown trout are also introduced species but have a much broader diet than red-fin. 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 27 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 red-fin and are more acceptable as a recreational species.

Stocking in future will be influenced by a translocation evaluation of the environmental impact of trout stocking now being finalised.

Habitat effects: **Negligible**

SOCIAL EFFECTS

A large number of freshwater angling licences are sold annually. For the 1999/2000 season, a total of 14,209 licences were sold, including umbrella licences. This represents an increase of 20% in the number of valid licences when compared to the 1998/99 season (11,906).

ECONOMIC EFFECTS

The fishery operates in the south-west and is reputedly a major 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. A major angling event is planned for the 2000/2001 season which will give a better indication of the economic effects of this fishery.

FISHERY GOVERNANCE

Management of the fishery involves regular stocking of trout, and catches are controlled by bag and size limits and closed seasons.

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.

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 also scheduled for reconstruction and draining during the 2001/02 season, which may reduce future catches during the refurbishment process. Fisheries WA 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 State's commercial aquaculture industry is dominated by South Sea pearl production in the north, mussels and algae production for beta carotene on the west coast, and freshwater crayfish in the southern inland bioregion. Production of species such as non-maxima pearl oysters, edible oysters and abalone continues to increase.

Pearling Activities

The culture of pearl oysters of the species *Pinctada maxima* has been a major success. Centred on Broome, the pearling industry has operated since the 1880s, initially as a source of mother-of-pearl and more recently as Australia's largest and most successful aquaculture sector, producing quality South Sea pearls. The industry has continued to develop with a sound management base, with farms operating from Exmouth Gulf through to the Northern Territory border.

Aquaculture Activities

The level of activity and interest in aquaculture ramained high with a diverse range of aquaculture enterprises operating throughout Western Australia. These included the production of algae for beta carotene, mussels, yabbies, marron, freshwater finfish and non-*maxima* pearl oysters. Development work and commercial production continued for marine finfish, abalone, edible oysters, pearl oysters of the species *Pinctada albina* and *Pinctada margaritifera* and trochus. Prawn farming is considered to have significant potential, with two farm sites already licensed and the assessment of one other proceeding. Better genetic strains, feeds and stock management were developed for yabby farming. The first stage of identifying potential sites for land-based abalone aquaculture has been completed, and the large-scale mariculture site identification study being undertaken for the Aquaculture Development Council is nearing completion.

Aquaculture Development Initiative

Fisheries WA is responsible for implementation of the Government's aquaculture development initiative, in consultation with the Aquaculture Development Council and the Aquaculture Council of WA.

An aquaculture plan for the Recherche Archipelago was finalised during 2000/2001, and aquaculture plans for Shark Bay and Exmouth Gulf are being prepared. A large number of licence applications for species such as marron and freshwater finfish continued to be assessed for freehold land. Significant resources were directed to the public consultation and assessment process for coastal water applications under Ministerial Policy Guideline no. 8. Work also focused on the preparation of guidelines for the granting of aquaculture leases, drafting of lease documentation and administrative work associated with translocation and shellfish quality assurance.

Aquaculture development in regional areas focused on the provision of extension services and technical advice to existing operators and prospective investors. This work was undertaken predominantly by regionally based Development Officers, with additional specialist technical advice from research staff. Fostering of Aboriginal aquaculture was also a major activity, particularly with the multi-species hatchery under construction in Broome.

The agency maintained strong linkages with peak industry bodies and the relevant management advisory committees. Twelve projects were supported through the Aquaculture Development Fund (ADF) during 2000/2001, utilising funds in excess of $115,000.

Key Achievements

- A substantial increase in the number of aquaculture licences (438 at 30 June 2001).
- Continued implementation of the Government aquaculture development strategy.
- Completion of an aquaculture plan for the Recherche Archipelago.
- Expansion of the aquaculture research team, closely linked to industry and external research funding.
- Revision and expansion of the 'Aquaculture WA' series and other major advisory publications on key aquaculture species.
- Public release of a report on pearling legislation under National Competition Policy agreements.
- Introduction of the Vessel Monitoring System in Zone 1 to enable more accurate monitoring of wild stock catches in the pearl oyster fishery.
- Upgrading of the aquaculture pages on the Fisheries WA website.
- Development of a statewide aquaculture enquiry database.
- Final stages of development of an internet-based input–output model for sea-cage and pond aquaculture (ADF project).
- Commencement of an implementation plan for an Expression of Interest process through the Department of Land Administration to enable aquaculturists to gain access to identified sites for abalone aquaculture.
- Completion of a risk analysis of larval escape through abalone culture effluent systems.
- Refurbishment and expansion of the South West Freshwater Research and Aquaculture Centre at Pemberton.
- Achievement of export status for three shellfish growing sites in Western Australia.
- Facilitation of the construction of a $3.2 million multi-species hatchery on a site at the Broome Tropical Aquaculture Park.
- Establishment, with the University of WA, of a major marron genetics and aquaculture research facility at Shenton Park (ADF and FRDC project).
- Participation in the second annual MusselFest at Rockingham.
- Development (with industry) of a broodstock conditioning system for greenlip abalone.

Pearling and Aquaculture

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. Fisheries WA manages mussel farming in Cockburn Sound in accordance with an agreement between the Minister for Fisheries and the Fremantle Port Authority. Tenure for the existing farming sites at the Kwinana Grain Terminal expired in December 1999 and Fisheries WA secured an alternative farming site at Southern Flats within Cockburn Sound. Production is increasing at this site. The pearling industry utilising blacklip pearl oysters *(Pinctada margaritifera)* has also commenced in the Abrolhos Islands.

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 Health Department. The program involves regular sampling of bivalve shellfish-growing areas for toxic algae and faecal coliform bacteria in order to monitor shellfish quality and the classification of new 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 have been given approval by the Australian Quarantine and Inspection Service (AQIS) for export status.

Activities during 2000/2001 included the completion and submission to AQIS of triennial reports on the suitability of the WASQAP for maintaining the quality of harvested shellfish in Western Australia, an annual audit of the WASQAP by AQIS and the classification of a new growing area in Cockburn Sound.

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 2000b), with licensees primarily engaged in the culture of black pearls. Currently there are over 1,000 ha licensed for the culture of pearl oysters, of which 21% is utilised, carrying over 210,000 shell. Site utilisation in the Abrolhos Islands is set to increase, with average projected growth per licence approximately 45% over the next 12 months.

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.

As large numbers of young shell are now approaching operable size, the number of seeded shell is likely to increase fourfold in the next two years and to exceed 100,000 shell in three years. This dramatic increase in production will lead to a higher profile for black pearls produced in Western Australia.

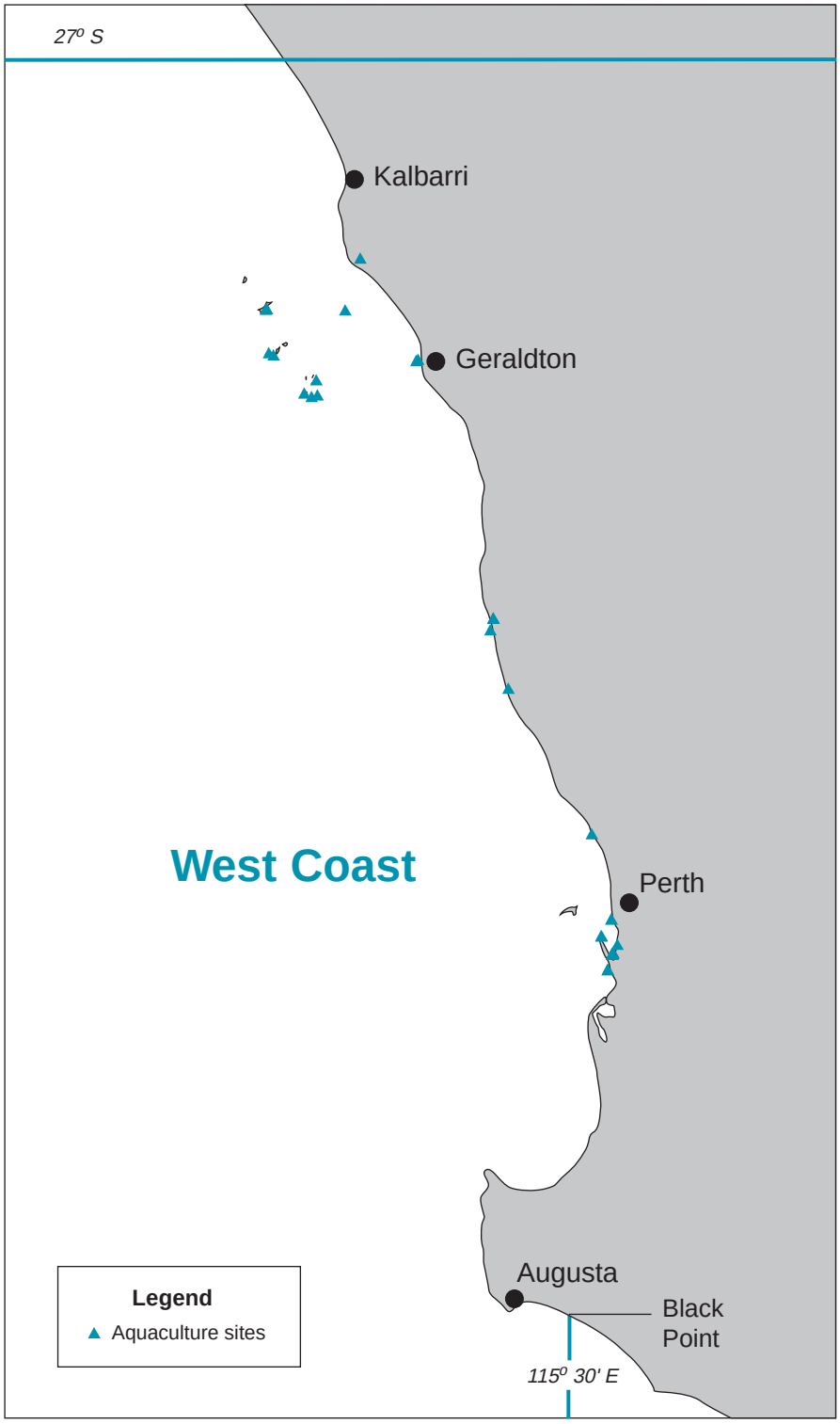
West Coast Aquaculture Figure 1 shows the major licensed aquaculture sites in this bioregion.

Regional Compliance and Extension Overview

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. Extension activities included public enquiries, participation in a second highly successful mussel festival at Rockingham, technical support – particularly for black pearl farmers in the Abrolhos Islands – and site identification work.

Regional Research Overview

Around Perth, activities include joint research with the WA Maritime Training Centre (WAMTC) on marine finfish and abalone aquaculture. A further collaborative project with WAMTC and Agriculture WA, with funding support from the Grains Research and Development Corporation and Grains Research Council, involves the evaluation of local agricultural products such as lupins and canola in aquaculture feeds. Environmental research on the impact of sea cage farming of snapper and rainbow trout is being conducted with the University of Stirling, Scotland. Joint work with Curtin University (funded by the ADF and FRDC) is aimed at rearing rock lobster larvae and assessing the potential for growout of wild-caught pre-juveniles (puerulus). Joint research with other universities is fostering husbandry, disease and nutritional research for marine aquaculture. Collaborative efforts with industry are aimed at producing a commercial supply of artemia (brine shrimp) cysts, for marine hatcheries, from microalgae production units (established for extracting beta carotene).



WEST COAST AQUACULTURE FIGURE 1

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

Pearling and Aquaculture

Mussel Farming

Mussel Farming Status Report

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Mussel 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. Additional area has been negotiated in the Southern Flats area of Cockburn Sound to give the Cockburn Sound mussel farmers more secure access to productive growing areas.

Production method

Vertical rope and bag culture on longlines.

AQUACULTURE PRODUCTION

Production current season (1999/2000): 683 tonnes

Number of producers for year 1999/2000: 11

Production projection next year (2000/2001): 800–1,000 tonnes

ECOSYSTEM EFFECTS

Low risk because there is no addition of feeds. Faecal wastes are far less likely to cause high organic loadings on the sea bed in Western Australia than in other mussel industries, as mussel lines are more widely separated in response to low food levels.

SOCIAL EFFECTS

Small industry as a direct employer. Few social effects other than to attract recreational fishers for finfish.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 1999/2000: $1.69 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, there has been recent development in the production of a range of aquaculture species.

Culture of marine invertebrates including prawns and sea cucumbers has progressed significantly with the successful production of prawn post-larvae in the Exmouth area. Sea cucumber culture has advanced with the installation of hatchery facilities and the collection of biological data on broodstock.

Research and development of techniques for the aquaculture production of Serranid finfish (e.g. estuary cod) continues in the Gascoyne, with improvements to broodstock handling increasing the yield of gravid females; however, significant impediments to increased production of this species include synchronous production of ripe males and efficient control of environmental parameters such as salinity. The production of ornamental aquarium fish is an important parallel to food fish culture in the Gascoyne.

Hatchery production of *Pinctada maxima* pearl oysters is of critical importance in this region, where recruitment of oysters in the wild is irregular. 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.

Black pearl production through culture of *P. margaritifera*, *P. albina* and *P. penguin* species has expanded, with farms increasing carrying capacity and also holding greater numbers of 'seedable' shell. Areas that suffered heavy stock and equipment losses during cyclones in recent years have rebuilt farms and stock numbers. Increased levels of technical skill and commercial experience among pearl farmers throughout the Gascoyne are being translated into improved growth rates and lower production costs. The volume and quality of black pearls from trial harvests have improved every six months as the number of suitably sized oysters at these farms accumulates and husbandry skills are gained. Market response to the Western Australian product has been very promising, with premium prices paid for locally mounted value-added product.

Management activities during 2000/2001 included the facilitation of meetings and the development of grower groups in regions with a concentration of aquaculture licensees, and fine tuning and implementation of policy relating to the collection of non-*maxima* pearl oyster spat. Aquaculture licensing advice, and assessment of applications for licences or variations to licences, remained important responsibilities of management in the Gascoyne region. Liaison with growers and the provision to them of information, advice and assistance continued through field visits and remote communication.

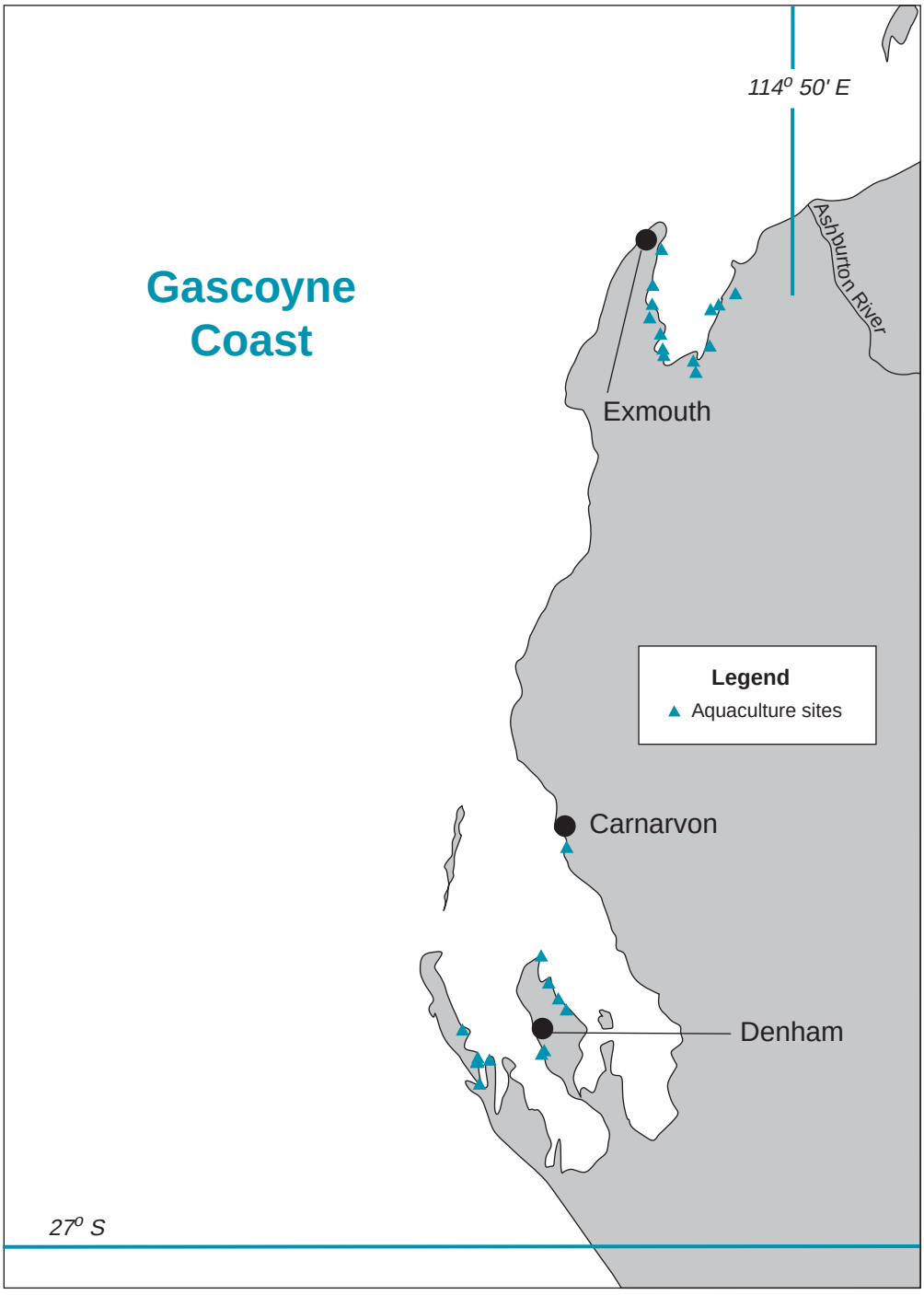
Gascoyne Coast Aquaculture Figure 1 shows the major licensed aquaculture sites in this bioregion.

Regional Compliance and Extension Overview

Compliance activities were focused primarily on site inspections to ensure compliance with licence conditions. Extension work included assistance in relation to the identification of a site for pearl production in Shark Bay.

Regional Research Overview

Collaboration has been initiated on tropical marine aquarium fish and sea cucumber research near Exmouth.



GASCOYNE COAST AQUACULTURE FIGURE 1

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

Pearling and Aquaculture

North Coast Bioregion

Regional Management Overview

The north coast bioregion is dominated by the production of pearls from the species *Pinctada maxima*. Activities within the 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 waters of the State.

Pearl oyster farms are predominantly situated in sheltered waters and range from the Montebello Islands to the northern waters of the Kimberley. One company generally transports part of its wild stock quota to the Northern Territory for the culturing process, however this company has begun to develop the necessary pearl farm infrastructure in the north Kimberley area to allow farming in Western Australia. Pearl farm lease applications are assessed through a public consultation process in accordance with Ministerial Policy Guideline no. 8. The assessment of pearl farm lease applications continued to be a major activity in 2000/2001.

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 Fisheries WA in liaison with the Pearling Industry Advisory Committee (PIAC). During 2000/2001, the TAC for the 2001 fishing season for Zone 2/3 remained at 502,500 shells (one quota unit equals 1,100 shells).

The status of stocks in Zone 1 was also reviewed. A TAC of 40,000 shells for the Exmouth Gulf component of the Zone 1 fishery was maintained for the 2001 fishing season. A maximum size limit of 160 mm was also continued for shell taken in Exmouth Gulf to ensure that any residual animals following fishing in a season were not open to future exploitation and flowed through to the breeding stock.

This year all vessels operating in Zone 1 were required for the first time to be fitted with an automatic location communicator to assist in monitoring compliance with the TAC.

The seeding of hatchery-produced oysters was continued by some companies through licensees utilising hatchery options available to industry. Licensees also had the option of substituting hatchery production for wild shell quota.

The annual value of production for pearls in 2000 was estimated at about $220 million for the whole Western Australian pearl industry.

PIAC met on three occasions, with an extraordinary meeting held in January 2001 to consider the report on the National Competition Policy review of pearling legislation. The reports were released for public comment in May 2001.

The agency, in consultation with the Pearl Producers' Association and PIAC, agreed to review the legislative framework for pearling, taking into account the new environmental reporting requirements under the Commonwealth's *Environmental Protection and Biological Diversity Conservation Act 1999*, the outcomes of the National Competition Policy review of the pearling industry, and the industry's future business needs. Some additional changes to the pearling regulations to facilitate pearling compliance and industry management practices will be considered in the short term.

Other issues, including budget development and management, operational planning and management of pest incursions, continued to be a focus of attention during 2000/2001.

Other aquaculture management initiatives in the north coast bioregion were focused on pearl production for *Pinctada margaritifera* and reef reseeding for trochus and other reeftop molluscs. Significant resources were also directed to a prawn aquaculture proposal for the Wyndham area. A licence has been issued for a 650 ha prawn farm on a site near Derby.

North Coast Aquaculture Figure 1 shows the major licensed aquaculture sites in this bioregion.

Regional Compliance and Extension Overview

During 2000/2001, Fisheries Officers based in Broome and Karratha undertook a compliance monitoring program across all zones of the pearl oyster fishery. Companies have continued to increase production of hatchery-reared shell and the compliance focus shift to the monitoring and control of this product has increased. Major compliance issues are the verification of shell numbers and size prior to seeding operations, and the movement of hatchery shell within and also between farms. Regular nursery site audits are conducted to monitor hatchery shell growout and to verify progress for the conversion of hatchery options to hatchery quota. Approvals to allow the use of hatchery shell for technician training and for mantle tissue in seeding operations have also increased compliance requirements in this area.

Several 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 agency. 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 Fish Health section of Fisheries WA. Conversion of hatchery options to hatchery quota is monitored by a combination of operations logbooks, nursery and operations audits, and at-sea compliance presence during operations.

Field officers based in Karratha and Broome patrolled from Exmouth Gulf (Zone 1) to the Kimberley development zone (Zone 4). 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 joint agency (Fisheries WA and Department of Transport) ocean-going patrol vessel *Walcott*, with small agency vessels being used as dive platforms.

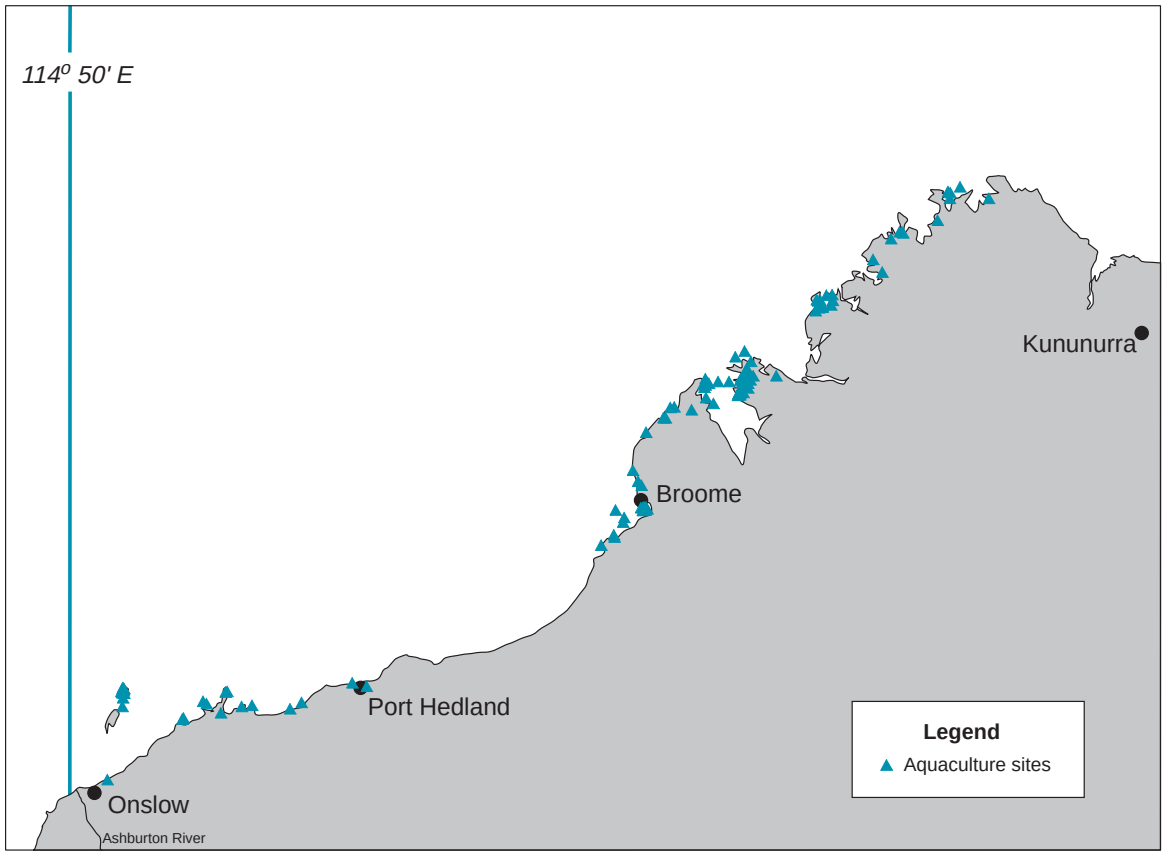
Regional Research Overview

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.

FRDC-assisted research into the mother-of-pearl (MOP) component of the pearl oyster stocks (pearl oysters > 170 mm shell size) is now in its final year. A second FRDC project, which began in July 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.

During 2000/2001, Fisheries WA handed over to the Bardi Community of One Arm Point a pilot-scale trochus hatchery to provide stock for assessing the effectiveness of enhancing reefs near King Sound. The establishment of the hatchery was part of an international project funded by the Australian Centre for International Agricultural Research, the Aboriginal and Torres Strait Islander Commission (ATSIC) and the ADF. Significant progress has been made with the construction of a large, Aboriginal-owned multi-species hatchery at Broome Aquaculture Park, with research staff providing scientific and design advice. ATSIC has also assisted Fisheries WA and TAFE at Broome with the development of an Aboriginal aquaculture training initiative.

In a major study of salt field biota, the artemia (brine shrimp) resources have been characterised in one major salt field. Fisheries WA has helped fund hatchery production trials with barramundi at TAFE in Broome. Research staff based in this region have undertaken national liaison to assess the opportunities and constraints for indigenous aquaculture in Australia.



NORTH COAST AQUACULTURE FIGURE 1

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

Pearling and Aquaculture

Pearl Oyster Fishery

Pearl Oyster Fishery Status Report

Prepared by K. Friedman and 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 total allowable catch.

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°10' 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 2000): 617,500 shell

Landings

The total allowable catch is controlled by a quota system. In 2000 the TAC 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 bulk of landings were taken from Zone 2/3 (88% of all shell fished). The Zone 2/3 TAC for 2000 was 10% greater than for 1998 and 1999. This increase in TAC, to 502,500 shell, 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 2,000 shell special 'tourism' allowance was not increased. The reported catch for Zone 2/3 for the 2000 season was 501,419 shell (Pearl Table 1).

Zone 1 of the pearl fishery had a TAC of 115,000 shell for 2000. The reported catch of 66,772 shell (Pearl Table 2) was well below this allocation, as some licensees chose to use hatchery-reared shell in preference to wild stock in the 2000 season. This conversion to hatchery stock, as envisaged in the management arrangements, has been caused by decreased availability of wild stock due to cyclone damage to traditionally productive areas, particularly in Exmouth Gulf.

Fishing effort

Total effort for 2000 in all zones was 15,151 dive hours. The total effort for 2000 in Zone 2/3 was 9,258 dive hours, which represented a 10% decrease on the 1999 Zone 2/3 effort of 10,300 dive hours. This reduction was mainly due to increased stock abundance and better than average diving conditions. The total effort in Zone 1 during 2000 was 5,893 dive hours, representing a 23% increase on the 1999 total effort of 4,789 dive hours. This increase occurred despite there being a decrease in catch (Pearl Table 2), and may be attributed to three main factors: firstly, a lower stock abundance, particularly in the northern sectors of the fishery; secondly, an increase in speculative diving (searching time) as industry attempted to locate new fishing grounds within the middle sector of Zone 1; and thirdly, poor diving conditions experienced on traditional fishing grounds.

Catch rate

The catch rate for the pearl oyster fishery (all zones) was 37.5 shells per dive hour (shells/hr). This represents a slight increase on last season's overall catch rate (36.5 shells/hr). The overall catch rate in the pearl oyster fishery was predominantly influenced by catch rates in Zone 2/3 where landings were greatest.

Catch per unit effort in Zone 2/3 in 2000 was the highest ever recorded at 54.2 shells/hr, which represented a significant increase on the previous record catch rate of 1999 (44.5 shells/hr), and a 84% increase on the 10-year (1988–1997) average of 29.5 shells/hr (see Pearl Table 1). This improvement in catch rates was not spread equally between Zones 2 and 3. In Zone 2, the catch rate was 55.5 shells/hr, while the catch rate in Zone 3 alone was 32.4 shells/hr. The increase in catch rate when compared to historical records is somewhat tempered by the increased efficiency of industry vessels, which have adopted GPS and 'plotter' technology since about 1992. However, the ever more stringent shell size selection and quality grading methods applied by industry may have negated potential gains realised through the use of technology.

The Zone 1 catch per unit effort was 11.3 shells/hr in 2000, which represented a significant decrease of 40% from the 1999 figure of 18.9 shells/hr (Pearl Table 2). Effort in 1998 and 1999 shifted across Zone 1, from Exmouth Gulf in the south to the Port Hedland region (including the buffer zone extension) in the north. In 2000, Exmouth Gulf yielded just 36% of the catch (53% less than the average for 1990–1997), while the Port Hedland region was the source of 52% of the shell (11% less than last year but still 64% greater than the 1990–1997 average). In 2000, previously under-utilised areas in the middle sectors of the fishery have begun to show promise again (12% of the Zone 1 catch). Whereas the catch rate in the Port Hedland region has steadily decreased from 26.4 shells/hr in 1998 to 11.5 shells/hr in 2000, the catch rate in the middle sector of the fishery has steadily increased in the last three years from

10.8 shells/hr in 1998 to 17.2 shells/hr in 2000. Exmouth Gulf (the southern sector of the Zone 1 fishery) saw an increased catch rate between 1998 and 1999 (from 11 shells/hr in 1998 to 19.3 shells/hr in 1999) but this has again declined to 10.1 shells/hr in 2000.

Recreational component (2000): **Nil**

Stock assessment completed: **Yes**

The primary measure of stock availability is catch per unit effort. In Zone 2/3 the high level of catch rate recorded in recent years (1994–1996 and 1999–2000) had previously only been experienced during the late 1970s and early 1980s when the pearling fleet was fishing both culture and mother-of-pearl shell. The increased catch rates in 1999 and 2000 are believed to have resulted from high abundance, favourable diving conditions and the influence of technological efficiencies on industry practices.

The state of the fishery is of primary importance when one considers changes in catch per unit effort. The unprecedented high catch rate results indicate that recruitment to the Zone 2/3 pearl oyster stock is at a level sufficient to maintain or increase stock levels, permitting safe and economic fishing operations. As with most bivalve fisheries, the *P. maxima* fishery is characterised by large variability in recruitment. The high catch rates recorded in 1999 and 2000 are undoubtedly partially due to a large pulse of recruits passing through the size range targeted by the fishery. This increase in recruitment can be partially attributed the presence of favourable environmental conditions for larval and juvenile survival. In addition to environmental effects on larval development, settlement, juvenile growth and survival, the weather conditions were unusually settled during the main fishing periods in 2000 which assisted divers through good water visibility. This was despite the occurrence of Cyclone Rosita in April 2000 which caused wide-scale damage to pearling facilities located near the cyclone's path just south of Broome.

Increases in catch rates have occurred in Zone 2/3 as the fleet decreases the effective search and fishing area. Catches in 2000 were made in less than half the area (as reported in 10 x 10 mile grid squares) that was utilised at the beginning of the 1990s. Fishers have concentrated fishing effort on productive pearling grounds in shallower water (< 12 m on average). In the last five years the average depth fished has fallen every year. Assessment of the sizes of oysters fished in Zone 2/3 show 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 reveal that the wider range of pearl oyster grounds off the Eighty Mile Beach are subjected to low levels of fishing pressure, while yearly recruitment is supporting the fishery within its most productive locations. Within Zone 2/3 there is, however, a history of differential catch rates between major fishing areas. For example, although catch rates in Zone 3 were higher than those recorded in Zone 2 during 1994–1996 (peaking at 50.2 shells/hr in 1995), catch rates were lower in Zone 3 than in Zone 2 in 1999 and 2000, suggesting that the factors responsible for the increased catch rates in Zone 2 were not as apparent in Zone 3 during the past two years.

The distribution of catch and effort in Zone 1 in 2000 was similar to that recorded in 1998 and 1999 as a result of management decisions designed to reduce fishing pressure in Exmouth Gulf. These decisions involved setting a TAC of 40,000 shell for Exmouth Gulf, and extending the Zone 1 buffer zone 30 nautical miles east to allow operators access to previously under-utilised grounds in the southern areas of Zone 2. The overall importance of the northern sector catch decreased for the first time this season as declining catch rates began to impact total catch. Although this decline is to be expected due to the fact that unfished built-up stock was available after 1998, catch monitoring in this northern sector reveals that fishers are still 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 other sectors in the fishery. Although the link between spat sampling and future recruitment is preliminary at this stage, the generally low spat collection results are in line with the general perception that recruitment in this sector of the fishery is more sporadic and less regular than in Zone 2/3. The indicators presented above suggest that fishing pressure on traditionally fished ground in this sector of Zone 1 is too high, despite the wild shell quota not being fully fished by licensees.

Catches from under-utilised areas in the middle sectors of the fishery are again nearing more promising levels (12% of the Zone 1 catch). The steadily increasing catch and catch rate recorded from pearl grounds in the middle sector of the Zone 1 fishery, which show signs of recent recruitment (based on length frequency sampling), provide a welcome relief for the more heavily fished northern and southern sectors of the fishery. Catch rates in Exmouth Gulf (southern sector) returned to 1998 levels despite management changes (1998) reducing fishing pressure in this sector. It seems the destructive effects of Cyclone Vance on the eastern side of the Gulf, and generally poor diving conditions in 2000, have negatively affected catches despite 40% of the Exmouth Gulf TAC not being fished. In addition to the loss of productive ground through cyclone activity, some traditional fishing areas in the south of the Gulf are not being fished because they are positioned within pearl farm lease boundaries. Management controls in Exmouth Gulf will be retained during the 2001 season to limit effort and encourage the rebuilding of pearl oyster stocks in that area. If there is a decline in abundance indicators in 2001, further controls in this fishery will be needed.

Exploitation status: **Fully exploited**

The 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

Pearling and Aquaculture

165–170 mm usually remain in the fishery as breeding stock. The fishery focus has also moved away from the deep-water pearling grounds, that now remain unfished or only lightly fished. Stocks remaining on these deep-water pearl grounds are likely to contribute to overall broodstock abundance and recruitment in both shallow and deep-water areas.

The current annual quota for the fishery is less than the annual recruitment of oysters, therefore the breeding stock is being maintained or in some areas increased. This is especially true for Zone 2/3, which has seen excellent recruitment in recent years. Current management arrangements for Exmouth Gulf in the southern sector of Zone 1 (160 mm maximum size) are designed to ensure that breeding stocks in that sector are improved in the longer term. In contrast, heavy fishing pressure on some pearling patches in the northern sector of Zone 1 could have a negative effect on broodstock populations if flow-through of recruits to broodstock sizes was limited by high fishing effort.

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**

The 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 Lacepedes 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 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): $220 million

The value of cultured pearls and by-products is considered to be approximately $220 million for the year 2000. 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: 15,331–22,599 dive hours

Catch figures in Zone 2/3 showed significantly elevated catch rate in the last two 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. It is expected that Zone 2/3 of the pearl oyster fishery should achieve its 2001 quota within or below the five-year range (1994–1998) of 12,003–16,576 dive hours, given the higher catch rates expected. If the elevated catches in 2000 were taken into account, one would expect from experience (1994–1996) that the 2001 catch rate will continue to be elevated (though not as high as 2000), reflecting the protracted time period that an elevated pulse of recruits takes to pass through the targeted size classes of the fishery.

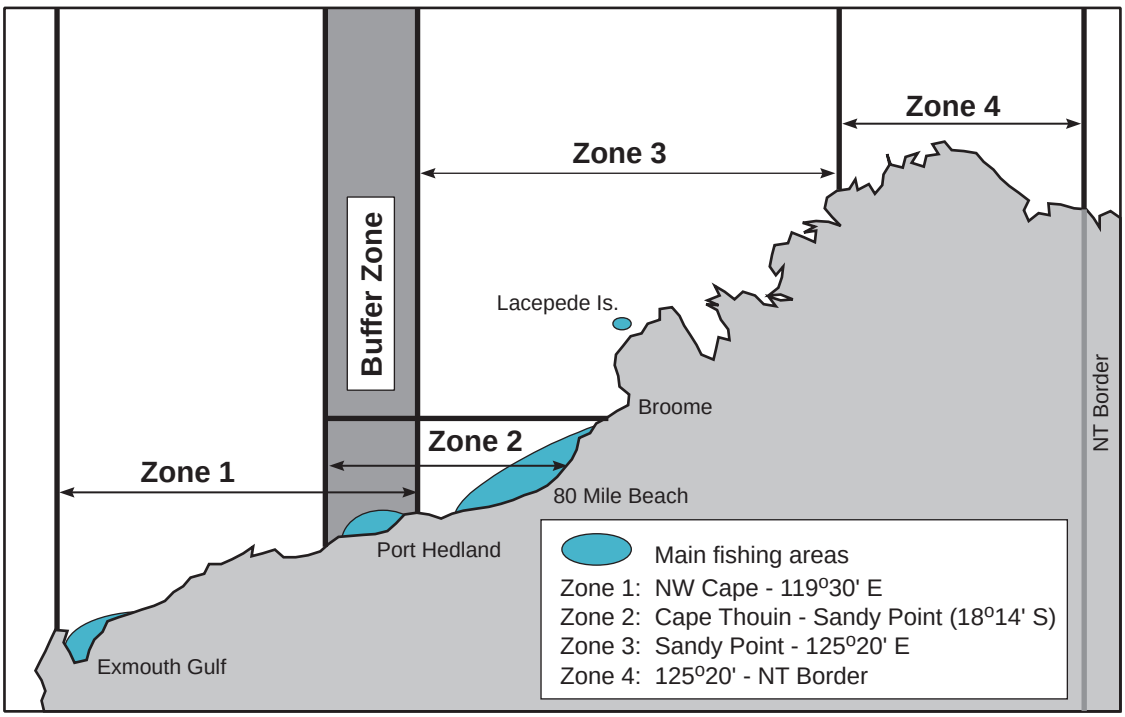
In Zone 1, approximately 70,000 shell (of the 115,000 shell TAC) is expected to be caught from wild shell stocks in 2001, with the remainder of the quota to be filled from hatchery production. The acceptable effort range for Zone 1 to achieve a catch of 70,000 shell is 3,328–6,023 dive hours (based on a pro rata effort estimation for 70,000 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 controls are recommended for 2002 to ensure adequate numbers of oysters flow through to the breeding stock in all sections of Zone 1. This will mean that pearling companies will need to rely on greater quantities of hatchery-produced shell from the facilities established for that purpose, and work on a reduced wild stock catch quota under ever-stricter spatial controls.

EXTERNAL FACTORS

The pearl oyster stocks underpinning the fishery in Zone 2 (88% of total pearl oyster catch in 2000) continue to provide an elevated level of production to support this major Western Australian industry. The new FRDC-funded project, which seeks to determine the predictability of the relationship between numbers of spat of *P. maxima* on adult oysters (piggyback spat) and future catch rates, will potentially give the fishery data on abundance of upcoming stock. This information would

greatly assist managers in determining quota allocations, as there is currently a heavy reliance on retrospective catch data to determine future management controls. In a fishery that targets pearl oysters for approximately three years once they reach legal size, projections based on retrospective catch data can under-estimate and over-estimate available stock.

There is a recognised need to document the uptake of GPS/plotter technology, and the seasonal variance in diving conditions such as visibility, to assess how catch rate is affected by factors other than shell abundance. Documentation of the adoption and operation of GPS and plotter technology will be prepared in 2001. Methods for assessing and documenting diving conditions within the framework of catch reporting will be discussed at industry research meetings in October 2001.



PEARL FIGURE 1

Distribution of pearl oyster stocks and fishing zones in Western Australia.

Pearling and Aquaculture

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

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

South Coast Bioregion

Regional Management Overview

The south coast bioregion encompasses the major centres of Albany and Esperance. Aquaculture activity in the region is focused at Albany and includes commercial mussel and edible oyster production and trial abalone production. Management activities were directed at management of the Albany Aquaculture Park in which three sites are leased for abalone and edible oysters. Additional applications for mussel farming in King George Sound were assessed through the public consultation process (Ministerial Policy Guideline no. 8). Administrative oversight of the WA Shellfish Quality Assurance Program was continued. Activity in the Esperance area related to the aquaculture plan for the Recherche Archipelago and interest in abalone aquaculture.

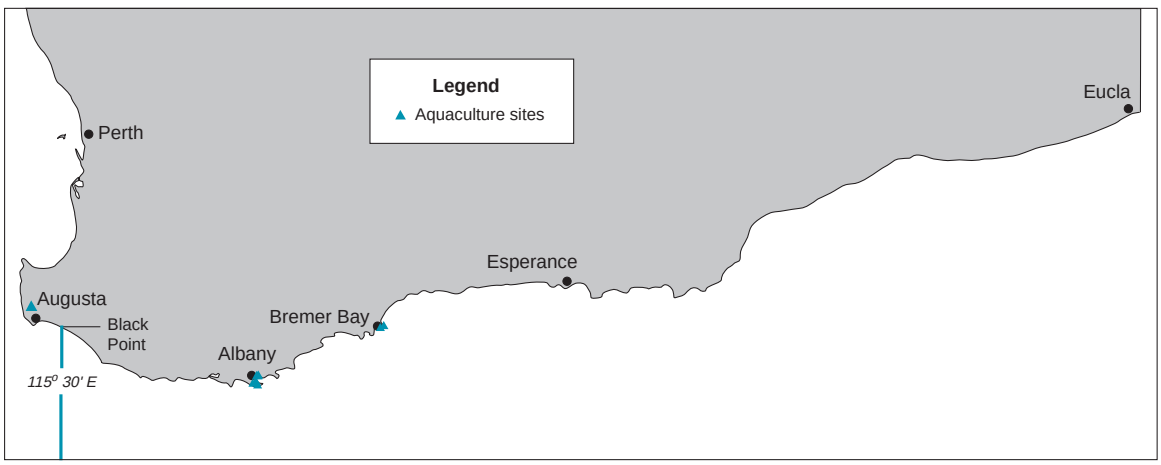
South Coast Aquaculture Figure 1 shows the major licensed aquaculture sites in this bioregion.

Regional Compliance and Extension Overview

Regional officers conducted site inspections to ensure compliance with licence conditions and, in particular, site marking requirements. Officers were also involved in supervising the sampling of waters and shellfish and monitoring harvesting closures as part of the WA Shellfish Quality Assurance Program. Extension activities were focused principally on public enquiries and planning in relation to aquaculture development, particularly abalone.

Regional Research Overview

A major research activity has been the evaluation of greenlip and Roe's abalone fed various diets in a project managed jointly by Fisheries WA and industry, with financial support from the ADF. Major progress has been made with conditioning greenlip abalone broodstock out of season and using these for commercial production of juvenile abalone. Performance of greenlip abalone in sea-based culture near Albany continues to be extremely encouraging. Assessment of the potential environmental impact of mussel farming on benthic habitats, supported by Fisheries WA, FRDC and ADF, is nearing completion near Albany.



SOUTH COAST AQUACULTURE FIGURE 1

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

Pearling and Aquaculture

Northern Inland Bioregion

Regional Management Overview

Small-scale cage farming of barramundi on Lake Argyle has been successfully developed by a local fishing company over recent years. In an effort to expand production more rapidly to create economies of scale, an expression of interest process to select a developer for large-scale barramundi farming was undertaken by Fisheries WA, and completed in June 2001. The outcome of the process was that the Selection Board preferred not to grant preference to any of the applicants. While not creating an incentive for rapid growth in aquaculture development on Lake Argyle, this decision should clear the way for smaller developers, who have already shown some interest, to make application for additional aquaculture licences. Fisheries WA will continue to work with interested proponents to encourage smaller-scale aquaculture projects at Lake Argyle, and is confident that there will be some significant development over the next one to two years.

Other management activities in the bioregion included the provision of technical advice in relation to the production of redclaw crayfish, aquarium fish, sooty grunter and barramundi by landholders on the Ord irrigation system around Kununurra.

Northern Inland Aquaculture Figure 1 shows the major licensed aquaculture sites in this bioregion.

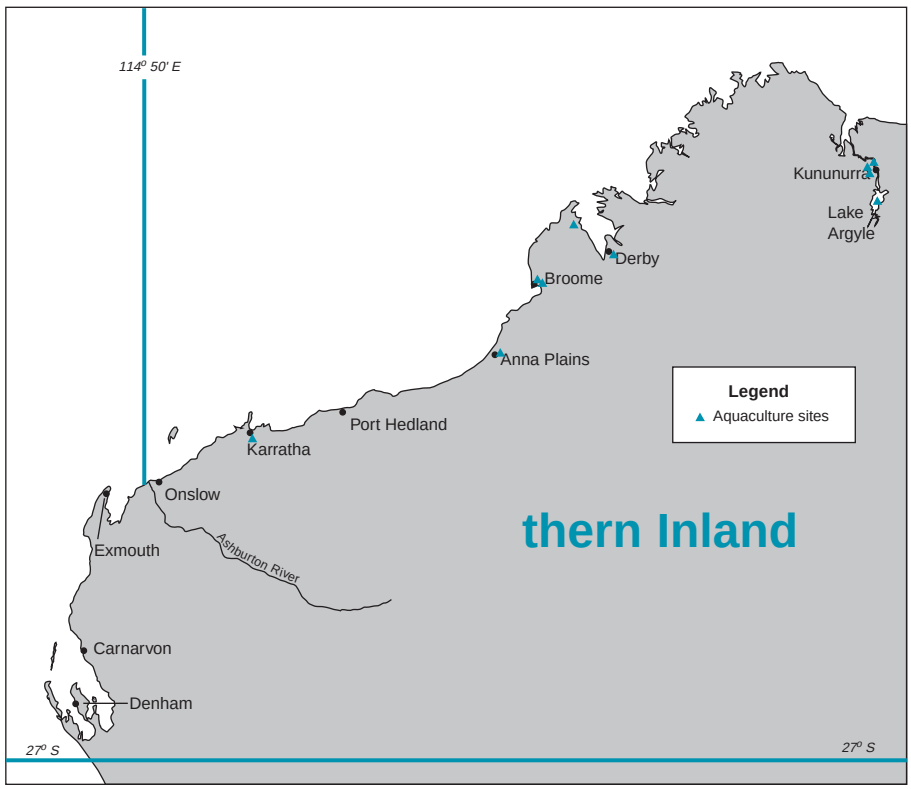
Regional Compliance and Extension Overview

Aquaculture Development Officers were stationed in Broome and Kununurra. One of their major roles is to facilitate the necessary approvals to commence major aquaculture ventures in the Kimberley. Special efforts are 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, inspection of properties for their suitability for the production of redclaw crayfish, and the establishment of aquaculture research facilities at the Frank Wise Institute of Tropical Research at Kununurra.

Extension work included the provision of assistance to the Gascoyne Inland Aquaculture Group which is looking at the production of ornamental fish in artesian waters. Ongoing technical advice was also provided in response to public enquiries.

Regional Research Overview

Research staff have contributed to efforts to develop a risk assessment of barramundi farming in Lake Argyle and assisted a barramundi hatchery nearby. Barramundi is one of the species included in an ADF project, on modelling nutrient outputs from farming systems for key aquaculture species, undertaken by research staff in collaboration with Israeli scientists. Interaction with Aboriginal communities has included establishing a pilot farming trial with sooty grunter.



NORTHERN INLAND AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture sites in the northern inland bioregion.

Barramundi Farming

Barramundi Farming Status Report

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Intensive production in cages in Lake Argyle or in recirculating systems in the southern half of the State. Interest in producing barramundi is growing strongly, with 35 licences issued as at 30 June 2001. Production from these farms is expected to increase in 2000/2001.

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 (1999/2000): Not reportable

Where fewer than five producers are involved in a particular industry, the data are subject to the confidentiality provisions of the *Fish Resources Management Act 1994* and are not reported. However, the barramundi production forms a significant part of a statewide freshwater finfish farming industry of 55 tonnes.

Number of producers for year 1999/2000: 3

Production projection next year (2000/2001): 40–50 tonnes

The increased number of new producers allows a projection to be made.

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. Land-based farms producing more than 1 tonne of fish require discharge licensing, which includes monitoring of water quality. Fisheries WA recommends use of swirl separators and/or settlement/reed ponds to improve the quality of this discharge prior to release or reuse.

SOCIAL EFFECTS

Not a major employer of staff so far. Visual impact is relatively minor.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 1999/2000: Not reportable

INDUSTRY GOVERNANCE

A Fisheries WA licence must be issued and a water quality monitoring program that is to the satisfaction of the Department of Environmental Protection is a condition of the licence.

EXTERNAL FACTORS

This industry has the potential to grow significantly, particularly in Lake Argyle.

Pearling and Aquaculture

Southern Inland Bioregion

Regional Management Overview

The southern inland bioregion is dominated by production of yabbies, marron and freshwater finfish. Management and licensing arrangements have not changed significantly over the past year.

Trout ova and fry from the South West Freshwater Research and Aquaculture Centre (SWFRAC) at Pemberton were sold to freshwater trout farmers, and yearlings were sold to growers using inland saline waters.

The production of freshwater and marine ornamental fish species is a small but rapidly growing sector of the aquaculture industry in Western Australia. Improved extension material highlighting the opportunity for these species as candidates for aquaculture is available.

Southern Inland Aquaculture Figure 1 shows the extent of sites in this bioregion.

Regional Compliance/ Extension Overview

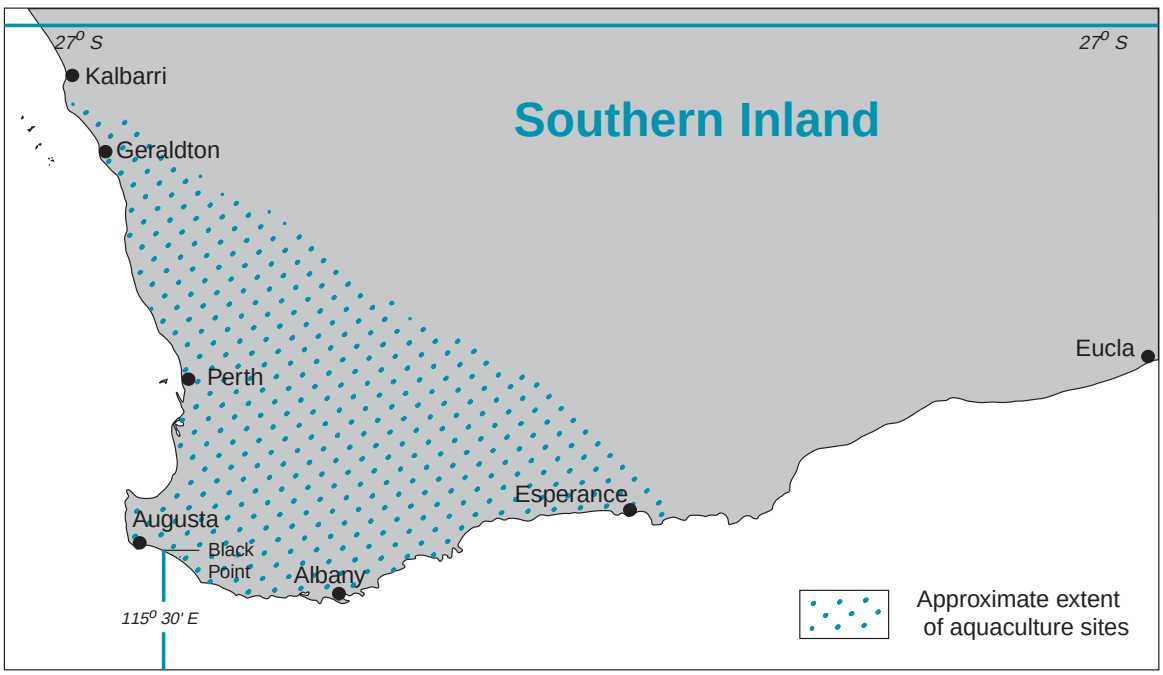
Aquaculture Development Officers stationed at Albany and Narrogin provide an extension service to farmers as well as providing displays and information at country shows and workshops. For 2000/2001 there was a particular focus on the production of trout, marron and yabbies, with extensive resources being 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. Officers conducted site inspections to ensure compliance with licence conditions and site marking requirements. They were also involved in supervising the sampling of waters and shellfish and the monitoring of harvesting closures as part of the WA Shellfish Quality Assurance Program. One prosecution brief was submitted for the sale of yabbies without an aquaculture licence.

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. Research staff in these locations also taught a five-month full-time course for potential marron and trout farm managers.

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



SOUTHERN INLAND AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture sites in the southern inland bioregion.

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 built at the SWFRAC (with additional funding from the Commonwealth Regional Assistance program, South West Development Commission and the Department of Training).

Analysis of harvest data from 40 commercial marron ponds was progressed. Quantitative analysis of the factors influencing production strongly supported agency extension advice on increasing feed rates and providing paddle-wheel aeration, refuges and bird protection. The quality of the water supply was less influential. A major feed trial with industry has indicated that feed quality is not the limiting factor even during the second year of the growout phase. A summer harvesting trial with industry was very encouraging for improving continuity of supply for live export markets.

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. Very cost-effective procedures for providing feed and managing competition for food in dams were developed. About 20 yabby farmers participated in a logbook program which demonstrated substantial regional variation in production.

Upgrading of production facilities at the SWFRAC allowed production of about 50,000 yearling rainbow trout for farmer assessment of production in saline ponds or dams. Dry conditions have depressed demand in 2001, but trials, including marketing initiatives, are being continued with assistance from the Development and Better Interest Fund. Research trials in sea cages confirmed that selective breeding at SWFRAC over many years has produced a very fast-growing strain of rainbow trout.

Marron Farming

Marron Farming Status Report

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Licensed purpose-built farms 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:

- An Aquaculture Licence (Marron) allows the holder to sell marron of any size to any person. Applicants must demonstrate that they own or occupy private property with a minimum of 2,500 m^2 of impounded water available for marron aquaculture purposes.
- An Aquaculture Licence (Marron Limited) allows the licence holder to sell marron of 76 mm 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 (1999/2000): 42 tonnes

Number of producers for year 1999/2000: 139

Production projection next year (2000/2001): 50–60 tonnes

ECOSYSTEM EFFECTS

Low risk because there is relatively little water discharged from marron farms. Fisheries WA 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.

SOCIAL EFFECTS

Diversification of farm usage away from other, sometimes unprofitable, agricultural uses. The industry involves a large number of family-based farms.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 1999/2000: Nearly $1 million

INDUSTRY GOVERNANCE

Licence approvals are required.

EXTERNAL FACTORS

A significant number of new purpose-built marron farms have been developed during 1999/2000, and other existing farms have constructed more ponds. This should progressively contribute to expansion in State production. Development of a new farm to full production usually requires around three years and for most farms production is influenced by rainfall.

Pearling and Aquaculture

Yabby Farming

Yabby Farming Status Report

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Yabbies 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 (1999/2000): 211 tonnes

Number of producers for year 1999/2000: 27

(This number refers to licensed farmers or processors. Note most farmers do not require licences.)

Production projection next year (2000/2001): 180–220 tonnes

ECOSYSTEM EFFECTS

Low risk 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.

SOCIAL EFFECTS

Yabby farming is a female-dominated industry which provides direct income to a large number of families in the wheatbelt.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 1999/2000: $2.78 million

The value has increased in part because of the reporting, for the first time, of wholesale value rather than farm gate value. Other factors are higher production, particularly with more winter harvesting, and emphasis on producing larger, more valuable yabbies.

INDUSTRY GOVERNANCE

Licence approvals are required. Commercial yabby farming is only permitted to the east of the 'yabby boundary' and north of Perth.

EXTERNAL FACTORS

Stocks recovered, from drought-induced low yields, after the above-average rainfall of 1996. The strategic plan for development aims at increasing farmer participation and increasing the low or inconsistent production of many dams.

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. Production data for the first six months of 2000/2001 indicate that the industry has recovered well from this setback. Prospects for the industry are very good as research results (e.g. monosex growout, improved feeding regimes and regular, more effective trapping) are adopted by industry, although production depends greatly on rainfall.

Trout Farming

Trout Farming Status Report

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Intensive trout culture is confined to the lower south-west by summer water temperatures and limited by the need for a large through-put volume of water. Potential exists to expand production by the utilisation of irrigation dam water in transit to agricultural farms on the south-west coastal plain. In addition, farmers with saline underground water are evaluating the performance of rainbow trout, stocked as yearlings and grown out in dams during cooler months.

Production methods

Highly intensive pond culture for food and extensive farming in large gully dams stocked for pay fishing. Low-intensity purpose-built ponds are being constructed by inland saline farmers.

AQUACULTURE PRODUCTION

Production current season (1999/2000): Not reportable

Where fewer than five producers are involved in a particular industry, the data are subject to the confidentiality provisions of the *Fish Resources Management Act 1994* and are not reported. However, the trout production forms a significant part of a statewide freshwater finfish farming industry of 55 tonnes.

Number of producers for year 1999/2000: 4

Production projection next year (2000/2001):
Not reportable

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. Fisheries WA 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 and 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 enacting current discharge patterns.

A translocation review is largely completed, particularly for direct stocking of trout into public fisheries. 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 1999/2000:
Not reportable

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.

Ornamental Fish Farming

Ornamental Fish Farming Status Report

Prepared by G. Maguire

INDUSTRY DESCRIPTION

Production areas

Statewide.

Production methods

Dedicated small ponds and aquaria; breeding and rearing of juveniles for live sales.

AQUACULTURE PRODUCTION

Production current season (1999/2000): 126,000 fish

Number of producers for year 1999/2000: 32

Production projection next year (2000/2001):
200,000–300,000 fish

ECOSYSTEM EFFECTS

Low environmental risk because there is relatively little water discharged from ornamental fish farms. Operators are required to ensure that stock does not escape into natural waterways.

ECONOMIC EFFECTS

Estimated annual value (to producers) for year 1999/2000: $170,000

INDUSTRY GOVERNANCE

Licence approvals need to be obtained.

EXTERNAL FACTORS

Commercial production recorded for 1999/2000 indicated considerable volatility in production for major aquarium fish groups.

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 agency's role in the protection of the marine estuarine and riverine environments as required by the Government's fisheries policy. To facilitate these activities on behalf of the wider community, a reference group of stakeholders was set up in the year 2000. 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 Environmental Protection Authority (EPA) and the Office of the Auditor General (OAG). The reference group provides input on fish habitat protection, ecologically sustainable development (ESD) and related activities of Fisheries WA.

Activities relevant at a bioregional level are discussed in the appropriate sections which follow. Progress towards statewide initiatives is reported below.

ESD Assessment of WA Fisheries

Fisheries WA staff have taken a lead role in the development of a national framework for reporting on fisheries within the context of ESD. The development of the ESD framework has been prepared at the direction of the Standing Committee on Fisheries and Aquaculture. Fish and Fish Habitat Protection Program staff are liaising with other State fisheries and environmental agencies to develop a framework which can address the issues of concern to all stakeholder groups.

During 2000/2001, a draft ESD policy document was developed to outline how ESD reporting and assessment will be implemented in relation to the *Fish Resources Management Act 1994* and associated legislation. In addition, the ESD framework has been further refined by the incorporation of a formal risk assessment analysis to determine the appropriate level of management response to issues raised by stakeholders. For medium- or high-risk issues that require specific management, a detailed report that specifies explicit objectives and performance measures must now be completed.

These ESD reporting methods are currently being used to complete the applications to Environment Australia on the sustainability of commercial fisheries to enable continued export of products past 2003. Draft assessment reports have been produced which relate to the major export fisheries including western rock lobster, Shark Bay prawn, Shark Bay scallop, Exmouth Gulf prawn, Shark Bay snapper and abalone.

The development of these ESD reports has relied heavily upon the information presented previously in the *State of the Fisheries* reports and used in the annual Fisheries WA performance assessment.

To ensure that this reporting and assessment process is viewed by stakeholders as transparent, objective and robust, an appropriate third-party audit is needed for all fisheries (not only export fisheries). While the current fisheries assessments are subject to OAG audit, the possible extension of independent auditing to cover these new ESD criteria and their associated assumptions is currently being negotiated between Fisheries WA, the EPA and the OAG.

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.

A review of the success of the national Fisheries Action Program and the State's Fishcare WA program has been completed. A total of 13 Fishcare projects valued at $33,000, and five Fisheries Action Program projects valued at $151,000, were approved for Western Australia in 2000/2001. This brings the total value of all projects funded in Western Australia under both programs to $1,182,000 since 1996.

Two of the 13 new Fishcare WA projects provide benefits across more than one bioregion. These are:

- Aquaculture and farming (CBC Fremantle).
- Comparisons in habitats, age composition, growth and biology of tarwhine – Shark Bay and Perth waters (Murdoch University).

Other projects were regionally based and are described below in the relevant bioregion section.

Marine Reserves and Marine Planning

Fisheries WA continued working with CALM to implement the Government's marine reserves program. Both the Minister for Fisheries and Fisheries WA have a vital role in these processes. Fisheries WA manages fishing, pearling and aquaculture in all marine reserves. It also works with Environment Australia in the planning of marine protected areas in Commonwealth waters.

Areas of the waters of Western Australia may be reserved as fish habit 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, which have special significance for the rock lobster fishery and

conservation purposes, are reserved as an FHPA. During the year, the Lancelin Island Lagoon was set aside as an FHPA and the Minister released the draft plan of management for the proposed Cottesloe Reef FHPA. In addition, the draft plan for the proposed Miaboolya Beach FHPA was completed.

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). Reef protected areas exist at a number of locations around Western Australia including Cowaramup Bay, Esperance Jetty and Yallingup Reef. In July 2000, the *Kunmunya* and *Samson II* wreck sites near Point Samson were closed to all fishing and set aside as an RPA.

Marine Environments

Successful collaborations between Fisheries WA 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:

- Fisheries WA has been contributing to the implementation of the Report of the National Taskforce on Introduced Marine Pests through membership of the National Introduced Marine Pests Coordinating Council. This work has included the development of an interim protocol for the management of introduced marine pests associated with vessels entering Australian waters illegally. This is a growing issue and Fisheries WA has worked closely with AQIS and other relevant Commonwealth agencies in the development of the policy.
- During the year, Fish and Fish Habitat Protection Program staff consulted with all stakeholders to develop a comprehensive set of guidelines for the establishment of FHPAs. The guidelines outline a process which enables community groups to initiate the establishment of FHPAs and other protected areas.
- A Fisheries Management Paper on fish protection measures was completed (Bunting 2001). This report outlines the breadth of legislative and administrative arrangements that Fisheries WA uses to protect fish and their habitats.
- The Minister introduced an order to protect coral from recreational collectors in Western Australian waters.

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 2000/2001. This included further progress on marine protected areas, including planning for the proposed Jurien Bay Marine Park and the management of the Abrolhos system.

In April 2001, the Minister established the Lancelin Lagoon FHPA. Fisheries WA worked with the Marine Conservation Society of WA to set aside this marine protected area. In addition, in June 2001, the Minister released the draft plan of management for the proposed Cottesloe FHPA. Fisheries WA is working with the Cottesloe Reef Protection Society on this project. Both of these areas were identified by community groups who considered them important for educational purposes and expressed a willingness to take a lead role in their stewardship.

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:

- Fisheries WA conducted a public workshop to assist in developing a research project to study the health of the Abrolhos reef system and the impacts of human activities on the reef.
- A major reef health baseline data project has been developed to provide a strategic approach to the conduct of reef health science initiatives at the Islands. This project is an important precursor to the sustainable use and development of the Islands and surrounding waters.
- With the assistance of funding provided under the Natural Heritage Trust, environmentally sensitive public moorings were installed at the Abrolhos Islands. These facilities will enable the general public to access dive sites without damaging the environment.
- With the assistance of Fisheries WA, the WA Maritime Museum completed an extensive survey of the historical sites on Beacon Island.
- A plan for sustainable tourism at the Abrolhos Islands was released. The aim of the plan is to improve public access to the islands while protecting the environment.
- A review of the land conservation values of the Abrolhos Islands was completed.
- A full registry of fishing industry moorings was completed.
- Work has commenced on the draft bycatch action plan for the Abrolhos Islands and Mid West Trawl Managed Fishery.

Fish and Fish Habitat Protection

Four new Fishcare WA projects were funded in the west coast bioregion. These were:

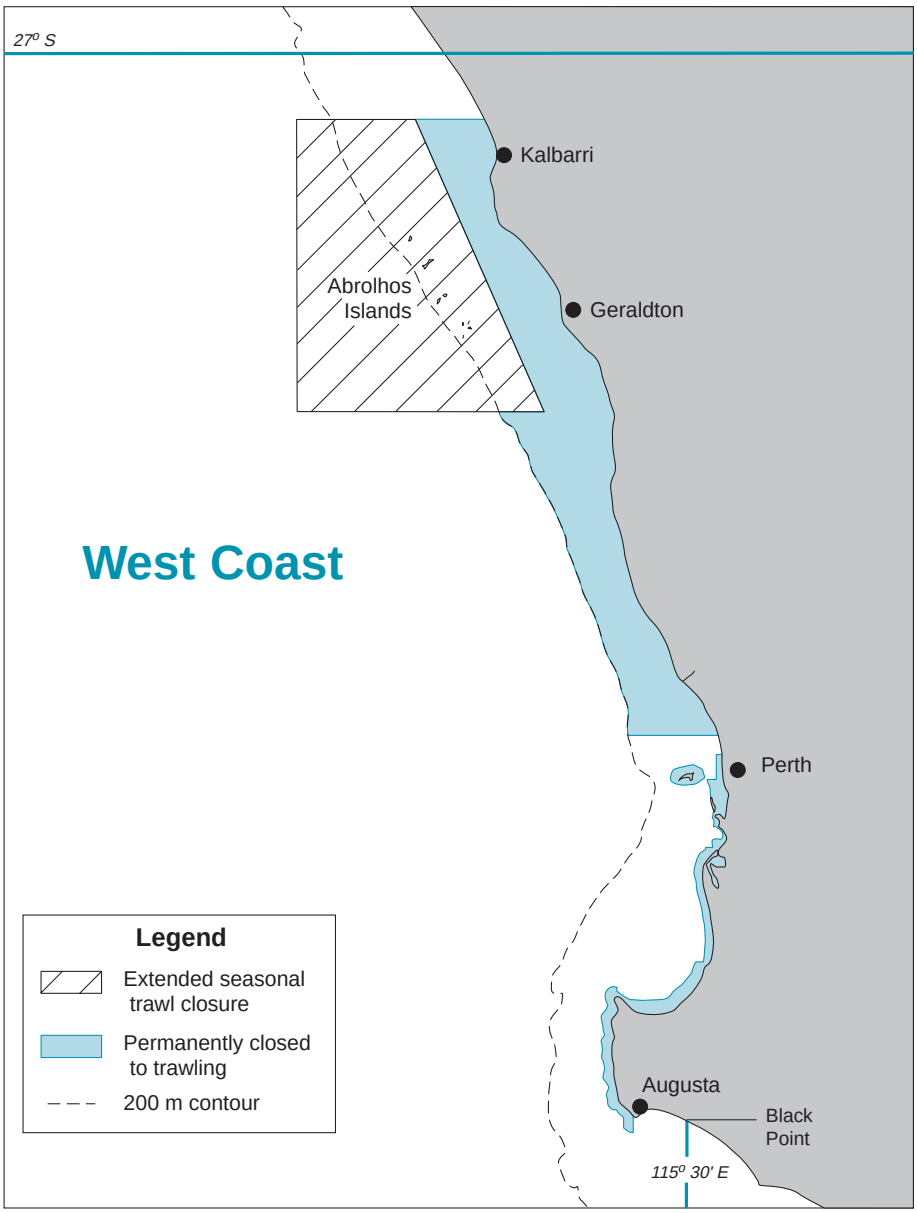
- Geographe Bay marine environment (West Busselton Primary School).
- Jurien Bay snorkel trail (Jurien District High School).
- Bunbury Back Beach reef survey (Reef Diving Association).
- Impact of humans on bottlenose dolphins in Cockburn Sound (Murdoch University).

Fish Habitat Protection Overview

On the west coast, marine habitats are largely protected from any physical impact of fishing by extensive closures to trawling, the only permitted fishing method which can significantly affect the sea floor. Essentially, all seagrass habitats are protected, with trawling limited to sand areas inhabited by target species such as scallops (West Coast Habitat Protection Figure 1).

In addition, habitat protection is provided by specific FHPAs, RPAs and marine parks in sensitive areas (West Coast Habitat Protection Figure 2).

During 2000/2001, the establishment of a dedicated two-man field operations team in the Abrolhos Islands enhanced 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. Island schools were visited to present talks to the children, and a newsletter was commenced to provide an update on



WEST COAST HABITAT PROTECTION FIGURE 1

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

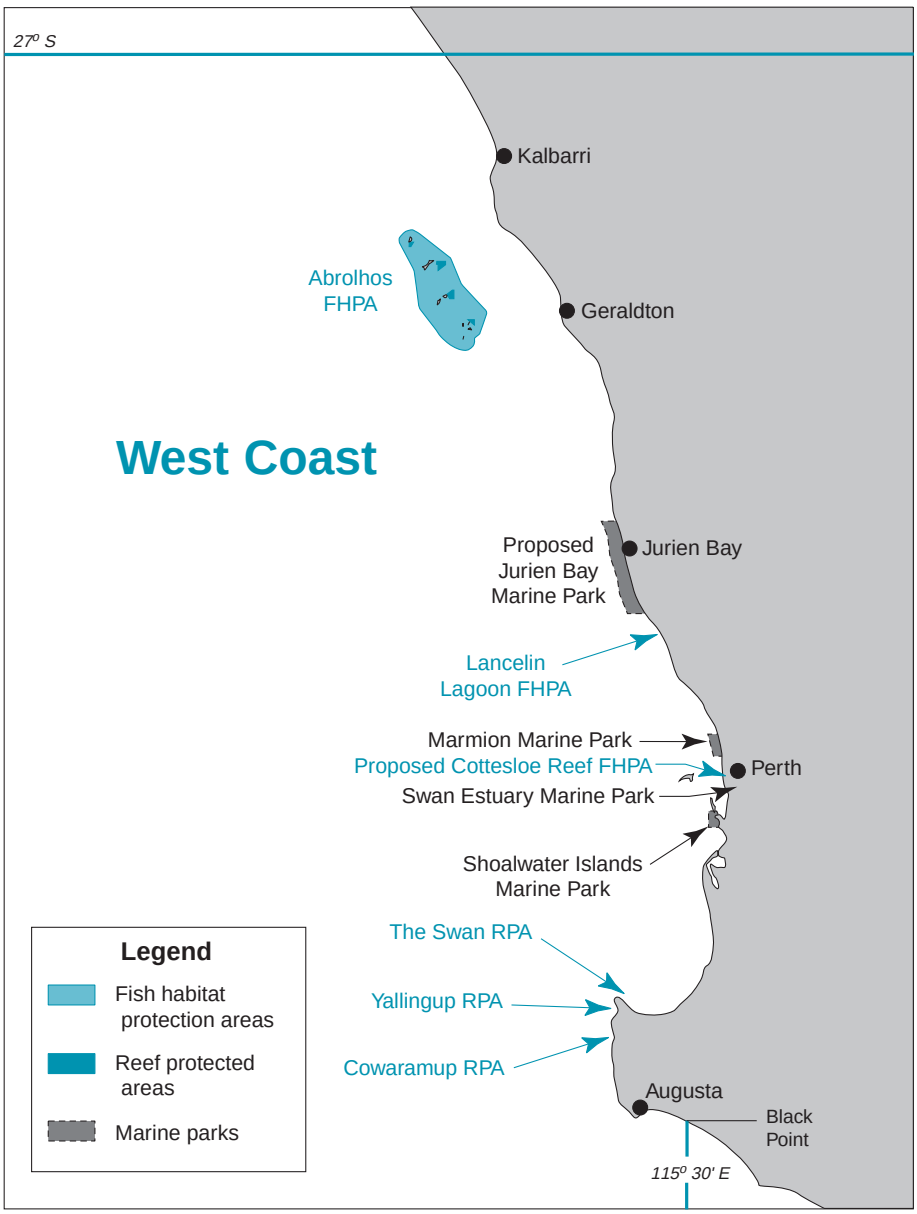
fisheries issues to Island fishers during the season. Advisory and logistical support was also provided to a major media visit in April 2001 to help showcase the Abrolhos.

Voluntary air service protocols were implemented, and airstrip maintenance carried out, to ensure visitor and passenger safety. Camp, jetty and aquaculture lease inspections were conducted to ensure standards were being maintained. A mooring register was completed, as were interim discussions to remove and identify hazardous moorings. The agency itself installed environmentally sensitive moorings in key anchorage areas to minimise benthic habitat damage while supporting responsible diving by ecotourism operators. Officers also continued to provide a sea rescue support and emergency management role.

Officers completed on-site training with the WA Maritime Museum in the duties of a Historic Shipwreck Inspector. Visits from WA Museum staff were also facilitated, and field assistance provided to research projects including studies on seabird diet and nesting patterns, finfish research, RPA habitat studies and sea-lion and seal study.

An outbreak of noxious daisies at East Wallabi airstrip was quickly destroyed to preserve the environmental integrity of this important island.

A high level of community consultation continues, with input from the various user groups and specialist committees.



WEST COAST HABITAT PROTECTION FIGURE 2

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

Fish and Fish Habitat Protection

Gascoyne Coast Bioregion

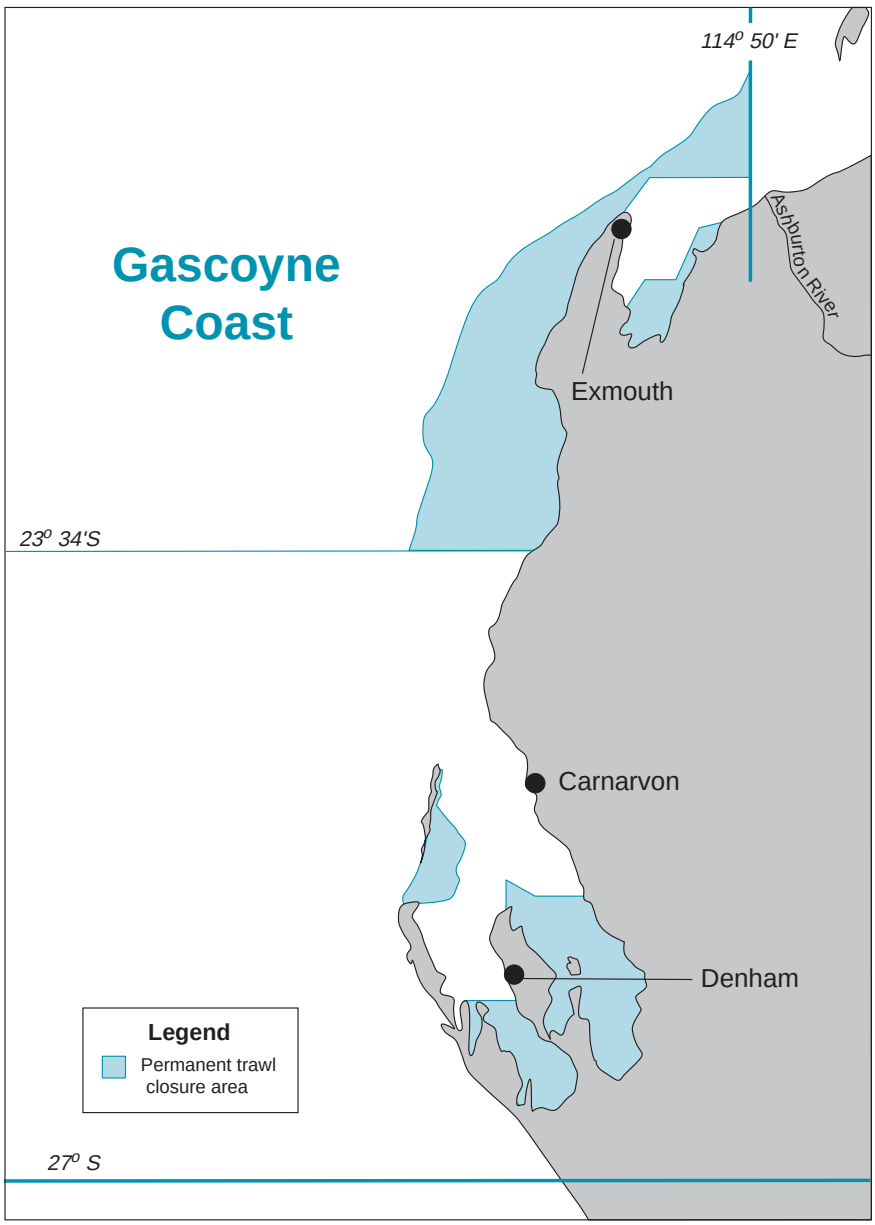
Environmental Management Overview

Significant achievements toward environmental management of fishing in the Gascoyne coast bioregion during 2000/2001 included Fisheries WA's input to the plans for the Ningaloo Marine Park.

A draft bycatch action plan for the Shark Bay Prawn Managed Fishery was completed. The plan contains a variety of management strategies to limit and report upon the impacts of trawling in Shark Bay. The program introduced bycatch reduction devices to eliminate large animals like sharks and rays from the catch. In addition, work is progressing on the development of fish escape devices in the trawl nets. Work is continuing on bycatch action plans for the Shark Bay Scallop and Exmouth Gulf Prawn Managed Fisheries.

The draft plan of management for a proposed FHPA for Miaboolya Beach at Carnarvon was completed.

The Gascoyne Region Fisheries Environmental Management Review (FEMR) was released. The review describes the fish resources of the region and the pressures which may affect them. It also describes how Fisheries WA will work to protect these resources from undesirable change resulting from human activities. This



GASCOYNE COAST HABITAT PROTECTION FIGURE 1

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

strategy is the first of five regional FEMRs which will be prepared by the agency.

Two new Fishcare WA projects were funded in the Gascoyne coast bioregion. These were:

- Ningaloo Reef environmental sustainability program (Scout Association of WA).
- Preliminary investigation of the biology of sharks in intertidal mangroves at Shark Bay (Murdoch University).

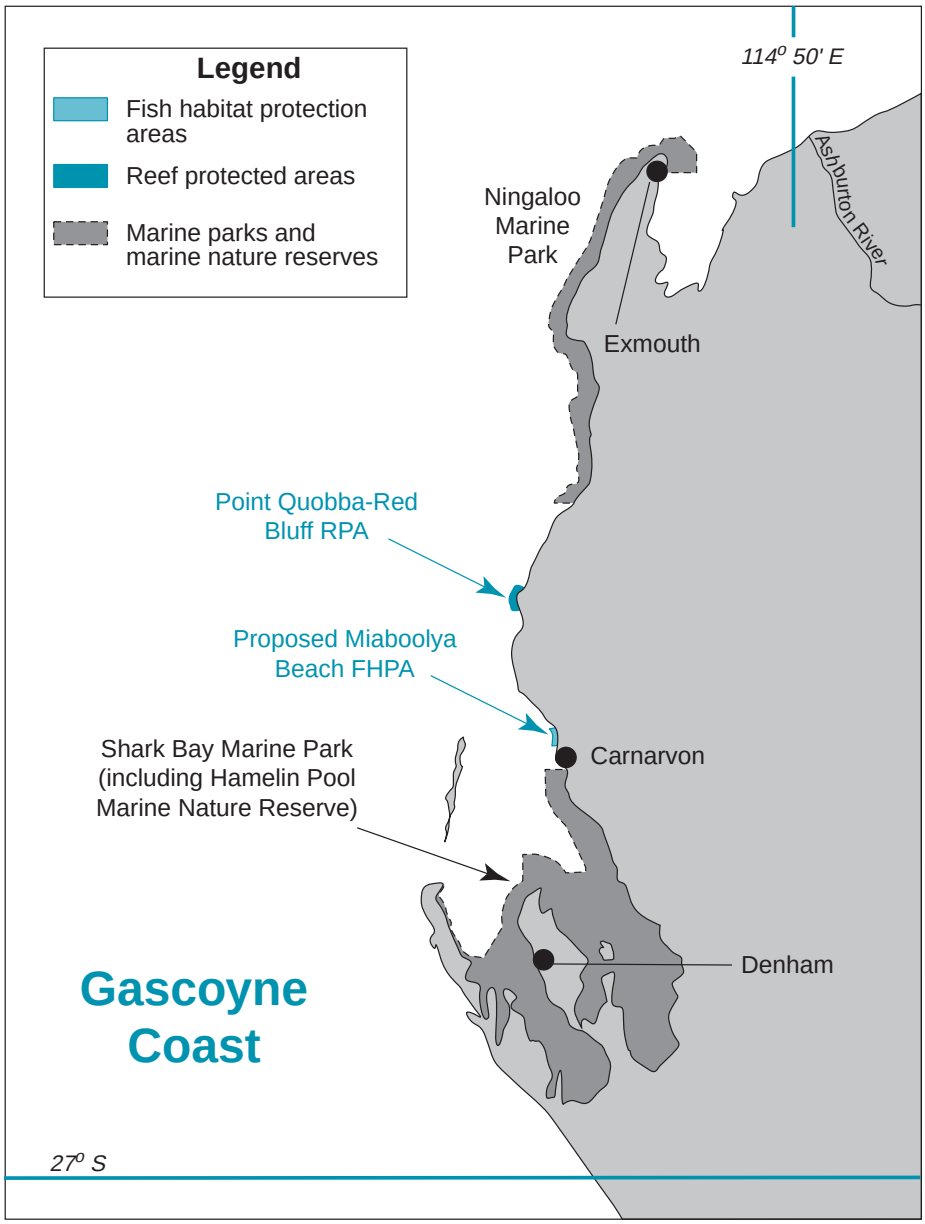
One new Fisheries Action Program project was funded in the Gascoyne coast bioregion. This was:

- Whale shark conservation through public education (Australian Marine Conservation Society).

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.

Fish and Fish Habitat Protection

North Coast Bioregion

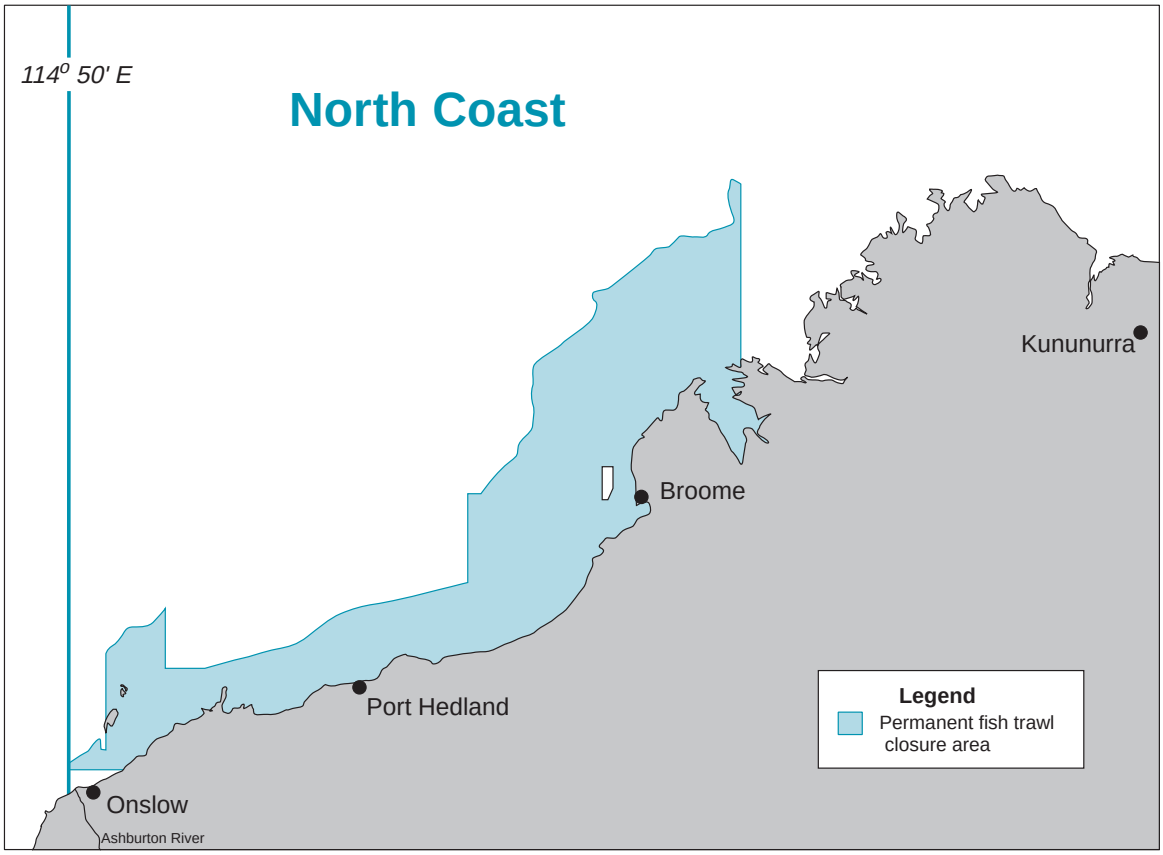
Environmental Management Overview

During 2000/2001, Fisheries WA has worked with CALM in the further development of the management plan for the Rowley Shoals Marine Park. In addition, advice has been provided as part of the planning process for the Dampier Archipelago and Montebello marine park proposals. The agency has also been working with the Commonwealth in the preparation of a draft plan for the proposed Cartier Island Marine Park.

During the year, Fisheries WA staff worked with the Port Walcott Dive Club to establish a protected area around the *Kunmunya* and *Samson II* wreck sites (north of Point Samson). The protected area is expected to be declared in July 2001.

Work has commenced on a draft bycatch action plan for the Pilbara Fish Trawl Interim Managed Fishery.

The agency also participated in the preparation of a major environmental study of the North West Shelf which is being coordinated by the Department of Environmental Protection.



NORTH COAST HABITAT PROTECTION FIGURE 1

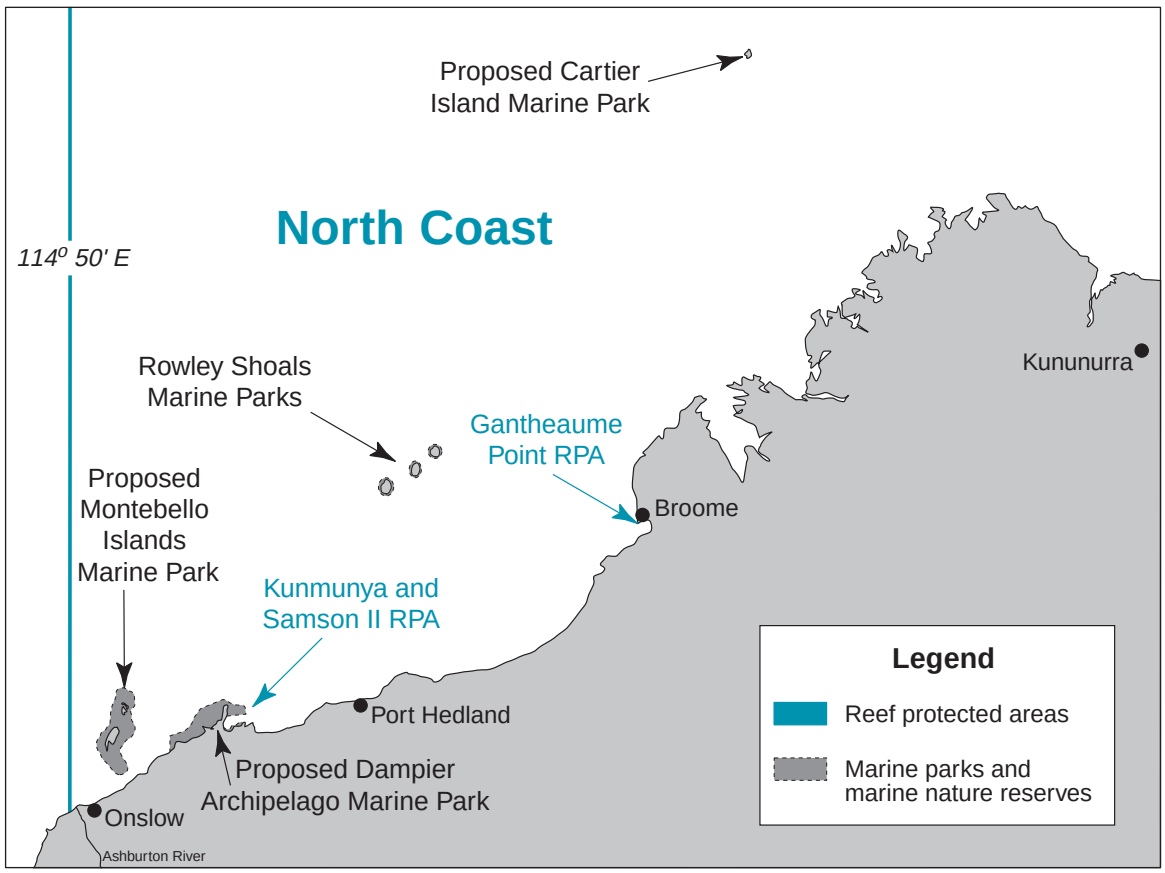
Map showing areas permanently closed to trawling for finfish in the north coast bioregion.

In 1999 there was an infestation of black-striped mussels in Darwin Harbour and there was concern that they may have translocated to the Kimberley region. Fisheries WA has been working with the WA Museum to monitor the ports of Broome, Derby and Wyndham in an attempt to identify possible infestations of this pest at an early stage. In December 2000, a seized illegal entry vessel was brought in to Broome, and on inspection was found to be infested with black-striped mussels. Fisheries WA worked with AQIS and other Commonwealth agencies to move the vessel out of Australian waters and have it destroyed.

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 RPAs at sensitive coastal locations, marine parks at the Rowley Shoals and proposed marine parks in the Dampier Archipelago, Montebello Islands and Cartier Island (North Coast Habitat Protection Figure 2).



NORTH COAST HABITAT PROTECTION FIGURE 2

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

Fish and Fish Habitat Protection

South Coast Bioregion

Environmental Management Overview

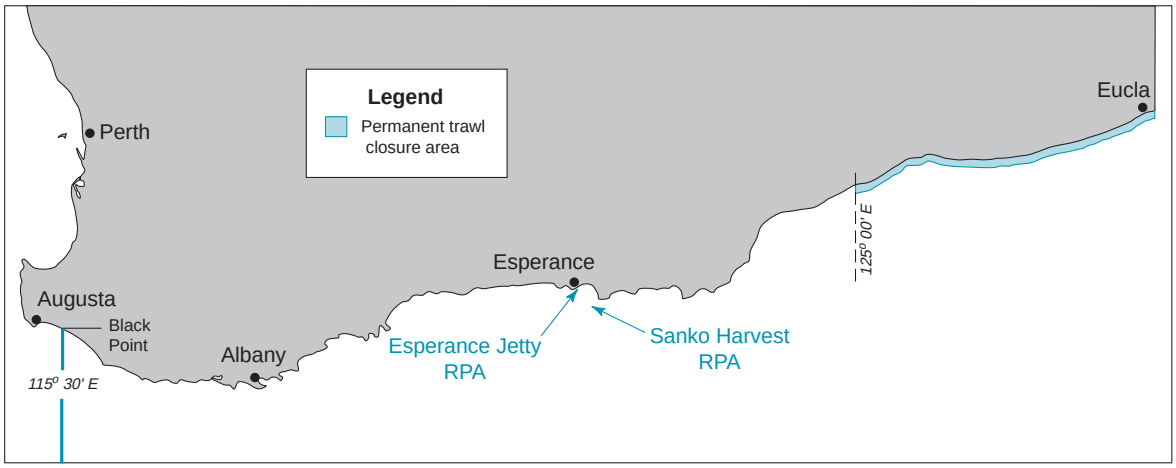
One new Fisheries Action Program project was funded in this region. This was:

- Community evaluation of fish stock health in coastal habitats of Albany (Edith Cowan University).

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, RPAs are in place to protect specific marine habitats of interest to the community (South Coast Habitat Protection Figure 1).



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

During 2000/2001, work commenced on a survey of northern inland streams to help develop our understanding of the freshwater native fish in the region. This work is being undertaken by staff and students from Murdoch University, and supported by funds from the Fisheries Action Program.

Two new Fisheries Action Program projects were funded in the northern inland bioregion. These were:

- Freshwater native fish surveys of the Fitzroy River (Kimberley Land Council).
- Biology and distribution of fish in the inland waters of the North West Pilbara (Murdoch University).

Southern Inland Bioregion

Environmental Management Overview

The conservation of the 13 species of freshwater native fish which exist in Western Australia is a growing issue for Fisheries WA. Some of these species are endemic to Western Australia, and therefore their survival depends on us. Most of these fish are under pressure because of deteriorating environmental conditions. Therefore Fisheries WA 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.

In addition, a number of public education projects are under way to inform people about native fish and their protection. The agency has provided funds to assist Murdoch University to prepare a series of posters about native fish. Further, the agency 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 recognition of the threat from environmental changes to the long-term survival of the Margaret River marron strain, the agency has collected a stock of these animals. These marron are now breeding successfully in captivity at the SWFRAC, and will be available for restocking should the need arise in the future.

Five new Fishcare WA projects were funded in the southern inland bioregion. These were:

- The tilapia – its impact on the Greenough and Chapman Rivers ecosystems (Geraldton Secondary College).
- Habitat rehabilitation and freshwater native fish research (Busselton Senior High School).
- Investigation and revegetation of fish ladders (Bennett Brook Catchment Group).
- Publishing of brochure/posters on freshwater fishes of south-western Australia (Murdoch University).
- Riverwatch – riverbank care (Kelmscott Primary School).

One new Fisheries Action Program project was funded in the bioregion. This was:

- Artificial habitats for marron enhancement and biodiversity protection in south-western Australia (Fisheries WA).

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Appendices

Appendices

APPENDIX 1

Stock Exploitation Status and Catch Ranges for Major Commercial Fisheries (Appendix 8 from Annual Report 2000/2001)

Fishery	Stock assessment complete	Exploitation status	Breeding stock assessment	Previous acceptable catch or effort range (tonnes/days)	*Catch (tonnes) current season	Year	Future acceptable catch or effort range (tonnes/days)	Year	Comments current season catch
WEST COAST BIOREGION									
Western rock lobster	Yes	Fully exploited	Adequate	13,500-14,500	14,523	99/2000	8,166-14,523	2000/01	Above forecast catch due to exceptional puerulus settlement 3-4 years previously.
Roe's abalone	Yes	Fully exploited	Adequate	116 (Q) (740-990 days)	107.7 (755 days)	2000	107.9 (725-929 days)	2001	New management plan now treats Roe's abalone as a single fishery.
South-West trawl	NA	NA	NA	Not available	Prawns 32 Scallops 23	2000	Not available	2001	Prawn catch is mainly king prawns.
Abrolhos Islands & Mid-West trawl	NA	Fully exploited	Adequate	250-400	429	2000	50-600	2001	Recruitment is dependent on environmental conditions each year.
Cockburn Sound	NA	NA	Not appropriate	40-95	56	2000	40-95	2001	Finfish only (excludes bait fish).
West coast purse seine	Yes	Fully exploited	Depleted	260	14	2000	NA	2001	Reduced catch due to mortality effect and limited availability of pilchard stock.
Estuarine fisheries (west coast)	Yes**	Fully exploited**	NA	Not available	305	2000	Not available	2001	Includes fish and crustaceans.
GASCOYNE COAST BIOREGION									
Shark Bay prawn	Yes	Fully exploited	Adequate	1,611-2,183	2,250	2000	1,501-2,330	2001	Higher than average king prawn catch due to high catchability linked to sea temperature.
Exmouth prawn	Yes	Fully exploited	Adequate	771-1,276	565	2000	771-1,276	2001	Tiger prawn recruitment levels reduced due to negative cumulative cyclone effects. King and endeavour prawn catches reduced by closures.
Shark Bay scallop	Yes	Fully exploited	Adequate	1,500-2,750	1,345	2000	1,250-3,000	2001	Catches remain at low end of range due to continuing negative environmental impacts on recruitment.
Shark Bay snapper	Yes	Fully exploited	Adequate	450-550 (Q)	488	2000	550 (Q) (820-950 standard days)	2001	Reduced catch due to low effort. Snapper catch only.
Shark Bay beach seine & mesh net	Yes**	Fully exploited**	Adequate**	95-140 (whiting)	127 (whiting)	2000	95-140 (whiting)	2001	Whiting catch only.
NORTH COAST BIOREGION									
Onslow prawn	NA	NA	NA	61-132	87	2000	60-130	2001	Higher summer rainfall gave improved banana prawn catches.
Nickol Bay prawn	NA	NA	NA	Banana prawn 300-500	Banana prawn 467	2000	All prawns 90-300	2001	Unusually high summer rainfall provided exceptionally high banana prawn catches
Broome prawn	Yes	Under-exploited	Adequate	King prawn 36-164	King prawn 76	2000	King prawn 35-170	2001	Fishing season matched to lunar-phase-driven recruitment patterns in order to achieve higher exploitation rates.
Kimberley prawn	NA	NA	NA	301-645	236	2000	240-500	2001	Banana prawn catch showed limited response to higher rainfall.
Pearl oyster	Yes	Fully exploited	Adequate	617,700 oysters[1] (Q) (15,331-22,599 dive hours)	568,191 oysters (15,151 dive hours)	2000	572,500 oysters[1] (Q) (15,331-22,599 dive hours)	2001	Quota in Zone 1 was not fully utilised owing to substitution of hatchery produced stock.

Fishery	Stock assessment complete	Exploitation status	Breeding stock assessment	Previous acceptable catch or effort range (tonnes/days)	*Catch (tonnes) current season	Year	Future acceptable catch or effort range (tonnes/days)	Year	Comments current season catch
NORTH COAST BIOREGION (CONT.)									
Pilbara trawl	Yes**	Fully exploited	Adequate	2,100-2,400	2,075	2000	1,900-2,200	2001	Assessment only includes major species.
Pilbara demersal trap & line	NA	Fully exploited	Limited data	300-400	316	2000	150-300	2001	Range for trap only as line is not restricted.
Northern demersal	NA	Fully exploited**	Declining**	600-1,000	470	2000	600-1,000	2001	Low catch due to low effort.
Kimberley gillnet & barramundi	Yes**	Fully exploited**	Adequate**	25-40 (barramundi)	45 (barramundi)	99/2000	25-40 (barramundi)	2000/01	Higher barramundi catch obtained although effort trending lower.
North coast shark	NA	NA	NA	NA	103	99/2000	NA	2000/01	Developing fishery. Lower catch due to redirection of effort.
Spanish mackerel	NA	NA	NA	260-390	305	2000	249-358	2001	Commercial catch of Spanish mackerel only. Range is preliminary estimateonly, fishery yet to stabilise.
SOUTH COAST BIOREGION									
Esperance rock lobster	Yes	Fully exploited	Adequate	50-80	69	99/2000	50-80	2000/01	Catch figures and projections include the fishery's three management zones: Esperance, GAB and Albany.
Abalone (greenlip/ brownlip)	Yes	Fully exploited	Adequate	235.63 (Q) (1,110-1,520 days)	223.37 (1,173 days)	2000	229.54 (Q) (1,110-1,520 days)	2001	Two zones previously managed separately now amalgamated into one fishery since 1999.
WA salmon	Yes	Fully exploited	Adequate	1,300-3,600	2,283	2000	1,300-3,600	2001	Environmental factors (Leeuwin Current) influence recruitmentand catch levels in subsequent years.
Australian herring trap	Yes	Fully exploited	Adequate	450-1,200	818	2000	450-1,200	2001	South coast catch only.
Southern & west coast demersal gillnet & longline	Yes**	Fully exploited**	Adequate**	875-1,075**	785	99/2000	725-975**	2000/01	Key species only reported. Breeding stocks of two major species are adequate; whiskery shark catches have increased in two sectors which has reduced breeding stocks.
Estuarine fisheries (south coast)	Yes**	Fully exploited**	NA	200-500	252	2000	200-500	2001	Includes fish, molluscs and crustaceans.
Albany/King George Sound purse seine	Yes	Not applicable	Severely depleted	0	Not applicable	2000	50-100	2001	Fishery closed as a result of mortality. Research quota set for 2001.
Bremer Bay purse seine	Yes	Not applicable	Severely depleted	0	Not applicable	2000	100-200	2001	Fishery closed as a result of mortality. Research quota set for 2001.
Esperance purse seine	Yes	Fully exploited	Depleted	1060	983 (453 boat days)	2000	1,000-1,200	2001	Quota set allowing for disease but recognising good recruitment. (Effort cannot be projected.)
NORTHERN INLAND BIOREGION									
Lake Argyle catfish	Yes	Over-exploited	Decreasing	100-140	231	99/2000	100-140	2000/01	Catch well above historic levels due to activation of latent 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.

Appendices

APPENDIX 2

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APPENDIX 3

Table of Catches from Fishers' Statutory Monthly Production Returns of 1999/2000

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 agency. The table represents the latest year for which a complete set of data is available.

Catch category	Landed weight (kg)	Live weight (kg)
Fish		
Anchovy	9,457	9,457
Barracuda (northern pike)	1,058	1,064
Barramundi (giant perch)	30,111	47,650
Bigeye (not tuna)	22,289	22,289
Boarfish	4,703	5,281
Bonefish (Pacific bonefish)	194	194
Bonito	1,446	1,482
Bream, Argyle	10	13
Bream, black	28,145	28,145
Bream, buffalo	180	180
Bream, mixed	107	107
Bream, monocle	14,404	14,404
Bream, Robinson's	37,246	37,690
Bream, sea	1,219	1,219
Bream, silver (tarwhine)	15,744	15,744
Bream, western yellowfin	10,841	10,841
Catfish, sea (golden cobbler)	42,142	42,388
Chinaman fish (not cod)	14,710	15,835
Cobbler	52,613	73,980
Cobbler, silver	85,357	230,526
Cod	103,007	106,851
Cod, bar (grey-banded, 8-bar)	6,474	6,586
Cod, Chinaman	5,220	5,837
Cod, Maori	20	20
Cod, Rankin	111,451	119,608
Cod, spotted	49,996	50,029
Dart	185	185
Dolphinfish	475	540
Emperor, blue-lined (grass, black)	1,305	1,335
Emperor, blue-spot	15,725	15,725
Emperor, spangled	3,752	4,333
Emperor, sweetlip	49,980	52,199
Flagfish (Spanish flag)	174,166	174,210
Flathead, other	10,780	10,785
Flathead, rock	92	92
Flounder	2,518	2,630
Footballer (footballer sweep, banded sweep)	331	344
Foxfish (hogfish, pigfish)	538	538
Garfish, sea	45,285	45,285
Groper	153	204
Groper, baldchin	43,027	45,991
Groper, blue	27,053	33,801
Gurnard	279	282
Hapuku	13,590	13,855
Herring, Australian	841,385	841,387
Herring, hairback	21	21
Herring, Perth	12,328	12,328

Catch category	Landed weight (kg)	Live weight (kg)
Fish (continued)		
Javelin fish	25,638	25,638
Jewfish, Westralian (dhufish)	195,898	210,879
Jobfish	67,505	67,566
Jobfish (goldband snapper)	136,353	136,530
Jobfish, rosy	171,010	171,031
John Dory	91	98
Kingfish, black (cobia)	25,176	25,620
Kingfish, yellowtail	1,288	1,428
Knifejaw	798	951
Leather jacket	30,479	48,552
Ling, pink (rock ling)	38	38
Long tom	85	85
Mackerel, blue	13,855	13,855
Mackerel, grey	4,213	4,800
Mackerel, other	67,525	72,676
Mackerel, scaly	2,800,045	2,800,045
Mackerel, shark	318	343
Mackerel, Spanish	262,626	337,347
Mangrove jack	10,548	10,665
Maray	10,885	10,885
Morwong	288	294
Mullet, bluetail	20	20
Mullet, diamond scale	99	130
Mullet, other	2,168	2,168
Mullet, red	62,091	62,091
Mullet, sea	386,285	386,285
Mullet, yellow-eye	82,774	82,774
Mulloway	48,016	49,721
Parrot fish	9,310	9,327
Perch, Moses	54,552	54,601
Perch, other	18,736	19,258
Perch, pearl	36,814	37,008
Perch, red (maroon sea perch)	14,880	14,979
Perch, scarlet sea (saddletail)	96,574	96,687
Perch, yellowtail	1,260	1,260
Pike, sea	4,735	4,735
Pilchard	1,463,750	1,463,750
Queenfish	828	2,017
Red emperor	257,877	259,464
Redfish	46,920	48,755
Redfish, Bight	9,038	9,596
Roach	13	13
Salmon, Western Australian	2,597,744	2,597,744
Samson fish (sea kingfish)	93,838	102,110
Scad, yellowtail	7,757	7,757
Shark, blacktip	36,537	64,971
Shark, bronze whaler	220,520	348,232
Shark, creek whaler	1,710	2,720
Shark, eastern school	4,342	6,906

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Catch category	Landed weight (kg)	Live weight (kg)
Fish (continued)		
Shark, 'golden' (copper whaler)	1,381	2,196
Shark, grey nurse	737	1,135
Shark, gummy	154,622	244,956
Shark, hammerhead	33,867	53,772
Shark, lemon	1,362	2,168
Shark, mako (shortfin)	861	1,222
Shark, other	126,365	199,644
Shark, pencil	1,433	2,285
Shark, pigeye	450	716
Shark, silvertip	240	382
Shark, spot tail	400	636
Shark, spurdog	1,470	2,332
Shark, tawny nurse	211	335
Shark, thickskin (sandbar)	146,488	232,469
Shark, tiger	25,689	33,768
Shark, whiskery	140,909	210,092
Shark, wobbegong	32,287	51,092
Skates and rays, other	13,051	23,874
Snapper, bullnose (variegated emperor)	1,132	1,132
Snapper, golden (fingermark sea perch)	343	394
Snapper, frypan	53,316	53,316
Snapper, Lenko (deep sea)	42	42
Snapper, long nose	27,628	29,175
Snapper, north-west (large)	90,802	91,751
Snapper, north-west (small)	480,581	480,623
Snapper, north-west	150,439	166,825
Snapper, pink	728,590	738,732
Snapper, Queen	45,930	53,856
Snapper, red-spot emperor	44,126	44,126
Snapper, red (swallowtail)	251,586	251,590
Snapper, ruby	104	106
Snapper, Tang's	6	6
Sole	2,145	2,145
Sprat, blue	22,406	22,406
Sweep	1,437	1,653
Sweetlip	100,532	102,793
Tailor	55,800	55,800
Threadfin bream (butterfish)	194,703	194,703
Threadfin salmon	11,450	13,584
Threadfin salmon, giant (king)	137,889	149,656
Trevalla, deepsea	4,714	4,718
Trevally, golden	26,768	26,821
Trevally, other (skippy)	219,257	221,602
Trevally, skipjack	7,998	8,033
Trout, coral	27,738	28,535
Trout, spotted (duskytail groper)	754	754
Tuna, bigeye	3	3
Tuna, mackerel	236	236
Tuna, northern bluefin	1,994	1,994
Tuna, other	26,560	26,786
Tuna, skipjack (striped)	1,135	1,297
Tuna, southern bluefin	6	7
Tuna, yellowfin	3,600	3,896
Turrum	226	226
Tuskfish, bluebone	17,468	17,626
Whitebait	243,999	243,999
Whiting, golden-lined	6,565	6,565
Whiting, King George	45,351	45,377
Whiting, other	3,674	3,674
Whiting, western sand	206,245	206,286
Other fish varieties	157,219	168,037
Total fish	**15,359,282**	**16,311,855**
Crabs		
Crab, coral	480	480
Crab, king	8,019	8,019
Crab, mud	3,171	3,171
Crab, sand (blue manna)	673,089	673,089
Crab, snow (Australian)	57,930	57,930
Crab, spider	2	2
Crab, spiny	49,127	49,127
Crab, three-spot surf	655	655
Total crabs	**792,473**	**792,473**
Prawns		
Prawn, banana	533,776	533,776
Prawn, brown tiger	1,046,266	1,046,266
Prawn, coral	286,972	286,972
Prawn, endeavour	385,255	385,255
Prawn, leader (black tiger)	1,686	1,686
Prawn, western king	2,260,696	2,260,696
Other prawns	21,826	21,826
Total prawns	**4,536,477**	**4,536,477**
Rock lobsters		
Bugs	20,020	20,020
Rock lobster, southern	70,039	70,039
Rock lobster, tropical, painted	336	336
Rock lobster, western	14,531,974	14,532,039
Total rock lobsters	**14,622,369**	**14,622,434**
Molluscs		
Abalone, brownlip	15,682	39,227
Abalone, greenlip	66,306	182,324
Abalone, Roe's	100,512	110,801
Cockle	3,095	3,095
Cuttlefish	32,155	32,155
Mussel	1,936	1,936
Octopus	82,508	155,096
Oyster, western rock	7	49
Scallop, saucer	717,791	3,454,343
Squid	62,837	62,837
Other molluscs	80	80
Total molluscs	**1,082,909**	**4,041,943**
Other classes		
Beche de mer	21,239	62,597
Sea urchin	5	5
Total other classes	**21,244**	**62,602**
Grand Total	**36,414,754**	**40,367,784**

FISHERIES
WESTERN AUSTRALIA