State of the Fisheries Report
1998/1999

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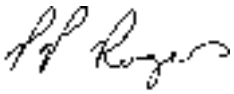
Executive Director's Overview

The *State of the Fisheries* document is designed as an essential supplement to the Annual Report to Parliament and provides a more detailed level of information to support the agency's non-financial performance measures. By summarising management changes, compliance activities and research data such as landings, effort, catch rates, stock assessment and breeding stock levels, this document provides a valuable reference point for Western Australian fisheries of major importance to the commercial, recreational and aquaculture sectors. Information relevant to Fisheries WA's Fish and Fish Habitat Protection Program and activities undertaken on behalf of the Commonwealth is also provided.

The report indicates that overall the major fish stocks which support fisheries in Western Australia continue to be in a reasonably healthy condition, and remedial action is occurring where stocks are under stress.

While the data provided on the status of our fish resources indicate that historical controls on fishing have been effective, ever-increasing fishing pressure, particularly on coastal fish stocks, requires that Fisheries WA must maintain its extensive research and monitoring projects reported here to ensure that appropriate and timely management changes can be made. Similarly, field management projects by Fisheries WA regional staff reported here are essential to ensure that fishers understand and comply with the regulations to conserve fish stocks and minimise the environmental effects of fishing.

I would like to take this opportunity to acknowledge the dedication and professionalism demonstrated by all Divisions of the agency in ensuring that these important data are 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 Fisheries WA fisheries management programs which conserve the State's fisheries.



Peter P. Rogers
Executive Director

Editor's Overview

State of the Fisheries reports in detail on the activities and impacts of the commercial and recreational fishing sectors which utilise the wild fish stocks in Western Australia. In addition, the status of the developing aquaculture industries is recorded to enable the public of Western Australia to follow the development of this important sector. Activities of the Fish and Fish Habitat Protection Program and the Australian Fishing Zone management group are also reported to complete the coverage of the agency's responsibilities.

For fisheries resources management programs to be successful, a high degree of cooperation is necessary between the users of the State's fish resources and the agency's Divisions of Fisheries Research and Fisheries Management Services. The level of cooperation and collaboration between fishers and agency 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 the 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. Similarly, the agency's programs are strongly supported by the Volunteer Fisheries Liaison Officers, who provide recreational fishing education support as well as data for monitoring recreational stocks. Individual recreational fishers and recreational fishing clubs also voluntarily contribute significant data to the recreational fisheries monitoring projects.

Data from all of these sources, together with fishery-independent research and monitoring projects, provide the basis for fisheries management in Western Australia.

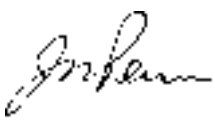
In using this volume, readers should note that the major part of the information contained in this report relates to the last full year of production from the relevant fishery sectors. Owing to the time required for the process of data gathering, validation and analysis, this period is the 1997/98 financial year or the 1998 calendar year. In contrast, the information relevant to resource management activities relates to the most recent year (1998/99) and provides an indication of actions flowing from the assessments of the state of the stocks in the previous year.

The major purpose of this report is to provide detailed information on the status of individual fisheries across the State which underpins the Performance Indicators (PIs) for the agency presented in the Annual Report to Parliament. These PIs relate particularly to sustainability of the State's fish stocks and include measures of breeding stock levels and catch projections for all major commercial stocks. These data are summarised in Appendix 1 (repeated from Appendix 9 in the Annual Report of Fisheries WA) which sets out in tabular form the situation of the State's most important fisheries and their performance during the last reporting year. The more detailed data contained in the individual fishery status reports provide 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 used to audit the agency's PIs.

It should be noted that the confidentiality provisions of the *Fish Resources Management Act 1994* preclude the publication of catch and associated data for fisheries with fewer than five operators. For this reason, three fisheries previously covered by this document, the Exmouth Gulf Beach Seine Fishery, the Mid-West Coast Purse Seine Fishery and the South Coast Inshore Trawl Managed Fishery, are not publicly reported this year. These fisheries however continue to be monitored by the agency.

This volume is published each year as a companion to the Fisheries WA Annual Report to Parliament. Having been published annually since 1994/95, this series is now providing an ongoing record of the performance of the fisheries and fishing industries of Western Australia.

Preparation and validation of the extensive array of information contained within this report is a significant task to which many Fisheries WA 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 team members, Mrs Kelly Jacoby for her enthusiasm and dedication to the difficult process of compiling and formatting this volume, and Ms Fran Head for her expert assistance in the editorial process.



Dr J.W. Penn
Director Fisheries Research

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 in Regional Offices in Fremantle, Albany, 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 species are not over-fished. The management controls may be input controls, such as limitations on the number of licences, seasonal closures and gear restrictions, or output controls (quotas) which directly limit the quantity of fish that can be caught. There are often also permanent closed areas or other measures to protect juvenile or breeding fish or to protect important habitats.

A key factor in the successful management of fisheries is the rational implementation of advice on management issues and industry recognition of the need for a particular management approach. 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 staff 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 and Abalone Managed Fisheries, the purse seine fisheries, the demersal gillnet and longline fisheries, and the Northern Demersal Scalefish Interim Managed Fishery.

The five major commercial fisheries (West Coast Rock Lobster, Abalone, Exmouth Prawn, Shark Bay Prawn and Shark Bay Scallop) operate in a cost-recovered management environment, which requires that licensees in these fisheries cover their cost of management. Cost recovery has been phased in over a number of years, with the level of cost recovery reaching 100% of agreed cash costs in 1998/99. The remaining fisheries pay a contribution towards their management costs of 1.35% 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.

Key Achievements

During 1998/99, a number of milestones were achieved in commercial fisheries, including:

- Gazettal of the Broome Prawn Managed Fishery Management Plan.
- Implementation of Fisheries Adjustment Schemes for the Leschenault, Hardy, Swan-Canning and Mandurah estuaries.
- Release of a discussion paper on the future management of the South Coast Estuarine Fishery.
- Development of a trial for crab pots in Mandurah estuary.
- Release of draft policy on developing fisheries.
- Vessel Monitoring System (VMS) fully operative in Northern Demersal Scalefish Interim Managed Fishery fleet and undergoing trial in the Shark Bay Prawn and Shark Bay Scallop Managed Fisheries.
- Development of a program to examine bycatch and bycatch reduction devices in the Shark Bay Prawn Managed Fishery (with Fish and Fish Habitat Protection Program).
- Gazettal of a major amendment to the Abalone Management Plan incorporating the recommendations of the Abalone Management Consultative Group.
- Finalisation of extensive consultation on inshore crab fishing.
- Implementation of interim management arrangements for crab fishing in Geographe Bay.
- Development of new crab fishing arrangements for Shark Bay.

West Coast Rock Lobster Managed Fishery

Management Overview

In 1998/99, as in the previous six seasons, the policy objective for the West Coast Rock Lobster Managed Fishery was to rebuild the breeding stock to provide future recruitment of young lobsters to the fishery. Although catches in 1991/92 and 1992/93 were high, a major concern was advice received from the Fisheries Research Division that the breeding stock of

rock lobster had been fished down to about 15% of the unfished or virgin size. This was below the internationally accepted safe level of approximately 25% of the original breeding biomass.

A management package, attempting to address this problem by leaving more breeding stock in the water, was introduced for the 1992/93 season. The effect of the package in enhancing the breeding stock was not considered sufficient and a new package was developed during 1993 by the Rock Lobster Industry Advisory Committee (RLIAC). This new package for the 1993/94 season aimed at leaving an additional 1,000 tonnes (approximately 10% of the average catch) of lobsters in the water at the end of that season.

Management controls included an 18% reduction in the number of lobster pots allowed to be used by each boat, a total ban on taking females in breeding condition (setose and tarspot), and an increase in the legal minimum size of lobsters from 76 mm to 77 mm from 15 November to 31 January. Separate maximum sizes for female lobsters in the north and south of the fishery were also set to reflect the latitudinal differences in both growth and maturation rates of the lobsters.

This package of management measures was originally intended to remain in place for two years while RLIAC developed options for the long-term management of the fishery. However, as the package appeared to be succeeding in its objective of rebuilding the breeding stock, and as its retention was supported by most fishermen, it was extended and has continued through to the 1998/99 season.

Extensive consultation on management arrangements for future seasons took place during 1997/98, with increased focus on the markets for lobsters and an examination of a variety of strategies to optimise the value of the lobster catch. However, most of the fishing industry did not support changes to the season and the management package has remained essentially unchanged.

Since indications are that the management package has been very successful in achieving the objective of rebuilding the breeding stock, no major changes are contemplated for the 1999/2000 season.

The majority of fishermen still appear to be committed to supporting the maintenance of most components of the existing management regime, and particularly those parts that protect breeding females. Nevertheless, some fishermen have questioned the need to maintain the 18% pot reduction and the protection of larger lobsters. Fisheries WA is undertaking research to determine the relative impact of each of the measures designed to protect the breeding stock so that better informed decisions can be made about possible changes to the management package.

First draft National Competition Policy Reviews have been undertaken for both the processing and catching sectors, and both have raised interesting issues about alternative management regimes. In addition to the anticipated question about the alternative of output- or quota-based management, these papers have also suggested that a less regulated processing sector may provide greater community benefits. A proposed Parliamentary Inquiry into the industry by the Standing Committee on Ecologically Sustainable Development may also have implications for the future management of the fishery.

Catch in the 1998/99 season is anticipated to be a record high, in excess of 13,000 tonnes. While the Asian economic crisis has decreased prices in some traditional markets the industry has, through aggressive marketing, been able to develop new market opportunities in Europe, China and the United States, as well as expanding domestic consumption, both of which have contributed to maintaining healthy prices for rock lobster.

Compliance and Community Education Overview

Management of this fishery has achieved a continued high level of compliance during the 1998/99 season through a combination of sea and land patrols. Fisheries Officers carried out licence and gear inspections and provided advice to industry during the season.

The infringement notice system was in its fourth year of operation. There were 305 infringement warnings given, 46 infringement notices issued and 8 breach reports filed in the 1998/99 season (Rock Lobster Table 1).

Significant breaches during the season included a conviction for removing lobsters from another fisherman's pots which resulted in a 12-month cancellation of the offender's commercial fishing licence. A further conviction was recorded for stretching of the carapace (to achieve 'legal length'), and a commercial fishing licence cancellation is being heard before the Objections Tribunal. Conviction was also gained for possession of totally protected fish by holding of under-sized rock lobster in pots pending gauge change from 77 mm to 76 mm.

The lobster processing sector demonstrated a high level of compliance this season for the 1997/98 season.

Rock Lobster Table 1 Summary of commercial rock lobster breaches, warnings and infringements for the years 1997/98 and 1998/99.

Offence Type	1997/98			1998/99		
	Breaches	Warnings	Infringements	Breaches	Warnings	Infringements
Closed Season	2	0	1	0	0	0
Illegal Gear	1	1	4	2	1	1
Obstruction	1	0	0	-	-	0
Processing	0	0	3	1	-	2
Records/Returns	2	4	1	0	0	0
Spawners	3	54	6	0	114	9
Under Size	10	173	36	3	190	34
Excess Gear	2	0	3	0	0	0
No Licence	2	0	0	0	0	0
Over Size	0	10	1	0	0	0
Closed Waters	0	0	0	2	0	0
Other	1	1	0	2	1	0
Total	**24**	**243**	**55**	**8**	**305**	**46**

Research Overview

Research activities continued to focus on forecasting future catch levels, monitoring of breeding stock levels and assessing migration and growth rates. During the year, a new simulation model to assess management options for maximising the value of the fishery was developed. In addition, a major document detailing the effects on the fishery of the five years of stable management 1993/94 to 1997/98 was presented to industry. The objective of the management package, to return breeding stock abundance to safe levels, was shown to have been achieved by the breeding stock indices provided by the Fisheries Research Division.

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

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

Previous catch projections for year 1997/98:
10,000-11,000 tonnes (commercial)

Catch current season (1997/98):
10,463 tonnes (commercial)

continued over

Estimated annual value (to fishers) for year 1997/98:
$210 million

Catch projection next year (1998/99):
13,000-14,000 tonnes (commercial)

Recreational component (1997/98):
807 tonnes (estimated)

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°8´east longitude; thence due north along 115°8´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.

Annual Production

Main fishing method
Rock lobster pots.

Landings
Trends in the annual catches from the West Coast Rock Lobster Managed Fishery (WCRLMF) are shown in 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 1997/98 catch in the WCRLMF was forecast from puerulus settlement to be 10,000-11,000 tonnes. Processors' figures show the catch from the WCRLMF for the 1997/98 season was 10,463 tonnes, 3.6% below the long-term average catch of 10,850 tonnes but 5.7% greater than the previous season's 9,902 tonnes. In 1997/98, the catches in A Zone and B Zone were 1,792 tonnes and 3,573 tonnes respectively, 0.2% higher and 1.2% lower than the previous season; however, the C Zone landings of 5,098 tonnes were 13.4% better than the 1996/97 season.

In 1997/98, a survey of recreational rock lobster fishers estimated that they caught approximately 807 tonnes, which was a 56.4% increase on the catch estimate for 1996/97 of 516 tonnes. The increase apparently was due to larger catches in the southern sector, adjacent to the metropolitan area. These estimates provide a good 'index' of recreational catches, however the method of estimating the recreational catch is presently the subject of a research review.

The total catch of western rock lobster from this fishery (commercial and recreational) was 11,270 tonnes, 8.2% higher than the previous season's catch of 10,418 tonnes.

Fishing effort

The nominal fishing effort for 1997/98 was 10.73 million pot lifts, 1.1% higher than the 10.62 million pot lifts for the previous season (Rock Lobster Figure 1). The 1997/98 nominal effort for the A, B and C Zones of the WCRLMF was 1.25 million, 3.84 million and 5.64 million pot lifts respectively, similar to the previous season's 1.2, 3.94 and 5.48 million pot lifts. Effort equivalent to 0.83 million commercial pot lifts was used by the recreational fishery to land their catches. This was 48% higher than the 0.56 million pot lifts used in 1996/97.

The total effort used in the WCRLMF during 1997/98 was 11.56 million pot lifts, 3.4% higher than the 11.18 million pot lifts made in 1996/97.

Catch rate

Catch per unit of fishing effort in 1997/98 increased slightly (5.4%) over the rate in 1996/97 (0.98 and 0.93 kg/pot lift respectively) (Rock Lobster Figure 2). Trends in catch rates show a 'cyclical' pattern due to variations in 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 five seasons have remained relatively high due to the effects of the management package introduced in 1993/94.

Stock Assessment

The stock remains fully exploited. The current management arrangements introduced in 1993/94, aimed at rebuilding the breeding stock, have achieved their objective. The 18% pot reduction and minimum size increase to 77 mm carapace length (15 November to 31 January) has 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, this 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.

Pot usage under the management arrangements introduced in 1993/94 remained at 82%, or 56,819 pots allowed to be used during 1997/98. Industry continued to restructure and a further eight vessels have left the fishery since August 1996, bringing the number of active commercial rock lobster boats in the fleet to 602. Since latent effort has largely been removed from the fishery at this stage, pot reductions are now an effective tool with which to manage fishing effort in the WCRLMF. However, effort 'creep' has become evident, with nominal effort levels now 3.4% greater than the 10.38 million pot lifts of 1993/94 and 1994/95. Therefore, effective fishing effort continues to increase, not only from effort 'creep' but also from the improved use of sophisticated fish-finding and navigational technology, resulting in an increase in efficiency. This will have to be factored into both future management decision-making and stock assessments.

Breeding Stock Levels

The north and south coastal fishery-dependent spawning stock indices, which are based on commercial monitoring data, are presented in Rock Lobster Figure 3, and the fishery-independent survey of the breeding stock is presented in Rock Lobster Figures 4 and 5.

Both indices show that there was a substantial response to the management package, aimed at improving egg production, introduced for the 1993/94 season. Current indications from both methods used to monitor the breeding stock index are that egg production has recovered significantly since 1993/94 and has now reached a rate around the target of 25% of unfished breeding stock levels.

Fishery-independent breeding stock surveys to monitor the strength of egg production in the fishery will be continued. Indices derived from fishery-based data, however, may become distorted as a result of the

effects of technology on fishing effort efficiency, variations in the distribution of fishing effort in response to annual variations in puerulus settlement and subsequent recruitment to the fishery, and/or market-driven factors.

Catch Projection for Year 1998/99

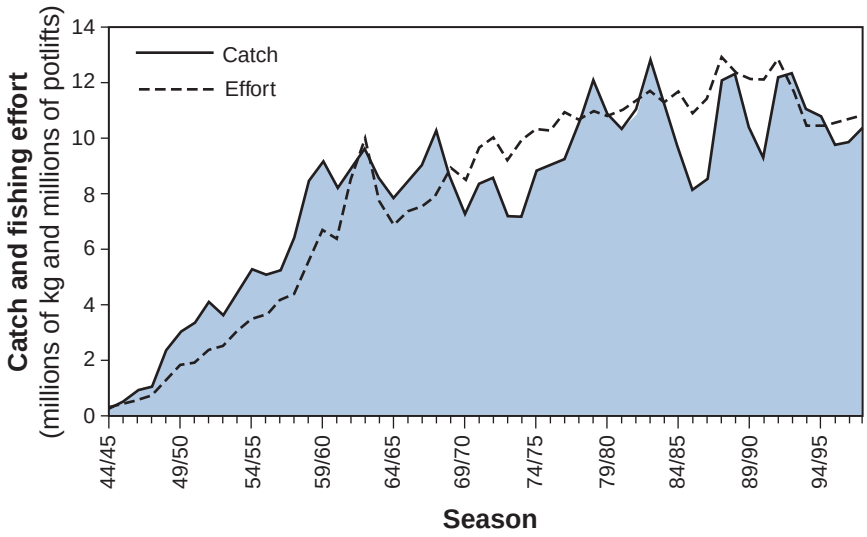
Total catch predictions for the WCRLMF are now made by summing the regional catch predictions based on puerulus settlement at the Abrolhos Islands (A Zone), Seven Mile Beach (B Zone) and Alkimos (C Zone) (Rock Lobster Figure 6). Seasons 1998/99 and 1999/2000 are expected to produce around 13,000-14,000 tonnes and 14,000-14,500 tonnes respectively, as a result of exceptional puerulus settlement in 1995/96 and good settlement in 1996/97 (Rock Lobster Figure 6).

Product Value for Year 1997/98

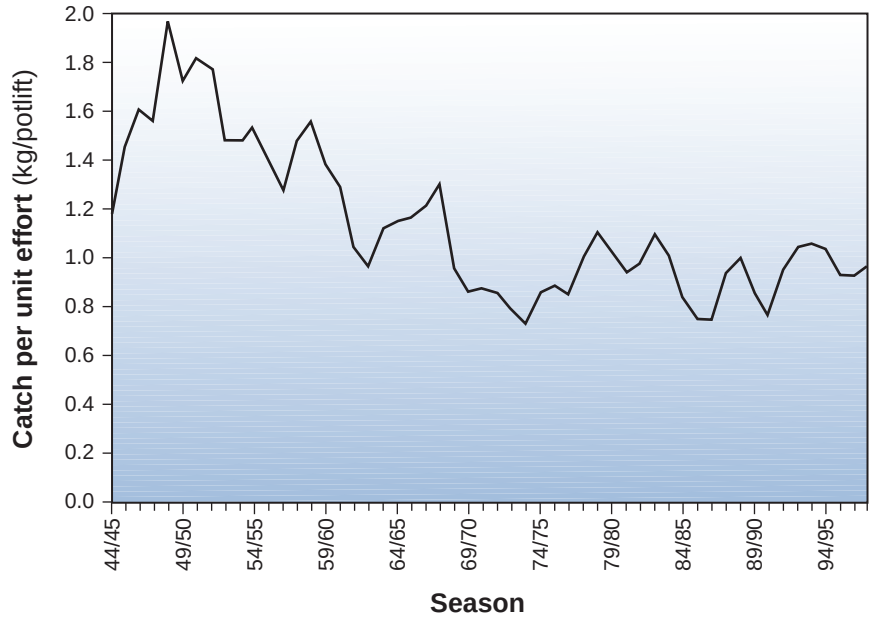
The prices fishermen received for the western rock lobster varied considerably throughout the season. In the northern and southern sectors of the fishery the average prices paid to the fishermen in 1997/98, of $20.20/kg and $19.25/kg respectively, were about 26% lower than the previous season. The value of the landed catch in the WCRLMF was approximately $210 million in 1997/98.

General Comments

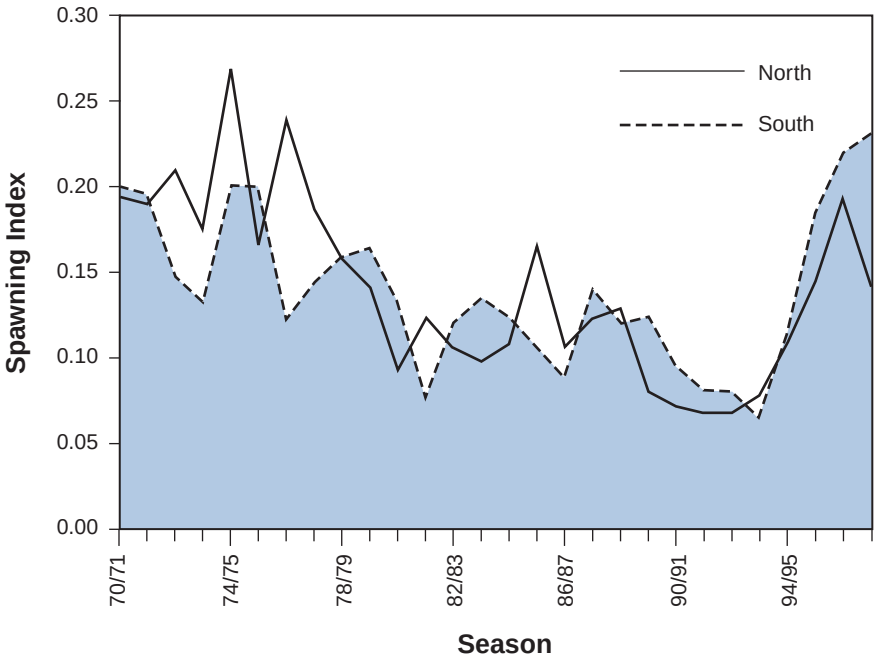
The current management package has achieved its objectives of reducing the exploitation rate, increasing the breeding stock and allowing egg production to be maintained at the target levels. Catches are forecast to increase in 1998/99 and 1999/2000, then to decline to average levels as result of recent lower puerulus settlement. The increased recreational catch in 1997/98 was primarily due to a greater number of licences being issued and a higher proportion of licensees actually undertaking some fishing activity. This response may have been due in part to the higher forecasts for catches in the southern sector of the fishery for the 1997/98 season.



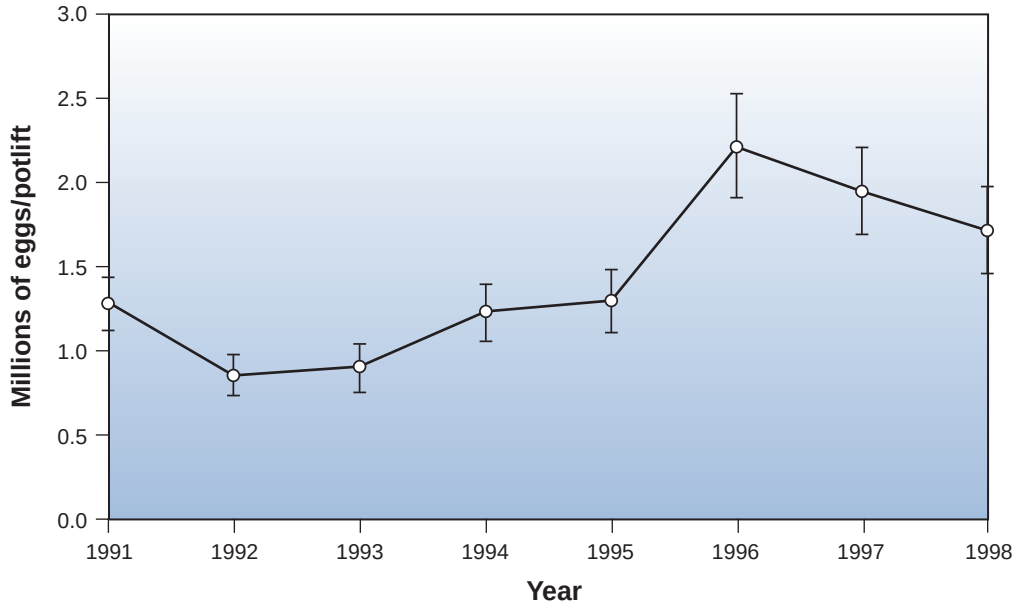
Rock Lobster Figure 1 Annual catch and nominal fishing effort from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 1997/98.



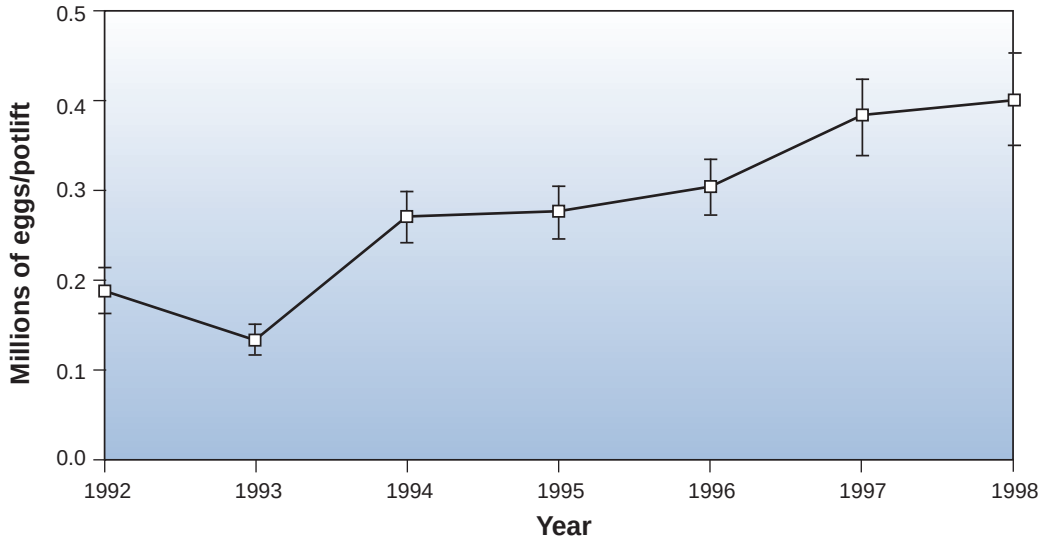
Rock Lobster Figure 2 Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 1997/98.



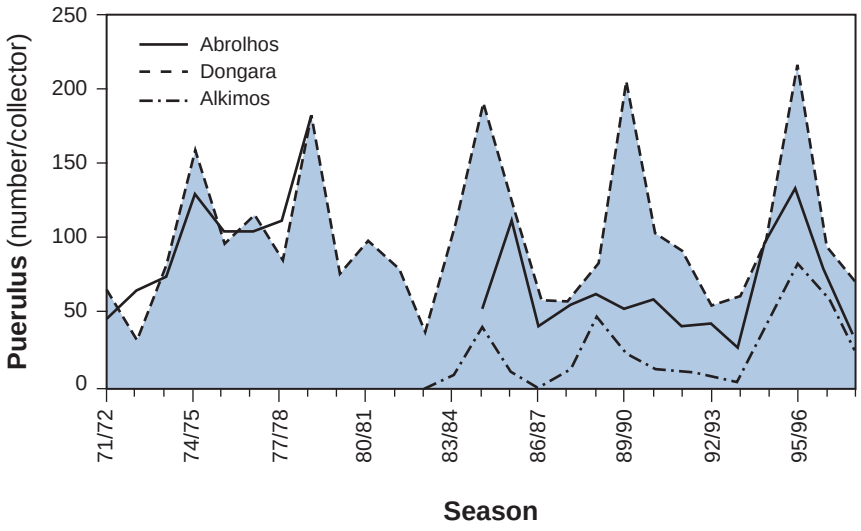
Rock Lobster Figure 3 Time series of monitoring spawning stock index (an index of numbers of eggs/pot lift integrated over the whole season) for the north (Jurien and Dongara) and south (Fremantle and Lancelin) coastal regions.



Rock Lobster Figure 4 Egg production indices as measured by the independent breeding stock survey at the Abrolhos Islands.



Rock Lobster Figure 5 Egg production indices as measured by the independent breeding stock survey at the five coastal sampling sites.



Rock Lobster Figure 6 Annual indices of puerulus settlement for the Abrolhos (A Zone), Seven Mile Beach (Dongara) (B Zone) and Alkimos (C Zone).

South Coast Rock Lobster Fisheries

Management Overview

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*. A maximum pot entitlement of 10 pots/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.

Other south coast rock lobster fishing endorsements: In addition to the Esperance fishery, southern rock lobster are also taken by vessels endorsed to fish for lobsters on the south coast outside of the Esperance zone. These vessels operate in two zones, catching predominantly southern rock lobster, although catches of western rock lobster, *Panulirus cygnus,* have been reported in the area to the west of the Esperance fishery.

Effort in these areas adjacent to the Esperance fishery is controlled by a limitation on the number of endorsements 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 according to varying seasonal catchability. 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 (pot lifts) and catch varying from year to year with the availability of lobsters.

It should also be noted that the future management of deep-sea crabs, which are taken in the area of the south coast and western rock lobster fisheries, is currently being reviewed by Fisheries WA.

Windy Harbour/Augusta Rock Lobster Managed Fishery: The small rock lobster fishery in this area was restructured in 1996 and now contains only two operators. It is therefore no longer reported as a separate fishery, for confidentiality reasons.

Compliance and Community Education Overview

Esperance Rock Lobster Managed Fishery: Compliance in this fishery is based on pre-season gear checks and monitoring for protected lobsters during the season. All gear was found to be in legal condition prior to the commencement of the season.

One boundary infringement investigation was carried out utilising the agency patrol vessel *Walcott,* however no illegal activity was detected.

Compliance activity in the areas adjacent to the Esperance fishery was limited to pre-season gear checks and monitoring of landed catches both at fishing locations east of Esperance and in the district locations of Esperance, Albany and Augusta. Compliance was generally good.

Research Overview

Research in this sector involved 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.

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
The Esperance Rock Lobster Managed Fishery is being fished at sustainable levels. The fisheries in the Great Australian Bight (GAB) and Albany zones are being locally depleted.

Breeding stock levels:
Southern rock lobster are likely to belong to a single stock. Breeding stock levels in Western Australia are not critical to the stock.

Previous catch projections for year 1997/98:
40-70 tonnes

Catch current season (1997/98):
82 tonnes

Estimated annual value (to fishers) for year 1997/98:
$2.3 million

Catch projection next year (1998/99):
50-80 tonnes

Recreational component (1997/98):
Negligible

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 1997/98, 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 1997/98, 31 vessels were endorsed to fish in the GAB and Albany zones. Endorsements were frozen in 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.

Annual Production

Main fishing method

Rock lobster pots.

Landings

A catch of 52 tonnes of southern rock lobsters was taken in the ERLMF in 1997/98, a similar catch to that made in the 1996/97 season (48 tonnes). The combined catch for the GAB and Albany southern rock lobster fishery zones in 1997/98 was 30 tonnes, similar to the 1996/97 figure (33 tonnes). Catches in the western sector of the open access area increased from 8 to 11 tonnes, but in the eastern sector of the fishery catches decreased from 25 to 19 tonnes.

Fishing effort

The ERLMF experienced an 8% decrease in nominal fishing effort levels from 67,700 pot lifts in 1996/97 to 62,500 pot lifts in 1997/98. Total effort for the Albany and GAB zones in the 1997/98 season was 88,600 pot lifts, a decrease of 3,500 pot lifts (3.3%) on the previous season's 91,600 pot lifts. Fishing effort increased in the Albany zone, from 21,600 pot lifts in 1996/97 to 29,100 pot lifts in 1997/98, and decreased in the GAB zone, from 70,000 pot lifts in 1996/97 to 59,400 pot lifts in 1997/98. 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 1997/98 season in the ERLMF increased by 18.3%, from 0.71 kg/pot lift in 1996/97 to 0.84 kg/pot lift in 1997/98. The combined catch per unit of fishing effort for the GAB and Albany zones in the 1997/98 season was 0.34 kg/pot lift, a 6% decrease from the 0.36 kg/pot lift for the 1996/97 season. Catch rates increased from the 1996/97 value in the Albany sector of the open access fishery by 9%, from 0.35 to 0.38 kg/pot lift, but decreased in the GAB by 14%, from 0.36 to 0.31 kg/pot lift.

Stock Assessment

Indications from production modelling of the Western Australian portion of the southern 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. Production modelling results show that the eastern and western zones probably only had biomasses of legal-sized lobsters of between 30 and 100 tonnes prior to exploitation. In comparison, the Esperance area has a long history of sustained exploitation (Rock Lobster Figure 7), and though inconclusive, model results would suggest that the virgin biomass for this part of the fishery was substantial (of the order of 600-1,000 tonnes).

Stock assessments for the GAB and Albany zones show that sustainable yields in both zones are small and, at current fishing levels, the biomass in both areas is being rapidly depleted. Current rates of exploitation will probably lead to lobster fishing in the GAB and Albany zones becoming uneconomic in the future. The unsustainable fishing pressure in the neighbouring zones should not affect the ERLMF, because recruitment to that zone is not considered to be dependent on egg production from Western Australian waters.

Breeding Stock Levels

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 this area probably makes an insignificant contribution to the southern 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.

Catch Projection for Year 1998/99

50-80 tonnes.

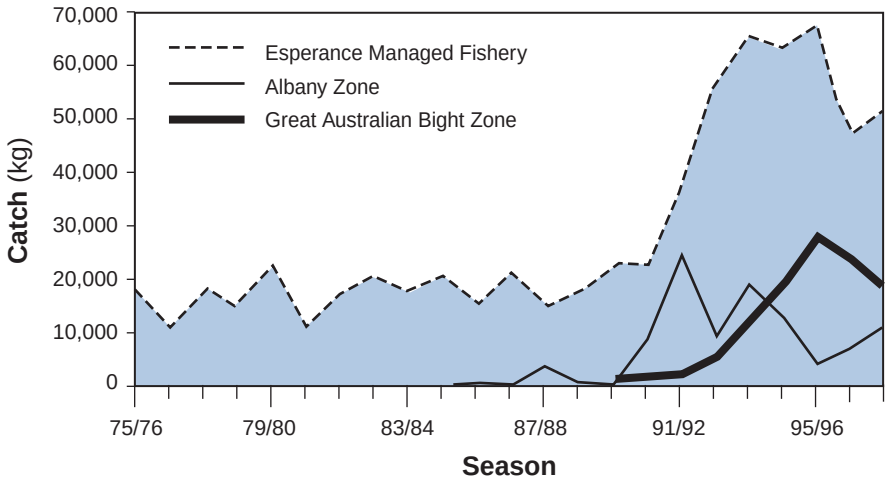
Product Value for Year 1997/98

$2.3 million.

General Comments

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.

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. There are indications that the catch per unit of effort (CPUE) may be declining and these trends will need to be closely monitored in the future.



Rock Lobster Figure 7 Seasonal catches of southern rock lobster by management area, 1975/76 to 1997/98.

Shark Bay Prawn Managed Fishery

Management Overview

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 caught, 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 prawns and coral prawns. The fishery has an annual value of around $25-30 million, however the value of the catch fluctuates according to catches, the prices of prawns on world markets, and exchange rates.

Management of the Shark Bay Prawn Managed Fishery is based on limited entry, boat size, gear controls, season and area openings and closures, moon phase and daily fishing time controls.

The 1999 fishing season commenced on 10 March and is planned to close on 25 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, various subsidiary openings and closures occur which are aimed at protecting prawns from growth and recruitment over-fishing. In 1999 a number of 'moon closures' have also been introduced, extending from three to five days over the full moon period, 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 areas of the fishery remain closed to protect tiger prawn breeding stocks and to prevent the fishing of small prawns.

Cooperative management of the fishery is achieved through the Shark Bay Prawn Management Advisory Committee (MAC). This process has been established to achieve maximum economic return from the prawn resource as well as maintaining sustainability of the fishery and ensuring cost-effective management. 1999 saw the appointment of a new Chair to the Shark Bay Prawn MAC.

Compliance and Community Education Overview

Licence and gear inspections were carried out by Fisheries Officers from Carnarvon and Denham.

Aircraft were again used extensively by officers at Carnarvon. These activities were supplemented by the use of a large patrol vessel from Geraldton which paid particular attention to surveillance of nursery areas and placed officers on board trawlers to inspect catch and gear.

A smaller patrol vessel, the PV *John Brockman,* commissioned in May 1998 and located at Denham, undertook patrols in the southern sector of the fishery, concentrating on the nursery areas in Denham Sound.

The Vessel Monitoring System (VMS) at Carnarvon was again trialled in conjunction with industry throughout April, May and June 1999.

Fisheries Officers provided information on conservation and compliance to operators within the industry during pre-season briefings.

Research Overview

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

A new research initiative during 1997/98 was a collaborative project with industry to review the impact of trawling on non-target species and evaluate gear modifications to reduce bycatch and improve product quality.

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

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
King prawns and tiger prawns fully exploited

Breeding stock levels:
Adequate

Previous catch projections for year 1998:
Major penaeids 1,155-2,063 tonnes, comprising:

King prawns	*790-1433 tonnes*
Tiger prawns	*365-784 tonnes*
Endeavour prawns	*1-13 tonnes*

continued over

Catch current season (1998):
Major penaeids 2,185 tonnes, comprising:

King prawns	*1,614 tonnes*
Tiger prawns	*538 tonnes*
Endeavour prawns	*32 tonnes*

$32.5 million

Major penaeids 1,611-2,183 tonnes (based on five-year range)

Individual species (based on five-year range):

King prawns	*1059-1614 tonnes*
Tiger prawns	*538-784 tonnes*
Endeavour prawns	*3-32 tonnes*

Not applicable

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 (Prawn Figure 1).

Twenty-seven vessels are licensed to engage in prawn trawling in this fishery and all licences were active in 1998. The season opened on 17 March and closed on 3 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 16 April.

Denham Sound was closed to trawling from 1 May and reopened on 1 August when the ENA was closed to protect juvenile recruits.

The Torbay Line opened on 1 August and closed on 3 November.

Annual Production

Main fishing method
Otter trawl.

Landings
The total landings of major penaeids for the 1998 season were 2,185 tonnes, comprising 1,614 tonnes of king prawns, 538 tonnes of tiger prawns and 32 tonnes of endeavour prawns. There were also 237 tonnes of minor penaeids (coral prawns) landed.

King prawn landings for 1998 were considered exceptional, exceeding the five-year average by 46% (Prawn Figure 2). This may be due to the strength of the Leeuwin Current which was well above average, and/or to continued high levels of effective fishing effort.

Tiger prawn landings were lower than the five-year average by 12%.

Scallop landings by the prawn fleet totalled 75 tonnes meat weight. All Shark Bay Prawn Managed Fishery vessels have Shark Bay Scallop Managed Fishery Class B licences.

Fishing effort
Effort recorded in the 1998 daily logbooks for the fleet showed nominal effort as 56,175 hours, which was a reduction of 2,000-3,000 hours when compared to the last four years' effort. Though the effective fishing effort remained high for 1998, the actual number of hours fished was slightly reduced because of the shorter fishing period during 1998 compared to the last four fishing seasons.

Catch rate
Catch rates of 28.7 kg/hr for king prawns and 9.6 kg/hr for tiger prawns were recorded for the 1998 season. These represent an increase of 17% and a decrease of 10.3% respectively over the five-year averages for these species.

Stock Assessment

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 these two species are likely to remain in the vicinity of 1,100 and 500 tonnes respectively.

Breeding Stock Levels

Owing to the multi-species nature of this fishery, levels of exploitation of both king and tiger prawn stocks are being carefully monitored with the aim of achieving maximum sustainable catches simultaneously.

Current stock and recruitment studies indicate that the king prawn stock remains at a point where recruitment is not affected by spawning stock levels. At the current level of exploitation, fluctuation in annual king prawn harvest is likely to result from effort levels and environmental variation, and not from abundance of spawning stock.

In contrast, the recruitment levels of tiger prawns during the 1980s were affected by the spawning stock biomass. Management practices have been employed to increase the survival of th ese spawning stocks. A reduction in the fleet size from 35 to 27 vessels through the buy-back scheme introduced in 1990, together with the new area closures introduced in that year, appears to have benefited tiger prawn stocks. Tiger prawn catches have returned to the levels achieved in

the 1970s, in the range 400-700 tonnes. Changes in the efficiency of the fishing fleet must be monitored carefully to ensure that tiger prawn spawning stocks are not over-exploited.

Catch Projection for Year 1999

Under current effort levels, and based on the five-year range of catches, the projected king prawn catch is 1,059-1,614 tonnes, while the tiger prawn catch range, under normal environmental conditions, will be 538-784 tonnes. The Leeuwin Current index was one of the strongest on record, which would indicate that the catch of king prawns may reach record levels during 1999.

Product Value for Year 1998

Wholesale prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices were as follows:

King prawns	$14.50/kg
Tiger prawns	$16.40/kg
Endeavour prawns	$10.00/kg
Coral prawns	$3.50/kg

General Comments

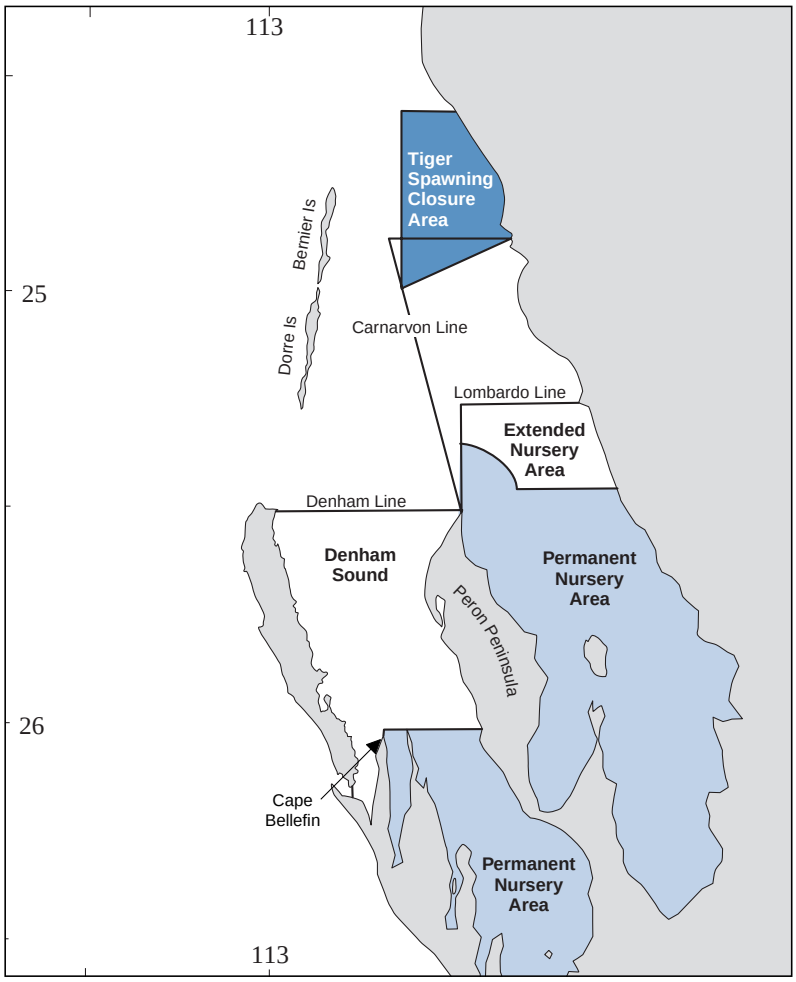
The tiger prawn closure area introduced during the 1996 season was again implemented from 12 July to 8 October (Prawn Figure 1). North of Koks Island (which lies just off the northern tip of Bernier Island), 24-hour fishing was allowed from 17 March until 8.00 a.m. on 11 April to fish for squid.

Two new vessels with increased fishing power replaced two older vessels within the prawn fleet this season. The effective effort in this fishery is increasing, which may affect the more vulnerable tiger prawn stock.

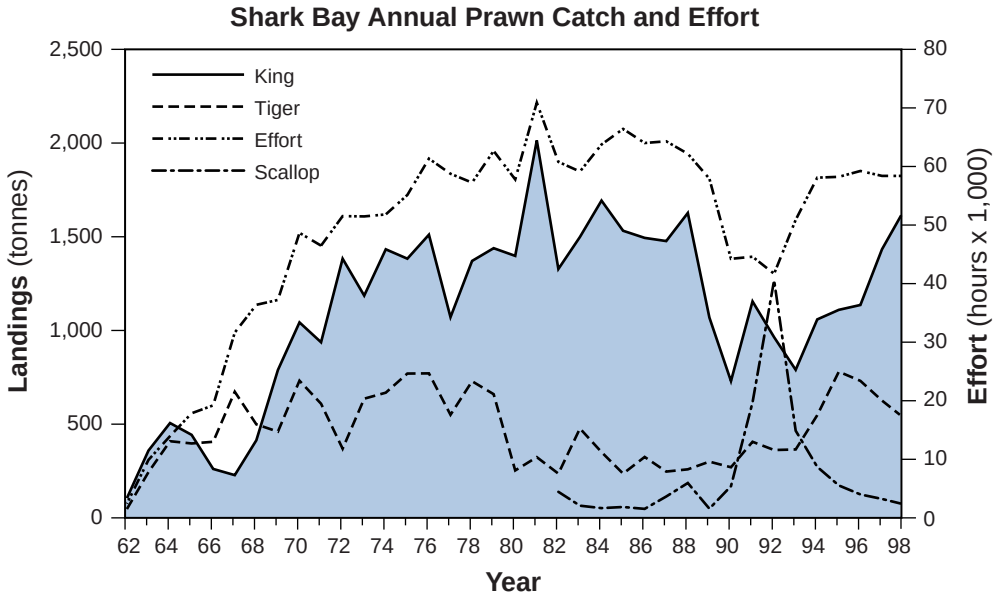
The Fisheries Research Division will continue to investigate the relationship between the strength of the Leeuwin Current (Fremantle sea level) and king prawn catches, as it shows promise of improving catch forecasts.

In collaboration with the fishing industry, and in conjunction with a Natural Heritage Trust-funded project, research has been conducted into reducing bycatch through the use of bycatch reduction grids and other modifications to trawling gear.

Spatial models of this fishery are also under development; these will assist researchers to advise managers and the fishing industry on the likely outcome of management changes on the status of stocks and on the value of the fishery.



Prawn Figure 1 Boundaries of the Shark Bay Prawn Managed Fishery.



Prawn Figure 2 Shark Bay Prawn Managed Fishery annual catch and effort, 1962-1998.

Exmouth Gulf Prawn Managed Fishery

Management Overview

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)*. This fishery has an annual value of around $13 million depending on species mix, prices and exchange rates.

The 1999 fishing season commenced on 5 April and is proposed to close on 15 November. Within the main fishing period, various subsidiary area openings and closures occur aimed at maximising the long-term yield from the fishery, particularly of tiger prawns, and to protect breeding stocks as well as maximising the catch of larger prawns suitable for export.

In 1999 a number of extended 'moon closures' have also been introduced over the full moon period, 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 less marketable due to soft-shelled prawns. Four-day moon closures were trialled early in the season to measure their effectiveness at extending the period of tiger prawn fishing as part of a marketing strategy for the fishery.

Management controls also include gear restrictions linked to controls on maximum vessel size and power.

Cooperative management of the fishery is achieved through the Exmouth Gulf Prawn Management Advisory Committee (MAC). This process has been established to achieve maximum economic return from the prawn resource as well as maintaining sustainability of the fishery and ensuring cost-effective management. In 1999 a new Chair was appointed to the Exmouth Gulf Prawn MAC.

Compliance and Community Education Overview

Sea patrols and radar watches were conducted during 1998/99 using a radar-equipped patrol boat based at Exmouth, while aircraft were again used extensively. At-sea patrols were enhanced by the use of the new patrol vessel *Walcott*. Operations focused on maintaining the integrity of nursery areas within the fishery.

Due to the impacts of Cyclone Vance, compliance activities were re-programmed during the early part of the season to coincide with the late commencement of fishing activity.

Research Overview

Research activities during 1997/98 focused on stock assessment and surveys to monitor both annual recruitment of tiger prawns and spawning stocks. All vessels completed detailed research logbooks which, together with survey data and factory records, provide the database for managing the fishery.

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

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
King prawns adequate; tiger prawns increasing

Previous catch projections for year 1998:
Major penaeids 771-1,276 tonnes, comprising:

King prawns	*370-502 tonnes*
Tiger prawns	*205-682 tonnes*
Endeavour prawns	*121-293 tonnes*

Catch current season (1998):
Major penaeids 1,058 tonnes, comprising:

King prawns	*508 tonnes*
Tiger prawns	*377 tonnes*
Endeavour prawns	*170 tonnes*
Banana prawns	*3 tonnes*

Estimated annual value (to fishers) for year 1998:
$15.3 million

Catch projection next year (1999):
Major penaeids 771-1,276 tonnes (based on five-year range)

Individual species (based on five-year range):

King prawns	*370-508 tonnes*
Tiger prawns	*205-682 tonnes*
Endeavour prawns	*121-293 tonnes*

Recreational component (1997):
Nil

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; the nce 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' (Prawn Figure 3).

There were 15 vessels licensed to operate in the Exmouth Gulf Prawn Managed Fishery during the 1998 season.

The 1998 season commenced on 1 April with the opening of Area A (predominantly king prawn grounds). Fishing in Area B commenced on 27 April. Area C (P1 and P2 fishing grounds) was opened on 25 May. Both Areas B and C were closed on 6 July. Vessels then fished Area A until they ceased fishing on 14 November and the season officially closed at 8.00 a.m. on 15 November.

Annual Production

Main fishing method

Otter trawl.

Landings

The total annual prawn landings from Exmouth Gulf for the 1998 season were 1,058 tonnes, an increase of 6% on the five-year mean of 998 tonnes but up 29% on last year's combined landings of 815 tonnes (Prawn Figure 4). King prawns (508 tonnes) were again the predominant species taken, along with 377 tonnes of tiger prawns, 170 tonnes of endeavour prawns and three tonnes of banana prawns.

Fishing effort

Total nominal effort for the 1998 season was 33,953 hours. The lower effort for the 1998 season can be attributed to the retirement of one vessel from the fleet, which reduced the hours fished. The headrope length (net size) of the remaining vessels was increased so that the historical total headrope length of the fleet was retained, giving a comparable effort level of 36,216 hours.

Catch rate

Catch rates of king and tiger prawns compared favourably against seasons with similar total landings. The catch rate for king prawns was 13.9 kg/hr, for tiger prawns 10.4 kg/hr, and for endeavour prawns 4.6 kg/hr.

Stock Assessment

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 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. Indications are that at current effort levels and with favourable environmental conditions, catches of these two species will remain relatively static.

The king prawn stock, which had normal levels of recruitment, was within the range normally predicted for this fishery.

The tiger prawn stock within Exmouth Gulf was rebuilt significantly during 1997. During the 1997/98 summer period, the environmental conditions within Exmouth Gulf were normal (low rainfall with no cyclonic disturbances), with no adverse effects for the tiger prawn stock. Therefore the higher total landings for the 1998 season were expected.

The level of the tiger prawn stock was monitored during the period June-July 1998 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 vessels, and were found to be higher than in the previous year. Provided environmental conditions are normal (no early summer cyclonic activity) within the Exmouth area, a further increase in tiger prawn landings is expected for the 1999 season.

With the introduction of new fishing net configurations, there is potential for fishing efficiency to increase even if the numbers of vessels and total hours of fishing are reduced. These changes must be monitored carefully to ensure that tiger prawn spawning stocks are not over-exploited.

Breeding Stock Levels

During 1997, the tiger prawn spawning stock surveys conducted during the months of August, September and October (standard survey periods) determined that the breeding stock levels were less than optimal.

Continuing concerns about tiger prawn stocks necessitated the close monitoring of catch rates in Areas B and C following the lunar closure on 15 June 1998. When average catch rates approached 16 kg/hr, these areas were closed to fishing to maintain sufficient spawning stock. This threshold catch rate was determined by the historical levels that supported good recruitment in the following season.

Standardised spawning surveys were again conducted in August, September and October of 1998, and indicated catch rates for tiger prawns averaging 10.4 kg/hr. These were an improvement on those of the 1997 survey, but were still below the optimum of 14-16 kg/hr. Careful management will ensure further rebuilding of tiger prawn stocks.

Catch Projection for Year 1999

Under current fishing effort levels, the catch projections for 1999 indicate a total of 771-1,276 tonnes for major penaeids. Projections for individual species give the following ranges: king prawns 370-508 tonnes, tiger prawns 205-682 tonnes and endeavour prawns 121-293 tonnes. These figures are for normal environmental conditions and are based on a five-year average.

Product Value for Year 1998

Wholesale prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices were as follows:

King prawns	$14.50/kg
Tiger prawns	$16.40/kg
Endeavour prawns	$10.00/kg
Banana prawns	$10.50/kg
Coral prawns	$3.50/kg

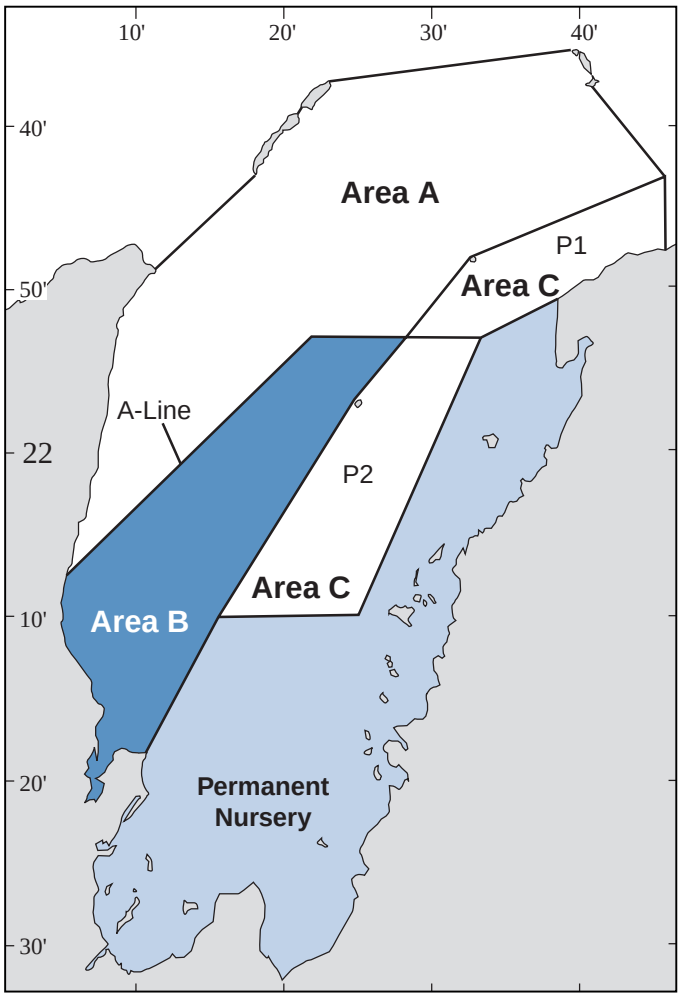
General Comments

There were no major management changes introduced for the 1998 season. Opening and closure dates for the fishery and areas within the fishery were mainly influenced by moon phases. The P1 and P2 fishing grounds opened simultaneously on 25 May, after which the entire fishery was open to trawling. During this period the tiger prawn catch was monitored. By 19 June it was apparent that the tiger prawn stock required vigilant monitoring, which was achieved by daily monitoring of catch unloads and daily logbook records of tiger prawn catches.

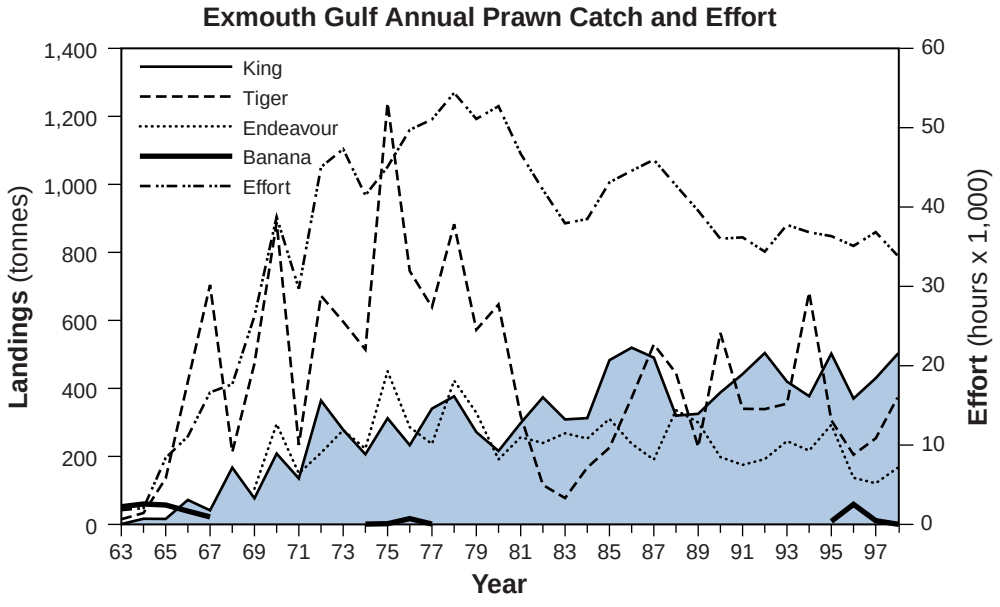
Fishing ceased on 2 July on the tiger prawn stocks, and areas B and C (south of the A line) were officially closed on 6 July. The whole fishery closed on 15 November.

The major fishing company, M.G. Kailis, retired one vessel from its fishing fleet this season; however, the headrope length (size of nets) of some the remaining vessels was increased, within the limits of the company's overall allocation. This was done as 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.

Spatial models of this fishery are under development; these will assist researchers to advise managers and the fishing industry on the likely outcome of management changes on the status of stocks and on the value of the fishery.



Prawn Figure 3 Boundaries of the Exmouth Gulf Prawn Managed Fishery.



Prawn Figure 4 Exmouth Gulf Prawn Managed Fishery annual landings and effort, 1963-1998.

Onslow Prawn Managed Fishery

Management Overview

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 1999 fishing season commenced on 5 April and will end on 15 November. Within the main fishing period, a number of nursery area openings and closures allow access to tiger prawn and banana prawn stocks. Catches in these nursery areas are closely monitored to ensure the prevention of growth and recruitment over-fishing. In 1999 the boundaries of the Ashburton Nursery were realigned to allow access to additional tiger prawn stocks, however catches taken from the new area are being particularly closely monitored to ensure that the increase in access will not jeopardise recruiting stocks.

Other management controls include limited entry, gear restrictions and controls on replacement boat size.

Compliance and Community Education Overview

Karratha Fisheries Officers conducted several licence and gear inspections aboard vessels alongside the wharf in Beadon Creek, Onslow.

Sea patrols were also conducted by agency patrol vessels assisted by Karratha-based Fisheries Officers who monitored closed waters and carried out both gear and licence inspections.

A number of patrols, including those aboard agency patrol vessels, were carried out in the company of officers from the Department of Transport under the Joint Servicing Agreement.

No major offences were detected within the fishery.

Research Overview

Research for managing this small fishery involves stock monitoring and assessment utilising the Catch and Effort Statistics System (CAESS) data provided by industry, as well as information from interviews with vessel skippers. Annual meetings are held with vessel 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.

Fishery Status Report

Main Features

Stock assessment complete:
Not assessed

Exploitation status:
Not assessed

Breeding stock levels:
Not assessed

Previous catch projections for year 1998:
30-265 tonnes

Catch current season (1998):
Major penaeids 61 tonnes, comprising:

King prawns	*35 tonnes*
Tiger prawns	*14 tonnes*
Endeavour prawns	*11 tonnes*
Banana prawns	*2 tonnes*

Estimated annual value (to fishers) for year 1998:
$0.9 million

Catch projection next year (1999):
61-132 tonnes (based on five-year range)

Recreational component (1999):
Not applicable

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 wat er 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'* (Other 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)
Area 3	(incorporating Fortescue Nursery)

During the 1998 season the areas were open during the following periods:

Area 1	1 April-15 November
Area 2	1 April-15 November
Area 3	1 March-15 November
Fortescue Nursery	1 May-15 November
Ashburton and Coolgra Point Nursery Areas	Closed throughout the whole season

Different licence classes apply to this fishery allowing vessels to trawl in specific zones. These classes are listed below (figures in brackets indicate 1998 endorsements):

Class A	Areas 1, 2 and 3 (4 vessels)
Class B	Areas 2 and 3 (3 vessels)
Class C	Area 2 (12 Exmouth Gulf vessels)
Class D	Area 3 (12 Nickol Bay vessels)

Annual Production

Main fishing method

Otter trawl.

Landings

The total landings for the 1998 season were 61 tonnes, including 14 tonnes of tiger prawns, 35 tonnes of king prawns and 11 tonnes of endeavour prawns (Other Prawn Figure 2).

The banana prawn landing of 2 tonnes was very low, and appears to be related to the low rainfall over the preceding summer period (December to March inclusive).

In contrast, the tiger, king and endeavour prawn catches increased in comparison with those of the previous season.

Fishing effort

Not assessed.

Catch rate

Not assessed.

Stock Assessment

The catches during 1998 were at the low end of the range for all species (except king prawns, which were average at 35 tonnes). This was particularly the case for banana prawns, which declined to a very low catch level, from 90 tonnes in 1997 down to 2 tonnes in 1998. This corresponded to a very low summer rainfall, which commonly correlates with low recruitment for this species. Further work is under way to assess the relationship between summer rainfall and catches from the two separate nursery areas for this species within the Onslow trawl fishery.

Breeding Stock Levels

Not assessed.

Catch Projection for Year 1999

Under current effort levels, the projections for the 1999 season range of prawn catches, based on the five-year range, are:

King prawns	19-56 tonnes
Tiger prawns	5-96 tonnes
Endeavour prawns	5-22 tonnes
Banana prawns	2-91 tonnes

Product Value for Year 1998

Wholesale prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices were as follows:

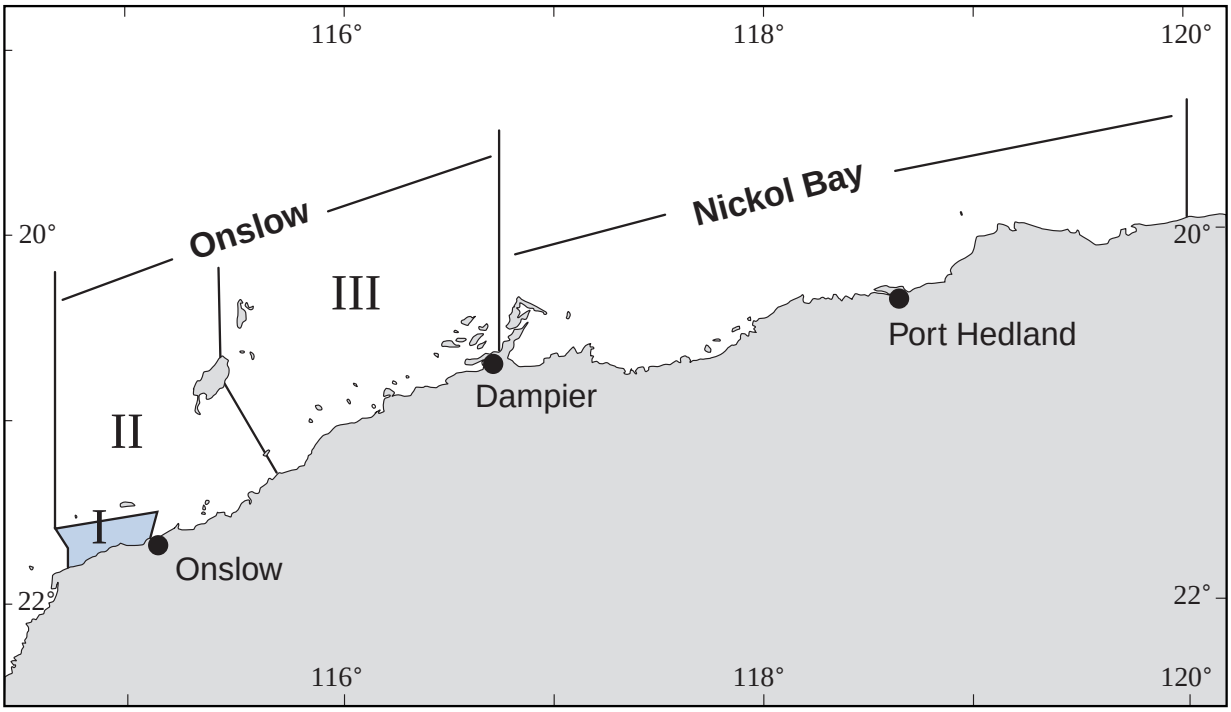
King prawns	$14.50/kg
Tiger prawns	$16.40/kg
Endeavour prawns	$10.00/kg
Banana prawns	$10.50/kg
Coral prawns	$3.50/kg

General Comments

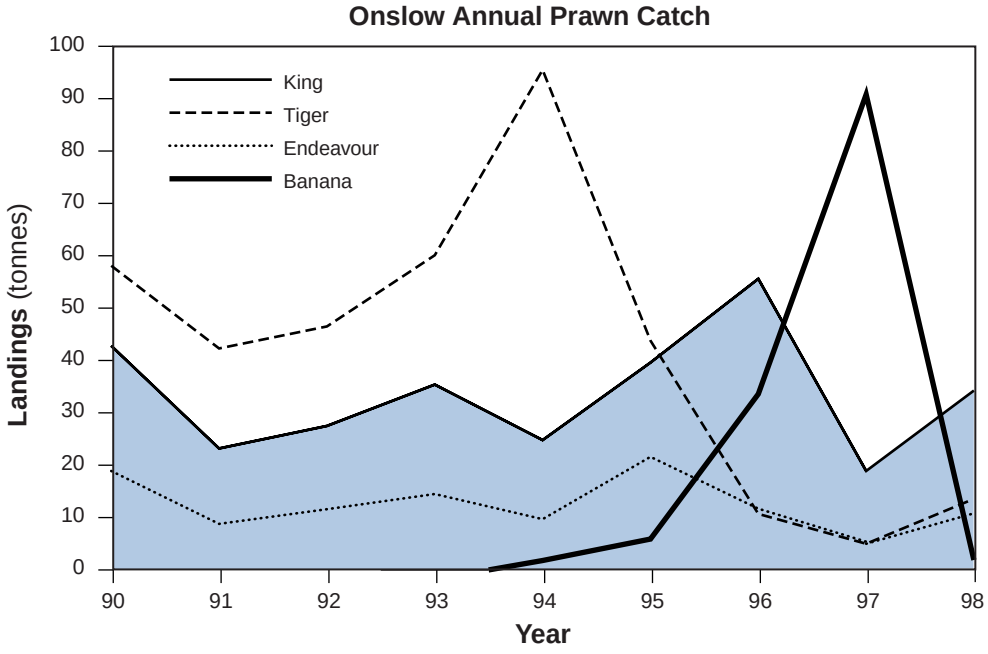
The monitoring of stocks in this fishery is undertaken using data from CAESS. The catches taken are, however, from a number of separate nursery areas and are highly variable from year to year. This is particularly the case for the rainfall-dependent banana prawn, which was the dominant species caught during 1997 yet provided the smallest component of the catch taken during the 1998 season.

Catches of tiger prawns from this fishery are also quite variable. It is likely that the severity of storms impacts negatively on tiger prawns in some years, and moreover, the effect varies depending on whether juvenile prawns are still in vulnerable, shallow seagrass nursery areas at the time. Severe storms can impact directly on king prawns and endeavour prawns as well. At times, debris from flooding can compound the problem by restricting fishing activities, and hence landings for the year.

The king prawn catch for 1997 declined as a result of flooding from the Ashburton River dispersing the stock and thus reducing their catchability. It was expected, however, that the king prawn catch would return to the normal range for the 1998 season, and this in fact occurred.



Other Prawn Figure 1 Boundaries of the Onslow and Nickol Bay Prawn Managed Fisheries.



Other Prawn Figure 2 Annual landings for the Onslow Prawn Managed Fishery, 1990–1998

Nickol Bay Prawn Managed Fishery

Management Overview

The Nickol Bay Prawn Managed Fishery targets western king prawns *(Penaeus latisulcatus)*, brown tiger prawns *(Penaeus esculentus)*, endeavour prawns (*Metapenaeus* spp.) and banana prawns *(Penaeus merguiensis)*, with most prawn fishing activity occurring in inshore areas. A number of the Nickol Bay prawn trawlers also operate in the Pilbara Fish Trawl Interim Managed Fishery.

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

Compliance and Community Education Overview

Karratha Fisheries Officers conducted frequent licence and gear inspections aboard vessels at Point Samson and Dampier.

Sea patrols were also conducted aboard agency patrol vessels by Fisheries Officers who carried out catch, gear and licence inspections.

A number of patrols, including those aboard agency patrol vessels, were carried out in the company of officers from the Department of Transport under the Joint Servicing Agreement.

No major offences were detected within the fishery.

Research Overview

Research for the management of this small fishery involves stock monitoring and assessment utilising data from CAESS provided by industry, information from vessel skippers, and rainfall records. Stock assessment of the banana prawn stock 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.

Fishery Status Report

Main Features

Stock assessment complete:
Not assessed

Exploitation status:
Not assessed

Breeding stock levels:
Not assessed

Previous catch projections for year 1998:
168-237 tonnes

Catch current season (1998):
Major penaeids 89 tonnes, comprising:

King prawns	*50 tonnes*
Tiger prawns	*3 tonnes*
Endeavour prawns	*< 1 tonne*
Banana prawns	*36 tonnes*

Estimated annual value (to fishers) for year 1998:
$1.2 million

Catch projection next year (1999):
Major penaeids 89-222 tonnes, comprising:

King prawns	*20-73 tonnes*
Tiger prawns	*3-37 tonnes*
Endeavour prawns	*0-5 tonnes*
Banana prawns	*150-250 tonnes**

*(*using rainfall-catch relationship; others based on five-year range)*

Recreational component (1998):
Nil

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'* (Other Prawn Figure 1).

During the 1998 season the areas were open during the following periods:

Nickol Bay	1 May-15 November
Sloping Point to Dixon Island	1 May-31 August
Dixon Island to One Lung Point	1 May-15 November
Depuch Nursery Area	1 May-31 August
De Grey Nursery Area	1 May-15 November
Onslow III	1 March-15 November

There were 14 vessels licensed to trawl for prawns in Nickol Bay during 1998.

Annual Production

Main fishing method
Otter trawl.

Landings

The banana prawn landing of 36 tonnes for the 1998 season was low compared with the 212 tonnes caught in 1997, but fell within the range of 10-100 tonnes projected on the basis of the low rainfall in the 1997/98 summer period.

Other prawn landings for the 1998 season were 53 tonnes, comprising 50 tonnes of king prawns, 3 tonnes of tiger prawns and less than 1 tonne of endeavour prawns (Other Prawn Figure 3).

Fishing effort

Not assessed.

Catch rate

Not assessed.

Stock Assessment

The relationship between banana prawn catch and rainfall is assessed annually. Other prawn stocks are insufficient to carry out a formal stock assessment. A relationship exists between the summer period rainfall (December-March) and the catch of banana prawns in the same year (Other Prawn Figure 4). Adjusting the forecast of banana prawns for the 275 mm of rain during the 1998/99 summer period provides a catch projection of between 150 and 250 tonnes.

Breeding Stock Levels

Not assessed.

Catch Projection for Year 1999

With the current effort levels, the projections for the range of prawn catches for the 1999 season, based on the five-year range, are as follows:

King prawns	20-73 tonnes
Tiger prawns	3-37 tonnes
Endeavour prawns	0-5 tonnes
Banana prawns	150-250 tonnes

The total catch projection is between 150 and 250 tonnes.

Product Value for Year 1998

Wholesale prices for prawns vary depending on the grade and quality of the product and the market forces operating at any one time. Generally, average prices were as follows:

King prawns	$14.50/kg
Tiger prawns	$16.40/kg
Endeavour prawns	$10.00/kg
Banana prawns	$10.50/kg
Coral prawns	$3.50/kg

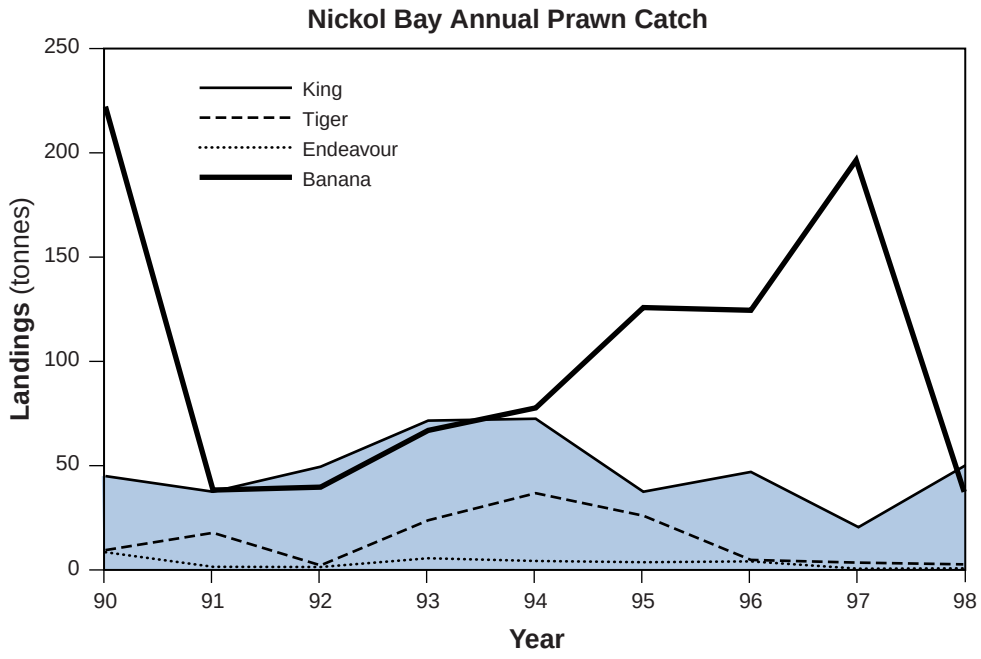
General Comments

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

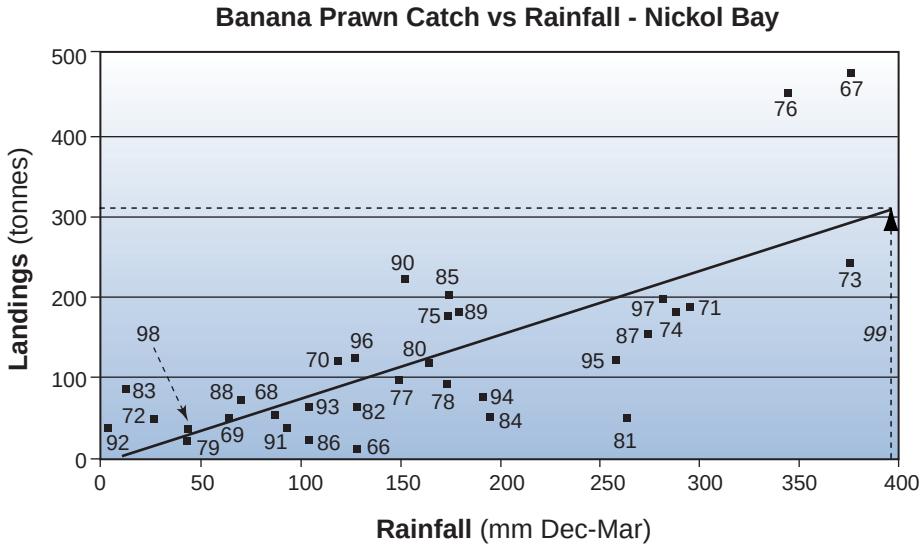
The majority of vessels in the prawn fleet of Nickol Bay are also licensed to fish finfish stocks offshore (the Pilbara Fish Trawl Fishery). Some also fish for prawns in the Kimberley Prawn Managed Fishery. As such, the fishing effort in the Nickol Bay Prawn Managed Fishery is dependent on management measures taken elsewhere, and on the catch rates available in these other fisheries. Fishing for finfish has encouraged the construction of larger vessels 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 impact of these restrictions and of falling finfish catches has been to force 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 relatively poor catches of banana prawns in 1998 were anticipated because of the low rainfall (only 45 mm) during this critical period. With 275 mm of rainfall recorded for this same period during 1998/99, much improved landings of banana prawns are forecast.

There are designated nursery areas in Nickol Bay designed to protect the harvest of under-sized banana prawns. During 1998 these areas were opened for fishing on 15 March but immediately closed when fishing revealed that the prawns were still too small on average (large prawns are more valuable). The nursery areas were reopened on 1 May when the prawns had reached a larger, more valuable size.



Other Prawn Figure 3 Annual landings for the Nickol Bay Prawn Managed Fishery, 1990-1998.



Other Prawn Figure 4 Relationship between banana prawn landings and rainfall between December and March for years 1966-1998.

Broome Prawn Managed Fishery

Management Overview

The Broome Prawn Managed Fishery is a small trawl fishery off Broome. The fishery 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).

On 1 March 1999, the management plan for the Broome Prawn Managed Fishery came into effect. Essentially, the management plan encompasses the previous management arrangements for the interim managed fishery, with the addition of a provision for the Executive Director to direct licensees to install bycatch reduction devices if required, as well as the installation of vessel monitoring equipment.

Compliance and Community Education Overview

Fisheries Officers based in Broome control the operation of this six-week fishery each year. Gear and licence checks were carried out during the season, with infringement notices being served on the masters of two vessels for minor licensing offences.

This fishery continues to be generally self-regulating, with the major concern being crew licensing for the short season.

Research Overview

Research data for managing this small seasonal fishery is provided by detailed research logbooks completed by all vessels. This data is used for stock assessment and monitoring which is discussed with industry at annual review meetings. During 1997/98 the relationship between catch and moon phase was investigated and has resulted in some modifications to the management arrangements.

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

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

continued over

Previous catch projections for year 1998:
King prawns 35-140 tonnes (based on five-year range)

Catch current season (1998):
Penaeids 238 tonnes, comprising:

King prawns	*164 tonnes*
Coral prawns	*74 tonnes*

Estimated annual value (to fishers) for year 1998:
$2.6 million

Catch projection next year (1999):
King prawns 36-164 tonnes

Recreational component:
Not applicable

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 1998 fishing season on 15 June and closed on 15 September.

Five Western Australian-based Northern Prawn Fishery vessels are licensed to operate in this fishery.

Annual Production

Main fishing method
Otter trawl.

Landings
The total landings for the 1998 season were 238 tonnes, including 164 tonnes of king prawns and 74 tonnes of coral prawns.

King prawn landings for 1998 were 113% higher than the five-year average (77 tonnes) (Other Prawn Figure 5).

Fishing effort
Nominal effort recorded in the daily research logbooks for the fleet was 3,789 hours.

Catch rate
A catch rate of 40.9 kg/hr for king prawns and 18.3 kg/hr for coral prawns was recorded.

Stock Assessment

Catches for 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 vessels transiting to the Northern Prawn Fishery in the Gulf of Carpentaria. The success of this fishery depends on how the limited fishing season (approximately six 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 Northern Prawn Fishery mid-season closure rather than the appropriate lunar period. Consequently, the timing of the fishing period has not always been optimal for exploiting the king prawn stock.

Following advice from the Fisheries Research Division, the timing for the opening and closing of the season in 1998 was adjusted to match the lunar-phase-driven recruitment and catchability patterns in order to achieve the best catch rates available during this fishing period.

The catch of king prawns for the 1998 season was above average, producing 164 tonnes. It must be noted that the duration of the fishing season, at approximately 13 weeks (15 June to 15 September), was double the duration of past seasons. However, the initial six weeks' fishing resulted in a catch of 122 tonnes of king prawns, and as this period was of equivalent duration to the annual season fished from 1991 to 1997 inclusive, a direct comparison can be made which still indicates an above-average catch.

A Delury depletion analysis was carried out on the 1998 logbook data to quantify the standing stock of king prawns in the Broome fishery. From this a standing stock of approximately 233 tonnes was estimated. This indicates that approximately 70% of the stock was taken by fishing, utilising the 3,789 hours of fishing recorded in this fishery. It is estimated that, at the rate of depletion observed, it would theoretically take approximately 5,200 hours to catch the whole stock (reducing the catch rate to zero). The approach of using a depletion analysis has great 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 the fishing season (a measure of spawning stock) and the recruitment of king prawns the subsequent year.

Breeding Stock Levels

Depletion analysis indicated that approximately 30% of the king prawn stock was left when fishing stopped. This stock could continue to breed. In addition, some spawning may have occurred by females prior to their capture. These data indicate that the king prawn stock is above the level of 20% of breeding stock biomass needed to sustain the fishery.

Catch Projection for Year 1999

Under current effort levels, the king prawn catch projection for the 1999 season is 36-164 tonnes, based on the five-year average.

Product Value for Year 1998

Wholesale prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, prices for 1998 were as follows:

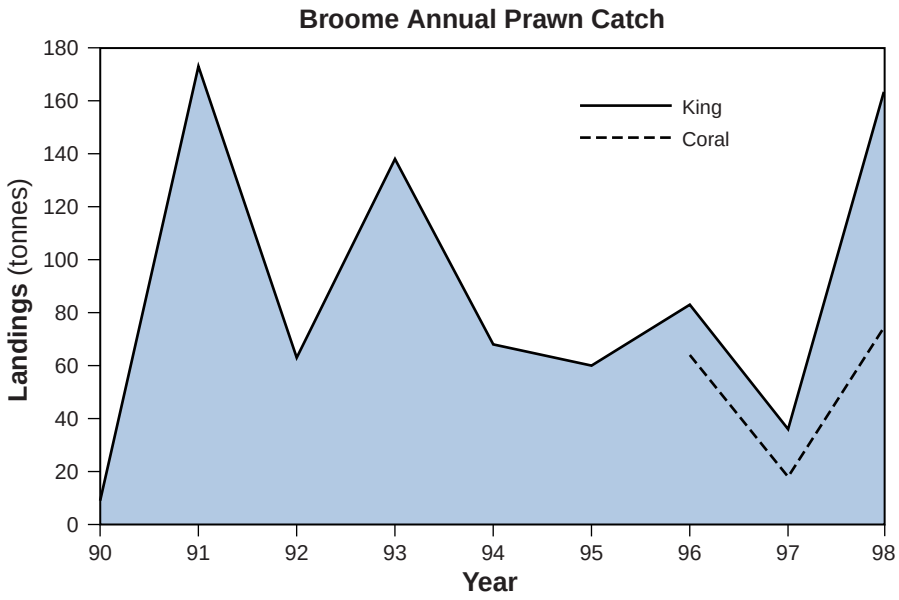
King prawns	$14.50/kg
Coral prawns	$3.50/kg

General Comments

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 during the full moon. By bringing the timing of the season in line with lunar period, fishing efficiency has been maximised, and more consistent annual catch levels of king prawns are anticipated.

This fishery is valuable despite its short season because it allows 13 weeks' fishing by five vessels in a way that complements fishing activity in the Northern Prawn Fishery, and in other fisheries in Western Australia. Without this fishery, Western Australian vessels fishing in the Northern Prawn Fishery would spend too much valuable time shifting locations with few opportunities to fish in transit.

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.



Other Prawn Figure 5 Annual landings for the Broome Prawn Managed Fishery, 1990-1998.

Kimberley Prawn Managed Fishery

Management Overview

The management controls for the Kimberley Prawn Managed Fishery are based on limited entry, seasonal closures, gear controls and restrictions on boat replacements.

The Kimberley Prawn Managed Fishery is off the north of the State adjacent to the Northern Prawn Fishery. Opening and closing dates have been aligned with those of the Northern Prawn Fishery.

Compliance and Community Education Overview

Compliance activities for this fishery are limited to inspections of fishing vessels entering the port of Broome en route to the fishing grounds, and opportunistic inspections during sea patrols targeting other fisheries.

The majority of vessels operating within this fishery are serviced from Darwin, and the distance between the ports of Darwin and Broome makes at-sea inspections of vessels operating on these grounds difficult and expensive. The increased presence of the joint Fisheries WA and Department of Transport patrol vessel *Walcott* in the northern waters will increase the opportunities for at-sea inspections. However, compliance resources available for this fishery are limited, and these inspections will continue to be conducted on an ad hoc basis as part of patrols dedicated to other fisheries.

Research Overview

Research data for monitoring this fishery, which is fished by both Western Australian and Commonwealth (Northern Prawn Fishery) licensed vessels, are provided by Western Australian fishers' monthly returns and research logbooks collected by the Australian Fisheries Management Authority (AFMA).

Research assessments are provided to annual meetings of vessel operators and provide the basis for recommending changes to management arrangements each year.

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

Fishery Status Report

Main Features

Stock assessment complete:
Not assessed

Exploitation status:
Not assessed

Breeding stock levels:
Not assessed

Previous catch projections for year 1998:
230-590 tonnes

Catch current season (1998):
Major penaeids 436 tonnes, comprising:

Tiger prawns	*46 tonnes*
Endeavour prawns	*15 tonnes*
Banana prawns	*373 tonnes*

Estimated annual value (to fishers) for year 1998:
$4.8 million

Catch projection next year (1999):
Major penaeids 278-576 tonnes

Tiger prawns	*15-46 tonnes*
Endeavour prawns	*13-80 tonnes*
Banana prawns	*250-450 tonnes**

*(*using rainfall-catch relationship; others based on five-year range)*

Recreational component:
Not applicable

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 1998 season opened on 1 April and closed for the mid-season closure on 15 June. The fishery reopened on 1 August and ran until the final season closure on 30 November.

There are three classes of licence issued that cover all vessels allowed to fish the Kimberley Prawn Managed Fishery, as described in the Kimberley Prawn Managed Fishery Notice. Eighteen Western Australian licensed vessels and 26 Northern Prawn Fishery licensed vessels operated in the fishery during the 1998 season.

Annual Production

Main fishing method
Otter trawl.

Landings
The total landings for the 1998 season were 436 tonnes, including 373 tonnes of banana prawns, 46 tonnes of tiger prawns, and 15 tonnes of endeavour prawns (Other Prawn Figure 6). There was less than 1 tonne of squid landed.

The banana prawn catch was within the range expected for this species, particularly since the catch is highly variable due to environmental conditions (summer rainfall). The tiger and endeavour prawn catches were also within the expected range for these species (15-60 tonnes and 10-80 tonnes respectively).

Fishing effort
Not assessed.

Catch rate
Not assessed.

Stock Assessment

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.

Preliminary investigations have shown promising relationships between early season rainfall (December to March) and the subsequent catch of banana prawns. Rainfall during the period December 1998 to March 1999 was higher than average (689 mm at Derby and 1244 mm at Kalumburu), which would indicate that banana prawn catches for 1999 should be in the range 250-450 tonnes.

Breeding Stock Levels

Not assessed.

Catch Projection for Year 1999

Under current effort levels, the catch prediction for the banana prawn and tiger prawn stocks is 250-450 tonnes and 15-46 tonnes respectively. Similarly, the catch projection for endeavour prawns is 13-80 tonnes. Total catch projection is 278-576 tonnes, based on the banana prawn–rainfall relationship and the five-year average for other species.

Product Value for Year 1998

Wholesale prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, average prices were as follows:

Tiger prawns	$16.40/kg
Endeavour prawns	$10.00/kg
Banana prawns	$10.50/kg

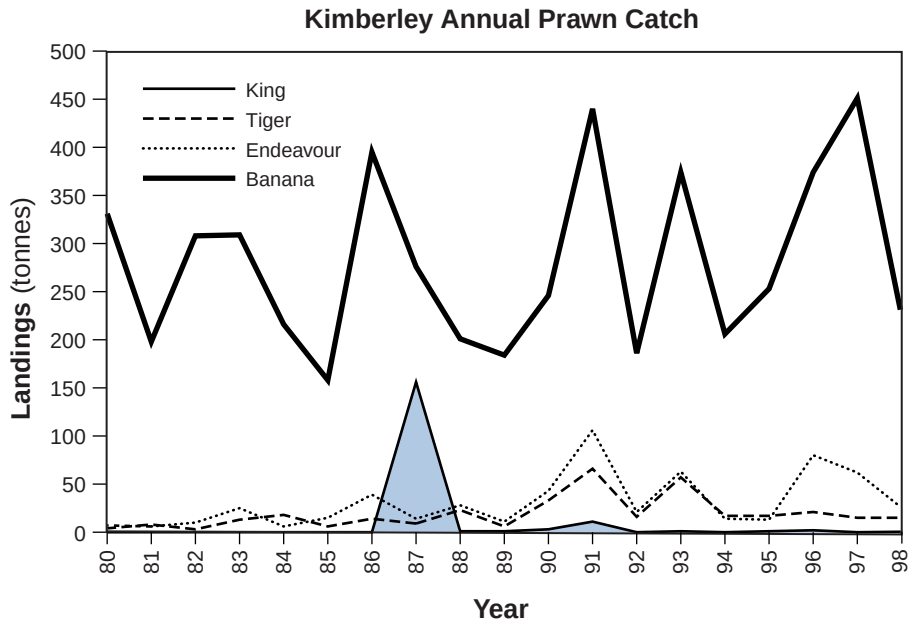
General Comments

Minimum catch monitoring is completed for this relatively minor fishery. Data for vessels operating in this fishery come from both Western Australia's monthly returns and AFMA's Northern Prawn Fishery logbook.

The relationship between summer rainfall (December to March) and the catch of banana prawns in the following season has been used to assist forecasting. 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 this fishery.

Squid catches continue to be poor, with only about 400 kg reported. In contrast, in 1993 there were 430 tonnes of squid landed. It is not known whether this dramatic reduction is due solely to environmental change, or to the normal range of cyclical variation in abundance, or whether in part it reflects the effects of fishing.

This fishery is used by relatively few boats for the complete fishing season. Boats from Nickol Bay and elsewhere in Western Australia use it at some times of year to complement catches in their local fisheries. Vessels fishing in the Northern Prawn Fishery (NPF) in the Gulf of Carpentaria use this fishery for periods each year, and in fact the Kimberley fishing season is usually set to mirror dates used in the NPF, to prevent the small Kimberley fishery from attracting too much fishing effort from its large neighbour.



Other Prawn Figure 6 Annual landings for the Kimberley Prawn Managed Fishery, 1980-1998.

Abalone Managed Fishery

Management Overview

The Abalone Managed Fishery exploits 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.

Prior to 1 April 1999, the fishery was divided into three zones. In Zone 1, licence holders took greenlip, brownlip and Roe's abalone east of Shoal Cape. In Zone 2, licensees took the same species between Shoal Cape and Busselton jetty. In Zone 3, divers were only licensed to take Roe's abalone.

The management arrangements in place limited entry into the fishery and imposed minimum legal shell sizes, total allowable catches in each zone and individual quotas on individual licence holders. Special rules also applied to commercial fishers who fished in the metropolitan area of the fishery (Moore River to Cape Bouvard).

On 31 March 1999 a major amendment to the Abalone Managed Fishery management plan was implemented. The notable changes brought about by the amendment included a change to the licensing period, with the result that all licence holders now operate within the same licensing period, i.e. 1 April in any year to 31 March in the following year. Also, 'zonal management' changed to 'area management', with the number of managed areas increasing from three to eight.

Each area is allocated an area catch limit, with the sum of the combined area catches equal to the total allowable catch (TAC) for the fishery. Each managed fishery licence is endorsed with a number of tradeable units of entitlement to a specific area, which may be temporarily traded between existing licence holders or permanently sold to existing or new licence holders. Each licence in the fishery must be permanently endorsed with a minimum unit holding (800 units for Roe's abalone and 450 units for greenlip/brownlip abalone). Following implementation of the amendment to the management plan, one unit of entitlement became equivalent to 5 kg of abalone in any area for the 1999 quota year.

The new arrangements also mean that commercial divers fishing in the metropolitan area must now cease fishing two weeks prior to the commencement of the recreational abalone fishing season and must not fish at all during the weeks that span the season. However, fishing can recommence on the Monday following the closure of the recreational fishing season. (Fishing on weekends and public holidays remains prohibited.)

Divers and processors are required to provide daily catch and disposal records with details of all abalone landed and consigned in Western Australia to facilitate catch monitoring and enforcement. Processors are also required to lodge returns which provide Fisheries WA with details of all abalone sold.

A combined management/research and industry meeting was held in February 1999 to discuss management and research issues of concern to Fisheries WA and members of the Abalone Managed Fishery and industry. A similar meeting is planned for the 1999/2000 licensing year.

The Abalone Management Advisory Committee (AbMAC) met eight times during 1998/99. Chaired by Mr Ian Taylor, the MAC provides recommendations to the Minister for Fisheries on matters relevant to the Abalone Managed Fishery. It also publishes a newsletter for public distribution outlining AbMAC business.

The first Abalone Overview document was published in November 1998. A second edition describing the significant changes to management will be released in the current year.

Compliance and Community Education Overview

Compliance levels in the commercial sector have generally been good during the past year, with reports of breaches of management rules in 1998/99 decreasing to one, which related to a quota violation.

However, poaching activity by unlicensed operators running illegal commercial operations was again evident. Strategies employed by the agency over the past few years, which include focusing the Special Investigations Section on this particular problem, have resulted in a number of successful abalone poaching apprehensions. One dedicated operation, codenamed 'Singapore Noodle', and four secondary operations have so far resulted in nine persons being convicted of a total of 24 offences resulting in $500,000 in fines and penalties.

The media attention given to these high fines and penalties has ensured that the general public is aware of the activities of fish thieves, and serves as an effective 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.

The National Docketing System is being trialled for abalone across all abalone-producing States, however it is only partially in operation in Western Australia until such time as amendments to the *Fish Resources Management Act and Regulations* are in place.

Research Overview

Basic research monitoring for the three major abalone stocks is undertaken annually utilising industry data from the quota records and the CAESS records. In each zone, the fishing effort required to achieve the catch quota set is examined annually to ensure that the quota level is sustainable.

Specific research projects include biological studies and fishery-independent surveys on greenlip abalone in Zone 2 (concluded in 1997/98), and detailed biological research on the growth, movement, mortality and genetics of the Roe's abalone stocks along the west coast (Zone 3), concluded at the end of 1998/99.

The following status reports summarise the research findings for each zone of this fishery.

Abalone Zone 1 Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Greenlip - adequate, but at risk
Brownlip - adequate

Previous catch and effort projections for year 1998:
540-635 days to catch total quota:

West of Point Culver	*100.5 tonnes (whole weight) (greenlip and brownlip)*
East of Point Culver	*8.25 tonnes (whole weight)*

Catch and effort current season (1998):
669 diver days to take catches of:

West of Point Culver	*100.4 tonnes*
East of Point Culver	*0.04 tonnes*

Estimated annual value (to fishers) for year 1998:
$4 million

Catch and effort projection next year (1999):
540-670 diver days (acceptable range based on past seven years) to take catches of:

West of Point Culver	*100.5 tonnes (quota) (whole weight)*
East of Point Culver	*8.25 tonnes (quota) (whole weight)*

Recreational component (1998):
Unknown; believed to be less than 5% of commercial catch

continued over

Boundaries and Access

Zone 1 extends from the WA/SA border to Shoal Cape. There are six divers licensed to take greenlip, brownlip and Roe's abalone.

The quota period in Zone 1 was 1 April 1998 to 31 March 1999. (Note: As the bulk of the catch is taken early in the 'quota year', the data for the fishery is now, for simplicity, recorded against the nearest calendar year when most of the catch is taken. For example, for the current 1998/99 quota period, most of the catch was taken in 1998, therefore the data will be recorded against 1998.)

Annual Production

Main fishing method
Diving.

Landings
Catches currently are controlled by quotas, with the individual quota in Zone 1 for the 1998 quota year being 6.2 tonnes (meat weight) west of Point Culver (maximum 5 tonnes greenlip). Zone 1 divers have an additional quota of 500 kg from the area east of Point Culver. The Zone 1 greenlip catch was 82.5 tonnes (whole weight) and brownlip catch was 17.9 tonnes (whole weight) for the 1998 season (Zone 1 Abalone Table 1).

Fishing effort
Total effort in Zone 1 for 1998 was 669 days for a total of 2,516 diver hours. This was marginally greater than the range of effort predicted for 1998, which was 540-635 days.

Catch rate
The greenlip catch rate in 1998 was 123 kg/diver day, which was similar to the catch rate in 1997, which was 122 kg/diver day.

Stock Assessment

Greenlip: Evidence for a potential decline in stock abundance is available from two sources: firstly, a long-term decline in meat weights which is consistent across all the main producing grids, and is backed up by similar results from long-term individual licensee data, and secondly, local declines in nominal catch per unit effort from two of the six most productive fishing grids. Given the generally perceived lack of responsiveness of catch per unit effort to changes in stock abundance in abalone fisheries, these results must be treated with some seriousness, although the effect of changes in divers may be contributing to this

overall decrease in catch rates. The area of most immediate concern for this species is Grid 107 (Israelite Bay).

This interpretation needs to be mitigated against potential effects of management changes which may have contributed to the observed patterns. For example, in 1993/94 size limits were changed from meat weight to a minimum shell length of 140 mm, although the industry voluntarily retained a 145 mm minimum size for fishing. A significant decline in average meat weight was detected for the period 1989 to 1994, but not for the period 1994 to 1998, which gives some credence to the importance of management changes in affecting the data. Seasonal variation in meat weight and handling practices with respect to blood loss also need to be considered.

Brownlip: The stability of the management arrangements since 1989, i.e. a maximum of 5 tonnes greenlip out of a total individual quota of 6.2 tonnes, has resulted in a good comparative data set for brownlip. Stocks of brownlip appear in good shape, and may even be increasing, as suggested by the increase in average weight being caught.

Breeding Stock Levels

The greenlip breeding stock is considered adequate due to size limit, but may be at risk noting the long-term decline in average meat weight from the fishery and in catch rates. The brownlip breeding stock appears adequate based on meat weight trends.

Catch and Effort Projection for Year 1999

To be fished at a sustainable level, the quota should be taken within the seven-year range of 540-670 diver days. However, in 1998 the quota was again taken at the high end of this range, and unless stock abundances improve it is likely that effort will continue to be at the high end of the projected range and possibly even outside it.

Product Value for Year 1998

Estimated average prices per kilogram meat weight were reported as $107.50 for greenlip and $102.50 for brownlip. On the basis of the average prices, the Zone 1 greenlip/brownlip fishery was worth approximately $4 million.

General comments

The fishery continues to be a valuable fishery despite the downturn in the main markets and slightly lower prices. The status of the greenlip stock is of concern owing to the ongoing gradual decline in average meat weights, and higher effort levels needed to achieve the quota in the last five years. Consideration should be given to reducing the pressure on greenlip by setting a species quota and allowing a slightly higher take of brownlip abalone within the existing TAC. Given the need for more precise stock assessments, a detailed research logbook to complement the quota returns and provide more accurate monitoring data should be implemented on an urgent basis.

Zone 1 Abalone Table 1 Zone 1 divers' abalone catch and effort by quota period (catch in whole weight).

Quota period	Greenlip abalone (tonnes)	Brownlip abalone (tonnes)	Roe's abalone (tonnes)	Diver days	Greenlip CPUE (kg per diver day)	Quota period (months)	Start month
1988/89	86.59	25.47	5.13	624	139	12	1 Nov
1989/90	67.17	16.54	4.05	403	167	12	1 Nov
1990/91	88.10	14.76	9.98	599	147	12	1 Nov
1991	30.56	5.48	4.27	237	129	4	1 Nov
1992	86.93	16.73	7.93	528	165	12	1 Nov
1993	85.47	16.56	9.95	519	165	12	1 Nov
1994	82.82	18.11	9.29	634	131	12	1 Nov
1995	80.67	19.68	6.46	680	119	12	1 Nov
1996	81.67	19.13	6.11	632	129	12	1 March
1997	87.79	21.02	10.23	720	122	13	1 March
1998	82.52	17.95	6.12	669	123	12	1 April

Notes

1. Data source: quota returns.
2. Standard conversion factors for meat to whole (live) weight where used are 2.75 for greenlip, 2.5 for brownlip, and 2.5 for Roe's abalone.
3. Diver days refers to fishing effort by Zone 1 divers only.
4. Roe's abalone catch is only that taken by Zone 1 divers. West coast licensed abalone (Roe's abalone only) divers are also permitted to catch a small proportion of their quota on the south coast. See Roe's Abalone Status Report for more details.
5. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.
6. Catch rates refer to greenlip abalone only and are calculated using whole weights.

Abalone Zone 2 Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

Previous catch and effort projections for year 1998:
650-850 days to take a catch of:
Greenlip and brownlip 110 tonnes (whole weight)

Catch and effort current season (1998):
658 diver days to take a catch of:
Greenlip and brownlip 108.6 tonnes (whole weight)

Estimated annual value (to fishers) for year 1998:
$4 million

Catch and effort projection next year (1999):
Quota of 99 tonnes (whole weight) greenlip and 10 tonnes (whole weight) brownlip is expected to be taken within 650-850 diver days

Recreational component (1998):
Unknown; believed to be less than 5% of commercial catch

Boundaries and Access

Zone 2 extends from Shoal Cape to Busselton jetty. There are eight divers licensed to take greenlip, brownlip and Roe's abalone.

The quota period in Zone 2 was 1 April 1997 to 31 March 1998. (Note: As the bulk of the catch is taken early in the 'quota year', the data for the fishery is now, for simplicity, recorded against the nearest calendar year when most of the catch is taken. For example, for the current 1998/99 quota period, most of the catch was taken in 1998, therefore the data will be recorded against 1998.)

Annual Production

Main fishing method
Diving.

Landings
The individual quota for the 1998/99 quota year (beginning 1 April 1998) was 5 tonnes (meat weight). The 1998 Zone 2 greenlip catch was 104.4 tonnes (whole weight) and the brownlip catch was 4.2 tonnes (Zone 2 Abalone Table 1).

The total Zone 2 abalone catch for the 1998 season was 108.6 tonnes (whole weight), an increase from 105.5 tonnes for the 1997 season.

Fishing effort
Total effort in Zone 2 in 1998 was 658 days for a total of 2,241 dive hours. The effort was towards the bottom of the predicted range of 650-850 days. This compares with 685 days (2,229 hours) in 1997.

Catch rate
Catch rate in Zone 2 was 159 kg/diver day during the 1998 season compared with 146 kg/diver day for 1997.

Stock Assessment

Greenlip: Stocks of greenlip abalone appear in good shape in this zone. This appears to have been the result of a combination of reducing quotas temporarily and closures/openings to the most productive part of the fishery (Augusta). Future management should consider beneficial effects of rotational fishing patterns in this particular zone, particularly in light of the effects of the Augusta closure on yields.

Brownlip: Stocks of brownlip abalone appear in good shape; they have not been targeted in recent years, however historical catches indicate there may be a 5+ tonne sustainable annual production of this species in this zone. In addition, anecdotal evidence from the industry suggests that there are substantial under-exploited stocks of brownlip which could possibly support an 8 tonne annual yield.

Breeding Stock Levels

The breeding stock is considered adequate, noting that the legal minimum size is above the size at maturity.

Catch and Effort Projection for Year 1999

It is expected that the zone quota (109 tonnes) will be achieved within the five-year range of 650-850 diver days. It is likely to be at the lower end of the projected range if the stock abundance is similar to last year.

Product Value for Year 1998

Estimated average prices per kilogram meat weight were reported as $107.50 for greenlip and $102.50 for brownlip. On the basis of the average prices, the Zone 2 greenlip/brownlip fishery was worth approximately $4 million.

General Comments

The fishery in this zone has now recovered from the low catch period of the mid-1990s. The current catch rates and fishing days needed to achieve the quota indicate that the stocks have returned to the relatively productive levels of the late 1980s. To ensure improved reliability in future stock assessments, a detailed diver research logbook program should be implemented to support the quota database. With this improved level of data further tuning of the TAC could be undertaken.

Zone 2 Abalone Table 1 Zone 2 divers' abalone catch and effort by quota period (catch in whole weight).

Quota period	Greenlip abalone (tonnes)	Brownlip abalone (tonnes)	Roe's abalone (tonnes)	Diver days	Greenlip CPUE (kg per diver day)	Quota period (months)	Start month
1987	93.56	7.38	0.76	814	115	12	1 Jan
1988	95.74	14.64	1.73	848	113	12	1 Jan
1989	71.07	8.15	0.88	560	127	10	1 Jan
1989/90	90.20	9.34	2.95	717	126	12	1 Nov
1990	26.31	4.01	1.80	275	96	6	1 Nov
1991	100.71	9.18	6.66	924	109	12	1 May
1992	88.13	13.56	4.62	801	110	12	1 May
1993	93.32	14.59	2.89	895	104	12	1 May
1994	94.35	14.11	5.66	966	98	12	1 May
1995	71.19	7.58	5.12	691	103	12	1 May
1996	95.00	2.81	6.57	538	177	11	1 May
1997	100.20	5.28	5.62	685	146	12	1 Apr
1998	104.43	4.21	5.26	658	159	12	1 Apr

Notes

1. Data source: quota returns.
2. Standard conversion factors for meat to whole (live) weight where used are 2.75 for greenlip, 2.5 for brownlip, and 2.5 for Roe's abalone.
3. Diver days refers to fishing effort by Zone 2 divers only.
4. Roe's abalone catch is only that taken by Zone 2 divers. West coast licensed abalone (Roe's abalone only) divers are also permitted to catch a small proportion of their quota on the south coast. See Roe's Abalone Status Report for more details.
5. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.
6. Catch rates refer to greenlip abalone only and are calculated using whole weights.

Roe's Abalone Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

Previous catch projections for quota period 1997/98:
A catch of 120 tonnes (all zones) taken within 750-1,100 diver days (all zones)

Catch current seasons (1997/98 and 1998/99):
(See notes on quota periods under 'Boundaries and Access')

Zone 3 licensees	*102.4 tonnes (whole weight) (Oct 97-Sep 98)*
Zone 1 and 2 licensees	*13.6 tonnes (whole weight) (Oct 97-Sep 98)*
Zone 3 licensees	*73.5 tonnes (whole weight) (Oct 98-Mar 99)*
Zone 1 and 2 licensees	*10.2 tonnes (whole weight) (Oct 98-Mar 99)*

continued over

Estimated annual value (to fishers) for year 1997/98:
$4 million (all zones)

Estimated annual value (to fishers) for 6 month season 1998/99:
$2.6 million (all zones)

Catch and effort projection next year (Apr 1999-Mar 2000):
A catch of 108 tonnes (Zone 3 licensees), 8 tonnes (Zone 2 licensees), and 9.96 tonnes (Zone 1 licensees). Effort projection is 750-950 diver days (Zone 3 licensees).

Recreational component (1998):
20-25 tonnes from the Perth metropolitan area; unknown from other areas

Boundaries and Access

Abalone Zone 1: There are six Zone 1 divers taking Roe's abalone as well as greenlip and brownlip abalone within Zone 1, which extends from Shoal Cape to the SA border.

Abalone Zone 2: There are eight Zone 2 divers taking Roe's abalone as well as greenlip and brownlip abalone in this zone, which extends from Cape Naturaliste to Shoal Cape.

Dedicated Roe's abalone fishers: There are 12 dedicated Roe's abalone fishers, or Zone 3 licensees, who are licensed to take Roe's abalone from all areas of the State. Quota areas are subdivided into Zones 1 and 2 as described above, and the west coast (Zone 3). Zone 3 extends from Cape Leeuwin to the NT border, with an additional quota area for the Perth metropolitan fishery (Cape Bouvard to the mouth of the Moore River) introduced for the 1997/98 and 1998/99 seasons.

The quota period for Zone 1 and 2 licensees was from 1 April 1998 to 31 March 1999.

Two quota periods are reported here for the Roe's abalone fishery. The quota periods for Zone 3 licensees were October 1997 to September 1998 and October 1998 to March 1999 in all areas of the State. The metropolitan season has previously been open to commercial fishers for a limited period from mid-October to mid-December. Year-round access for the Perth metropolitan fishery was introduced for the 1997/98 and 1998/99 seasons. Access to Penguin Island has remained restricted to the first two weeks of the season.

Catch and effort from the Zone 3 (Roe's abalone only) divers is reported for the nearest quota period (1 October 1997 to 30 September 1998, and 1 October 1998 to 31 March 1999). Catch and effort from the Zones 1 and 2 divers is reported for the same period (Zone 3 Abalone Table 1), but this does not correspond to a quota period for the Zone 1 and 2 licensees (see status reports on abalone Zones 1 and 2).

Annual Production

Main fishing method
Diving.

Landings
1997/98

Zone 3 licensees from whole State	102.4 tonnes
Zone 2 licensees from Zone 2	5.8 tonnes
Zone 1 licensees from Zone 1	7.8 tonnes
Total catch	**116.0 tonnes**
	(Zone 3 Abalone Table 1)

1998/99

Zone 3 licensees from whole State	73.5 tonnes
Zone 2 licensees from Zone 2	5.1 tonnes
Zone 1 licensees from Zone 1	5.1 tonnes
Total catch	**83.7 tonnes**
	(Zone 3 Abalone Table 1)

Fishing effort 1997/98
789 days or 2,854 hours (Zone 3 licensees).

Fishing effort 1998/99
656 days or 2,407 hours (Zone 3 licensees).

Catch rate 1997/98
130 kg/day or 35.9 kg/hour (Zone 3 licensees).

Catch rate 1998/99
112 kg/day or 30.5 kg/hour (Zone 3 licensees).

Stock Assessment

Stock assessment is conducted primarily through the examination of research data provided as part of the quota monitoring and monthly returns. Short surveys are also conducted at irregular periods to address localised concerns of stock depletion. Variations to quota levels are considered after annual assessment of the catch and effort data and take into account advice from industry.

Population structure is being assessed through a genetic analysis designed to indicate the degree of genetic separation of populations at varying levels of geographic separation. This will give information on the dispersal capabilities of the species and indicate the appropriate scale for assessing stock levels.

Breeding Stock Levels

Research has shown that the size of Roe's abalone at sexual maturity (50% of adults) in the Perth metropolitan area (40 mm) is well below the State minimum legal size (60 mm). This measure together with the quota set is currently considered to provide adequate protection for the breeding stock. In the metropolitan area, additional protection for the sub-tidal, commercially targeted breeding stock is provided by the higher minimum legal size of 70 mm for the commercial sector of the fishery.

During 1998, stock surveys were conducted on six areas of reef platform within the recreational area of the fishery. The densities measured at four of the five reef sites surveyed were considered to be high enough to allow an adequate flow of abalone to the breeding stock. Reef platform stocks at Penguin Island are improving but remain low in comparison to the other areas, so Penguin Island remains closed to the recreational sector of the fishery in order to allow breeding stocks on the reef platforms to rebuild.

Both Zone 1 and Zone 3 fishers have voluntarily increased the minimum size to 75 mm in the area east of Point Culver to address concerns of localised stock depletion around Twilight Cove.

Catch Projection for Year 1999/2000 Quota Period

It is anticipated that the individual commercial quotas can be achieved in each of the three zones. The range of effort anticipated is 750-950 days for the Zone 3 licensees to take their quota, which is the range of historical effort required to take the quota at current levels of stock abundance.

Product Value for 1997/98 and 1998/99 Quota Periods

During the 1997/98 season prices for Roe's abalone varied from $47/kg in October to the mid-$20s/kg following the downturn in the Asian economies. Average prices for the season were around $35/kg whole weight. This represents a $1 decrease over the 1996/97 quota period. Based on this average price, the fishery for Roe's abalone taken by fishermen from Zones 1, 2 and 3 was valued at around $4 million for the 1997/98 season. The price has remained fairly stable during the six months of the 1998/99 season at around $31/kg. This resulted in a value of around $2.6 million for the 1998/99 season.

General Comments

The reduced market price impacted negatively on the value of the fishery during 1997/98. The stocks however continue to perform satisfactorily, with the quota achieved using fewer fishing days than in the previous two years. The recreational sector continues to take significant catches in the metropolitan area without significantly impacting on the stock as a whole.

Zone 3 Abalone Table 1 Roe's abalone catches (tonnes whole weight), effort (days) and CPUE (kg/hour) (whole weight) for licensees by Zone 3 quota period since the 1990/91 season.

Quota period	South Coast								West Coast		Total State		
	Zone 1				Zone 2								
1 Oct to 30 Sept	Z1	Z3	Zone total	Z3 CPUE (Zone 1)	Z2	Z3	Zone total	Z3 CPUE (Zone 2)	Z3	Z3 CPUE (West Coast)	Total Catch	Z3 Total effort (days)	Z3 Total CPUE (kg/hr)
1990/91	9.4	16.8	26.2	31.38	2.5	11.9	14.4	20.41	76.6	28.09	117.2	910	27.57
1991/92	7.1	16.3	23.4	22.82	6.5	5.7	12.2	24.62	76.5	28.17	112.1	804	28.43
1992/93	8.7	15.9	24.6	30.77	5.7	7.6	13.3	24.47	76.1	33.05	114.0	744	32.51
1993/94	11.0	16.8	27.8	33.20	1.9	7.6	9.5	26.23	78.1	32.27	115.4	816	33.57
1994/95	6.4	16.2	22.6	23.06	6.2	11.7	17.9	21.79	75.1	34.08	115.6	900	30.32
1995/96	8.5	16.4	24.9	37.55	4.9	10.1	15.0	27.90	76.3	29.24	116.2	1029	30.93
1996/97	6.8	16.5	23.3	27.31	6.1	12.1	18.2	24.92	78.0	29.56	119.5	990	29.02
1997/98	7.8	13.3	21.1	27.86	5.8	11.7	17.5	32.29	77.4	37.13	116.0	789	35.89
1998/99*	5.1	9.6	14.7	28.29	5.1	7.6	12.7	28.07	56.3	30.95	83.7	656	30.54

Source: daily catch and effort data from quota returns.
Where Z1 = Zone 1 licensees; Z2 = Zone 2 licensees; and Z3 = Zone 3 licensees.
* The 1998/99 quota period was 01/10/1998 to 31/03/99

Shark Bay Scallop Managed Fishery

Management Overview

The Shark Bay Scallop Managed Fishery is Western Australia's most valuable scallop fishery, based on the take of southern saucer scallop *(Amusium balloti)*.

Management of the fishery is complicated by two fishing fleets (prawns and scallops) having access to the scallop stock and competing directly for a share of the resource. To ensure equity between the two fleets, the 1999 scallop fishing season commenced on 5 May and will close on 25 October, the same day as the Shark Bay Prawn Managed Fishery. This management approach is aimed at maximising economic return to the stakeholders and reducing resource-sharing issues between the fleets, as well as maintaining adequate levels of breeding stock. Other management measures include limited entry, area closures, vessel capacity and crew limits.

Catch in this fishery varies widely depending on the strength of recruitment. 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 (MAC), which includes representatives from both the Shark Bay Scallop and Shark Bay Prawn Managed Fisheries. A new Chair was appointed to the Shark Bay Scallop MAC in 1999.

Compliance and Community Education Overview

Licence and gear inspections were carried out by Fisheries Officers from Carnarvon and Denham.

Aircraft were again used extensively by officers at Carnarvon. The use of a large patrol vessel from Geraldton (which paid particular attention to surveillance of closed waters and placed officers on board trawlers to inspect catch and gear) supplemented these activities.

The PV *John Brockman*, commissioned in May 1998 and located at Denham, undertook patrols in the fishery, concentrating on the waters of Denham Sound and to the east of Bernier and Dorre Islands.

The Vessel Monitoring System (VMS) at Carnarvon was again trialled in May and June 1999.

Fisheries Officers provided information on conservation, stock management and compliance to operators within the industry during pre-season briefings.

Research Overview

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.

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

Previous catch projection for year 1998:
180-250 tonnes (meat weight)

Catch current season (1998):
252 tonnes (meat weight)

Estimated annual value (to fishers) for year 1998:
$5.5 million

Catch projection next year (1999):
210-440 tonnes (meat weight)

Recreational component (1997):
Not applicable

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 vessels with Class A licences (scallop only) and 27 vessels with Class B licences (prawn and scallop) are endorsed to fish the waters of Shark Bay and Denham Sound. The boundaries for Class A vessels are the waters of Shark Bay and Denha m 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 Prawn Figure 1).

The 1998 scallop season commenced on 16 May. Owing to low catches, trawling for scallop by Class A vessels ceased during July, although the season officially closed on 3 November.

Annual Production

Main fishing method

Otter trawl.

Landings

The total scallop catch for this fishery was 252 tonnes meat weight (or 1,260 tonnes whole weight). The Class A fleet caught 177 tonnes, which is 70% of the total catch. The Class B fleet caught 75 tonnes, which represents the remaining 30% of the total catch (Scallop Figure 1).

Fishing effort

The total effort recorded by the Class A vessels in 1998 was 12,224 hours.

Catch rate

A total catch per unit effort of 14.5 kg/hr was recorded for the Class A fleet.

Stock Assessment

The status of the stock is determined from a pre-season (November-December) survey of recruitment and residual stock. 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 1997 was poor, as measured using the data from the November scallop survey. This poor recruitment was reflected in the low catch (252 tonnes) taken in 1998, though the total catch was at the upper end of the range projected for the season.

Breeding Stock Levels

The management arrangements for the fishery over the 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 which are believed to be correlated inversely with the strength of the Leeuwin Current.

Catch Projection for Year 1999

The catch projection for the 1999 season is approximately 210-440 tonnes (meat weight), based on the November 1998 survey which indicated that recruitment was low.

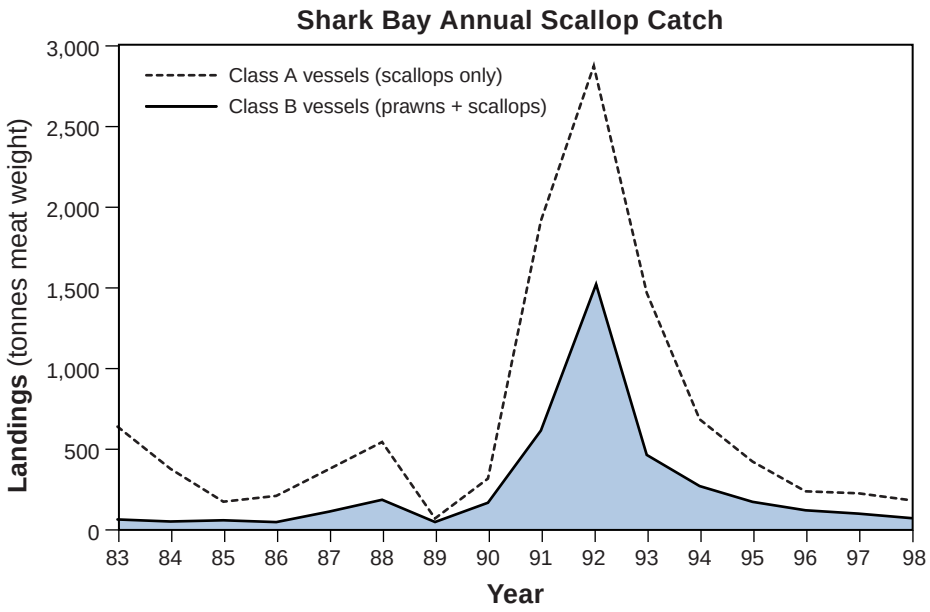
Product Value for Year 1998

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 scallop meat was $22/kg (meat weight).

General Comments

A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay. Generally, high sea levels correlate with poor recruitment. During 1997, however, the correlation with sea level predicted a better recruitment than was observed in the November survey, while the 1998 recruitment was again low due to poor environmental conditions. This suggests 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 which occurs. The low catch for the 1998 season was expected; however, 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) remain favourable.

When the Shark Bay scallop season commenced in May 1998, the market demand was not strong, owing to the economic downturn in the Asian region. The price for scallop meat was weak and averaged around $22/kg. The low price was not due to over-supply of scallop meat, as the catch of scallop from Canada (which is in direct competition with Australia) was also low.



Scallop Figure 1 Annual scallop landings by fleet for the Shark Bay Scallop Managed Fishery, 1983-1998.

Other Scallop Fisheries

Management Overview

Several smaller fisheries also contribute to Western Australia's scallop catch, primarily the Abrolhos Islands and Mid-West Trawl Managed Fishery and the South-West Trawl Managed Fishery (Fremantle-Geographe Bay). Scallop landings also result from a small amount of trawl activity that takes place off the south coast.

Each fishery takes saucer scallops *(Amusium balloti)* by otter trawling and, as is the case with the Shark Bay Scallop Managed Fishery, recruitment is highly variable and catch in these fisheries varies greatly from year to year.

All scallop fisheries operate under input controls, with restrictions on boat numbers, gear restrictions and restrictions on times and areas of fishing.

Compliance and Community Education Overview

Abrolhos Islands: There were no significant compliance issues during the 1999 Abrolhos scallop season. Vessels operated for the first four weeks of the season.

South-West Trawl: Compliance monitoring of this fishery was conducted in the Mandurah district and in Geographe Bay. No infringements were detected.

Research Overview

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 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

Main Features

Stock assessment complete:
Not assessed

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

Previous catch projections for year 1998:
90-150 tonnes (meat weight) based on October 1997 survey

Catch current season (1998):
42 tonnes (meat weight)

continued over

Estimated annual value (to fishers) for year 1998:
$0.9 million

Catch projection next year (1999):
Based on October 1998 survey, 80-120 tonnes (meat weight)

Recreational component:
Not applicable

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 vessels licensed to fish for scallops in this limited entry fishery. The permitted fishing area opened on 7 April and was closed on 30 June 1998.

The Port Gregory trawl fishery operates as part of the Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWTMF). The permitted fishing area opened on 1 March for prawns and 7 April for scallops, and was closed on 31 October 1998.

Annual Production

Main fishing method
Otter trawl.

Landings
The total landings for the 1998 season were 42 tonnes meat weight (or 210 tonnes whole weight) (Other Scallop Figure 1).

Fishing effort
A total of 1,600 trawl hours or 179 fishing days, derived from logbook data, were recorded for the 1998 season.

Catch rate
30.7 kg (meat weight)/hour.

Stock Assessment

As with the Shark Bay scallop fishery, 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 in the last two seasons and is planned to continue. More detailed assessments are not undertaken.

Breeding Stock Levels

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.

Catch Projection for Year 1999

Under current effort levels, the catch projection for the 1999 season is 9-527 tonnes (meat weight), based on the five-year range. Using the October 1998 survey data, however, the catch range is likely to be 80-120 tonnes (meat weight).

Product Value for Year 1998

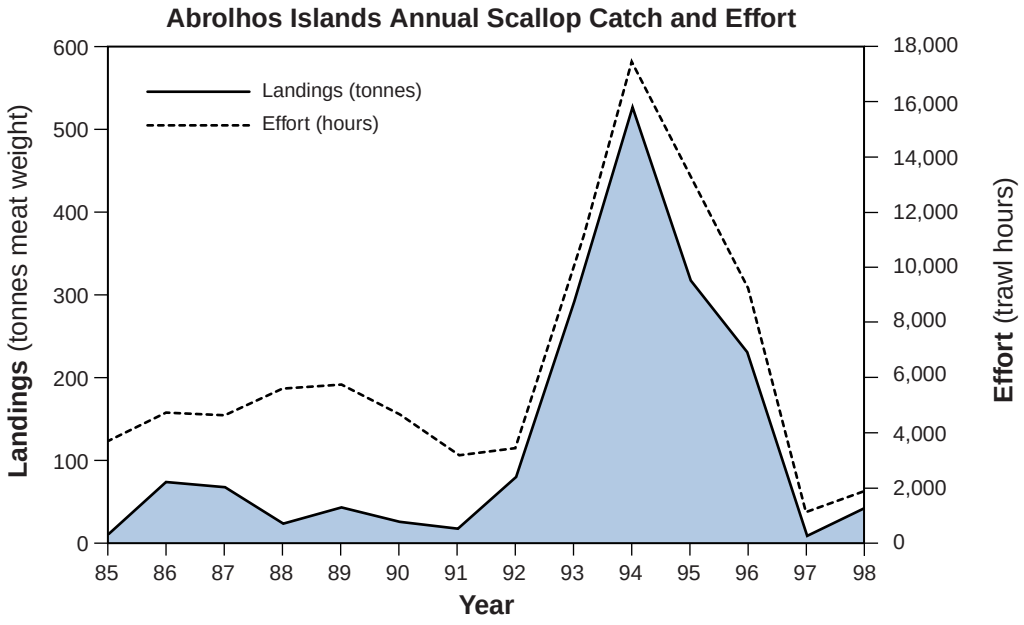
The estimated value of the catch has been based on the average wholesale price per kilogram obtained in the Shark Bay fishery, that is $4.40/kg (whole weight) or $22/kg (meat weight).

The estimated value of the AIMWTMF for 1998 was $0.9 million.

General Comments

During October 1998, a research survey was carried out on board a commercial fishing vessel. The purpose of the survey was to gauge scallop recruitment so that industry might organise their fishing operations for the 1999 season. It is anticipated that this survey will continue around this period each year and form the basis of a stock assessment and forthcoming season catch projection for this fishery.

The catch of king prawns from the Port Gregory area is minor and regarded as an incidental catch of the AIMWTMF. There is no stock assessment or catch projection for this portion of the AIMWTMF.



Other Scallop Figure 1 Annual scallop landings for the Abrolhos Islands and Mid-West Trawl Managed Fishery, 1985-1998.

South-West Trawl Managed Fishery Status Report

Main Features

Stock assessment complete:
Not assessed

Exploitation status:
Not assessed

Breeding stock levels:
Not assessed

Previous catch projections for year 1998:
No previous catch projections made

Catch current season (1998):
Prawns 18 tonnes
Scallops 1.3 tonnes (meat weight)

Estimated annual value (to fishers) for year 1998:
Prawns $0.3 million
Scallops $28,600

Catch projection next year (1999):
Not available

Recreational component:
Not applicable

Boundaries and Access

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

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

Zone A from 31°43′27″ S to 32°16′ S (3 vessels);
Zone B from 32°16′ S to 115°08′ E (12 vessels);
Zone C north-east of Cape Naturaliste (4 vessels);
Zone D Comet Bay off Mandurah (3 vessels).

A total of 14 vessels are licensed to operate in this fishery, some in more than one zone. Zone A, B and D vessels may fish all year round. Seasonal access to Zone C occurs between 1 July and 30 September.

Annual Production

Main fishing method
Otter trawl.

Landings
Prawns 18 tonnes.
Scallops 1.3 tonnes meat weight (or 6.5 tonnes whole weight).

Fishing effort
Not assessed.

Catch rate
Not available.

Stock Assessment

Not assessed.

Breeding Stock Levels

Not assessed.

Catch Projection for Year 1999

Not available.

Product Value for Year 1998

Prawns: Wholesale prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, prices for king prawns averaged $14.50/kg.

Scallops: The estimated value of the catch has been based on the average wholesale price per kilogram obtained in the Shark Bay fishery, that is $4.40/kg (whole weight) or $22/kg (meat weight).

General Comments

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. Owing to a significant latent fishing effort, there is a need to continue to monitor catch and effort within this fishery. Effort levels can only be assessed, however, by the number of days fished, which is derived from the CAESS records. This catch and effort data cannot be used to assess the stock, but does provide a source of information from which management decisions for this fishery can be made.

West Coast Blue Swimmer Crab Stocks

Management Overview

Blue swimmer crabs, which comprise the major proportion of inshore crab catches in Western Australia, are found along the entire coast of the State. These crab stocks are managed under specific legislated arrangements in Cockburn and Warnbro Sounds, and in the south and lower west coast estuaries. Blue crabs are also taken by licensed fishing vessels in Exmouth Gulf and Shark Bay, off Mandurah, and in Geographe Bay, under a variety of management measures under the *Fish Resources Management Act 1994*.

Crabs are targeted by a variety of fishing gear. Predominantly, crabs taken by commercial fishers are captured by either crab traps or drop nets. In fisheries such as the Exmouth Gulf Prawn and the Shark Bay Prawn and Scallop Managed Fisheries, trawl-caught crabs account for a significant proportion of the crab catch. Recreational fishers may take blue swimmer crabs by hand, non-piercing wire hook, wire scoop net and drop net.

The total annual commercial catch of crabs is continually monitored through information provided on monthly catch and effort returns. Data on recreational crab catches are collected through creel surveys conducted in response to funding availability and relative priorities. During 1998/99, competition for access to blue swimmer crabs in south-west estuaries and south-west oceanic waters continued to be a source of contention both between and within the commercial and recreational sectors.

The Inshore Crab Review process, commenced in 1996, continued throughout 1998/99. Two further discussion papers were released during the year, one addressing (specifically) a proposal for the management of inshore crab fishing in Geographe Bay, and the other containing recommendations for the future management of inshore crab fishing across the State.

Comprehensive advice and recommendations relating to the three-year review will be submitted to the Minister in 1999/2000, addressing crab fishing issues in estuarine and ocean waters. In the meantime, the review has resulted in interim arrangements being introduced for Geographe Bay and Shark Bay.

Geographe Bay: As a result of the consultation process, interim management arrangements for commercial crab fishing in Geographe Bay (statistical fishing block no. 96010) were introduced in June 1999.

- The area is closed to commercial crabbing up to 400 m offshore between Dolphin Road and the Port Geographe marina, and within 800 m of the Busselton jetty.
- No commercial crabbing is permitted between one hour after sunrise and one hour before sunset; or on weekends and public holidays; or during the spring, summer and autumn school holidays.
- Crab traps or drop nets are permitted.
- The commercial size limit has been increased to 128 mm.

These interim arrangements, and other issues of concern regarding crab fishing in Geographe Bay, will be discussed through the Voluntary Guidelines for Resource Sharing process.

Shark Bay:

- Fishermen operating around Denham waters in lower Shark Bay have been advised that they are required to satisfy catch criteria for the period 1 November 1994 to 31 October 1997 if they wish to continue to use crab traps in these waters.
- Fishermen authorised to fish in the Experimental Carnarvon Crab Pot Fishery have been advised that they will be required to satisfy the criteria set out in the Developing Fisheries Policy if they wish to continue to trap crabs in these waters.

Research Overview

Research monitoring of the expanding fishing activity for blue swimmer crabs was initially based on monthly returns and interviews with commercial crab fishers. Owing to the rapid expansion of this fishery and the need for additional research information to ensure sustainability of catches, a number of new research projects were instigated during 1997/98. Research is now under way 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. The following status report summarises the research findings for this fishery.

Stock Status Report

Main Features

Stock assessment complete:
Not assessed

Exploitation status:
Not assessed

Breeding stock levels:
Not assessed

continued over

Previous catch projections(1997/98):
600-700 tonnes

Catch current season (1997/98):
740 tonnes

Estimated annual value (to fishers) for year 1997/98:
$2.2 million

Catch projection next year (1998/99):
600-800 tonnes (based on catches of last two years)

Recreational component (1997/98):
Estimated 100-150 tonnes (based on survey data over last five years)

Boundaries and Access

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 the 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 16 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.

The trial arrangement for two commercial fishers to take crabs by pots (80 pots each) in the waters of Comet Bay has been extended until 31 December 1999. The Carnarvon Experimental Crab Pot Fishery is also continuing, with three fishers permitted to take crabs using 200 pots each for a period of up to two years. Exemptions to fish in the Carnarvon Experimental Crab Pot Fishery are granted on an annual basis. One Shark Bay beach seine fisher and one Cockburn Sound fisher are permitted to take crabs using up to 200 pots 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. Currently, quantification of recreational catches is under way for the Swan-Canning and Peel-Harvey estuaries.

Annual Production

Main fishing method
Pots.

Landings
A commercial catch of 740 tonnes of blue swimmer crab was taken in 1997/98, 15% up on the 641 tonnes caught in the 1996/97 season. Commercial catches in Cockburn Sound contributed 340 tonnes, while other areas which made a substantial contribution to total landings were the Peel-Harvey estuary (61 tonnes) and Shark Bay (151 tonnes) (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, over two-thirds (67.3%) of the commercial catch was taken by pots, while the balance of the catch was taken mostly by trawling (18.2%), gillnetting (9.4%) and drop netting (4.4%). Fishing effort overall has increased by 20% for pots, by 15% for drop nets and by 12% for trawling, while effort decreased by 25% for gillnets in the last year.

Catch rate
Because of the variety of fishing methods in use and areas being fished, a single catch rate statistic has not been produced. Comparative rates are given here for the three areas contributing most of the blue swimmer crab catch for the past year. The catch rate using pots in Cockburn Sound fell by 7% compared to the previous season. In the Peel-Harvey estuary, catch rates for both gillnets and pots fell by 25% compared to the previous year. In Shark Bay, the potting catch rates increased by 20%, most likely as a result of the increased knowledge and experience of pot fishers.

Recreational Catch

Estimates of recreational catches are available for some regions in Western Australia, based on surveys conducted over the past five years. These include Geographe Bay with an estimated recreational take of 17.5 tonnes, Cockburn Sound with 18.8 tonnes, Perth south (which includes Warnbro Sound, Shoalwater Bay, Cockburn Sound to Fremantle and west of Garden Island) with an estimate of 34.7 tonnes, and Leschenault Inlet with 45.7 tonnes. Sampling to estimate recreational catches in the Peel-Harvey estuary and Swan River is currently under way. Assuming that these two regions produce at least as much as is caught by recreational fishers in the Leschenault Inlet, the annual estimated recreational catch is between 100 and 150 tonnes.

Stock Assessment

No report is available.

Breeding Stock Levels

No specific data are available; however, the legal size at first capture is above the size at maturity, thus assuring some protection of the breeding stock.

Catch Projection for Year 1998/99

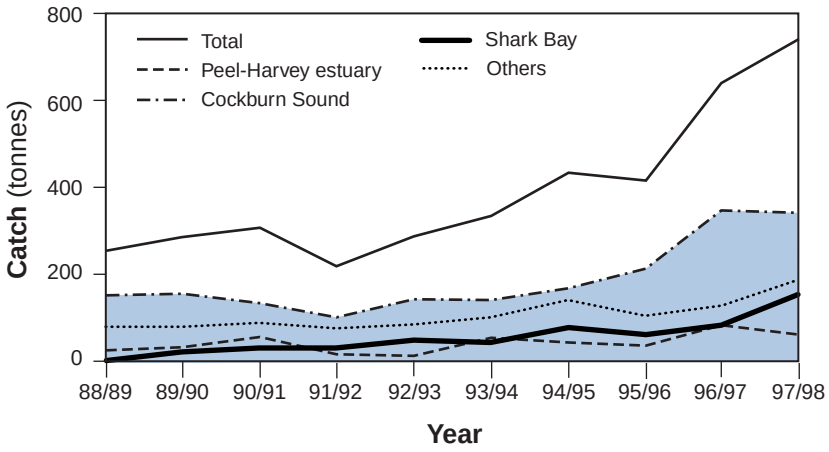
Commercial catches are expected to be in the range 600-800 tonnes, based on catches in the last two years.

Product Value for Year 1997/98

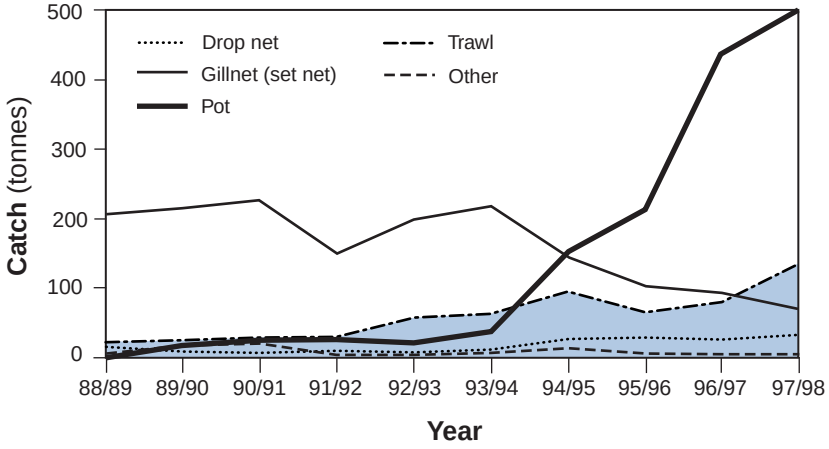
The catch was valued at approximately $2.2 million in 1997/98, with most of the product going to local and interstate markets.

General Comments

The commercial fishery has been expanding in the last few years as the main commercial sectors converted from set nets to dedicated crab pots, and there is still potential for future expansion in areas not currently exploited. However, recreational fishing pressure on the stocks is also expanding and will lead to increasing debate about resource sharing, particularly in the populated areas in the south-west of the State. Management of the fishery is currently under review and should be finalised during 1999/2000. Several research projects are under way to provide information for estimation of biological parameters to provide more detailed stock assessments in the future.



Blue Swimmer Crab Figure 1 Commercial catch history for the blue swimmer crab (*Portunus pelagicus*) in Western Australia between 1988/89 and 1997/98, indicating main regions of commercial catches.



Blue Swimmer Crab Figure 2 Blue swimmer crab catch taken by different gear types in Western Australia during the period 1988/89 to 1997/98.

Estuarine Fisheries

Management Overview

There are five restricted entry estuarine fisheries operating in the metropolitan and southern regions of the Western Australian coastline, as follows:

- Swan-Canning Estuarine Fishery
- Peel-Harvey Estuarine Fishery
- Leschenault Inlet Estuarine Fishery
- Hardy Inlet Estuarine Fishery
- South Coast Estuarine Fishery (includes Princess Royal Harbour)

Management of these fisheries is by a number of orders issued under Section 43 of the *Fish Resources Management Act 1994*. Management arrangements include gear restrictions, seasonal and time closures, area closures and boat restrictions. Many of the seasonal and time closures are designed on a resource-sharing basis to provide an equitable sharing arrangement for both space and resource access.

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 production while effecting a resource shift towards the recreational sector, specific estuarine Voluntary Fisheries Adjustment Schemes were activated for a brief period in 1998, allowing fishers to negotiate surrender of their estuarine endorsement. A total of 24 estuarine fishing units were removed by this process in 1998. Following this success, the schemes were reactivated in June 1999.

A discussion paper on the South Coast Estuarine Fishery was released for public consultation in May 1999. It is anticipated that revised management arrangements will be implemented in the year 1999/2000.

Estuarine Table 1 Number of independent fishing units for each estuarine fishery at June 1998 and June 1999, after the implementation of the Fisheries Adjustment Schemes.

Fishery	No. of fishing units		
	June 1998	Oct 1998	June 1999
Swan-Canning	9	6	5
Peel-Harvey	19	14	14
Leschenault Inlet	6	6	6
Hardy Inlet	4	2	2
South Coast	36	33	32

Compliance and Community Education Overview

Compliance within the commercial South Coast, Hardy Inlet, Leschenault, Swan-Canning and Mandurah (Peel-Harvey) Estuarine Fisheries was generally good, although a constant level of interference with commercial fishing gear is reported from Mandurah during the peak season. Fisheries Officers monitor licences, gear restrictions, closed–water boundaries, fish size limits and setting and retrieval limits in these fisheries. Two breach reports were submitted, both related to activities in the South Coast Estuarine Fishery. A major review of management arrangements within the South Coast Estuarine Fishery may lead to further compliance requirements in 1999/2000. A major education campaign for all stakeholders will also be implemented to ensure all new management arrangements are well understood and accepted.

Research Overview

Research monitoring of fish stocks in the south-west estuaries is primarily based on CAESS returns provided by industry. These data are interpreted utilising the extensive scientific knowledge of the fish stocks in estuaries derived from research by Fisheries WA and university scientists over 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.

West Coast Estuarine Fisheries Status Report

Main Features

Stock assessment complete:
Preliminary assessments for select targeted species only (black bream, cobbler and King George whiting)

Exploitation status:
Target species:
Black bream — *Not assessed*
Cobbler — *Over-exploited in Swan-Canning, Peel-Harvey and Leschenault estuaries*
King George whiting — *Not assessed*

Breeding stock levels:
Target species:
Black bream — *Not assessed*
Cobbler — *Recovering in Peel-Harvey estuary, low in Leschenault*
King George whiting — *Not assessed*

continued over

Previous catch projections for year 1998:

Swan-Canning	*66-92 tonnes*
Peel-Harvey	*224-424 tonnes*
Leschenault	*61-103 tonnes*
Hardy Inlet	*Data not available for publication (fewer than five operators)*

Catch current season (1998):

Swan-Canning	*75.6 tonnes (includes fish and crustaceans)*
Peel-Harvey	*325.8 tonnes (includes fish and crustaceans)*
Leschenault	*88.1 tonnes (includes fish and crustaceans)*
Hardy Inlet	*Data not available for publication (fewer than five operators)*

The above totals include the following catches of key target species:

Black bream	*2.6 tonnes*
Cobbler	*2.9 tonnes*
King George whiting	*20.6 tonnes*

Estimated annual value (to fishers) for 1998:

Swan-Canning	*$209,000 (includes fish and crustaceans)*
Peel-Harvey	*$711,000 (includes fish and crustaceans)*
Leschenault	*$194,000 (includes fish and crustaceans)*
Hardy Inlet	*Data not available for publication (fewer than five operators)*

Catch projections next year (1999):

Swan-Canning	*63-85 tonnes*
Peel-Harvey	*240-420 tonnes*
Leschenault	*67-108 tonnes*
Hardy Inlet	*Data not available for publication (fewer than five operators)*

Boundaries and Access

Swan-Canning	Commercial block 9501: Level of access - 9 units
Peel-Harvey	Commercial block 9502: Level of access - 19 units
Leschenault	Commercial block 9503: Level of access - 6 units
Hardy Inlet	Commercial block 8501: Level of access - 4 units (1 conditional)

The levels of access listed above are as at June 1998. 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. This report presents data for the most important estuarine fisheries and/or those fisheries which appear to be experiencing problems. Please note, where fewer than five fishers are involved in a particular fishery, the data are subject to the confidentiality provisions of the *Fish Resources Management Act 1994* and cannot be reported.

Black bream fishery: The black bream stocks are not subject to specific management, but are exploited as part of a larger estuarine fishery. Along the west coast, the catch is concentrated in the Swan-Canning estuary.

Cobbler fishery: The cobbler stocks are not subject to specific management, but are exploited as part of a larger estuarine fishery. Along the west coast, the catch is concentrated in three west coast estuaries, the Swan-Canning estuary, Peel-Harvey estuary and Leschenault Inlet. In a number of estuaries, special regulations specific to the target fishing of cobbler have been introduced to protect spawning aggregations and areas.

King George whiting fishery: The King George whiting stocks are not subject to specific management, but are exploited as part of a larger estuarine and inshore marine fishery. The catch is concentrated in two west coast estuaries, the Peel-Harvey estuary and Leschenault Inlet.

Annual Production

Main fishing method

Gillnet/haul net.

Landings

Swan-Canning: Reported catches in the Swan-Canning estuary over the last 25 years are shown in Estuarine Figure 1. The 1998 catch showed a slight decrease from the 1997 catch figures and continued an overall decline in catches during the 1990s.

Peel-Harvey: Reported catches in the Peel-Harvey estuary over the past 25 years are shown in Estuarine Figure 2. The total catch for 1998 showed a slight increase from the 1997 catch figures. The reported total catches have shown only slight variation during the 1990s.

Leschenault: The total catch for 1998, 88.1 tonnes, was very similar to the 1997 catch. While the overall total catches over the past 25 years display a declining pattern, the catches during the past decade have remained fairly stable.

Hardy Inlet: Data not available for publication (fewer than five operators).

Black bream: The reported catch of black bream in the Swan-Canning estuary in 1998 was 2.6 tonnes and continued its decline from the record high catch in 1996.

Cobbler: The reported catches of cobbler in the Swan-Canning estuary have been declining from the late 1980s, with 1998 being the lowest on record. The 1998 catches in the Peel-Harvey estuary have declined from 1997 levels. In the Leschenault Inlet, there has

been a sharp decline in the reported catch from the 1997 level. The actual reported catches from individual estuaries are confidential due to the small number of boats involved in taking this species.

King George whiting: The King George whiting catches for 1998 reported from the Peel-Harvey estuary continued the increase of the previous three years, probably due to the more marine nature of the Peel-Harvey system since the opening of the Dawesville Channel. Catches have not been this high since the early 1970s. A different pattern was seen in the Leschenault Inlet with declining catches throughout the 1990s. The current 1998 reported catch is the lowest since 1969.The actual reported catches from individual estuaries are confidential due to the small number of boats involved in taking this species.

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.

Swan-Canning: The fishing effort has tracked alongside the catches in this fishery (Estuarine Figure 1). The general trend has been a decrease in the number of fishing units since the mid-1970s; currently the mean monthly number of boats fishing is six.

Peel-Harvey: Fishing effort has remained at fairly constant levels during the 1990s after a rapid decline during the 1970s and 1980s (Estuarine Figure 2). Currently there are, on average, 16 boats actively fishing in the fishery each month.

Leschenault: The general overall trend is for a decline in fishing effort in this fishery. Between 1993 and the present, the fishing effort has remained stable at an average of five boats per month.

Hardy Inlet: Data not available for publication (fewer than five operators).

Catch rate

Swan-Canning: While the annual values of the catch rate (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.

Peel-Harvey: The catch rate has followed the catches in this fishery. The 1998 CPUE has increased from the 1997 CPUE.

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 1998 CPUE has increased from 1997 CPUE levels.

Hardy Inlet: Data not available for publication (fewer than five operators).

Stock Assessment

Black bream: A preliminary yield-per-recruit stock assessment was conducted for the black bream *(Acanthopagrus butcheri)* fishery in the Swan River. Biological data were incorporated for the Swan River population from research by Sarre.[1] An evaluation of the status of this fishery cannot be achieved until there is an understanding of the level of targeted fishing effort or a catch curve for this species.

Cobbler: A preliminary yield-per-recruit stock assessment was conducted for the cobbler *(Cnidoglanis macrocephalus)* fishery. Biological data were incorporated for Swan River cobbler from research by Nel.[2] Detailed evaluation of the status of this fishery cannot be achieved until there is an understanding of the level of targeted fishing effort or a catch curve for this species.

King George whiting: A preliminary yield-per-recruit stock assessment was conducted for the King George whiting *(Sillaginodes punctata)* fishery. Biological data were incorporated from research by Hyndes et al.[3] and Potter et al.[4] for King George whiting from the west coast. An evaluation of the status of this fishery cannot be achieved until there is an understanding of the level of fishing effort or a catch curve for this species.

Breeding Stock Levels

Black bream: A preliminary eggs-per-recruit model was conducted for the black bream fishery in the Swan River. Biological data were incorporated for the Swan River population from research by Sarre.[1] An evaluation of the status of breeding stock levels of this species cannot be achieved until there is an understanding of the level of fishing effort or a catch curve for this species.

Cobbler: A preliminary eggs-per-recruit model was conducted for the cobbler fishery. Biological data were incorporated for Swan River cobbler from research by Nel.[2] Detailed evaluation of the status of breeding stock levels of this species cannot be achieved until there is an understanding of the level of fishing effort or a catch curve for this species.

King George whiting: A preliminary eggs-per-recruit stock assessment was conducted for the King George whiting fishery. Biological data were incorporated from research by Hyndes et al.[3] and Potter et al.[4] for King George whiting from the west coast. An evaluation of the status of breeding stock levels of this species cannot be achieved until there is an understanding of the level of fishing effort or a catch curve for this species.

Catch Projection for Year 1999

The catch projections are given in the summary at the beginning of this section. The projections are derived by double exponential smoothed forecasting of the past annual catches and the variation of observations around the predictions. The confidence intervals are set at 80%.

Product Value for Year 1998

The value of the fisheries in each of the estuaries is given in the summary at the start of this section.

General Comments

To enhance the stock assessment of the key estuarine species, there is a need to gain a better understanding of targeted fishing effort and to gather the data to be able to develop a catch curve for these species.

Cobbler

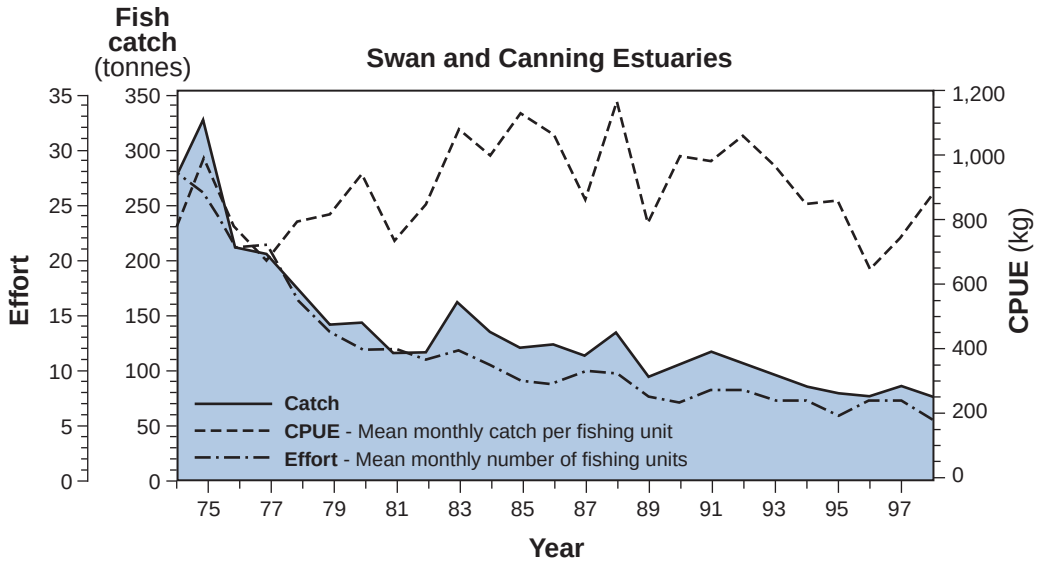
Management changes: The legal minimum size at capture has been increased to 430 mm total length for both recreational and commercial fishers. A seasonal closure to the 'bunting' (netting) of cobbler during the period September to October has been introduced in the Peel-Harvey system to protect cobbler when they aggregate to breed. However, it is stressed that a total ban on the capture of cobbler during the breeding season between August and November would be more effective. In view of its prominence as a key recreational target species in recent years and as a bycatch in both recreational fish gillnets and recreational prawn nets, it is important that all restrictions apply equally to both recreational and commercial sectors.

Biological assessments: Recent research results have shown quite clearly that cobbler stocks in each of the south-west estuaries are quite discrete, with virtually no exchange between adjacent stocks. They have also revealed that the historical legal minimum size at first capture was well below the mean size at maturity. The present decline in cobbler catches from many estuaries and embayments, and concerns for the declining quality of estuarine environments, have raised questions over the effect of these environmental factors on the availability of traditional nesting sites and hence breeding success. It was feared that breeding stock levels had dropped to very low levels in each of these three west coast estuaries and that under the present management regime, the stocks had little likelihood of recovering.

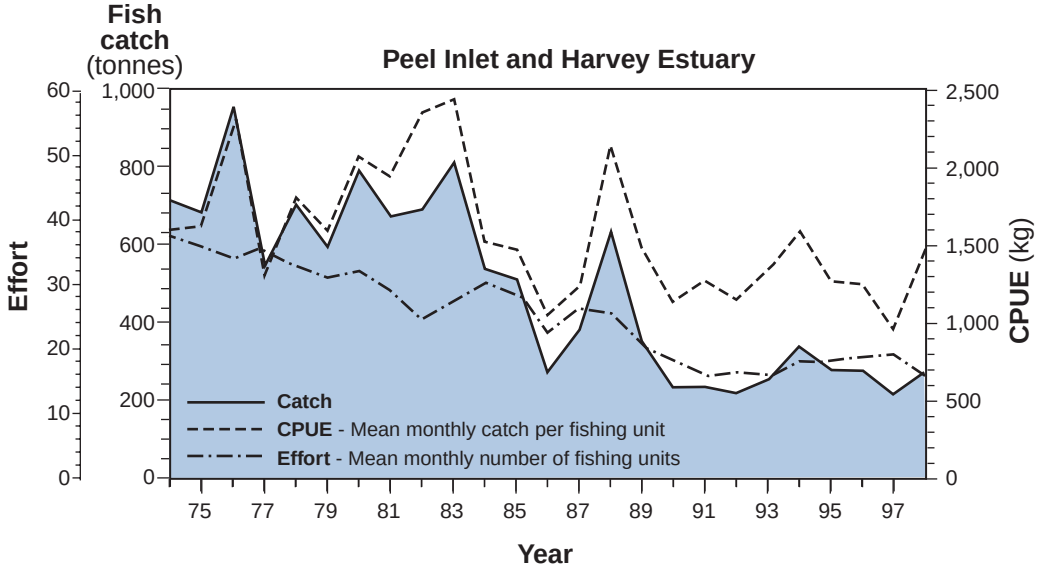
However, a number of factors may contribute to the recovery of these stocks in the future. For example, the entrance channel areas of both the Swan-Canning and Peel-Harvey estuaries are closed to commercial fishing. Secondly, the increasing development of rock walling and other bank stabilisation, particularly associated with the Dawesville Channel and canal development in the Peel-Harvey system, appears to have provided alternative nesting and nursery habitats to replace those located in degraded areas in the estuary proper.

The changes to the management regulations and habitat for cobbler are likely to have confounded the interpretation of the commercial catch data. In particular, changes to the minimum legal size, and the prohibition on taking cobbler during the spawning periods, may reduce the commercial cobbler catch in the short term, but should allow the stocks and catch to recover in future years.

1. Sarre, G. Unpublished data. PhD thesis, Murdoch University.
2. Nel, S. 1983. The ecology of two species of catfish (*Cnidoglanis macrocephalus and Paraplotosus albilabris*) in the Swan estuary. Honours thesis, Murdoch University.
3. Hyndes, G.A., Platell, M.E., Potter, I.C. and Lenanton, R.C.J. 1998. Age composition, growth, reproductive biology, and recruitment of King George whiting, *Sillaginodes punctata,* in coastal waters of south-western Australia. *Fishery Bulletin* 96: 258–270.
4. Potter, I.C., Platell, M.E. and Lenanton, R.C.J. 1997. Biological data for the management of competing commercial and recreational fisheries for King George whiting and black bream. Fisheries Research and Development Corporation report, FRDC project 93/82.



Estuarine Figure 1 The annual catch, effort and catch per unit effort (CPUE) for the total fishery of the Swan-Canning estuary over the period 1974-1998.



Estuarine Figure 2 The annual catch, effort and catch per unit effort (CPUE) for the total fishery of the Peel-Harvey estuary over the period 1974-1998.

South Coast Estuarine Fishery Status Report

Main Features

Stock assessment complete:
Preliminary assessment for black bream

Exploitation status:
Target species:

Black bream	*Current information is inadequate*
Cobbler	*Current information is inadequate*
King George whiting	*Current information is inadequate*

Breeding stock levels:
Target species:

Black bream	*Current information is inadequate*
Cobbler	*Stable in Wilson Inlet*
King George whiting	*Current information is inadequate*

Previous catch projections for year 1998:

South coast estuaries	*280-480 tonnes*

Catch current season (1998):

South coast estuaries	*365 tonnes (includes fish, molluscs and crustaceans)*
Black bream	*9.4 tonnes*
Cobbler	*79.0 tonnes*
King George whiting	*55.8 tonnes*

Estimated annual value (to fishers) for 1998:

South coast estuaries	*$1,151,000 (includes fish, molluscs and crustaceans)*

Catch projections next year (1999):

South coast estuaries	*220-480 tonnes*

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 (commercial block 9505), Wilson Inlet (9506), Irwin Inlet (9507), Broke Inlet (9508), Princess Royal Harbour (9509), Parry's Inlet (8502), Beaufort Inlet (8503), Wellstead Inlet (8504), Gordon Inlet (8505), Dempster Inlet (8506), Hamersley River (8507), Culham Inlet (8508), Oldfield River (8509), Torradup River (8510), Stokes Inlet (8511) and Jerdacuttup (8512). The level of access decreased during 1998, from 40 units in January to 33 in October.

South coast licensees have access to each of the individual south coast estuaries, except Beaufort Inlet (8503) where only three licensees a year are granted entry.

The status of the fishery in each of the above estuaries is reviewed annually. This report presents data for the most important estuarine fish stocks, particularly those which are showing significant variations.

Black bream fishery: The black bream stocks are not subject to specific management, but are exploited as part of a larger estuarine fishery. During the past five years the catch has been concentrated in Stokes Inlet, Beaufort Inlet and Oldfield Inlet.

Cobbler fishery: The cobbler stocks are not subject to specific management, but are exploited as part of a larger estuarine fishery. The catch is concentrated in two south coast embayments/estuaries, the Princess Royal Harbour and 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.

King George whiting fishery: The King George whiting stocks are not subject to specific management, but are exploited as part of a larger estuarine and inshore marine fishery. The catch is concentrated in two south coast embayments/estuaries, Oyster Harbour and Wilson Inlet.

Annual Production

Main fishing method
Gillnet/haul net.

Landings
The reported catch from south coast estuaries shows a stable history between 1993 and 1997, with an increase to the present 1998 figures (Estuarine Figure 3). In 1998, Beaufort Inlet, Gordon Inlet, Oldfield River, Parry's Inlet and Stokes Inlet reported decreased catches from 1997 levels. Increased catches from 1997 levels were recorded in Broke Inlet, Irwin Inlet, Oyster Harbour, Wellstead Inlet and Wilson Inlet. No fishing was reported in Culham Inlet, Dempster Inlet, Hamersley River, Jerdacuttup Lakes or Torradup River.

In order to more accurately reflect the finfish catches from the South Coast Estuarine Fishery, the method of reporting the commercial catch has changed this year. Prior to 1993, no separate fishing block existed for Princess Royal Harbour and King George Sound, so both were included in the south coast estuarine catch figures, even though King George Sound was not part of the SCEF. After that time, Princess Royal Harbour and King George Sound catches were recorded under separate fishing blocks by fishers, and these catches were included in the annual south coast estuarine catch, in order to provide continuity of reporting with previous years. This year the reporting format has been altered to exclude King George Sound while continuing to incorporate Princess Royal Harbour catches (Estuarine Figure 3). This change provides a

more accurate reflection of the production from this fishery for future management purposes.

Black bream: In south coast estuaries, the catches of black bream continued to decline from the high 1992 reported catch (Estuarine Figure 4). High overall catch figures reported during the early 1990s were attributed to the large catches in the Culham Inlet (64 tonnes in 1992).

Cobbler: The 1998 catches from the Wilson Inlet have increased from 1997 levels by 22.3 tonnes (Estuarine Figure 5).

King George whiting: The King George whiting catches from Wilson Inlet for 1998 continued to increase over 1997 values and are the highest catches reported for 25 years (Estuarine Figure 6).

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 1993, the fishing effort in the SCEF has declined in most commercially fished estuaries between Albany and Augusta (Estuarine Figure 3). In particular, Broke Inlet, Princess Royal Harbour and Oyster Harbour are reporting effort declines for 1998. East of Albany, the major estuarine system regularly fished each year is Stokes Inlet. In this system, fishing effort increased in 1995 and 1996 and has declined for the past two years. Increasing fishing effort has been reported during 1998 from Irwin Inlet and Wilson Inlet, to the west of Albany.

Catch rate

CPUE has closely followed the trend in catches overall in south coast estuaries. The catch rate for the south coast estuaries increased in 1998.

Stock Assessment

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, at the upper end of the historical range and average catch per vessel operating, indicates that this valuable stock is in a reasonable condition.

King George whiting: As noted above, formal stock assessment of the King George whiting stock in Wilson Inlet is not possible, however some conclusions can be drawn from the data. The overall effort level in this estuary, although at the maximum end of the historical range, has been relatively steady over recent years and does not account for the five-fold increase in catch of this species. Secondly, as the breeding stock for this species is generally outside of the estuary, the recent improvement in catch is most likely related to a substantial increase in recruits entering the estuary over the past two to three years.

Black bream: A preliminary yield-per-recruit stock assessment was conducted for the black bream *(Acanthopagrus butcheri)* fishery in the Wellstead estuary. Biological data were incorporated for the Wellstead estuary population from research by Sarre.[1] An evaluation of the current status of this fishery cannot be achieved until there is an understanding of the level of targeted fishing effort or a catch curve for this species.

Breeding Stock Levels

Cobbler: The breeding stock for cobbler in the important Wilson Inlet fishery is contained within the estuary. Given the recent levels of catch in this fishery, the breeding stock is considered to be adequate.

King George whiting: Breeding King George whiting occur in the open ocean which, together with the recent exceptional levels of recruitment in Wilson Inlet, indicates that the breeding stock for this area of the south coast is adequate.

Black bream: A preliminary eggs-per-recruit model was conducted for the black bream fishery in the Wellstead estuary. Biological data were incorporated for the Wellstead estuary population from research by Sarre.[1] An evaluation of the current status of breeding stock levels of this species cannot be achieved until there is an understanding of the level of fishing effort or a catch curve for this species.

Catch Projection for Year 1999

The predicted catch for 1999 is between 220 and 480 tonnes. This projection is derived by double exponential smoothed forecasting of the past annual catches and the variation of observations around the predictions. The confidence intervals are set at 80%.

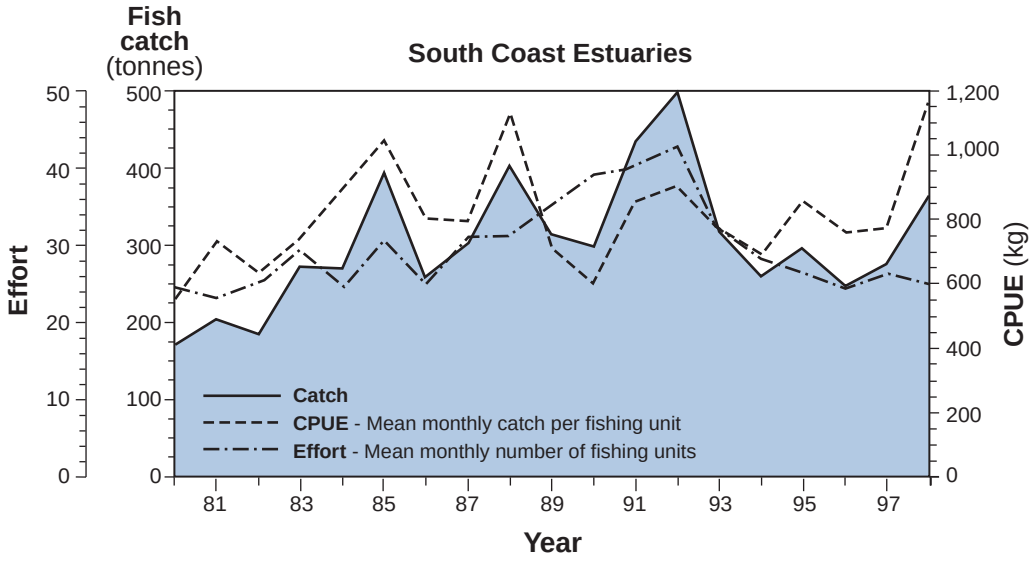
Product Value for Year 1998

The 1998 value of the fisheries in the south coast estuaries is $1,151,000.

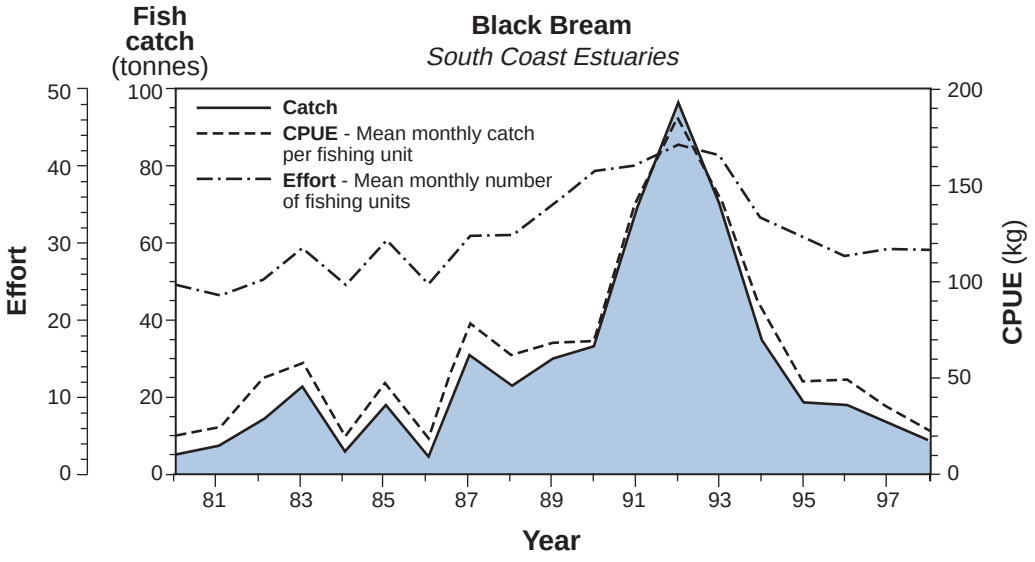
General Comments

To improve the stock assessment of the key estuarine species, there is a need to gain a better understanding of targeted commercial fishing effort and to gather the data to be able to develop a catch curve for these species which are important to both the commercial and recreational sector.

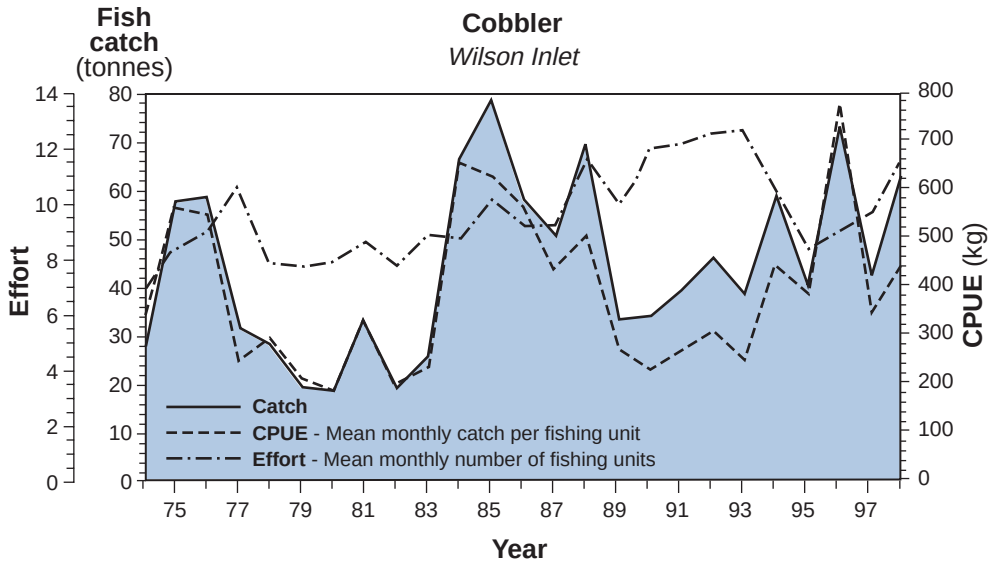
1. Sarre, G. Unpublished data. PhD thesis, Murdoch University.



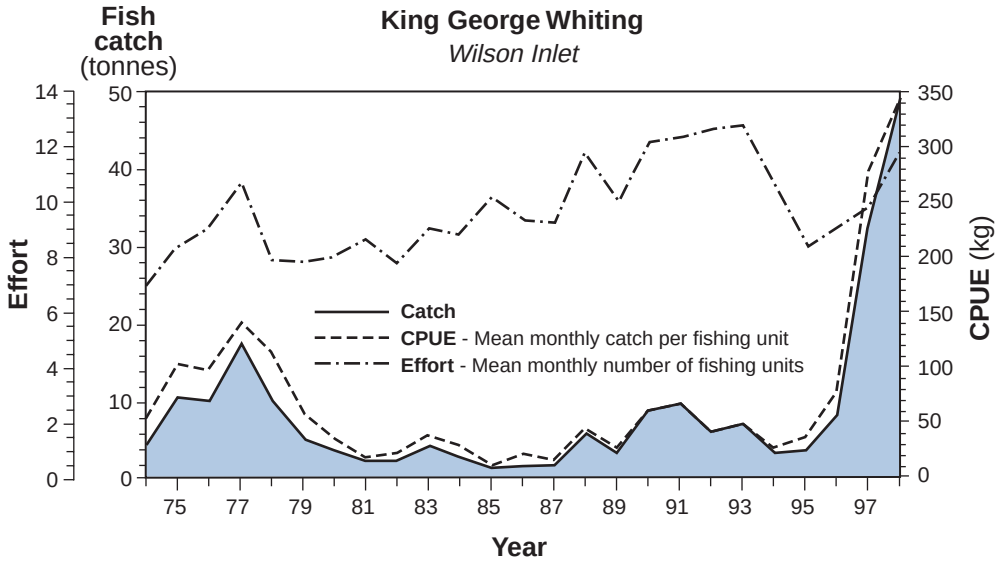
Estuarine Figure 3 The annual catch, effort and catch per unit effort (CPUE) for the South Coast Estuarine Fishery over the period 1980-1998. Prior to 1993, no separate fishing block existed for Princess Royal Harbour and King George Sound, so both were included in the south coast estuarine catch figures, even though King George Sound was not part of the SCEF. After that time, Princess Royal Harbour and King George Sound catches were recorded under separate fishing blocks by fishers. This year, catches between 1993 and the present have been recalculated to include catches from Princess Royal Harbour only in the SCEF.



Estuarine Figure 4 The annual catch, effort and catch per unit effort (CPUE) for the black bream *(Acanthopagrus butcheri)* fishery in south coast estuaries over the period 1980-1998.



Estuarine Figure 5 The annual catch, effort and catch per unit effort (CPUE) for the cobbler *(Cnidoglanis macrocephalus)* fishery of Wilson Inlet over the period 1974–1998.



Estuarine Figure 6 The annual catch, effort and catch per unit effort (CPUE) for the King George whiting *(Sillaginodes punctata)* fishery of Wilson Inlet over the period 1974–1998.

Shark Bay Beach Seine and Mesh Net Managed Fishery

Management Overview

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 which sets weekly delivery quotas and commercially acceptable size limits, which are above the legal minimum size for species concerned.

In June 1998 a total fishing ban on pink snapper was introduced in the waters of the eastern gulf of Shark Bay, as a result of stock depletion concerns. This had a minor impact on a limited number of licensees, who in the past have taken a small catch of pink snapper from this sector of the fishery.

Compliance and Community Education Overview

During 1998/99, inspections were undertaken at the Denham jetty and at sea using the PV *John Brockman*. Compliance with the management arrangements was good.

Research Overview

Research monitoring of the status of the stocks taken in the fishery is undertaken using CAESS data provided by industry to Fisheries WA, coupled with the extensive scientific knowledge gained from previous research.

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

Fishery Status Report

Main Features

Stock assessment complete:
Only for whiting **(Sillago schomburgkii)**

Exploitation status:
S. schomburgkii *fully exploited*

Breeding stock levels:
Adequate for **S. schomburgkii**

Previous catch projections for year 1998:

Whiting	*90-140 tonnes*

Catch current season (1998):

All species	*265.4 tonnes*
Whiting	*114.8 tonnes*

continued over

Estimated annual value (to fishers) for year 1998:

All finfish	*$800,000*
Whiting	*$380,000*

Catch projection next year (1999):

Whiting	*95-140 tonnes*

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'.

During 1998, nine unit fishing boat licence holders were registered in the beach seine and mesh net fishery and were based at Denham.

Annual Production

Main fishing method
Beach seine and haul net.

Landings
Whiting is the main target species in Shark Bay, although the catch consists of two species of whiting, sea mullet, tailor, bream and some snapper. 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 1998 were 114.8 tonnes of whiting. This was slightly lower than the 1997 catch of 122 tonnes, which was the highest reported between 1989 and the present. The 1998 total catch for the Shark Bay beach seine and haul net fishery of 265.4 tonnes has declined from last year's catch of 325 tonnes which was at the highest level reported during the past 10 years (Shark Bay Beach Seine Figure 2).

Fishing effort
During 1998, there was an average of seven boats fishing per month, expending 1,049 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 in the number of boat days fished during the 1990s.

Catch rate
CPUE (based on nominal effort) for the whiting fishery has increased during the past 10 years, with only minor fluctuations recorded in the mid-1990s. The present CPUE is 109.4 kg/boat day for the whiting fishery , which is the highest value reported since 1989 (Shark Bay Beach Seine Figure 1). The CPUE for the

Shark Bay beach seine and haul net fishery increased steadily between 1989 and 1995 and has remained relatively constant since 1995. The reported CPUE for 1998 was 253 kg (all species)/boat day.

Stock Assessment

A preliminary yield-per-recruit stock assessment was conducted for the whiting *(Sillago schomburgkii)* fishery in Shark Bay. Biological data were incorporated from research by Lenanton (1970).[1] A more detailed evaluation of the current status of the fishery cannot be achieved until a catch curve is developed for this species.

Breeding Stock Levels

As the mean size at first maturity for Shark Bay whiting is similar to the legal minimum length that applied up until 1988, and the minimum legal mesh size is the 50% selection point of 48 mm mesh net, virtually all of the catch is mature fish. Consistent catches of whiting over recent years provide a good indication that the breeding stock is being maintained.

Catch Projection for Year 1999

The catch projection for 1999 is 95-140 tonnes for whiting. The projection is derived by double exponential smoothed forecasting of past annual catches and the variation of observations around the predictions.The confidence intervals are set at 80%.

Product Value for Year 1998

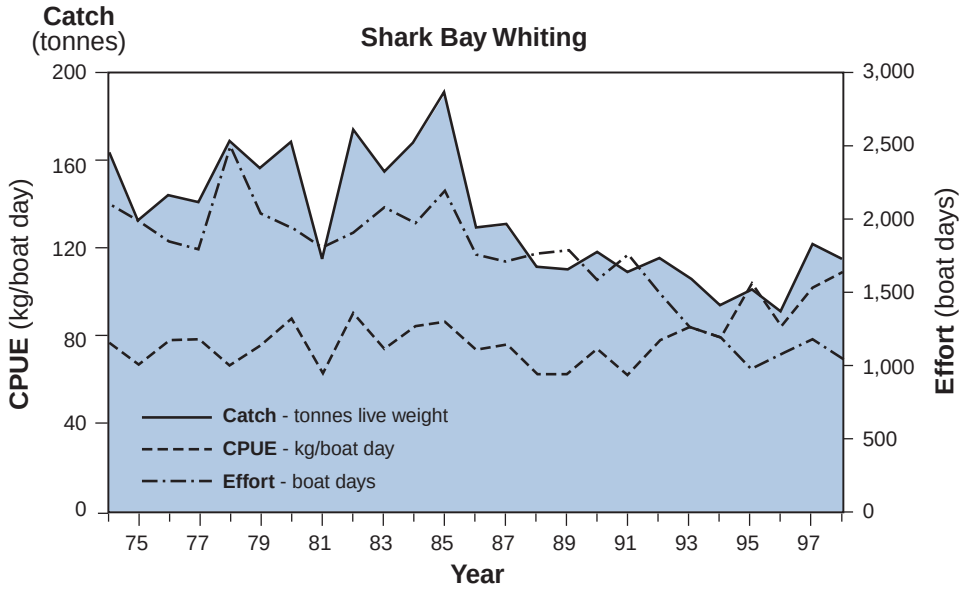
The estimated value of the total catch for 1998 is $800,000. The estimated value of the whiting catch is $380,000.

General Comments

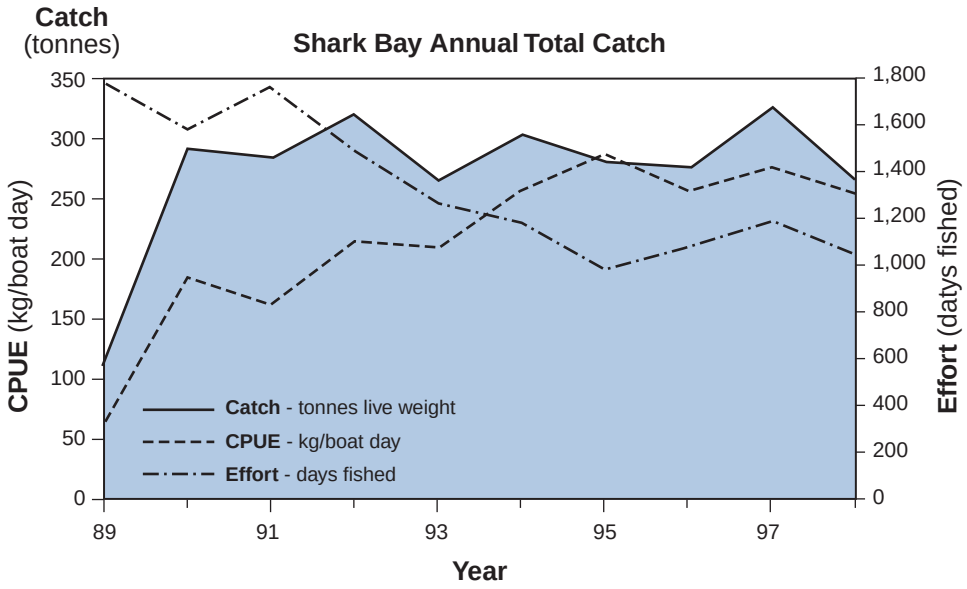
Historically, this status report has detailed the commercial Shark Bay Beach Seine and Mesh Net Managed Fishery catch and effort statistics. While there is no management plan for the fishery, the fishery is constrained by limited entry. At present, Shark Bay is an increasingly popular recreational fishing destination. Shark Bay has been designated a World Heritage Area, with all but a small portion also designated as a marine park. Recent research into Shark Bay snapper and an anglers' creel survey highlight the need for an integrated approach to the management of the fish resources within Shark Bay.

Annual catch and effort data are extracted and accumulated from statutory monthly CAESS returns provided by commercial fishers. Data within the CAESS database are continually maintained, both by addition of new statistical returns and by modification of records to correct errors of data entry or interpretation that are detected during ongoing analysis and data quality control by the research section responsible for studying each fishery.

1. Lenanton, R.C.J. 1970. The biology of the commercially fished whiting (*Sillago* spp.) in Shark Bay, Western Australia. Master of Science thesis, University of Western Australia. 160 pp + appendix.



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 1989-1998.



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 1974-1998.

Lower West Coast Beach and Embayment Fisheries

Management Overview

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 13 licensees in this fishery. Small pelagic fish are taken primarily by beach seine method within the coastal waters between the mouth of the Moore River, north of Perth, and Tims Thicket, south of Mandurah.

The major target species for this fishery is whitebait, *Hyperlophus vittatus,* with small quantities of other species being taken.

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.

The northern section of the stock is managed under the West Coast Beach Bait (Fish Net) Management Plan which applies to the area from Lancelin to Tims Thicket. Management of the southern section will come under the review of the south-west beach seine access arrangements, which are still to be finalised. Beach seining is the predominant method of fishing, which provides a measure of protection for the stock because of the limited ability to access the whitebait from the beaches.

The fishery is currently being assessed as to whether it qualifies under the Voluntary Resource Sharing Guidelines program.

Cockburn Sound (Crab) Managed Fishery: There are eight transferable Class A and eight non-transferable Class B licences with access to this fishery. This fishery has fully converted from using demersal tangle nets to using crab pots as the means of capture.

The future management arrangements for this commercial fishery are currently being reviewed under the Voluntary Resource Sharing Guidelines program. Outcomes from this process are likely to include

implementation of new management initiatives to facilitate an improved recreational share of the total annual crab catch from Cockburn Sound.

Cockburn Sound (Fish Net) Managed Fishery: There are six 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. There is concern also that declining Australian herring catches on the south coast may impact on the Cockburn Sound fishery.

Cockburn Sound (Mussel) Managed Fishery: There are three licensees with access to this fishery. In 1997 the Minister for Fisheries approved an amendment to the management plan to permit licence transferability on a limited basis, allowing mussel dive licences to be transferred to holders of aquaculture licences endorsed to cultivate mussels in Cockburn Sound. This essentially integrates the wild–catch fishery with the farmed mussel sector in Cockburn Sound.

Cockburn Sound (Line and Pot) Managed Fishery: There are currently 34 licensed fishers in this fishery, although not all licensees exercise their fishing entitlement. The fishing methods employed include handline, longline and squid jigging; the pots used are unbaited octopus pots. Baited pots require the written approval of the Executive Director of Fisheries WA.

Many of the species targeted by this fishery are also targeted by recreational fishers, e.g. sharks, 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 fully investigated.

Research Overview

Data for monitoring the status of the various stocks taken from Cockburn Sound are obtained primarily from the CAESS records provided by industry. These data, together with biological knowledge from historical research, enable any unusual trends in catch to be evaluated.

Research during 1998/99 focused on the herring stock, and biological data are being gathered on garfish as part of an Australia-wide study. In addition, a series of research projects to examine the status of the blue crab stocks in Cockburn Sound has been funded by the Fisheries Research and Development Corporation (FRDC).

Cockburn Sound Finfish Fisheries Status Report

Main Features

Stock assessment complete:
Not applicable (multi-species fishery)

Exploitation status:
Not applicable

Breeding stock levels:
Not applicable

Previous catch projections for year 1997:
49-125 tonnes (finfish only)

Catch current season (1998):
60.1 tonnes (catch excludes whitebait, pilchard, scaly mackerel, anchovy, blue sprat, molluscs and crustaceans)

Estimated annual value (to fishers) for year 1998:
$120,000 (Cockburn Sound Line and Pot Managed Fishery and Cockburn Sound Fish Net Managed Fishery)

Catch projection next year (1999):
38-92 tonnes (finfish only)

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 (Block 9600). 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. There are 34 fishers who have access to either one or both of these fisheries.

A status report for the whitebait stock follows. Separate status reports are given elsewhere in this volume for the West Coast Purse Seine, mussel (see Mussel Aquaculture) and crab (see West Coast Blue Swimmer Crab Stock) fisheries.

Annual Production

Main fishing method

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

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, from the West Coast Beach Bait (Fish Net) and the West Coast Purse Seine Managed Fisheries, which conduct part of their operations within Cockburn Sound. From the early 1990s the catches increased to a peak in 1992 and have been declining to the current level of 60.1 tonnes in 1998 (Cockburn Sound Figure 1).

The catch of sea garfish increased steadily from 1980 to a peak value in 1994. Since that time, the catch has declined, with a substantial drop in 1997. A slight increase over the 1997 catches was reported in 1998 when 22.2 tonnes were landed (Cockburn Sound Figure 2).

Similarly, Australian herring catches showed a steady increase, reaching a peak in 1994 (around 50 tonnes). Since that time, catches have declined each year to 21 tonnes in 1998 (Cockburn Sound Figure 3).

Fishing effort

The fishing effort (measured as the number of fishing boat days) in Cockburn Sound provides an indication of the overall usage of the area by the commercial sector, since it is composed of a number of different fisheries and various fishing methods.

The fishing effort peaked during the early 1990s to 1,400-1,600 boat days. The effort declined to 882 boat days in 1997. The reported effort for 1998 was 1,169 boat days.

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. The peak catch rate was 101.8 kg/boat day in 1992 and the lowest reported catch rate was 43 kg/boat day in 1990. The 1998 catch rate was 51 kg/boat day.

Stock Assessment

Not applicable.

Breeding Stock Levels

Not applicable.

Catch Projection for Year 1999

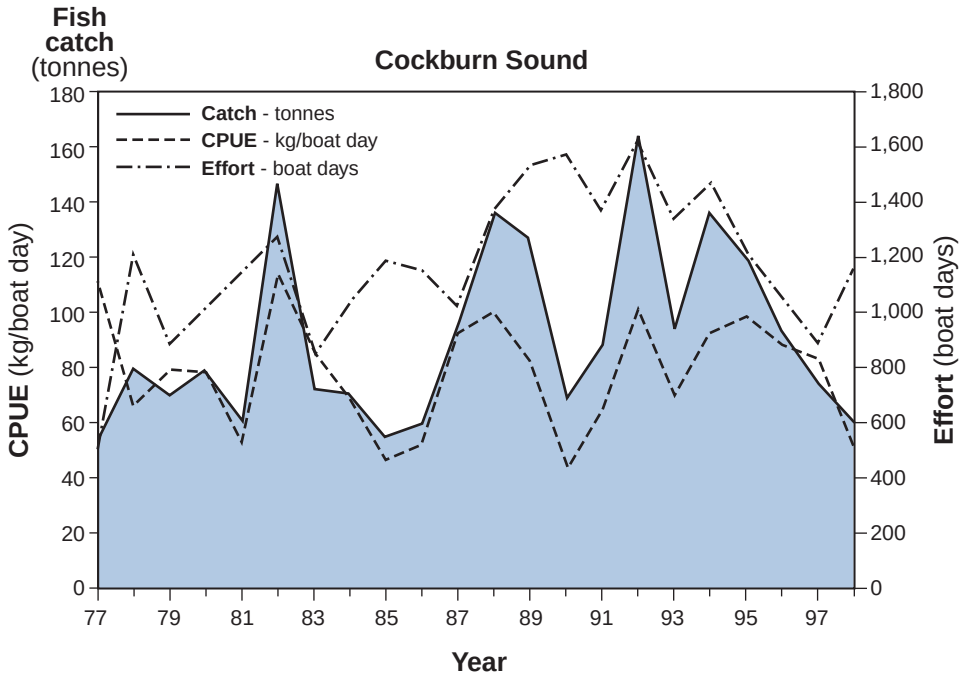
The catch prediction for 1999 is between 38 and 92 tonnes of finfish. This projection is derived by double exponential smoothed forecasting of the annual catches and the variation of observations around the predictions. The confidence intervals are set at 80%.

Product Value for Year 1997

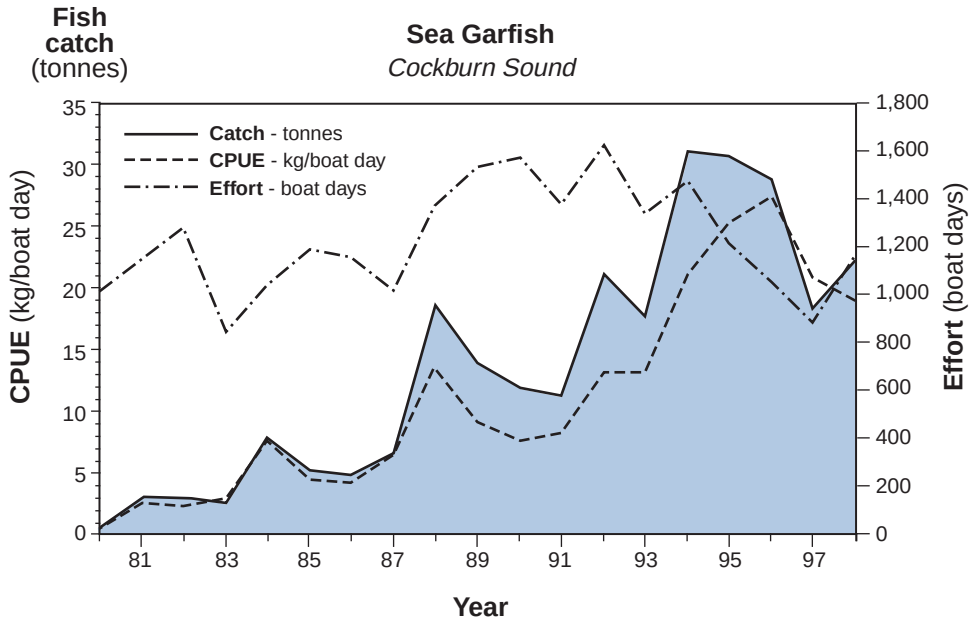
The estimated value of the finfish catch from Cockburn Sound for 1998 is $120,000 (Cockburn Sound Line and Pot Managed Fishery and Cockburn Sound Fish Net Managed Fishery).

General Comments

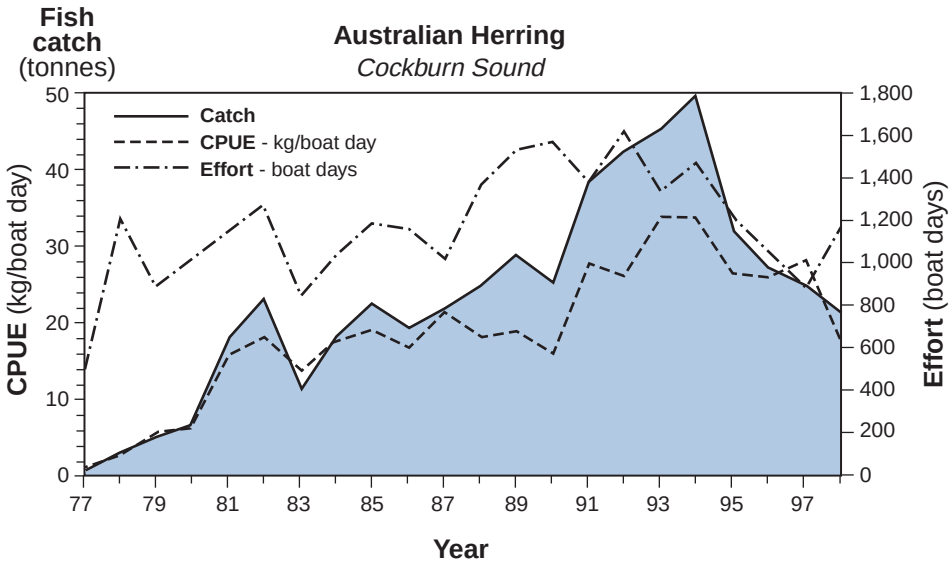
In addition to the commercial catches reported above, Cockburn Sound continues to provide one of the most popular sheltered recreational fishing areas in very close proximity to the Perth metropolitan area. About half of the 23 species of finfish that contributed to the 1998 commercial finfish catch are also important recreational species. They include tailor, Australian herring, trevally, King George whiting, garfish, yellowtail scad and pink snapper. Australian herring contributed 35% of the total commercial finfish catch from the Sound. The remaining six recreationally important species contributed 44% of the commercial finfish catch collectively. While relatively limited in overall value, the production from this fishery provides a valuable input to the metropolitan fresh fish market. Catch information from the small commercial sector also provides a valuable input to the research database for monitoring the abundance of these stocks which are also important to recreational fishing. Unfortunately, the lack of annual catch statistics from the recreational sector limits the ability to use these data for stock assessment purposes. However, the commercial CPUE does provide an index of annual abundance to monitor overall trends in stock availability to both sectors and to link to recreational data in years when surveys occur.



Cockburn Sound Figure 1 The annual catch, effort and catch per unit effort (CPUE) for finfish (excluding bait fish) for the Cockburn Sound fisheries over the period 1977-1998.



Cockburn Sound Figure 2 The annual catch, effort and catch per unit effort (CPUE) for sea garfish *(Hyporhamphus melanochir)* in the Cockburn Sound fisheries over the period 1980-1998.



Cockburn Sound Figure 3 The annual catch, effort and catch per unit effort (CPUE) for Australian herring *(Arripis georgianus)* in the Cockburn Sound fisheries over the period 1977-1998.

Whitebait Stock Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

Previous catch projections for year 1998:
130-180 tonnes

Catch current season (1998):
107 tonnes

Estimated annual value (to fishers) for year 1999:
$0.2 million

Catch projection next year (1999):
210-290 tonnes

Recreational component (1998):
Nil

Boundaries and Access

The West Coast Beach Bait (Fish Net) Managed Fishery extends from Lancelin in the north to Tims Thicket in the south (metropolitan and Mandurah regions), with access currently via limited entry licence. The south-west beach seine fishery extends from Tims Thicket in the north to Point D'Entrecasteaux. The whitebait fishery within this zone typically operates only between Cape Naturaliste and Preston Beach, which is termed the Bunbury region. Access arrangements for the whitebait fishery are currently under review.

Annual Production

Main fishing method
Beach seine net.

Landings
The figures presented here are for the catches of whitebait only; incidental finfish catch figures have been included in the Cockburn Sound status report.

Metropolitan: The catch of whitebait *(Hyperlophus vittatus)* for the metropolitan region during 1998 was

31.2 tonnes, an increase on the 1997 catch of 24.4 tonnes (Whitebait Figure 1). As the catches of whitebait from Mandurah for the past two years have been minimal (less than 1 tonne in 1998), they have now been included as part of the catch for the metropolitan region.

Bunbury: As expected there was a big reduction in catch, with only 76 tonnes caught compared to 294 tonnes the previous year (Whitebait Figure 1). This may be attributed both to natural variations in stock size and to a reduction in effort following stockpiling of product from the very good catch in 1997. Catches were again dominated by the summer period in this region, in contrast to the metropolitan region where good catches were made during winter.

Fishing effort

Given the nature of this fishery, no meaningful measure of effort and therefore catch rate can be obtained.

Catch rate

See Fishing effort above.

Stock Assessment

The only annual assessment for this fishery comes from the total catch. This shows that the abundance was lower in 1998 than in 1997, as predicted by the Leeuwin Current/whitebait model, although the actual catch was less than predicted. The means by which the Leeuwin Current influences catch levels is still not known. The strong Leeuwin Current in 1998 indicates that the 1999 catch is likely to increase. However, experience has shown that years of very good catches are followed by periods of relatively lower catches, so any increase in catch may not be as substantial as that suggested by the model.

Breeding Stock Levels

Modelling and plankton sampling indicate that the typical stock size of whitebait is probably less than 1,000 tonnes for the entire west coast.

Catch Projection for Year 1999

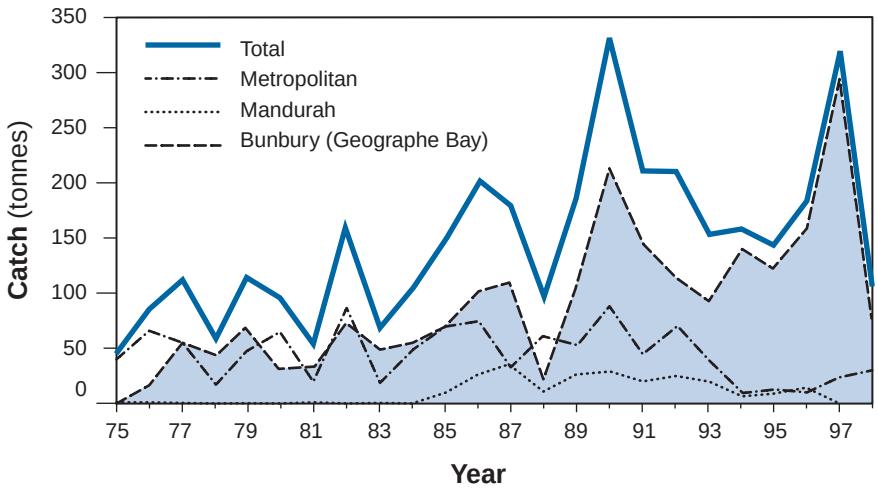
In general, the Leeuwin Current in 1998 was moderately strong, increasing in some months to extremely strong. The Leeuwin Current/whitebait model therefore suggests that the 1999 catch will be greater than that for 1998. The estimated catch project for 1999 is 210-290 tonnes. However, if the large catch in 1997 made a significant impact on the breeding stock, then an annual catch of less than 210 tonnes may occur.

Product Value for Year 1998

Price was similar to that obtained in 1997, with an average of $1.80/kg. Total catch value in 1998 was about $0.2 million.

General Comments

Annual catch in this fishery will most likely continue to exhibit large fluctuations under the influence of environmental factors. This fishery will therefore continue to be regulated through limited entry access and gear restrictions, and is in the process of becoming fully managed. It is anticipated that the Leeuwin Current/whitebait model will be critically reviewed during 1999.



Whitebait Figure 1 Total annual catch of whitebait for each region from 1975 to 1998 (note that as of 1998 if the Mandurah catch is < 1 tonne it will be added to the metropolitan catch).

Western Australian Salmon Managed Fishery

Management Overview

Western Australian salmon *(Arripis truttaceus)* are taken primarily during their annual east-to-west migration between February and April 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.

In February 1999, amendments to both management plans were implemented to permit the practice of penning (holding) salmon for up to 12 hours whilst awaiting or arranging loading and transport. No other amendments were made.

One South Coast Salmon Managed Fishery authority was surrendered under a Voluntary Fisheries Adjustment Scheme in late 1998.

Management issues and Ministerial advice relating to the fisheries are discussed at meetings of the Australian Salmon and Herring Industry Advisory Committee.

Compliance and Community Education Overview

The South Coast and South West Coast Salmon Managed Fisheries are monitored by staff located at Bunbury, Busselton, Augusta and Albany.

Compliance monitoring in this shoreline haul net fishery mainly involves beach inspections for block nets and/or the penning of fish, and compliance with Designated Fishing Zone boundaries and commercial fishing licences.

Compliance has remained high in both fisheries. Some instances of recreational/commercial conflict within designated zones were reported from the south coast, and where possible were addressed through consultation and mediation. Generally, however, conflict between commercial and recreational fishermen is minimal, and relations seem to be improving with more education, with each user group understanding and accepting the other's rights and desires.

Research Overview

The main information used to monitor this important commercial and recreational stock is from industry CAESS data and historical biological research.

Current research activities for the salmon stock include assessing the impact of the Leeuwin Current on salmon movement, investigations into the origin of recruits, and development of a simulation model for the fishery.

These research data have been used to compile the following status report.

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

Previous catch projections for year 1998:
1,700-5,000 tonnes

Catch current season (1998):
2,801 tonnes

Estimated annual value (to fishers) for year 1998:
$1,330,000

Catch projection next year (1999):
1,800-4,900 tonnes

Recreational component (1998):
Although the recreational catch is not part of this managed fishery, some catch and effort data are available. There is no information for 1998; however, a recreational fishing survey of shore anglers was conducted during 1994 and 1995. Data for the range of catches of Australian salmon over those two years are presented below.

West coast	*8-16% of combined recreational/commercial catch*
South coast	*4-6% of combined recreational/commercial catch*
South-east coast	*100% of combined recreational/commercial catch*

Boundaries and Access

Each of 19 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 the Busselton jetty.

Annual Production

Main fishing method

Beach seine.

Landings

Between March and May 1998, the south coast catch of salmon was 1,568 tonnes (CAESS data). There were 595 tonnes caught in the 'back run' between June and December. The January and February catch was 78 tonnes, which would have been part of the back run from the previous year. The south-west and west coast catch for 1998 totalled 560 tonnes (CAESS data). For these two areas almost all of the catch was taken between March and May.

The highest proportion of the 1998 south coast catch (1,190 tonnes; 53.1%) was taken from the central region (south coast area II), from east of Albany to Cape Riche. A total of 676 tonnes (30.2% of overall catch) was taken in the western sector of the fishery (south coast area III). This area covers from west of Albany to Windy Harbour. Fewer fish (374 tonnes; 16.7%) were taken from the eastern sector of the fishery (south coast area I), from Cape Riche to Point Charles east of Bremer Bay. The whole State catch for the year, of 2,801 tonnes, was about 200 tonnes more than the previous year (Salmon Figure 1).

Fishing effort

There are 19 south coast and 15 west coast fishing teams.

Catch rate

The average catch per fishing team was 82 tonnes for 1998.

Stock Assessment

The preliminary yield-per-recruit and egg-per-recruit analyses indicate that, while many smaller salmon are being caught by the fishery, the fishing effort has not impacted on the number of eggs available. Research to date has shown that environmental factors exert a dominant influence on year–class strength and subsequent recruitment to the Western Australian commercial fishery. However, this annual level of recruitment is a function of the relative size of contributions from Western Australian and South Australian nursery areas to the overall recruited year classes. Hence there is a need for some index of the relative contribution of South Australian and Western Australian recruitment to the Western Australian commercial catch. More complex yield-per-recruit or egg-per-recruit analyses are needed to account for this variability in recruitment before an accurate determination of the status of the stock can be completed.

Breeding Stock Levels

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 the critical biological reference point. This result is consistent with that from the yield-per-recruit analysis.

Catch Projection for Year 1999

The predicted catch for 1999 is between 1,800 and 4,900 tonnes. This projection is derived by double exponential smoothed forecasting of the past annual catches and the variation of observations around the predictions. The confidence intervals have been set at 80%

Product Value for Year 1998

The landed value of the catch is approximately $1,330,000 from the managed fishery. The south coast catch in 1998 was received by five processors: Albany Bait Producers, Princess Royal Seafoods, Allerton's Bait Supply, Bremer Bay Fish Processors and Albany Fish Supplies.

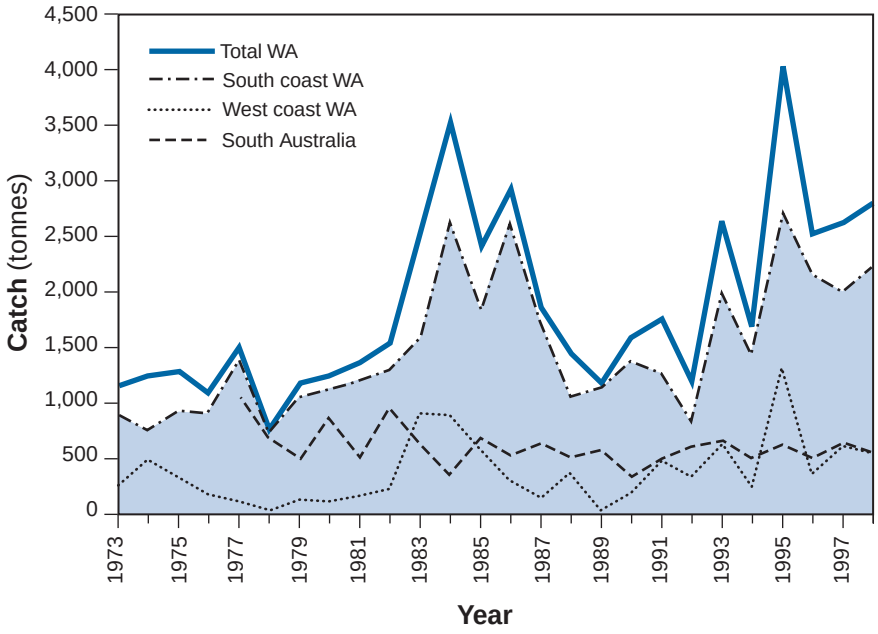
General Comments

In order to begin resolving stock assessment difficulties, preliminary sampling was undertaken in Western Australian nursery areas in late 1994 with a view to developing a recruitment index for Western Australian fish comparable to the existing South Australian recruitment index. Research on partitioning the catch into South Australian and Western Australian recruits, and the development of an index of stock abundance, are also proceeding.

Another aspect of research currently being pursued is monitoring the influence of the Leeuwin Current on the abundance and dispersal of 0+ recruits along the Western Australia south coast and into South Australia, and the abundance and timing of subsequent commercial catches of Australian salmon. Previous research by Lenanton et al. (1991) has shown a positive relationship between the annual recruitment of 0+ Australian salmon and sea level (indicator of Leeuwin Current strength) during the 1980s. It has been difficult to predict the later influence of the Leeuwin Current on the Western Australian commercial fishery because of 'the complicated size-dependent recruitment process and the variable annual rates of

fishing and natural mortality during the relatively long period of four or more years leading up to the recruitment into the fishery'.[1]

1. Lenanton, R.C., L. Joll, J. Penn and K. Jones. 1991. The influence of the Leeuwin Current on coastal fisheries of Western Australia. *Journal of the Royal Society of Western Australia,* **74**: 101-114.



Salmon Figure 1 Australian salmon catches for South Australia and Western Australia for the period 1973 to 1998. Catches prior to 1977 for South Australia are unavailable.

Australian Herring Fishery

Management Overview

The majority of the commercial catch of herring *(Arripis georgianus)* is taken using herring trap nets (also known as 'G' trap nets) from south coast beaches. A relatively small quantity of herring are taken by beach seine and set net.

Fish traps are only permitted to be used by specific endorsement on specifically assigned south coast beaches for a specified period (10 February to 25 March each year). 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 a licensed commercial fisherman holding an unrestricted fishing boat licence.

Herring is also a very important recreational fishing resource. In recognition of this, the South Coast Herring Fishery Voluntary Fisheries Adjustment Scheme has been introduced for the period February 1998 to 30 June 2000. In this process, fishermen are able to offer the surrender of their herring trap endorsement to the scheme and be compensated by a negotiated amount. Four herring trap endorsements were surrendered by this process in the year 1998/99.

Management issues and Ministerial advice relating to the herring fisheries are discussed at meetings of the Australian Salmon and Herring Industry Advisory Committee.

Compliance and Community Education Overview

The Australian herring fishery involves teams operating from nominated beaches and is mainly a continuation of each team's salmon fishing operation, with only two teams not being involved in the salmon fishery.

Compliance concentrates on the period of time for which nets may be set. There were no compliance problems encountered, with all fishers abiding by the season and time closures. No conflict was reported or investigated in this fishery during 1998-99.

Investigations were carried out into the alleged dumping of herring. Whilst not illegal, this practice is undesirable and was considered worthy of investigation, but no proof of dumping was identified.

A major herring research project led by Fisheries WA's Research Division, with support from compliance officers, commercial and recreational fishers and the community, concluded in June 1999. The cooperative fieldwork activities associated with this project continued to provide a better understanding of the roles of each group, as well as an excellent opportunity for community education on the importance of the fishery to both commercial and recreational fishers.

Research Overview

The annual assessment of the status of the herring stock has historically been undertaken utilising primarily CAESS data supplied by industry. As a result of a major downturn in herring catches during the early 1990s, a national research project funded by FRDC commenced in 1996/97 and is to be completed in June 1999. This project, involving Fisheries WA, the South Australian Research and Development Institute and Murdoch University, is providing more detailed data for future stock management.

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

Stock Status Report

Main Features

Stock assessment complete:
No

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

Previous catch projections for year 1998:

South coast only	*520-1,550 tonnes*

Catch current season (1998):

South coast only	*651 tonnes*
Total WA	*748 tonnes*

Estimated annual value (to fishers) for year 1998:

South coast only	*$247,000*

Catch projection next year (1999):

South coast only	*430-1,220 tonnes*

Recreational component (1998):
Although the recreational catch is not part of this fishery, some catch and effort data are available. There is no information for 1998; however, a recreational fishing survey of shore anglers was conducted during 1994 and 1995. Data for the range of catches of Australian herring over the two years are presented below.

West coast	*51-65% of combined recreational/commercial catch*
South coast	*5-9% of combined recreational/commercial catch*
South-east coast	*86-92% of combined recreational/commercial catch*

Boundaries and Access

All licensed commercial fishers are permitted to take Australian herring in any Western Australian open fishing waters. However, there are only 17 licensees (most are also Australian salmon fishers) permitted to take herring by means of a 'G' trap net set on 16 nominated south coast beaches during a short six-week season each year.

Annual Production

Main fishing method

Trap ('G') net and beach seine.

Landings

During 1998, the south coast Australian herring catch to the end of May (end of the trap net fishing season) was 628 tonnes (CAESS data). This is 300 tonnes less than the 1997 catch to that date. The annual south coast catch was 651 tonnes, which comprises 87% of the State total catch. Similarly the total State production has declined by over 200 tonnes between 1998 and 1997 (Herring Figure 1).

Fishing effort

There are 17 south coast fishing teams with access to the trap net fishery.

Catch rate

The average annual catch per south coast fishing team during 1998 was 38.3 tonnes.

Stock Assessment

A stock assessment is currently being prepared.

Breeding Stock Levels

As is the case with Australian salmon, virtually the entire commercial catch consists of mature individuals and peak seasonal catches are taken during the annual spawning migration. Increasingly, evidence suggests that the influence of factors other than fishing, i.e. environmental factors such as the Leeuwin Current, may be partly responsible for fluctuations in the catch and breeding stock levels. Further investigation is required.

Catch Projection for Year 1999

The catch prediction for the south coast fishery for 1999 is 430-1,220 tonnes. This projection is derived by double exponential smoothed forecasting of the past annual catches and the variation of observations around the predictions.

Product Value for Year 1998

The landed value of the south coast herring catch for 1998 is approximately $247,000.

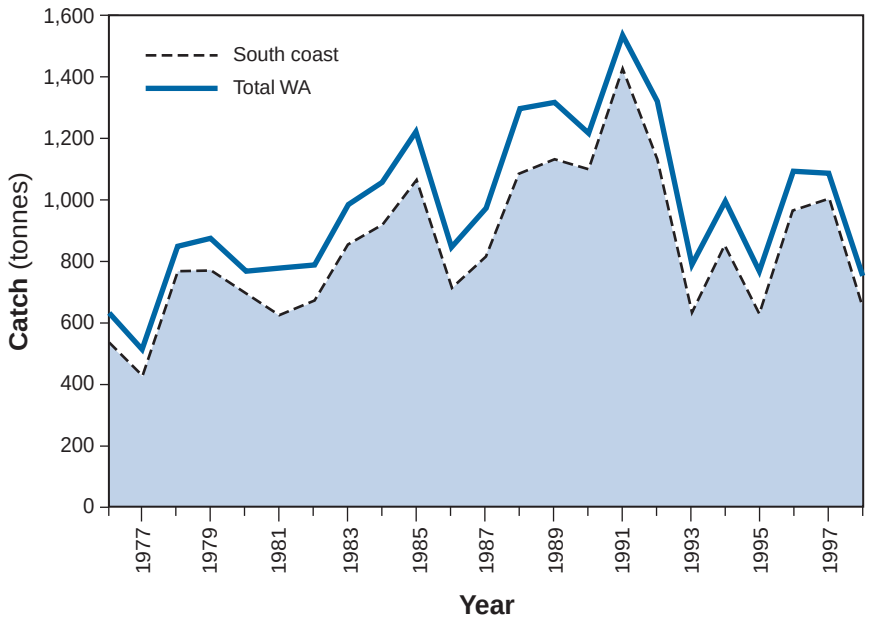
Historically, the major market for Australian herring was the western rock lobster fishery, with a small proportion sold for human consumption. The practice of using imported North Sea herring as rock lobster bait has been introduced in recent years, with varying proportions of local and imported herring species being used each year. In the 1997/98 rock lobster season, one bait supplier stated that the industry was using approximately 83% North Sea herring, with 17% being Australian herring.

General Comments

The trend over the decade to 1990/91 was towards increasing commercial catches of this species. As is the case with salmon, a proportion of the resource is recruited from South Australian nursery areas. Although this proportion has not yet been accurately assessed, it is thought that on a year-to-year basis, 'local' recruitment is far more important to the herring resource than it is for salmon. 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, have now been shown to be substantial nursery areas and can be a source of significant recruitment. Indeed, historical catch records indicate clearly 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 of 0.38 was found between the south and west coast catches using catch data between 1976 and 1998.

Over the first half of the 1990s there was a marked decline in the overall catch of this species by the commercial sector (Herring Figure 1). The lower catches experienced during this period may well be related to the impact of the long-running El Niño/ Southern Oscillation event (ENSO) from 1991 to 1994. This unusual event, which influenced oceanographic conditions along the Western Australian coast, may have affected the timing of the migratory spawning run, making fish less vulnerable to capture during the limited fishing season. Alternatively, the extremely weak Leeuwin Current may have adversely affected survival of juvenile stages of the herring, thus reducing recruitment to the fishery in subsequent years. Increases in the south coast catches from 1995 to 1997 may have resulted from a return of the strong Leeuwin Current. The 1998 reported total catch has decreased to 1995 levels. The lower catches may have resulted from climatic considerations or a reduced market demand for Australian herring as rock lobster bait.

An FRDC-funded research project is investigating both the basic biology of this species and factors influencing recruitment to the fishery. The agency's Fisheries Research Division is undertaking this project in collaboration with Murdoch University and the South Australian Research and Development Institute. The results from this research should be available for next year's report.



Herring Figure 1 Catches of Australian herring from the south coast and the total Western Australian catch for the period 1976 to 1998.

Lake Argyle Freshwater Catfish Fishery

Management Overview

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 which falls during the wet season breeding period of November and December.

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.

Compliance and Community Education Overview

Officers stationed in the East Kimberley region together with officers on patrol from Broome monitor this catfish fishery.

No compliance problems were encountered, however compliance for this fishery remains a low priority.

Research Overview

Data for assessing the status of this fish stock are derived from CAESS returns provided by industry. These data are analysed annually using standard fisheries models to enable the following status report to be provided for management.

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Decreasing

Previous catch projections for year 1997/98:
101-138 tonnes

Catch current season (1997/98):
141 tonnes

Estimated annual value (to fishers) for year 1997/98:
$387,000

Catch projection next year (1998/99):
102-142 tonnes

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 1997/98 there were six licensees who had access to Lake Argyle.

Annual Production

Main fishing method
Gillnet.

Landings
The fishery reached a peak catch in 1988/89 (133 tonnes), then fluctuated at a lower level until 1993/94. Between 1993/94 and 1996/97 there was a trend towards increasing catches in this fishery, with the catch in 1996/97 (147 tonnes) being the highest catch on record. The 1997/98 catch was 141.0 tonnes.

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/boat of 100 m lengths of gillnet used. The fishing effort during 1997/98 was 7,893 units, which is lower than the previous year.

Catch rate
Since 1983, the catch rate has remained fairly constant, although it declined in the three years from 1993/94 to 1995/96. During the past three years the CPUE has remained fairly constant.

Stock Assessment

A standard analysis of catch and effort data from monthly returns is undertaken annually. Assessment showed that the fishing effort applied in recent years may be exploiting the stock at an unsustainable level. A sustainable catch of approximately 100-120 tonnes, at 4,000 units of effort, has been estimated from the plateau of the catch and effort relationship (surplus production model) since 1987/88. A biomass dynamics model gives equilibrium values for catch and effort of approximately 100 tonnes and 4,000 units respectively. In a long-term scenario, the stock may not be sustainable with the levels of effort of nearly 8,000 units now in the fishery.

Breeding Stock Levels

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.

Catch Projection for Year 1998/99

The catch projection for 1998/99 is 102-142 tonnes. This estimate is based on the average of the observed catches for the past 10 years and the 95% confidence limits.

Product Value for Year 1997/98

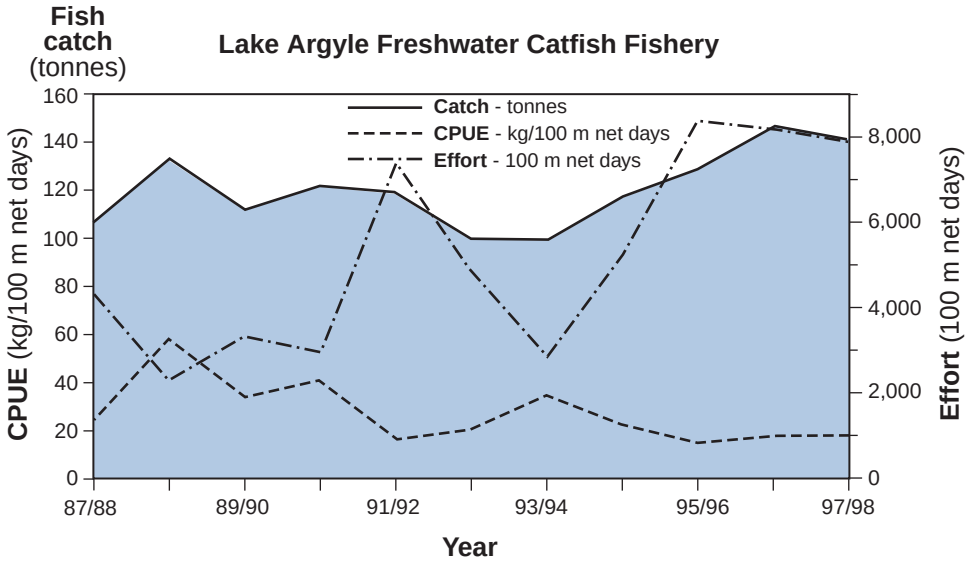
The landed value of the catch is approximately $387,000.

General Comments

An annual research report was made available for the annual management meeting with operators in Kununurra in February.

There has been some interest in whether the annual catches of Lake Argyle catfish are related to the area of Lake Argyle. Correlation analysis of the annual catch (tonnes) against the lake area did not produce a significant relationship.

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 very low fecundity of the species, which predisposes the stock to recruitment over-fishing. Noting that the current effort being expended in the fishery over the past two years is well above that needed for the estimated sustainable yield, management action is needed to contain any further increases in effort. Without a reduction in effort, the stock is likely to decline in future years.



Lake Argyle Figure 1 The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for Lake Argyle catfish over the period 1987/88 to 1997/98.

Kimberley Gillnet and Barramundi Managed Fishery

Management Overview

The Kimberley Gillnet and Barramundi Managed Fishery (KGBMF) extends from the WA/NT border to Eighty Mile Beach, south of Broome. 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.

Future management arrangements for this fishery are currently being considered.

As a result of the resource-sharing conflict between the KGBMF licensees and the recreational fishing sector, the Minister implemented a Fisheries Adjustment Scheme in April 1998 for voluntary surrender of KGBMF licences. This has reduced the number of KGBMF licences from 10 at the commencement of the scheme to seven as at June 1999.

Compliance and Community Education Overview

Limited resources coupled with the extensive geographical area of this fishery impose restrictions on compliance monitoring. Resource-sharing issues are increasing the demand for compliance activity, with the major areas of concern being the Lower Ord River and Roebuck Bay. In addition, many remote areas which have traditionally been accessed by this fishery have now become frequently visited tourist destinations. This has resulted from the establishment of fly in/fly out remote fishing camps and the increasing use of helicopters as a transport medium for recreational fishing tours.

The majority of compliance activities in this fishery relate to recreational fishing and continue to be in response to information reports from the public. Patrols were conducted to investigate reports of netting in closed water areas of Roebuck Bay and netting activity near the southern boundary of the fishery at Anna Plains.

Research Overview

The data necessary to assess the status of the series of barramundi stocks taken by this fishery is provided from CAESS. The following status report is compiled annually and provided to industry and regional management.

Fishery Status Report

Main Features

Stock assessment complete:
Only for barramundi (Lates calcarifer)

Exploitation status:
Barramundi fully exploited

Breeding stock levels:
Adequate for barramundi

Previous catch projections for year 1997/98:

Barramundi	*28-47 tonnes*

Catch current season (1997/98):

All species	*138.9 tonnes*
Barramundi	*32.4 tonnes*

Estimated annual value for year 1997/98:

All species	*$584,000*
Barramundi	*$240,000*

Catch projection next year (1998/99):

Barramundi	*25-40 tonnes*

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 eight vessels during 1997/98. It should be noted that the distribution of barramundi catches in Western Australia extends further south to the Ashburton River near Onslow, however, these catches are outside the boundaries of the managed fishery.

Annual Production

Main fishing method
Gillnet.

Landings
Each of five principal fishing areas is considered 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). Total landings of barramundi for all four prescribed fishing areas were 32.4 tonnes for 1997/98 (Barramundi Figure 1). This catch of barramundi was the lowest since 1981/82. In addition to the main target species, there was a reported catch of 106.6 tonnes of other fishes including approximately 3 tonnes of shark, 85.3 tonnes of giant threadfin and 18.2 tonnes of other finfish.

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 1997/98, the total effort across the four prescribed fishing areas was 1,418 units.

Catch rate
Overall, the fishery peaked in the mid- to late 1980s and since then, total catch and effort have fallen, with an accompanying increase in catch per unit of effort.

Stock Assessment

A biomass dynamics model was used to estimate preferred or optimum effort for the barramundi stock for each of the five principal fishing areas (including the Pilbara area which is outside the managed fishery). An annual effort of 500 units is the preferred level of effort from the model for Cambridge Gulf/Ord River and Broome. The preferred level is slightly higher for the Kimberley coast, King Sound/Fitzroy River and Pilbara coast. The 1997/98 fishing effort falls within the preferred levels described by the model, except on the Broome coast where equilibrium levels were exceeded.

Breeding Stock Levels

Assessment of the stocks indicates adequate levels of breeding stock to maintain recruitment to the fishery.

Catch Projection for Year 1998/99

The catch projection for barramundi for 1998/99 is 25-40 tonnes. This projection is derived by double exponential smoothed forecasting of the annual catches and the variation of observations around the predictions. The confidence intervals are set at 80%.

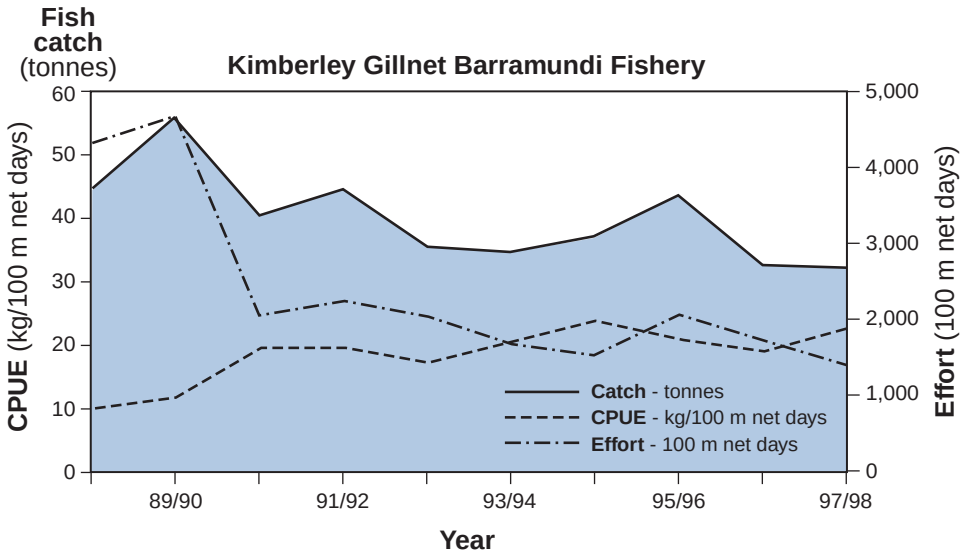
Product Value for Year 1997/98

The landed value of the catch is approximately $584,000 from the managed fishery.

General Comments

An annual research report was made available for the annual management meeting held in Broome in March. Management needs to consider, at least, the five subdivisions of the barramundi stocks over such a large distribution, because of differing histories of development, effort application, recreational interest and unit stock considerations. Barramundi are fished by unrestricted fishing boat licensees along the Pilbara

coast. There are no management restrictions on these fishers. Resource sharing between commercial and recreational fishers on the Ord River is a current issue. However, recent and anticipated levels of commercial fishing of existing operators pose no threat to the viability of the resource. In this reporting year, the catch of threadfin salmon was considerable, and higher than the catch of barramundi.



Barramundi 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 1997/98.

South Coast Purse Seine Managed Fishery

Management Overview

This fishery is based on the capture of pilchards *(Sardinops sagax)* by purse seine nets in the waters off the south coast of Western Australia between Cape Leeuwin and the WA/SA border. The product is highly regarded and has accessed numerous markets, 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 is thought to have had a serious impact on the stock. Although our knowledge of the pathogen is increasing every day, there is still much that is not known, 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), seasonal TACs have been declining in recent seasons, and the recent mortality event suggests it may be a number of seasons before any real recovery in fish numbers is observed.

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.

Compliance and Community Education Overview

Compliance activity in the South Coast Purse Seine Managed Fishery is undertaken by officers located at Albany and Esperance. Compliance activities concentrate almost exclusively on auditing the quota monitoring system, from both an administrative and an in-field perspective. At-sea inspections of zone boundaries, particularly in the Albany zone, are also carried out where possible.

Compliance with the quota system during the 1998/99 year was good. A reduced quota level within the fishery and a closure due to disease reduced the requirement for compliance and service levels were significantly lower than in previous years.

Research Overview

Data for setting catch quotas is derived from CAESS returns, quota returns and biological monitoring of the catch composition.

Research during 1999 will continue to focus on detailed monitoring of catches and fishing effort, together with regular fishery-independent spawning biomass surveys. These data together allow the annual review of stocks in each major zone and compilation of the following status report.

Research in 1999 will also focus on assessing the impact to Western Australian pilchard stocks of the mass mortality of pilchards which occurred throughout the species range in Western Australia in late 1998 and early 1999.

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate (overall)

Previous catch projections for year 1998:
Quota

Catch current season (1998):

South Coast total	*4,933 tonnes*
Albany zone	*2,085 tonnes*
Bremer Bay zone	*2,163 tonnes*
Esperance zone	*685 tonnes*

Estimated annual value (to fishers) for year 1998:
$3.4 million

Catch projection next year (1999):
Quota levels set prior to the mortality event were:

South coast total	*Quota:*	*5,200 tonnes*
Albany zone	*Quota:*	*1,500 tonnes*
	Effort:	*Not available*
Bremer Bay zone	*Quota:*	*1,900 tonnes*
	Effort:	*Not available*
Esperance zone	*Quota:*	*1,800 tonnes*
	Effort:	*Not available*

Recreational component:
Nil

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 (KGS) 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 exists, between Cape Leeuwin and Cape D'Entrecasteaux, but has not been fished significantly to date.)

The access to the fishery is under a limited entry system with each vessel having individually transferable quota.

Annual Production

Main fishing method

Purse seine net.

Landings

Using data from the quota returns, the catch of pilchards *(Sardinops sagax)* on the south coast in 1998 was 4,933 tonnes, with 2,085 tonnes from the Albany zone, 2,163 tonnes from the Bremer Bay zone and 685 tonnes from the Esperance zone (South Coast Purse Seine Figure 1). This is the lowest total catch of pilchards from the south coast for many years. Noting that Albany's TAC for 1998 was 3,000 tonnes, only 70% of this was achieved, which the Purse Seine Management Advisory Committee agreed was cause for serious concern over the status of the stock in this region. The Esperance catch was also much less than expected, having decreased from nearly 1,500 tonnes in 1997. Part of this decrease for Esperance was due to the need to close the fishery as a result of the mortality event which passed through the region during the peak catching period.

Fishing effort

Due to differences in fishing operations, effort will be reported separately for each zone.

Albany zone: Fifteen vessels recorded catches in the Albany zone in 1998, a decrease from 21 vessels in 1997. This represents a necessary step towards rationalisation of the size of the fleet, a process which needs to continue. The number of days fished (1,565 CAESS days) was accordingly lower than in 1997 (2,110 CAESS days). The amount of fuel used (182,300 litres), however, did not decrease but increased marginally.

Bremer Bay zone: There were six full-time fishing vessels again working this area. The number of boat days fished was 1,006, about 10% less than in 1997. Fuel use in 1998, however, increased to 72,840 litres, a rise of 19%.

Esperance zone: Six vessels fished in Esperance in 1998, but as in 1997, some landed pilchards in fewer than three months. The recorded number of CAESS days was about 543, similar to the 528 days used in 1997. Accurate figures for fuel used were not available for this region.

Catch rate

Albany zone: The catch rate using fuel consumption was 11.4 kg/L, a 33% decrease from 17.1 kg/L in 1997. The CAESS data indicated an 8% decrease to 1,332 kg/day from 1,443 kg/day in 1997, continuing the downward trend from 1,653 kg/day in 1996.

Bremer Bay zone: The catch rate for 1998 using fuel figures was 29.7 kg/L, a small decline from 35 kg/L in 1997. The CAESS data indicated that the catch rate was 2,150 kg/day, similar to that for 1997 (1,949 kg/day).

Esperance zone: Using only the two vessels which supplied fuel data on a regular basis, the catch rates in Esperance fell dramatically from around 23 kg/L to only 5.7 kg/L. Likewise, the CAESS data showed a decrease in catch rate from around 2,500 kg/day in recent years to only 1,261 kg/day.

Stock Assessment

The south coast population of pilchards is considered to consist of a single breeding stock, but with functionally distinct adult stocks at Albany, Bremer Bay and Esperance. Stock assessments for each zone are presented here, but a model which attempts to combine the biological and fishery data for each zone into a single stock assessment is still being developed. As a preliminary step towards this integrated model, detailed age-structured models have been developed for each of the three south coast zones. The results of these preliminary models, as presented to the Purse Seine MAC in late 1998 and early 1999, are presented for each zone. Furthermore, while the stock ass essments presented for each zone are for 1998, in each case the substantial losses due to the herpesvirus may cause serious declines in catches. The expected impact is not yet fully known and research into this issue will continue throughout much of 1999. As investigations indicate that the mortality due to the herpesvirus may be considerably greater than in the last mortality event (1995), severe cuts in TACs may be required in 2000/2001.

Albany zone: The assessment model indicated that the biomass at Albany has been declining since 1994 and is at its lowest recorded level. This result indicates that the Albany/KGS section of the south coast pilchard stock was still depleted at the end of 1998. The annual catch only amounted to about 70% of the TAC. While catches in a fishery could decrease substantially if there was a large shift in the distribution of a stock in response to anomalous environmental effects (e.g. elevated temperatures), the fact that the new model independently estimated that the pilchard biomass at Albany is in decline and is the lowest it has ever been supports the notion that a depressed stock contributed to the failure to achieve the TAC in this zone during 1998. Failure to achieve the TAC at Albany was therefore cause for serious concern

regarding the status of the stock, particularly since the model indicates that the stock is at its lowest level since the start of the fishery. Considering these results, a TAC of 0 tonnes was suggested for 1999/2000 as a low-risk option for the Albany stock. However, in an attempt to maintain the purse seine industry at Albany, intensive meetings were held between industry, management and research. A TAC of 1,500 tonnes was decided upon, recognising that this represented a moderately high risk to the stock. The recommended TAC was the lowest set thus far for this fishery, and may need to be revised further in the light of the virus mortality event.

Prior to the mortality, catch-at-age data for Albany indicated that the older age classes continued to dominate the catch (South Coast Purse Seine Figure 2). The pattern of flow-through of age classes was still evident and indicated that the age data continued to provide a good means of assessing trends in the adult stock at Albany. Furthermore, the data indicated that the age structure of the Albany adult stock was essentially still the same as that which was there in previous years, but with the addition of variable quantities of recruits. The level of recruitment of two-year-olds in 1998 was not as strong as in 1997, but was still reasonable. However, it should be noted that high levels of recruitment would have been required if the Albany stock of adults were to stop declining in size and increase, even without the advent of the virus mortality.

Bremer Bay zone: Bremer Bay has again had relatively poor recruitment compared to earlier years in the fishery. The decrease in the contribution to the catch at this region by four-year-olds which was seen in 1996 and 1997 was again evident in 1998. The increases in average length, weight and age (otolith weight) of pilchards from Bremer Bay recorded in 1997 was again evident in 1998 and indicates that the fishery in this region has continued to become more reliant on older age classes as a result of poor recruitment in recent years. However, there was a greater contribution of three-year-olds in 1998 which would have been expected to flow through as four-year-olds in 1999.

In assessing the Bremer Bay stock, an unexpected relationship between average weight, length and otolith weight has been noted during the mid-1990s. That is, weight and length were decreasing as otolith weight increased. This unusual relationship should not be used as a reason to ignore the overall evidence for a stock which is progressively becoming older. An older stock is indeed expected due to several years of poor recruitment, a very similar situation to that of the Albany region in recent years.

The model likewise indicated that the Bremer Bay stock was declining. The history of lower exploitation rates in this region than in Albany suggests that the stock decline at Bremer Bay was unlikely to be as severe as that which occurred at Albany. However, because the model indicated that the Bremer Bay biomass was in decline, the maintenance of current catch levels would have resulted in progressively larger exploitation rates, at least in the short term. That is, decreasing biomass automatically results in increasing exploitation rates. This suggested that maintaining catches at current levels (i.e. around 2,000 tonnes) represented a moderate to high risk for the Bremer Bay stock, prior to the virus mortality event. Noting the possible impact of the virus mortality, a full revision of the status of the stock will be needed during 1999.

Esperance zone: Esperance had a high level of recruitment in 1998. The proportion of two-year-olds in the catch was the highest recorded since 1992 and, prior to the mortality event, was indicative that the biomass should not decrease in size from 1998 to 1999. The relatively stable nature of the biomass at Esperance can be attributed to fewer years of poor recruitment than in the other south coast regions, and to a history of much lower exploitation rates. Although Esperance is similar to Albany in that catches in 1998 were much lower than expected, this had not yet given cause for concern because of the history of lower exploitation and because this fishery was not reliant on older age classes of fish. Exploitation rates based on the new model had yet to exceed 7% and appeared to be sustainable prior to the virus event. While the estimated biomass decreased during the period from 1994 to 1998, the good recruitment in 1998, along with the relatively consistent recruitment over the period of the fishery, had been enough to keep the biomass at a level similar to that prior to exploitation. Although no significant change to the TAC was planned for 1999, the virus impact has yet to be taken into account.

Breeding Stock Levels

Breeding stock for the entire south coast pilchard population was considered adequate during 1998, but with the acknowledgment that a localised depletion was evident at Albany and a similar situation was developing at Bremer Bay. Prior to the mortality event, the exploitable biomass for the Albany region in 1999 was estimated at 10,750 tonnes (± 50%), with the lower estimate more likely. The poor levels of recruitment at Bremer Bay in 1995-1997 continued in 1998, indicating that the breeding stock had been further reduced due to insufficient recruits to fully replace losses from natural and fishing mortality. The model estimates that the 1999 pre-mortality-event biomass of pilchards for the Bremer Bay zone would have been in the order of 16,080 tonnes (± 50%).

The model also indicated that the pre-mortality-event biomass of adult pilchards at Esperance in 1999 would have been 26,590 tonnes (± 50%). The plankton data and the catch-at-age information had indicated that there was a large breeding stock in the Esperance region. The Esperance component of the south coast breeding stock was thus considered to be relatively stable prior to the virus mortality event.

In order to estimate the size of the breeding stock following the mortality event, it is planned that the spawning biomass of pilchards in each of the south coast zones will be estimated using the daily egg production method during 1999.

Catch Projection for Year 1999

Owing to the possibility that the herpesvirus may have killed significant quantities of pilchards in Western Australia – and with evidence from the 1999/2000 season already suggesting that this is in fact the case – it is not possible to provide realistic predictions of catch rates. It appears likely that neither the Albany nor the Bremer Bay zone will catch the allocated quota in 1999. As the main catching season for Esperance is at the end of the calendar year, it is too early to speculate on possible catch levels for this region.

Product Value for Year 1998

Due to the lower south coast catch in 1998, the total amount of product consigned to pet food or for other bulk purposes (e.g. rock lobster bait, tuna food) decreased to about 5%, from a level of around 20% during 1997. The higher value angling blocks/trays and individually quick frozen (IQF) fish represented 95% of the total catch processed. The different product types for each zone are shown in South Coast Purse Seine Table 1.

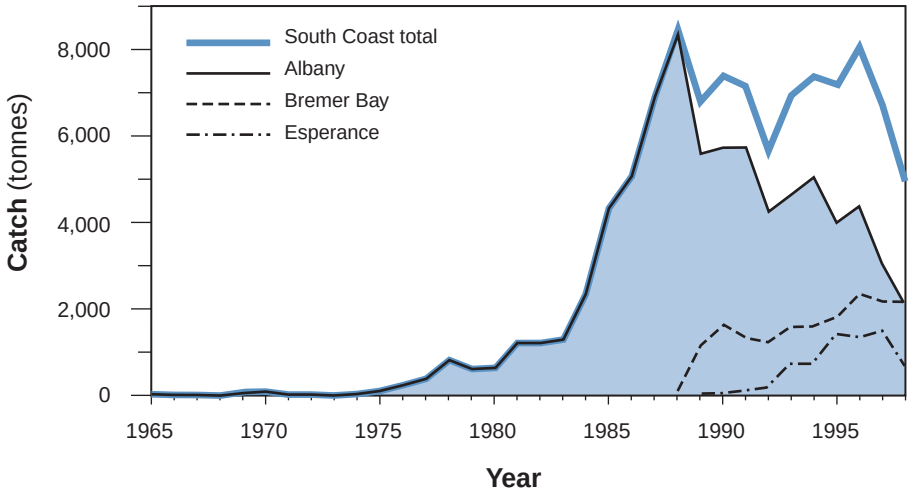
The price differential between pet food and angling bait was maintained. The price of pet/tuna food was $0.32-0.43/kg, while angling bait was similar to 1997, ranging from $0.65 to $0.75/kg in 1998. Total catch value for 1998 was approximately $3.4 million.

General Comments

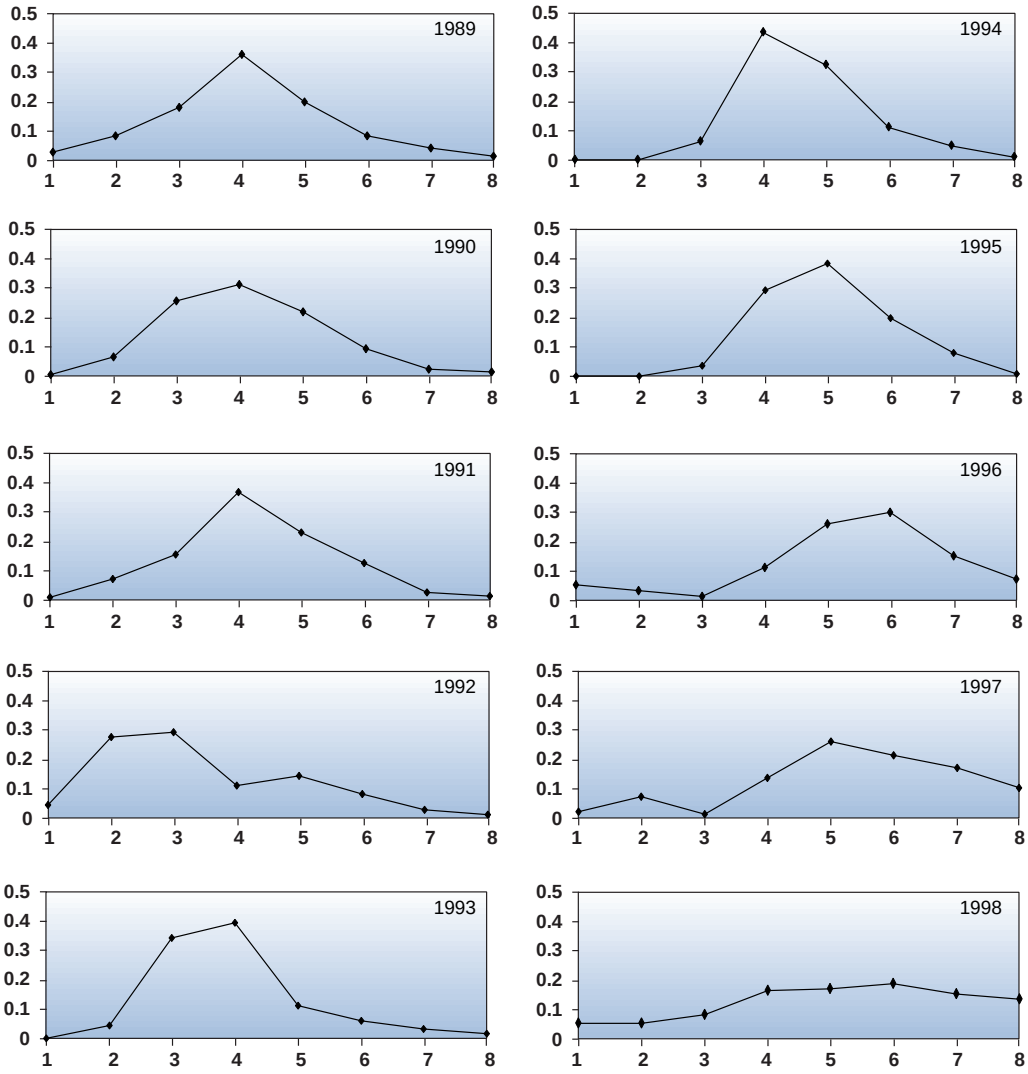
Assessment of the herpesvirus-induced mortality, along with monitoring of biological and fishery parameters, will continue. There is a possibility that the virus has had a significant effect on the entire south coast breeding stock, more than in the 1995 mortality event. This has implications for the short-term viability of the purse seine fisheries off southern Western Australia. Likewise, as 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.

South Coast Purse Seine Table 1 Processing details from Albany, Bremer Bay and Esperance for 1997.

Product	Albany	Bremer Bay	Esperance	Total south coast
Trays	1,413	1,369	442	3,224
IQF	588	691	180	1,459
Pet/tuna food	84	103	63	250
Total	**2,085**	**2,163**	**685**	**4,933**



South Coast Purse Seine Figure 1 Annual catch of pilchards on the south coast.



South Coast Purse Seine Figure 2 Annual catch-at-age curve (proportions by age-class) for the Albany zone including King George Sound.

West Coast Purse Seine Managed Fishery

Management Overview

This fishery is based on the capture of pilchards *(Sardinops sagax)* by purse seine nets in the waters off the west coast of Western Australia. The product is highly regarded and has accessed numerous markets, being sold for human consumption, angling bait, commercial bait, tuna food and pet food. The recreational angling bait market is currently the main focus.

As in the south coast fishery, the spread of a herpesvirus throughout the west coast in 1995 and again in 1998/99 is thought to have had a serious impact on the stock. The recent event and the possibility of a further outbreak represent a real threat to the industry.

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.

Compliance and Community Education Overview

The proposed introduction of quota management for this fishery is still to be implemented. This will increase the monitoring requirement to maintain the integrity of the quota allocation.

Research Overview

Research on this fishery continues to utilise CAESS data, biological monitoring of catches and spawning biomass estimates from egg and larval surveys.

These data are compiled into the following status report and ultimately will be used to set and review TACs once the fishery moves to quota management.

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited

Breeding stock levels:
Adequate

continued over

Previous catch projections for year 1998:
2,000-3,000 tonnes

Catch current season (1998):
1,832 tonnes

Estimated annual value (to fishers) for year 1998:
$1 million

Catch projection next year (1999):
Under review following pilchard mass mortality

Recreational component (1998):
Nil

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 to 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.

Annual Production

Main fishing method
Purse seine net.

Landings
The combined catch of pilchards for the managed fishery area and the developmental zone decreased substantially from 3,989 tonnes in 1996 to 2,378 tonnes in 1997 and 1,585 tonnes in 1998 (West Coast Purse Seine Figure 1). The catch of scaly mackerel increased from 70 tonnes in 1996 to 121 tonnes in 1997 and 247 tonnes in 1998.

The availability of adult pilchards in the fishery was low in 1998 but juveniles were reported by fishers as extremely abundant in the latter part of the year prior to the virus disease event. This observation was supported by analysis of the age structure of the catch throughout the year.

Fishing effort
Not available.

Catch rate
Not applicable.

Stock Assessment

In early 1999, a mass mortality event 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 similar disease event in 1995. A post-mortality biomass survey was considered necessary to estimate the size of the remaining stock.

In 1996, spawning biomass was estimated using a plankton-based survey to be at least 20,000 tonnes. The most recent spawning biomass survey was carried out in late July/early August of 1998 to estimate the spawning biomass of pilchards along the lower west coast of Western Australia between Yallingup (south of Cape Naturaliste) and Jurien Bay. This survey resulted in a spawning biomass estimate of 18,985 tonnes, with a range of 9,000-28,951 tonnes. An important result from the 1998 survey was the reduced confidence intervals. That is, the range of lower and upper limits around the best estimate of spawning biomass was much narrower than for the 1996 survey (13,000-55,000 tonnes). However, it was noted that the previous estimate was extrapolated from a very poor number of adult samples, a problem addressed in the 1998 survey. The tighter confidence intervals obtained in 1998 markedly reduced the range between the upper and lower limits. Of particular importance was the upper end of the range, which appeared to be much less than the estimate of 55,000 tonnes obtained in the 1996 survey. This most recent survey indicated that the spawning biomass of pilchards off the lower west coast was likely to have been less than 25,000 tonnes prior to the mortality event.

Large numbers of two- and three-year-old pilchards contributed to this fishery in 1996, suggesting that recruitment in the region was very good. This was confirmed in 1997 when three- and four-year-old pilchards dominated the annual catch, and in 1998 when four- and five-year-olds dominated the catch. In 1998, adult pilchards were less abundant than usual on the fishing grounds, although late in the year juveniles were very abundant, which had been expected to result in a strong recruitment of two- and three-year-old pilchards in 1999.

There is anecdotal evidence that the stock of pilchards off Fremantle moved away from the regular fishing grounds in late 1997 and that the more tropical scaly mackerel *(Sardinella lemuru)* largely replaced pilchards as the dominant sardine in the metropolitan region of the fishery. The decline in the pilchard catch which continued into 1998 may, therefore, have resulted from decreased availability to the fleet rather than sudden changes in stock size. However, there is no quantitative evidence for this assumption.

A review of the scientific advice provided by Fisheries WA was conducted in April 1999 by Dr Kevern Cochrane of the Food and Agriculture Organisation. The outcome of the review was that the stock assessment methods being used are appropriate. With specific reference to the west coast fishery, it was clear that the plankton-based surveys need to extend farther offshore to ensure that the whole of the spawning area is sampled.

Although a plankton-based survey of the spawning biomass was conducted in 1998, the mass mortality in early 1999 renders this biomass estimate invalid and a post-mortality survey is planned for July-August 1999.

Breeding Stock Levels

See Stock Assessment.

Catch Projection for Year 1999

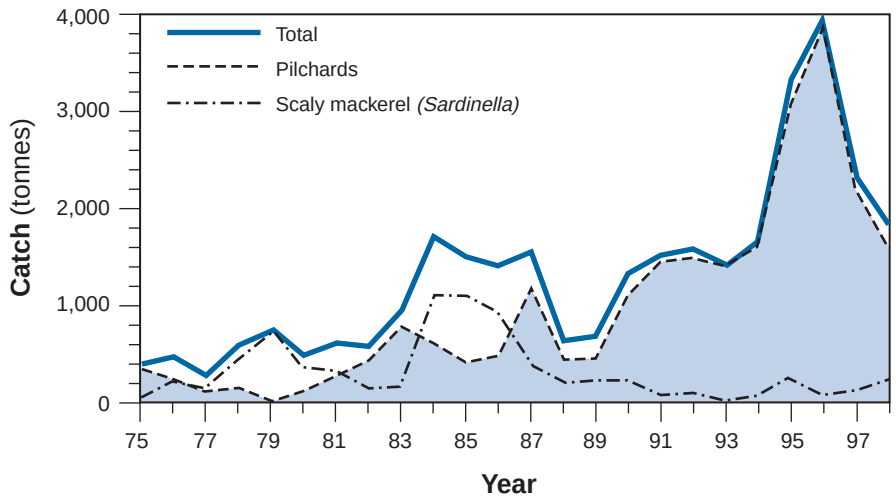
As a result of the unknown level of reduction in stock size due to the mass mortality in early 1999, a catch projection cannot be made.

Product Value for Year 1998

The majority of the product is still processed for angling bait, pet food and tuna food, although increasing amounts are now processed for human consumption. Total catch value for 1998 was approximately $1 million.

General Comments

A TAC of 3,000 tonnes (15% of the then spawning biomass of 20,000 tonnes) was proposed for this fishery in 1997 but was not implemented, and a management plan for this fishery has yet to be finalised. Less than 2,500 tonnes were caught in 1997, and less than 2,000 tonnes in 1998 in the absence of any quota restrictions, indicating that the stock size was smaller than estimated or that the stock had moved out of the normal searching range of the fishery. The reduction in stock size due to the mass mortality in 1999 is unknown. The biomass survey in 1999 will extend much farther offshore than previous surveys, taking into account any offshore shift in pilchard distribution. The post-mortality biomass estimate from this survey will be used to advise on appropriate TACs for the west coast fishery for the year 2000.



West Coast Purse Seine Figure 1 Annual catch of pilchards and scaly mackerel along the lower west coast.

Northern Demersal Scalefish Interim Managed Fishery

Management Overview

The Northern Demersal Scalefish Interim Managed Fishery (NDSIMF) was established on 1 January 1998. The boats with access to this fishery previously operated within the Kimberley Trap Fishery and the Kimberley Demersal Line Interim Managed Fishery. Several applicants seeking authorisation to operate within this fishery are involved in an independent tribunal process, which will determine their future access.

Both the trap and line sectors target demersal scalefish. The management methods for this fishery presently include a limited number of vessels, gear restrictions, size limits for some species and unitisation of time access.

This fishery was established by the Minister following a report from a working group set up in August 1995 to develop recommendations on long-term management arrangements for the Northern Demersal Scalefish Interim Managed Fishery.

In April 1998, the Minister appointed a Management Advisory Committee (MAC) for the fishery.

It is anticipated that the fishery will move to fully managed fishery status on 1 January 2000 at the cessation of the interim management arrangements.

The permit holders, the MAC and Fisheries WA are currently preparing a draft management plan for the Minister's consideration.

Compliance and Community Education Overview

The vessels in this fishery are based mainly at Broome, with some operating from Darwin at certain times of the year. During 1998/99 seven boats, utilising varying access entitlements, participated in the fishery. The fishery is under interim management arrangements and is managed mainly under time, gear and area restrictions.

The Vessel Monitoring System (VMS) is the major compliance tool used in this fishery, and compliance largely centres on the use of this system to manage individual fishing units' access time. Patrols were conducted to inspect catch during jetty unloads and at local processing establishments. Gear inspections were conducted during at-sea patrols using the joint agency patrol vessel *Walcott*.

Research Overview

A major research project is under way to assess the status of the major stocks which contribute to this fishery. This project will continue to the end of the year 1999/2000 and will provide the basis for setting long-term effort levels to maintain catches.

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

Fishery Status Report

Main Features

Stock assessment complete:
No

Exploitation status:
Fully exploited

Breeding stock levels:
Limited data

Previous catch projections for year 1998:
Not available

Catch current season (1998):
544 tonnes

Estimated annual value (to fishers) for year 1998:
$2.7 million

Catch projection next year (1999):
600-1,000 tonnes

Recreational component (1998):
Recreational fishing pressure in the Broome region is increasing, and potentially involves thousands of anglers per year. At present there is little recreational fishing effort directed towards deeper water fish species which are the key species targeted in the commercial fishery.

Boundaries and Access

The waters of the Northern Demersal Scalefish Interim Managed Fishery 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 (Zone 1) and an offshore zone (Zone 2) (see Northern Demersal Scalefish Figure 1). The demersal scalefish resources of the deeper waters of the offshore zone (greater than 200 m depth) are currently being investigated; these waters are shown on Figure 1 as the research fishing zone.

The inshore waters in the vicinity of Broome are closed to commercial fishing. The closed area extends from Cape Bossut to Cape Coulomb, inside a line which approximates as closely as possible the 30 m bathymetric contour.

Access to the Northern Demersal Scalefish Interim Managed Fishery is currently limited to 11 vessels.

Annual Production

Main fishing method

Fish trap and line techniques, mainly handline/dropline.

Landings

The reported catch in the Northern Demersal Scalefish Interim Managed Fishery declined in 1997 and 1998 after steady increases in reported catches from 1992 to 1996 (see Northern Demersal Scalefish Figure 2, Northern Demersal Scalefish Table 1). The reported catches in both sectors (line and trap) of the fishery were down on previous years. The trap catch in 1998 was 499 tonnes, while the line catch was 45 tonnes. A number of operators within the NDSIMF are also involved in other fisheries in the region, such as the fishery 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 in the Kimberley region increased to over 500 tonnes in 1997, but was much reduced in 1998 at just over 400 tonnes (see Northern Demersal Scalefish Figure 3, Northern Demersal Scalefish Table 2).

Fishing effort

The fish trap effort (in boat days fished) in 1998 was down on the 1997 level of fishing effort in response to the introduction of management controls (see Northern Demersal Scalefish Table 1). A large proportion of the allocated effort in the fishery was not utilised and this was reflected in lower catches. However, the CPUE was relatively stable, suggesting that the reduction in catch was not related to a stock decline. The line effort recorded in 1998 was only 10% of that recorded in 1997 (Northern Demersal Scalefish Table 1). The reduced line effort in 1998 resulted from some fishers operating in other fisheries until the latter part of 1998 and a reduced number of line boats operating within the fishery.

Catch rate

Catch per unit effort in the trap fishery was comparatively stable prior to 1997. The 1997 CPUE was down on previous years and suggested a slight downward trend. However, the implementation of management controls (i.e. a limitation on the available fishing effort) in 1998 has corresponded to an increase in the trap CPUE. The CPUE of the line fishery has been relatively stable over the past three years.

Stock Assessment

The introduction of formal management procedures has restricted the number of vessels permitted to fish the NDSIMF. A target total allowable catch of 800 tonnes was adopted so that the industry will be well positioned when the results of the stock assessment are finalised. The control adopted 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 NDSIMF demersal scalefish resource. Trap and line effort units are allocated on the basis of historical catch rates to enable the target catch to be achieved. Decision rules have been introduced to manage variations in catch around the target TAC.

A major three-year FRDC-funded research project began in 1997. The primary objective of this research project is to undertake a stock assessment of the key demersal finfish species in the NDSIMF, principally red emperor and goldband snapper. Preliminary results to date suggest a somewhat truncated length-frequency distribution for red emperor compared with the Pilbara fishery, which is currently operating above optimum levels. However, the level of exploitation of these species remains to be quantified in the Kimberley region.

Breeding Stock Levels

Limited data are available on breeding stock levels for the key species in this multi-species fishery at this stage in the research project. However, preliminary estimates of the size at maturity for goldband snapper and red emperor are approximately 46 cm and 44 cm fork length, respectively. Examination of the length-frequency distributions of these species from commercial catch sampling indicates that approximately 69% of goldband snapper and 68% of red emperor landed are above the preliminary estimates of the size at maturity.

Catch Projection for Year 1999

The allowable effort in 1999 has continued to be adjusted to target a TAC of approximately 800 tonnes. The effort level set for the 1999 calendar year was a total of approximately 1,716 fishing boat days, which is equitably distributed among all licence holders within the fishery. If the 1998 CPUE is maintained and all allocated effort is utilised, the target TAC of 800 tonnes will be achieved in the 1999 calendar year. If the CPUE and associated catch in 1999 decline below those achieved in 1998, a review will be undertaken to determine whether management action is required.

Product Value for Year 1998

The NDSIMF principally targets the high-value species such as red emperor and goldband snapper and landed a total of 544 tonnes of demersal scalefish in 1998, for a catch value of over $2.7 million. This value is down about 10% from the previous year owing to the lower catch. However, the average price received was marginally better in 1998.

General Comments

Currently, the demersal fishes of the Kimberley region are likely to be fully exploited and some species may be over-exploited. Detailed stock assessments of the key demersal finfish species to determine the stock exploitation status will be undertaken at the conclusion of the initial three-year research project in 1999/2000.

Northern Demersal Scalefish Table 1 Demersal finfish catches by method in the NDSIMF (longitude 120° to 129° E).

Year	Line		Fish trap		Total catch (kg)
	Catch (kg)	Effort** (block days)*	Catch (kg)	Effort (block days)*	
1985	9,031	310	3,832	261	12,863
1986	10,985	219	1,092	111	12,077
1987	29,680	498	150	49	29,830
1988	11,015	572	11,186	203	22,201
1989	27,205	267	26,595	81	53,800
1990	5,826	91	203,941	395	209,767
1991	20,407	255	316,228	750	336,635
1992	30,693	433	695,954	1,776	726,647
1993	24,240	283	747,215	1,713	771,455
1994	76,930	453	656,937	1,349	733,867
1995	272,840	1,204	555,162	1,200	828,002
1996	243,863	1,319	706,063	1,412	949,926
1997	147,582	788	555,172	1,293	702,754
1998	44,703	79	498,984	845#	543,687

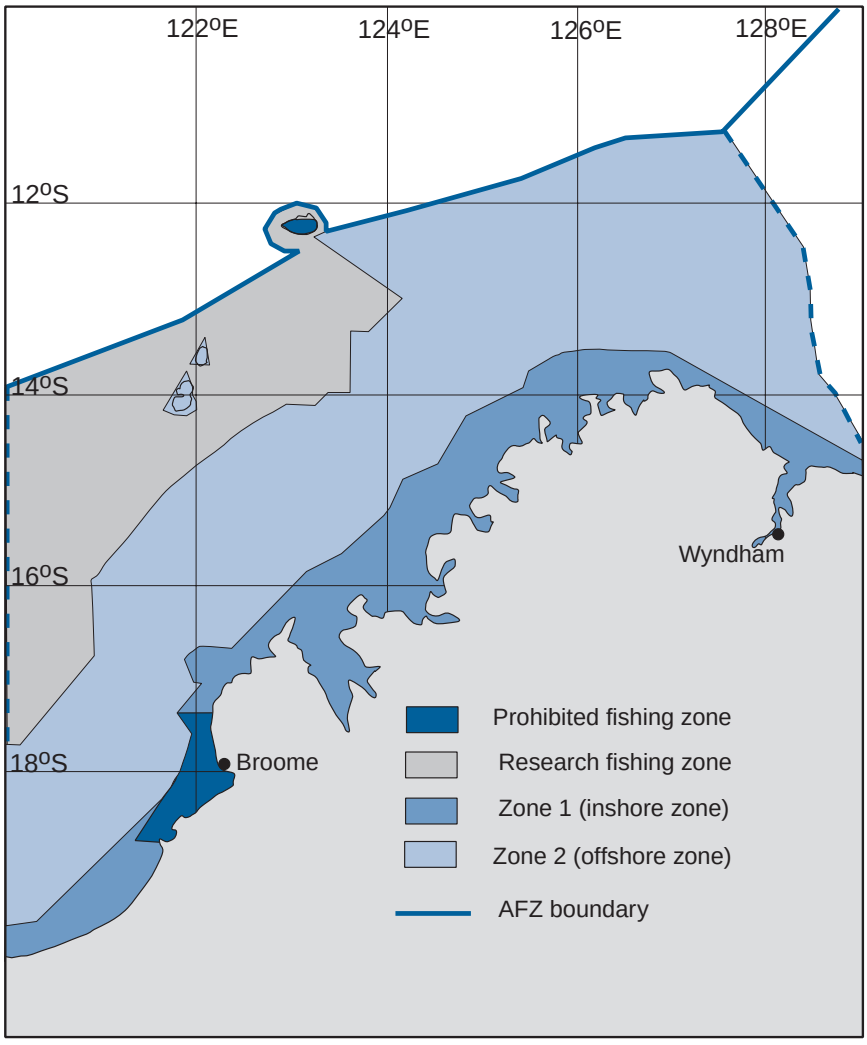
* Block days are defined as the number of days on which fishing occurred in a particular block by a particular vessel (that is, block boat days).

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

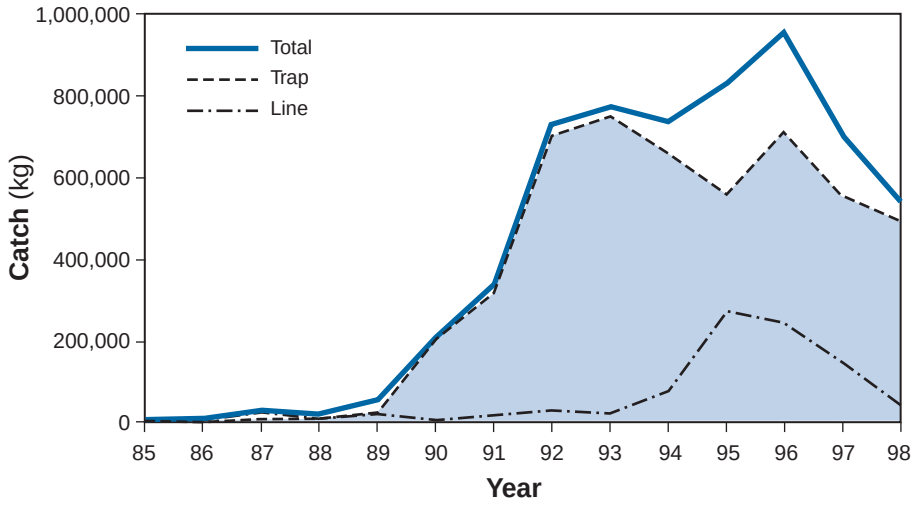
\# Trap fishing effort in 1998 has been converted to standard trap fishing days for comparison with previous years.

Northern Demersal Scalefish Table 2 Catches of mackerel in the Kimberley region (longitude 120° to 129° E).

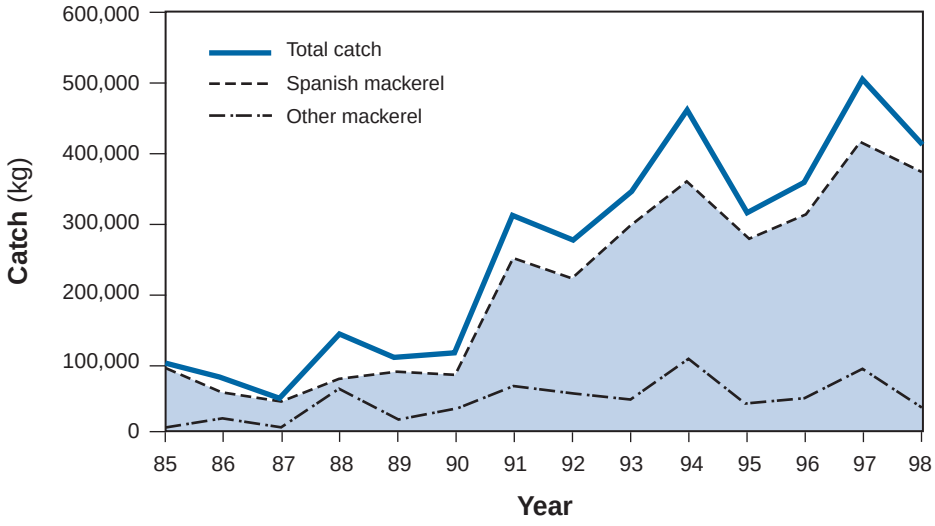
Year	Spanish mackerel (kg)	Other mackerel (kg)	Total catch (kg)
1985	92,303	7,361	99,664
1986	58,069	18,590	76,659
1987	44,663	4,074	48,737
1988	77,111	63,643	140,754
1989	88,150	17,705	105,855
1990	80,935	33,113	114,048
1991	247,287	63,886	311,173
1992	221,008	53,716	274,724
1993	294,170	45,699	339,869
1994	357,485	103,198	460,683
1995	274,634	40,062	314,695
1996	310,426	47,540	357,966
1997	415,017	89,663	504,680
1998	374,534	36,325	410,859



Northern Demersal Scalefish Figure 1 Boundaries and access zones of the NDSIMF.



Northern Demersal Scalefish Figure 2 Catch of demersal scalefish in the NDSIMF.



Northern Demersal Scalefish Figure 3 Catch of Spanish mackerel in the Kimberley region.

Pilbara Demersal Finfish Fisheries

Management Overview

Since the early 1990s, the majority of demersal finfish taken off the North-West Shelf have come from the Pilbara Fish Trawl Interim Managed Fishery. There are 11 licensed fishing boats in this fishery.

Fishing effort in this fishery is controlled through area closures, gear restrictions and time units monitored by the Vessel Monitoring System (VMS). Owing to concerns about excess effort in this fishery, a 33% reduction in time units was introduced under the management plan in January 1999.

There are six licensees in the Pilbara Trap Managed Fishery. Each licensee has been granted an initial allocation of 13 traps which are transferable amongst licensees, although the management plan allows the Executive Director to alter the value of a trap unit. New management arrangements for the Pilbara Trap Managed Fishery are currently being developed.

Management arrangements for the Pilbara Line Fishery are also currently under review, with consideration being given to submissions received from the discussion paper 'Management options for Pilbara demersal line fishing', released in November 1997.

Compliance and Community Education Overview

Since January 1998, the Pilbara Fish Trawl Interim Managed Fishery has been primarily monitored from the Karratha District Office via the Fisheries WA Vessel Monitoring System. In addition, Fisheries Officers from the Pilbara region have carried out numerous land-based and sea patrols to inspect the Pilbara fish trawl fleet, concentrating mainly on ensuring that all crew and vessels are appropriately licensed and that only the permitted fishing gear is being used. Catches are also checked on a regular basis.

Within the Pilbara Trap Managed Fishery, Fisheries Officers, with officers from DOT, completed two patrols utilising the PV *Walcott*. At sea inspections, as well as checks on licences and catches were carried out.

A number of checks on catches and licences were also carried out on Pilbara Line Fishery vessels, specifically at Port Headland, Point Sampson, Dampier and Onslow. No offences were detected.

Research Overview

Baseline research for managing these important fish stocks began in 1994/95. A second three-year FRDC-funded project, ending in June 1999, completes the work on the major target species and has provided 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 undertaken in conjunction with commercial trawlers under a separate FRDC-funded project.

The following status report, which provides a synthesis of the data from the fishery, is based on the results of this research and monitoring.

Fishery Status Report

Main Features

Stock assessment complete:

Trawl fishery	*Yes*
Trap and line fishery	*No*

Exploitation status:

Trawl fishery	*The most abundant, short-lived species range from under-exploited in some areas to over-exploited in other areas. Some long-lived species are over-exploited.*
Trap and line fishery	*Fully exploited*

Breeding stock levels:

Red emperor spawning stock is not adequate in the west of the trawl fishery

Previous catch projections for year 1998:

Trawl fishery	*2,300-2,700 tonnes*
Trap and line fishery	*Not available*

Catch current season (1998):

Trawl fishery	*2,512 tonnes*
Trap fishery	*250 tonnes*
Line fishery	*78 tonnes*
Troll (mackerel)	*121 tonnes*
Shark (all fishing methods)	*333 tonnes*
Charter	*36 tonnes*
Netting (excluding shark)	*24 tonnes*

Estimated annual value (to fishers) for year 1998:

$10.3 million

Catch projection next year (1999):

Trawl fishery	*2,300-2,600 tonnes*
Trap and line fishery	*Not available*
Mackerel, tuna, shark	*Not available*

Recreational component (1999):

Unknown

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 the 200 m isobath and seaward of a line generally following the 30 m isobath. This has been a managed fishery since 1992. The number of licences was reduced from 12 to six in 1996. In 1997, this fishery was converted to trap units, with a limit of 78 traps, or 13 traps/licence. The trap units are fully transferable.

The boundaries of the Pilbara Fish Trawl Interim Managed Fishery (Pilbara Figure 1) are the waters lying north of latitude 21°35′ S and between longitudes 114°9′36″ E and 120° E on the landward side of 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 in 1998 set down boundaries for six management sub-areas. There are 11 licence units with varying time allocations throughout Areas 1 to 6.

Line fishing is unrestricted in all areas of the fishery, but planning for limiting access 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 Managed Fishery Management Plan 1992 and the Pilbara Fish Trawl Interim Managed Fishery Management Plan 1997.

Annual Production

Main fishing method

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

Landings

Catch of the major species for 1998 is shown in Pilbara Table 1. The catches by different fishing methods for the years 1985 to 1998 are shown in Pilbara Table 2. A summary for 1998 is given below.

Demersal scalefish by trawl, trap and line	2,840 tonnes
Mackerel	121 tonnes
Shark	333 tonnes

The 1998 trawl fishery catch (1997 catch in brackets) was 2,512 tonnes (2,630 t). The reduced catch was expected as a result of effort reductions contained in the management plan introduced in January 1998. The major species landed in 1998 (1997 catch in brackets) were blue spot emperor 466 tonnes (446 t), red snapper 309 tonnes (253 t), red emperor 91 tonnes (149 t), flagfish 197 tonnes (188 t), threadfin bream 288 tonnes (273 t), and Rankin cod 33 tonnes (44 t). The catches of the larger, valuable species – red emperor, Rankin cod and scarlet perch – decreased in 1998 (as they did in 1997). The catches of blue spot emperor, flagfish, and rosy threadfin bream were similar to last year's catches.

The trap fishery catch is still stable, being 250 tonnes in 1998 (234 tonnes in 1997); line fishing catches were lower at 78 tonnes (109 tonnes), while trolling produced 121 tonnes (152 tonnes). Major species taken by trap and line were spangled emperor, red emperor, jobfish, Rankin cod and red snapper.

Shark fishing in 1998 produced a catch of 333 tonnes (96 tonnes), the increase being due to the three-month operation of a foreign longliner and increased retention of shark. Troll catches were predominantly mackerel.

The reported charter fishing catches are for vessels operating out of Exmouth and Onslow. These vessels fish primarily in the area between longitudes 114° and 116° east, where fish are plentiful around the offshore islands. The reported catches had been steadily increasing up to 1996, before a substantial decrease in 1997 and recovery in 1998.

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 1998 is also recorded as the net bottom time taken from skippers' logbook data.

In the trawl fleet there are the equivalent of seven full-time vessels. The number of hours the fleet spent in each area of the fishery (measured by a satellite monitoring system), and the allocated effort in brackets, were:

Area 1 15,076 (17,136)
Area 2 3,842 (3,360)
Area 3 0 (0)
Area 4 3,736 (3,360)
Area 5 4,955 (5,712)

The plan allows for some flexibility in the effort distribution between areas which resulted in an effort over-run of 14% and 11% in Areas 2 and 4 respectively. The deeper waters of Area 6 have a different species composition, and these species are expected to be more vulnerable to over-fishing than those closer to shore. This area was open to research trawling only, and the extent and nature of the resource have been investigated through research surveys undertaken by commercial trawlers.

Trapping by five boats resulted in 503 days effort in 1998 (compared to 330 days in 1997). Considerable effort increase is possible in the future, and further measures are required to reduce latent effort in this fleet.

In 1998, 39 line fishers reported operating for 692 days (733 days in 1997). The unrestricted access of line fishers to the Pilbara remains a potential problem but is being addressed by a line fishing review currently in progress.

The fishing activities of trap and line fishers have continued to expand into the waters seaward of the 100 m depth contour.

Catch rate

The catch rates (based on nominal effort) of red emperor and Rankin cod have declined in Areas 1, 3, 4 and 5, and blue spot emperor catch rates have declined in Areas 1 and 2 over the last three years. 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 because of improving skipper efficiency and use of electronic equipment to target fish. This expected efficiency increase means that the catch rate decrease is likely to be greater than that observed from the catch and effort data.

Catch rates for the trap fishery (based on the reported number of days fished) peaked in 1996 in the west of the fishery, and after a decline in 1997 recovered in 1998. The catch rates are generally higher in the east than in the west and this pattern has been constant for the last three years. The catch rates fluctuate, however, as skilled operators move in and out of the fishery.

The catch rates in the line fishery (based on the reported number of days fished) continue to fluctuate in both the western and eastern areas of the fishery as a few skilled operators commence and cease operations.

Catch rates for mackerel and shark are not available owing to the lack of detail in the reported effort information.

Stock Assessment

Trawl fishery: The continued decline in the catch rates of the long-lived species red emperor and Rankin cod, and the recent decline in blue spot emperor catch rates, indicate that the stocks of some species continue to be over-exploited. An age-structured model (using biological information, age structure, catch and catch rates) was used to assess the red emperor and blue spot emperor stocks. The assessment criterion was that 'the spawning biomass should not decrease below 25% of the virgin level'. The assessment indicated that red emperor decreased below the reference criterion in 1997 and 1998 in Area 1 and would decline to a low level at the current effort levels. In Area 2, the red emperor spawning biomass was close to the reference criterion in 1998 but at the 1998 effort level would be expected to increase. At the 1998 effort level, 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 reference point. There was no indication of decline for this species in Area 2. For red emperor and blue spot emperor, there was insufficient information for an assessment to be made in Areas 4, 5 or 6. In light of this assessment, the management plan was modified for 1999 with a 33% effort reduction in Area 1 and a 9% effort reduction in Areas 4 and 5.

Trap and line fishery: The catch rates have shown no decline in recent years but fluctuate with the changing efforts of a few skilful and dedicated operators. The effort and catch should be contained at the level of the last two years.

100 m to 200 m depth zone: Data has been collected on the species composition and the extent of the resource in this area but the results are not yet available.

Breeding Stock Levels

The spawning biomass of red emperor was estimated to have fallen below the reference point in Area 1 in 1997 and 1998. 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. Recovery of the spawning stocks in Area 1 is expected with the 1999 effort reductions. Careful ongoing monitoring to ensure compliance with effort reductions is required to maintain satisfactory breeding stock levels of the long-lived species.

Catch Projection for Year 1999

The catch projection for the trawl fishery is 2,300-2,600 tonnes, in line with the decrease in effort instigated by the management plan. Line and trap fishing, trolling and shark fishing are in a dynamic state and catch projections are not possible.

Product Value for Year 1998

$10.3 million.

There has been little overall increase in prices in the last 12 months, but the price of red emperor has continued to rise. The value of the trawl fish catch varies depending on the species mix of the catch, which consists of low-valued species such as blue spot emperor and threadfin bream (landed value $2/kg), and higher-valued species, like red emperor and jobfish, with a landed value of $5-$8/kg. The trap and line catch is dominated by the valuable species such as red emperor and jobfish.

The estimated value of the production of each sector in 1998 is:

Trawl	2,512 t @ $2.95/kg	$7.4 million
Trap and line	328 t @ $5.00/kg	$1.6 million
Troll	121 t @ $6.50/kg	$0.8 million
Shark	333 t @ $1.50/kg	$0.5 million
Total		$10.3 million

The prices above may contain some component of freight and handling and landed prices may in some cases be lower.

General Comments

The trap and line fishery continues to operate at a low level in the Pilbara region, but there is considerable latent effort in the trap fishery and, at present, unrestricted access by line fishers. The Pilbara fish trawl fleet catches declined in 1998 and the further effort reductions in 1999 are likely to allow recovery of the long-lived species like red emperor and Rankin cod. The smaller species such as flagfish and threadfin bream are probably under-exploited and to some extent the effort distribution can be directed to areas where small species are more abundant and long-lived species less abundant, but it would be valuable to develop fishing methods which increase catches of these species without increasing catches of the large, long-lived species. Improved marketing strategies are required to get a better economic return from the small species. Research is needed to obtain a better understanding of the relationship between habitat changes and recruitment levels within the trawl fishery area.

Pilbara Table 1 Commercial catches in tonnes and the percentages of each major species taken by trawl, trap and line in the Pilbara fishery in 1998.

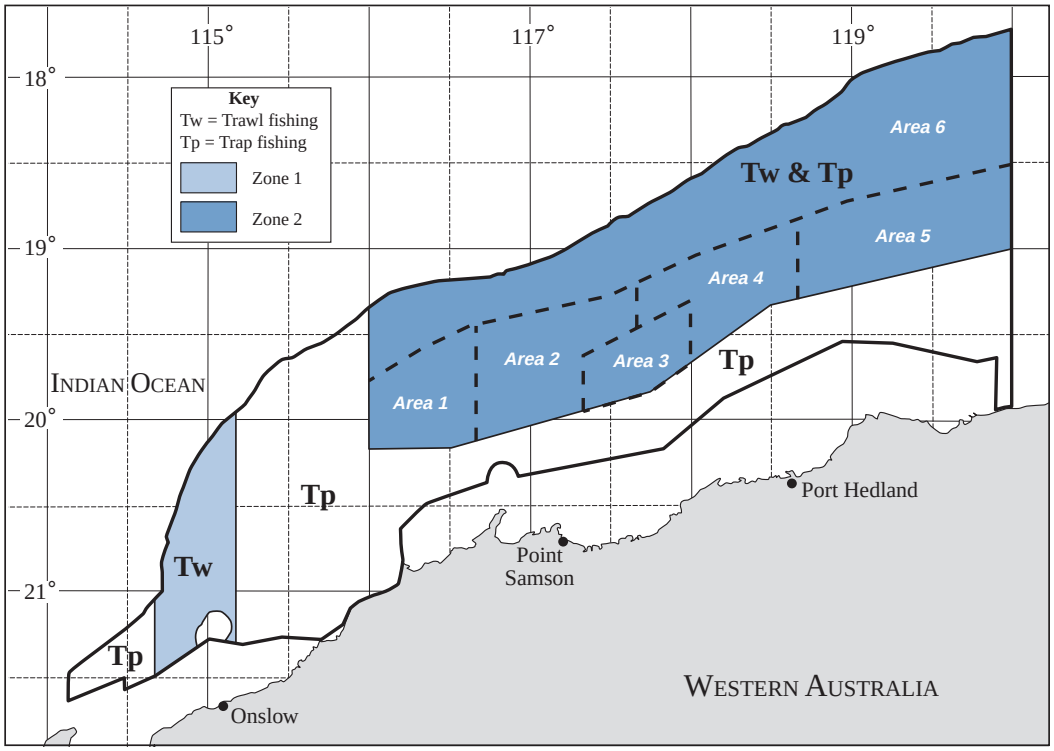
	Fish trawl catch		Trap catch		Line catch		Total catch
	tonnes	%	tonnes	%	tonnes	%	tonnes
red emperor	91	65	42	30	7	5	140
Rankin cod	33	43	39	51	5	6	77
scarlet perch	91	89	8	8	3	3	102
red snapper	309	95	14	4	3	1	326
jobfish	104	80	15	12	11	8	130
spangled emperor	48	47	36	35	18	18	102
blue spot emperor	466	91	46	9	1	0	513
flagfish	197	99	2	1	-	0	199
threadfin bream	288	100	-	0	-	0	288
frypan snapper	76	99	1	1	-	0	77
other species	809	91	47	5	31	4	887
All demersal	2,512	88	250	9	78	3	2,840

Pilbara Table 2 Summary of reported commercial catches (tonnes) of demersal scalefish by line, trap and trawl, total demersal scalefish, scombrid catch by trolling, shark catch by all methods, and the reported charter catch, in the Pilbara fishery.

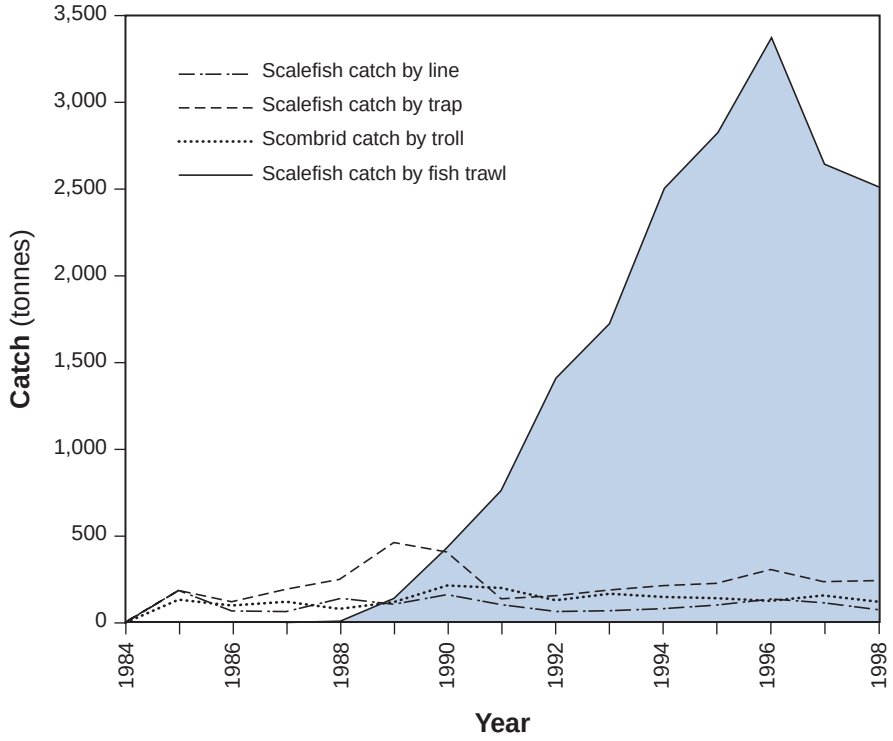
Year	Line	Trap	Trawl	Demersal scalefish	Troll	Shark	Charter
1985	180	168	-	348	132	22	-
1986	65	113	-	178	97	25	-
1987	67	192	3	262	119	19	-
1988	136	243	3	382	79	24	-
1989	104	457	124	685	116	29	-
1990	157	407	421	985	209	57	-
1991	107	119	754	980	196	132	3
1992	63	148	1,413	1,624	125	273	7
1993	67	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

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	1198	310	-
1990	1332	1321	698	-
1991	740	472	1132	8,660
1992	514	681	983	10,030
1993	876	696	832	10,725
1994	732	545	1484	22,087
1995	852	608	1571	21,529
1996	814	513	1550	25,246
1997	809	483	1389	19,810
1998	692	503	1291	20,555



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, troll and trawl.

Shark Bay Snapper Managed Fishery

Management Overview

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.

Throughout 1998/99, Fisheries WA management and legal staff have developed a new draft management plan, based on the recommendations of a working group formed to review management of the fishery. It is anticipated that the new plan will simplify the current complex management and administrative arrangements while providing more flexibility for both industry and Fisheries WA.

Compliance and Community Education Overview

Fisheries Officers from Denham and Carnarvon carried out licence inspections and monitored pink snapper landings over the peak season to ensure the integrity of the quota system was maintained. Several minor licensing breaches were found.

Processor monitoring and inspections were also carried out periodically.

Fisheries Officers and management staff held an annual consultative meeting to provide information on compliance and other issues within the fishery.

Research Overview

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

Monitoring of the fishery is undertaken annually using CAESS data.

This monitoring data has been used to provided the following status report.

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
The Shark Bay snapper stock is close to fully exploited

Breeding stock levels:
Adequate

Previous catch projections for year 1998:
500-550 tonnes with 1000 standard boat days effort

continued over

Catch current season (1998):

Pink snapper	*567 tonnes*
Other finfish	*143 tonnes*

Estimated annual value (to fishers) for year 1998:

Pink snapper	*$2.35 million*
Other species	*$0.6 million*

Catch projection next year (1999):
550 tonnes

Recreational component (1998):
14 tonnes (estimated)

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. Catches of snapper in the peak fishing season are subject to individual quotas, while gear controls apply in the off-peak season. The peak season catch in 1998 was 410 tonnes and the off-peak catch was 157 tonnes.

Annual Production

Main fishing method
Mechanised handline.

Landings
Catches of snapper from the ocean stock in 1997 and in 1998 were slightly higher than normal due to improving market capacity as markets other than Japan are developed. The pink snapper catch in 1998 was 567 tonnes. The snapper fishery also took 143 tonnes of other finfish species in 1998.

Fishing effort
The effectiveness of fishing effort varies markedly on a seasonal basis. Fishing effort in 1998 was 984 standard June-July line boat days.

Catch rate
Catch/line boat day of the managed fishery licensed boats for the peak months (June-July) was 576 kg in 1998 (Shark Bay Snapper Figure 1), slightly more than the 10-year average of 552 kg/boat day.

Stock Assessment

The pink snapper stock is close to fully exploited. A stock production model assessment in the mid-1980s produced an estimated maximum sustainable yield of around 600 tonnes.

Breeding Stock Levels

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, particularly in the eastern gulf where the breeding stock level is seriously depleted.

Catch Projection for Year 1999

1999 snapper catches are likely to be around 550 tonnes. Effort is likely to be around 1,000 standard June-July line boat days.

Recreational Component

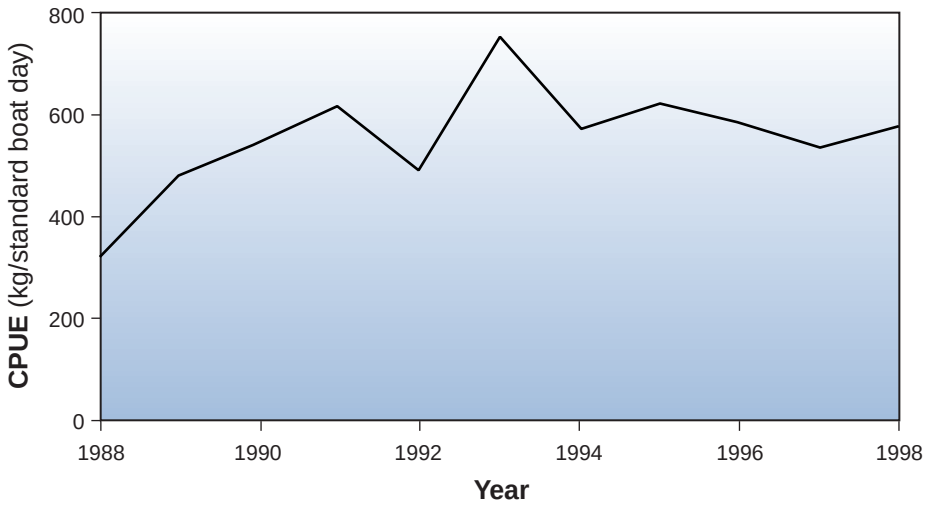
For the genetically distinct inner bay stocks (not covered by this status report), most of the catch is recreational and is now subject to separate management arrangements. Research for management of these stocks is reported under the Recreational Fisheries Program. The Gascoyne Recreational Fishing Survey, conducted between April 1998 and March 1999, has estimated the recreational catch from the offshore stock at 14 tonnes, approximately 2.5% of the commercial catch.

Product Value for Year 1998

Japanese demand for snapper has been declining in recent years and efforts have been made to explore other overseas and eastern states markets. In 1996, prices reached the lowest level for a decade at $3.90/kg. Average price in the 1998 season was $4.15/kg.

General Comments

Biologically, the stock exploited by the Shark Bay Snapper Managed Fishery is in good condition and is being successfully maintained by the combination of peak season quotas and off-season gear controls. Simplification of the complex management arrangements under an amended management plan is due to occur in 1999/2000.



Shark Bay Snapper Figure 1 Catch per unit effort by year from 1988 to 1998 for the Shark Bay Snapper Managed Fishery. Units are kg whole weight of pink snapper/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.

Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery *and* West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery

Management Overview

Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF):
During 1996/97, the Minister for Fisheries approved the implementation of a five-year management package 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 original biomass.

The fishery is midway through the phased effort reductions specified in the five-year package, and the results of scientific monitoring indicate that the reductions made to date have arrested the decline and are setting the fishery on track to achieving its biomass targets.

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 Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery. The biomass targets for the south coast fishery also apply to the west coast fishery, and the introduction of the management plan through the WA Demersal Gillnet and Demersal Longline Fishery Management Advisory Committee 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.

Compliance and Community Education Overview

The fishery extends right through the southern region. Compliance monitoring concentrates on the time/gear unit requirements and net length controls. Officers from Bunbury, Busselton, Augusta, Albany and Esperance are all involved in compliance monitoring. Where possible, aerial surveillance is used to check compliance with time/gear requirements. There were no reported breaches in this fishery, with good levels of compliance throughout.

Some commercial/recreational conflict continues in the Geographe Bay and mid-south coast areas, where recreational fishers are concerned about the possible effects of demersal nets on reef species. An ongoing education program by local compliance and management officers is carried out to generate a better understanding in the local community about commercial operations.

Research Overview

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.

Research monitoring of the fishery involves analysis of CAESS data and biological sampling of commercial catches. These research data are used to provide the following status report on the fishery.

Fishery Status Report

Main Features

Stock assessment complete:
Completed for three species - whiskery, dusky whaler and gummy sharks

Exploitation status:

Whiskery shark	*Over-exploited*
Dusky whaler	*Fully exploited*
Gummy shark	*Fully exploited*

Breeding stock levels:

Whiskery shark	*38.3% of virgin level*
Dusky whaler	*Not determined*
Gummy shark	*42.7% of 1975 level*

Previous catch projections for year 1997/98:

Whiskery shark	*200-250 tonnes*
Dusky whaler	*400-500 tonnes*
Gummy shark	*275-325 tonnes*

Catch current season (1997/98):

Whiskery shark	*231 tonnes*
Dusky whaler	*408 tonnes*
Gummy shark	*317 tonnes*

Estimated annual value (to fishers) for year 1997/98:
Total of shark and scalefish in JASDGDLF and WCDGDLIMF: $4.3 million

continued over

Catch projection next year (1998/99):

Whiskery shark	*200-250 tonnes*
Dusky whaler	*400-500 tonnes*
Gummy shark	*275-325 tonnes*

Recreational component:
Small

Boundaries and Access

Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery: The JASDGDLF was declared a limited entry fishery in 1988. 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:

(a) Zone 1, the western zone located between latitude 33° S and longitude 116°30′ E; and

(b) Zone 2, the eastern zone located between 116°30′ E and 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 600 m, but a 10% effort reduction in 1992 brought it to 540 m. In June 1994, further effort reductions were put in place. A 30% net length reduction in Zone 2 reduced the amount of net associated with one unit to 380 m, while in Zone 1, 20% of units were suspended. The 20% and 30% effort reductions were maintained in the 1995/96, 1996/97 and 1997/98 seasons.

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 North West Cape was introduced in 1997/98, and is currently in the 'appeals process'. Shark fishing between Shark Bay and North West Cape has been prohibited to protect breeding stocks of whaler sharks. Access to the WCDGDLIMF during 1997/98 was limited to 38 fishers who had powered net drum endorsements. Substantially fewer vessels are expected to have access after objections are finalised and the final management plan is introduced.

Annual Production

Main fishing method
Demersal gillnet.

Landings
JASDGDLF:

Total shark catch	911.1 tonnes
Total scalefish catch	118.2 tonnes
Whiskery shark catch	156.5 tonnes
Dusky whaler catch	240.4 tonnes
Gummy shark catch	310.9 tonnes
Other shark catch	203.3 tonnes

WCDGDLIMF:

Total shark catch	476.7 tonnes
Total scalefish catch	108.2 tonnes
Whiskery shark catch	75.3 tonnes
Dusky whaler catch	167.2 tonnes
Other shark catch	234.2 tonnes

Fishing effort
JASDGDLF: 180,786 kilometre gillnet hours.
WCDGDLIMF: 170,266 kilometre gillnet hours.

Effort is expressed as kilometre gillnet hours, with longline effort being converted to gillnet equivalent effort.

Catch rate
See Stock Assessment section.

Stock Assessment

Stock assessment is carried out for the three main shark species caught by the fishery - whiskery, dusky whaler and gummy shark. Details of the stock assessment are contained in 'Fisheries status and stock assessment for the Southern and West Coast Demersal Gillnet and Demersal Longline Fisheries', No. 6, January 1999, provided by Fisheries WA researchers to the WADGDLFMAC. A summary of the results of the stock assessments follows.

Whiskery shark: The catch of whiskery shark increased slightly in 1997/98, with catches relatively constant in all areas. Catch rates for whiskery sharks decreased substantially during the late 1970s and early 1980s. Since reaching these low levels, the catch rates have only slowly declined. Estimates of the current level of biomass (relative to the virgin level) range from 19% to 47%, with the best estimate at 38.3%. Estimates of current biomass levels are substantially higher than in previous years as a result of an improved method of assessing the status of the stock. At this level of biomass, the whiskery shark stock is still considered over-exploited. Risk assessment was used to calculate the probability of attaining the stock target set by the WADGDLFMAC (40% or greater of the virgin level of biomass by 2010). It was estimated that an effort reduction of 50% of the 1996/97 effort level would be required for there to be a 70% chance of meeting this stock target. The 1997/98 level of effort is approximately 11% lower than in 1996/97.

Dusky whaler: The catch of dusky whalers in 1997/98 was substantially below that of the previous year. Catch rates of dusky whalers are difficult to interpret because of the long period from entering the fishery to attainment of maturity. The difficulties with interpreting the catch and effort information make estimation of current biomass levels impossible. To overcome the limitations of using catch and effort data in the assessment of the dusky shark stock, a tagging study is used to estimate the age-specific exploitation rate. Demographic analyses incorporating these results

indicate the current level of fishing is not over-exploiting the stock, provided the exploitation rate of mature animals does not exceed 4%. This is a reasonable assumption as there is no dedicated fishery targeting this sector of the stock.

Gummy shark: The total catch of gummy sharks in 1997/98 was similar to that for the previous three seasons. Catch rates of gummy sharks have remained relatively stable since the early 1980s, before which catch rates had declined. Estimates of the current level of biomass (relative to the 1975 level) range from 22.6% to 60.2%, with the best estimate at 42.7%. At this level of biomass, the gummy shark stock is considered fully exploited. Risk assessment was used to calculate the probability of attaining the stock target set by the WADGDLFMAC (40% or greater of the 1975 level of biomass by 2010). To achieve this target the effort level in the fishery needs to be less than 70% of the 1993/94 level to ensure that the stock target of 40% of original biomass is met. The 1997/98 level of effort is approximately 4% higher than in 1996/97 and 70.1% of the 1993/94 level of effort.

Breeding Stock Levels

Whiskery shark	Best estimate 38.3% of virgin level and stable
Dusky whaler	Not determined, but considered likely to be above 40% of the virgin level
Gummy shark	Best estimate 42.7% of 1975 level and stable

Catch Projection for Year 1998/99

Whiskery shark	200–250 tonnes
Dusky whaler	400–500 tonnes
Gummy shark	275–325 tonnes

Product Value for Year 1997/98

JASDGDLF:	$2.84 million (shark and scalefish)
WCDGDLIMF:	$1.44 million (shark and scalefish)

The estimate of the value of the fishery declined substantially from previous years, due largely to a review of the prices that fishers obtain for product. Product values for these fisheries do not include the value of shark fins, which are not reported on catch returns. At approximately 5% of live weight, and a price of $20/kg, the estimated value of fins produced by these fisheries is $1.4 million.

General Comments

Stock assessment indicates the need for further effort reductions to meet or maintain the long-term stock biomass targets for whiskery and gummy sharks respectively. Management measures addressing these concerns are planned for introduction in the fisheries over the next three years. Assuming these measures are effective, the current level of exploitation of dusky whaler sharks appears to be sustainable, while the other two species are expected to stabilise and their breeding stock levels to gradually recover to acceptable levels.

North Coast Shark Fishery

Management Overview

The Western Australian-controlled sector of the North Coast Shark Fishery is managed by a notice implemented under section 43 of the *Fish Resources Management Act 1994*. This notice was first gazetted in May 1993 and covers 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.

The taking of shark by longline and gillnet between 123°45′ E and the WA/NT border is controlled by Joint Authority between Western Australia and the Commonwealth.

In light of changes to this fishery, in terms of jurisdiction and area, resulting from the most recent Offshore Constitutional Settlement arrangements in February 1995, Fisheries WA plans to implement a management strategy with one of the main aims being the minimisation of scalefish bycatch taken in the fishery.

There is a lack of knowledge regarding the dynamics of the target species in this fishery, and the lack of research in this area is a direct 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 across northern Australia that includes CSIRO and the Northern Territory and Queensland fisheries agencies.

Compliance and Community Education Overview

Limited fisheries compliance activities were directed at in this fishery in 1998/99. In view of its overall low level of production, it is likely to continue to have a low priority.

Research Overview

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. To improve the state of knowledge on this sector, a

collaborative research project proposal covering all tropical Australian shark stocks is being developed.

The following status report has been prepared based on CAESS data from industry and a general knowledge of tropical shark stocks from the scientific literature.

Fishery Status Report

Main Features

Stock assessment complete:
No

Exploitation status:
No assessment

Breeding stock levels:
No assessment

Previous catch projections for year 1997/98:
Not made

Catch current season (1997/98):
Western Australian area 205.8 tonnes (shark and scalefish)
Joint Authority area 51 tonnes (shark only)
Kimberley Gillnet and Barramundi Managed Fishery 50 tonnes (shark and ray only)

Estimated annual value (to fishers) for year 1997/98:
Approximately $530,000 from the three sectors

Catch projection next year (1998/99):
Not made

Recreational component (1997/98):
Small

Boundaries and Access

The North Coast Shark Fishery's management boundaries depend upon the type of gear used. Western Australia controls dropline fishing from longitude 114°06′ E to the WA/NT border (129° E) and longline fishing from longitude 114°06′ E to 123°45′ E. Longline and gillnet fishing from longitude 123°45′ E to the WA/NT border is managed by Joint Authority between Western Australia and the Commonwealth. Gillnet fishing west of longitude 123°45′ E is not permitted.

A total of 13 fishers have licensed access to one or more of these zones. Shark is also a significant component of the Kimberley Gillnet and Barramundi Managed Fishery.

Annual Production

Main fishing method
Dropline, longline and gillnet.

Landings

Western Australian area:
Shark and scalefish 205.9 tonnes (by North Coast Shark Fishery operators only)

Joint Authority area:
Shark 51 tonnes

Kimberley Gillnet and Barramundi Fishery:
Shark and ray 50 tonnes
Scalefish Reported separately in the Kimberley Gillnet and Barramundi Managed Fishery Status Report

Although catches of shark by these fisheries are reported by species, the categories used in CAESS are insufficient to reflect all species taken in this diverse fishery. As a result, catch by species is not reported.

Fishing effort
There are 13 vessels with specific licence access to these stocks, in addition to the Kimberley Gillnet and Barramundi Managed Fishery vessels. Because a number of these vessels take shark as non-target species, the extraction of useful effort statistics for these stocks is not possible.

Catch rate
Not calculated.

Stock Assessment

No assessment.

Breeding Stock Levels

No assessment.

Catch Projection for Year 1997/98

Not made.

Product Value for Year 1997/98

The overall value of shark catches in the three sectors making up this fishery is approximately $530,000. This figure does not include the value of shark fins, which are not reported on catch returns. At approximately 5% of live weight and a value of $20/kg, the estimated fin production value for these fisheries could be in excess of $100,000.

General Comments

The catches of shark from the State's northern sector are largely taken when fishing for other target species. This factor, in addition to the multi-species nature of the tropical shark fishery, makes formal stock assessment processes particularly difficult and uneconomic to pursue. Monitoring of the fishery is therefore likely to remain at a basic level, utilising CAESS data on catches. Improvements to the data and a better understanding of these fishing activities may, however, be possible as a by-product of the new FRDC-funded research project on the Spanish mackerel fishery, which is closely linked to shark fishing.

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.
- 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 26% of the total operating costs for the Recreational Fisheries Program, with the remainder from the Government Consolidated Fund (66%) and external grants for specific projects (8%).

Threats and Opportunities

Western Australia's recreational fisheries are a major community asset, and contribute in excess of $500 million a year to the State's economy.

Since 1987 the participation in recreational fishing of all kinds has more than doubled from 284,000 people to between 500,000 and 600,000 people a year, or from 27% to 34% of the population over 4 years old. The estimated fishing effort has also risen from an estimated 3 million fishing days to over 11 million fishing days, with the mean number of trips/fisher/year in the same period rising from 9.5 to 18.

In the State's licensed recreational fisheries a total of 56,899 people obtained licences in 1998/99, as follows:

Marron	21,449 licences
Rock lobster	32,721 licences
Abalone	15,175 licences
Netting	13,710 licences
South-west freshwater angling	12,088 licences

Of these, 8,386 people took out all categories of licence available. (All licence figures are given as at 30 June 1999.)

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.

Another area of significant growth is the fishing and aquatic ecotourism industry. In 1990 a Fisheries WA review identified 40 fishing charter operators in Western Australia. By 1997 this number had risen to 135, and a call for expressions of interest for fishing and aquatic tour operator licences in December 1998 attracted over 450 applications.

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 exploitation by their remoteness.

These factors are placing unprecedented pressure on many fish stocks at all stages in their life cycle. This is compounded by human-induced environmental change, including the eutrophication of rivers and estuaries and the destruction of fish habitats through industrial activities.

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.

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 four broad marine biogeographic regions of the Kimberley/Pilbara, Gascoyne, West Coast and South Coast, and two major inland fishing regions.

From a biological perspective the boundaries of these regions are largely consistent with (or represent sub-sections of) the major coastal 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 estuary 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.

In the north the creek systems, mangroves and rivers provide shore and small boat fishing for a variety of marine and freshwater species including barramundi, sooty grunter, mangrove jack, mud crabs and cods.

Southern estuary fisheries mainly consist of shore and small dinghy angling for species such as black bream, tailor, flathead, flounder, cobbler and whiting, and wading and drop-netting for blue swimmer crabs. Fishing activity is concentrated during the summer and early autumn months. Prawns also provide a highly seasonal and variable fishery in the Swan-Canning and Peel-Harvey estuaries.

The inshore marine fishery operates mainly out of boats smaller than five metres, and is most concentrated near major population centres, marinas and launch facilities and in areas such as Jurien Bay or Shark Bay where the inshore reef system or islands and promontories provide some protection from the oceanic swell and weather.

The offshore boat fishery operates mainly within the 50 m depth contour, targeting demersal species such as dhufish, baldchin groper, pink snapper, emperors, cods and sea-perches.

In areas such as Perth, Exmouth and Broome seasonal fishing for billfish and tunas is becoming an increasingly important part of the recreational and charter fishery.

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

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 WA 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.

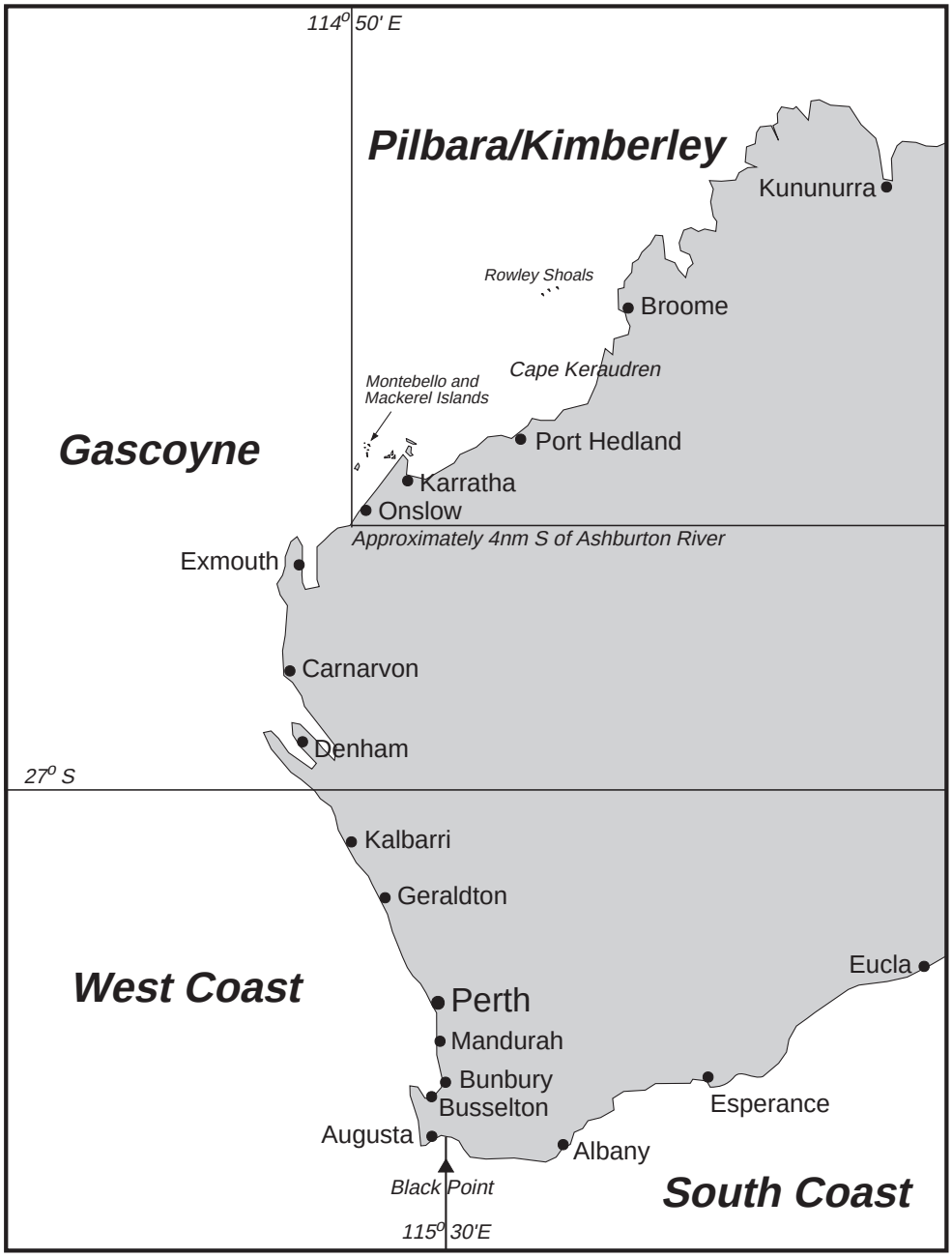
Each regional strategy is being developed by a community-based working group comprising fishing, conservation and tourism interests and will include recommendations for a detailed research and management program specific to that region.

In 1998/99 the Gascoyne Working Group released the first of these regional strategies as a draft for public comment. Following review of submissions, the working group will prepare final recommendations for the Minister for Fisheries in December 1999.

A second working group has been established to develop a draft strategy for the West Coast region and it is expected a discussion paper will be released in early 2000.

Planning for the Pilbara/Kimberley region will commence in early 2000, and for the South Coast in late 2000.

A major review of charter fishing and associated ecotourism was undertaken by an industry-based working group established by the Minister for Fisheries. The final report from the Tour Operators Fishing Working Group, 'Future management arrangements of the aquatic charter industry', was released in November 1998. New management arrangements for fishing and aquatic ecotour operators are expected to be implemented in early 2000.



Recreational Fisheries Figure 1 Map showing the State's four marine recreational fishing regions.

Recreational Fisheries Research

Recreational fisheries research focused on establishing baseline catch and effort information on the marine finfish and blue swimmer crab fisheries, improving knowledge of the biology of key recreational finfish species, and developing stock assessment models.

In 1998/99 nine major research projects were funded. These included a program of regional angler surveys to establish baseline data on recreational catch and effort in the State's four fishing regions, ongoing monitoring in the rock lobster, abalone and marron fisheries, an evaluation of the freshwater trout stocking program, completion of biological and stock assessment work on Australian herring, a stock assessment and monitoring program on Shark Bay inner gulf pink snapper stocks, and an evaluation of the survival of black bream stocked into low-salinity inland waters.

In future years, in addition to reporting the status of the licensed recreational fisheries, this document will report the outcomes of research carried out in the four recreational fishing regions. The recreational fishery of inner Shark Bay (Gascoyne region) is reported this year.

Recreational Western Rock Lobster Fishery

Management Overview

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.

Compliance and Community Education Overview

There have been no major compliance breaches in the recreational sector for the 1998/99 season. Proactive patrols by Fisheries Officers have achieved positive results, with high-visibility catch inspections acting as a deterrent. Officers have received complaints regarding pots missing, lines of gear being pulled, and non-compliance during the hours of darkness. Under-size catch remains an issue, as does tail clipping. However, the overall level of compliance for the season has been good.

Ongoing education services have been delivered, including the use ofVolunteer Fisheries Liaison Officers to provide community advice and collect research data.

Research Overview

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.

Fishery Status Report

Main Features

Catch current season (1997/98):
807 tonnes (estimated)

Participation rate for year 1997/98:
28,776 people purchased licences to fish for lobsters, but only an estimated 23,993 utilised their licence

Catch projection next year (1998/99):
900-1,000 tonnes (estimated)

Previous catch projection (1997/98):
450-550 tonnes

Boundaries and Access

The recreational western rock lobster fishery has no specific boundaries; however, fishing is concentrated in inshore regions in depths of less than 20 m. The Perth metropolitan region and Geraldton experience the greatest fishing activity. A recreational rock lobster licence is required to take lobsters, and in the 1997/98 season 28,776 licences were sold. The 1997/98 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.

Catch

Main fishing method
Pots and diving.

Landings
Estimated at 807 tonnes, with 565 tonnes by potting and 242 tonnes by diving.

Fishing effort
The average pot and diving fishers (excluding all those who held a licence but failed to use it) used their licences on 34 and 14 days respectively during the 1997/98 fishing season.

Catch rate
The average pot and diving catches were 1.5 and 2 lobsters/person/fishing day.

Stock Assessment

The recreational catch is a relatively small proportion of the commercial catch (around 8%). Stock assessments are an important focus of western rock lobster research and this information is given under the report on the commercial fishery.

Breeding Stock Levels

See the commercial fishery status report.

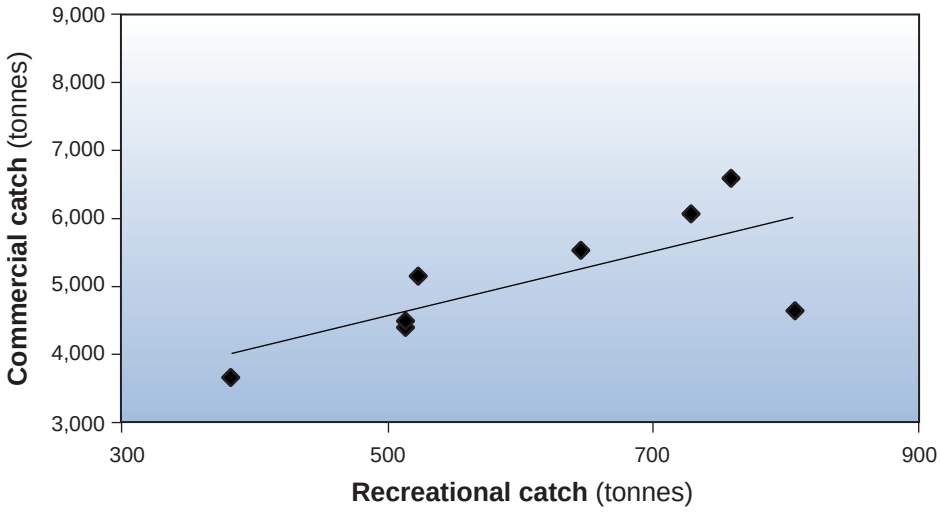
Catch Projection for Year 1998/99

900-1,000 tonnes (estimated).

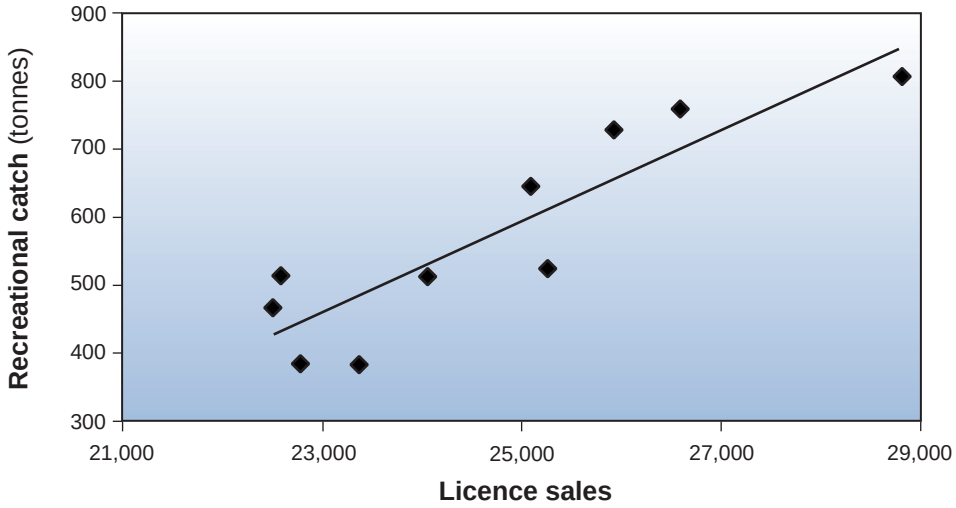
General Comments

The recreational rock lobster catch estimate of 807 tonnes for the 1997/98 season was substantially higher than the 516 tonne catch estimated for the 1996/97 season. The differences in the catches can be attributed to three factors: a 20% increase in the number of fishers who purchased recreational lobster licences; a large increase in the proportion of fishers who utilised their licence (79.5% in 1996/97 compared with 83.4% in 1997/98); and a slight increase in catch rates (from 1.3 lobsters/day caught by pot fishers in 1996/97 to 1.5 in 1997/98, and from 1.8 lobsters/day caught by divers in 1996/97 to 1.8 in 1997/98).

A decade of recreational lobster surveys has shown that the season-to-season catch estimate trends closely mirror those of the southern zone of the commercial fishery (Recreational Rock Lobster Figure 1), which is not surprising given that most recreational fishing takes place in the Perth metropolitan area. The most significant cause explaining this correlation is that recreational rock lobster licence sales fluctuate according to the strength of the year class entering into the fishery. As might be expected, sales are substantially higher in years of good recruitment, which in turn results in those years producing a higher overall recreational rock lobster catch (Recreational Rock Lobster Figure 2). These data provide a useful 'index' of recreational rock lobster fishing activity from season to season, however the absolute catch of lobsters taken is heavily reliant on weighting factors obtained from detailed studies undertaken a decade previously. Given the changes in recreational attitudes since that time, a review of the methodology for catch calculation is now being undertaken.



Recreational Rock Lobster Figure 1 Relationship between recreational and southern (Zone C) commercial catch, 1990/91 to 1997/98.



Recreational Rock Lobster Figure 2 Relationship between total recreational catch and number of rock lobster licences sold, 1988/89 to 1997/98.

Recreational Abalone Fishery

Management Overview

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. Reeftops are generally regarded as nursery areas for abalone, which tend to migrate over the reef edge into deeper gutters as they mature. Consequently, there are always large numbers of under-size abalone present among the legal-size animals in the main areas where recreational fishing occurs.

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. A recreational abalone licence is required to take abalone.

The Perth metropolitan and Greenough recreational abalone season commenced on Sunday 1 November 1998 and continued each Sunday only from 7.00 a.m. to 8.30 a.m. until 6 December.

This year Garden Island was included under the metropolitan management arrangements due to community concern over its accessibility and increasing fishing pressure on abalone stocks around the island. Penguin Island remained closed to abalone fishing to allow stocks to recover, following research surveys in 1996 which indicated that stocks around the island were depleted to very low levels.

Compliance and Community Education Overview

The strategies employed this season were effective in achieving a high level of compliance and community awareness among fishers. This was achieved through a high-profile awareness and in-field liaison campaign, both prior to and during the season, which utilised all forms of media to reach target audiences.

Fisheries Officers, supported by 64 Volunteer Fisheries Liaison Officers (VFLOs) and one temporary liaison

officer, were active along the coast to promote public awareness of and support for the conservation rules.

The number of VFLOs available this season increased by 34 on the previous year and enabled the effective coverage of a greater expanse of coastal reef.

Two aerial surveillance flights were undertaken from Cape Bouvard to Wedge Island to identify areas where people were targeting abalone outside the normal fishing areas and to gain accurate research data on the numbers of people taking abalone at different coastal locations.

The issuing of infringement notices again proved effective in the overall management of this recreational fishery. A total of 40 infringement warnings and 14 infringement penalties were issued in 1998/99. This resulted in fines totalling $2,600. Two matters resulted in prosecution action being initiated which resulted in fines and penalties totalling $5,660.

Research Overview

Scientific information for managing recreationally fished abalone stocks utilises the outcomes from specific research projects dealing with commercially exploited stocks. In addition, research surveys are undertaken to monitor the abundance of abalone on prime recreational reefs in the metropolitan area. Data from these surveys, carried out by VFLOs, Fisheries Officers and research staff, are also used to estimate the recreational catch of abalone on metropolitan reefs. The following status report is based on these research data.

Fishery Status Report

Main Features

Catch current season (1998):
Perth metropolitan area 23.1 tonnes whole weight (estimated)

Participation rate for year 1998:
Whole State (including combination licences) 11,070 licences (as at 1 December 1998, last week of the Perth metropolitan season)
Perth metropolitan area 18,300 fisher days

Catch projection next year (1999):
Perth metropolitan area 20-25 tonnes whole weight (estimated)

Boundaries and Access

The metropolitan area of the fishery extends from Cape Bouvard to Wedge Island. The number of recreational licences is not limited. Access by recreational fishers to the metropolitan area is controlled by allowable fishing times (7.00 a.m. to 8.30 a.m.) and a limited season (six Sundays). The 1998 season ran from 1 November to 6 December. A minimum legal size of 60 mm and a daily bag limit of 20 Roe's abalone is enforced throughout the State.

Catch

Main fishing method
Picking while wading, or free diving.

Landings
The total recreational take from the Perth metropolitan area was estimated at 23.1 tonnes, which is similar to last year's catch (Recreational Abalone Figure 1). The lower catch since 1995 reflects a major reduction in recreational fishing effort with the introduction of weekend-only fishing.

Fishing effort
18,300 fisher days or 3,050 fishers/day, which is similar to last year's effort.

Catch rate
1.19 kg/fisher/day or 17 abalone/fisher/day (estimated).

Stock Assessment

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, Mettams Pool, Bailey Street and Penguin Island. Measurements were taken in January and February 1999 (post-season) to use as an indication of the stock levels available for subsequent seasons. Post-season densities were highest at Burns Beach (with 109 abalone/m^2), followed by Bailey Street (77 abalone/m^2), Beaumaris (73 abalone/m^2), Mettams Pool (72 abalone/m^2) and lastly Penguin Island (57 abalone/m^2 averaged over two transects). 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. In 1999 recruitment was relatively low resulting in lower overall densities.

Penguin Island densities are derived from two platform transects. Densities from the initial transect were unexpectedly low, independent of fishing pressure. Including a larger sample area indicates densities similar to last year (65 and 57 abalone/m^2 in 1998 and 1999 respectively). The percentage of legal-sized animals was also similar to last year (17.8% and 16.7% in 1998 and 1999 respectively). The stock measurement procedure and the status of Penguin Island will be reviewed in 2000.

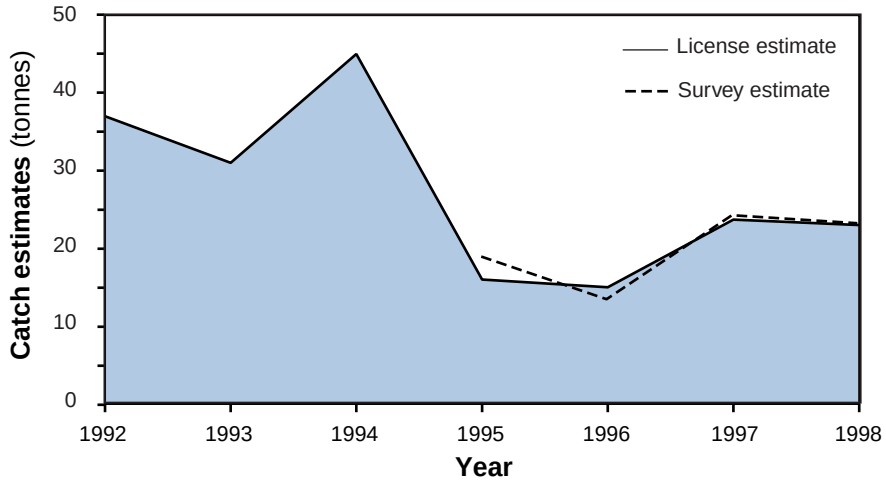
Breeding Stock Levels

Research has shown that abalone size at sexual maturity (50% of animals mature) in the Perth metropolitan area (40 mm) is below the State minimum legal size for Roe's abalone (60 mm). This is considered to provide adequate protection for the breeding stock. In the metropolitan area, additional protection for the sub-tidal, professionally targeted breeding stock is provided by a higher minimum legal size of 70 mm for the professional sector of the fishery.

The densities measured at four of the five reef stock assessment sites surveyed were considered to be high enough to allow an adequate flow of abalone to the breeding stock. At Penguin Island, where reef platform stocks were low, the reef platform remained closed to all fishing in order to allow the breeding stock to recover.

Catch Projection for Year 1999

20-25 tonnes (estimated).



Recreational Abalone Figure 1 Alternative estimates of the recreational Roe's abalone catch from the Perth metropolitan area since the introduction of recreational abalone fishing licences. Licence estimates are based on an assumed catch of 20 animals of approximately 70 mm shell length, or 70 g whole weight, on 25% of the available fishing days, by each individual licensed to participate in the recreational abalone fishery. Survey estimates are based on the results of research surveys conducted by Volunteer Fisheries Liaison Officers and staff of Fisheries WA.

Recreational Marron Fishery

Management Overview

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.

Fishing controls include licensing, bag and size limits, gear controls and a closed season. The fishing season was open from midday Saturday, 9 January 1999 to midday Sunday, 28 February 1999.

Major concerns with the marron fishery relate to its ability to withstand the existing level of fishing pressure, particularly in low rainfall periods. Post-season reviews are conducted regularly and can result in changes to management. In recent years, changes have included a bag limit reduction to 10 marron/day. Management also continues to emphasise snaring as the preferred method of capture in specific waterways.

'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.

A recreational fishing licence is required to take marron.

Compliance and Community Education Overview

A total of 14 breach reports were submitted by Fisheries Officers for the 1999 season. In addition, 30 infringement notices and 26 infringement warnings were issued. Infringement warnings and penalties were up on last year as a result of an intensive pre-season campaign by officers within the Busselton/Bunbury areas.

Community education was once again a priority. Local and Statewide media resources were utilised in the weeks leading up to the open season, emphasising conservation and the unique nature of the marron fishing experience, as opposed to viewing the daily bag limit as a target. Strong media coverage of several apprehensions and subsequent court appearances prior to and during the season reinforced the ramifications of non-compliance. Brochures explaining the rules were provided to licence purchasers and distributed through tackle shops, caravan parks, service stations and other outlets likely to be visited by marroners.

VFLOs assisted staff in maintaining a highly visible profile throughout the fishery. The expansion of the VFLO program within the region increased the ability to provide up-to-date information to fishers and promote responsible fishing practices and catch handling .

Compliance levels with in-season rules continued to increase in line with the fishing community's understanding of conservation requirements, however out-of-season fishing continues to be a concern.

Research Overview

Detailed research on the marron stocks in south-west rivers and estuaries was undertaken in the 1970s and 1980s. Current research involves the monitoring of stock levels both before and after the summer fishing season, surveys of catches taken by recreational licence holders and joint sampling with individual catchment groups. These data enable trends in stock levels to be monitored and adjustments made to the fishing season when necessary.

The following status report is based on these research findings.

Fishery Status Report

Main Features

Catch current season (1999):
Approximately 158,000 marron overall (minimum weight 19.7 tonnes)

Participation rate for year 1999:
21,330 licences issued for the 1999 season (as at April 1999), compared with 18,155 issued for the 1998 season

Catch projection next year (2000):
15-30 tonnes (estimated)

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 1999 the season was open between 9 January and 28 February.

Some waters have been declared 'snare-only' in order to reduce the effect of an increase in licence numbers and thus effort. 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).

Catch

Main fishing method
One scoop net (preferred for dams), or six drop nets (rivers) or one snare pole (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.

Landings

An estimated total of 158,000 legal-sized marron (minimum of 19.7 tonnes) were taken in the 1999 season (1998: 206,000 marron, 25 tonnes).

Fishing effort

The number of licences issued for the 1999 season was 21,330, with an estimated 13,899 of these (unusually low at 65%) used to make one or more trips, at an estimated average of 2.9 trips/licence holder. A total of approximately 40,910 trips were made, comprising an estimated 12,675 trips to dams and 26,661 trips to rivers. (1998: 52,914 total trips, with 11,787 trips to dams and 41,127 trips to rivers.)

Catch rate

The average catch rate in 1999 was estimated at 3.84 legal-sized marron/licence holder/night (1998: 3.66). The increase in the catch rate coupled with a decrease in total catch is probably due to a decline in fishing effort in rivers in 1999.

Stock Assessment

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 the subsequent summer. 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. In 1999, there was also a pre-and post-season survey of the Blackwood River conducted by the Blackwood Basin Group and volunteers in conjunction with Fisheries WA.

Total numbers of landed marron are calculated by using the mean number caught/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 likely to be captured during the season. However, more precise information would only be obtained by research surveys to all marron areas (approximately 96 individual stocks), which is logistically impractical.

The estimated numbers of trips (effort) to dams and rivers is calculated in a similar manner.

Breeding Stock Levels

Breeding stocks are protected from recruitment over-fishing by the minimum legal size limit and gear escape meshes. Most females in dams are capable of breeding once prior to attaining legal size, while those in rivers are capable of breeding twice. Small animals and females carrying eggs and young are fully protected and greater emphasis was placed on compliance activities prior to the 1999 season to increase protection of the stock during the peak breeding season.

Catch Projection for Year 2000

The catch for the 2000 season is dependent on summer water levels from 1999 winter rainfall, juvenile abundance in the preceding year, and the total effort expended during the season. Catches in rivers and dams may decline slightly at current levels of effort. The expected catch in years of low rainfall can be expected to be near 15 tonnes, while in years of high rainfall it is expected to be closer to 30 tonnes.

Based on climate patterns alone, the catch projection for the 2000 season is likely to be higher than for the 1999 season. Bureau of Meteorology data suggest that the expected rainfall for 1999 in the south-west of Western Australia has a 55% chance of exceeding the historical median rainfall for the area. However, post-season surveys of certain areas (Harvey Weir, Blackwood River) detected very low numbers of under-sized marron. Thus, fewer legal-sized marron are expected in these areas for the 2000 season. Overall, it is likely that the 2000 marron season should result in catches similar to, or slightly lower than, those from the 1999 season.

General Comments

There is a gradual increase in the average size of marron being caught, which can be attributed to snare fishers selecting larger animals. This is likely to be a result of more snare-only waters, with anglers selecting larger animals. Other areas should be considered for declaration as 'snare-only' for the long-term maintenance of the fishery.

Retention of under-size marron and pre-season poaching continue to be of concern and will require ongoing management. Pre-season patrols resulted in a number of convictions that were widely publicised. Pre-season patrols should be maintained and possibly extended for the 2000 marron season.

Yabbies, a potentially serious threat to the marron fishery, have been recorded from a number of areas within the marron recreational fishery. The most threatening report is of yabbies in Harvey Weir, a renowned snare-only fishery. Although the impacts of yabbies on marron in large dams are unknown,

biological information and previous experience suggest that yabbies could pose a potentially serious threat as they reproduce at a younger age than marron, produce more eggs and can reproduce several times a year. Further, there is a possibility of yabbies spreading the disease *Thelohania* throughout the recreational marron fishery. Monitoring should continue and control measures should be considered in order to protect the marron fishery.

Recreational Freshwater Angling

Management Overview

A south-west freshwater angling licence was reintroduced in July 1992. A licence is required for all freshwater fishing (other than for crustaceans) in waters south of latitude 29° S. Juveniles under 16 years of age are not required to hold a freshwater angling 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 1998/99. The committee consists of agency officers including the Pemberton hatchery manager, and representatives from RFAC, the WA Trout and Freshwater Angling Association and the general freshwater angling public.

Compliance and Community Education Overview

Compliance in this fishery was good in this period. The increased interest and participation in the fishery has continued, both by individual fishers and through dedicated fishing competitions organised by freshwater fishing organisations. This fishery is monitored by staff from the Bunbury, Busselton and Albany offices.

A number of VFLOs in the Bunbury area are members of freshwater angling and trout clubs or associations and are playing a key role in the education and awareness programs in place.

Research Overview

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 agency's Pemberton hatchery. 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 from the agency's hatchery facility is also under way comparing the tolerances of the hatchery strain, a small reproducing stock and hybrids of rainbow trout. Finally, rainbow trout yearlings have been allocated for trialling in inland saline waters, which may in future lead to additional recreational fishing opportunities. Research information from these projects, and the annual report from the manager of the Pemberton hatchery, have been used to compile the following status report.

Fishery Status Report

Main Features

Catch current season (1998/99):
Not assessed

Participation rate for year 1998/99:
11,906 licences (including 8,243 umbrella licences) issued for the 1998/99 season (as of April 1999), compared with 10,332 issued for the 1997/98 season

Catch projection next year (1999/2000):
Not available

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 the tourist put-and-take fishery. Rainbow trout yearlings are also being trialled for their potential in inland saline waters, for both aquaculture and recreational/tourist purposes.

Catch

Main fishing method
Angling with rod and line.

Landings
Not assessed. At present, there is no monitoring of the success or effort of this recreational fishery. However, a survey and logbook project are planned for 1999/2000.

Fishing effort

Not assessed. However, while no specific measures of effort are available, it can be assumed the increase in valid licences issued (up 15% from the 1997/98 season) reflects at least the expectation by anglers that more people would consider freshwater angling during the year.

Catch rate

Not assessed.

Stock Assessment

Rainbow and brown trout are produced in the Pemberton hatchery and stocked into public waters as breeding in south-west dams and rivers by trout is negligible. A total of 255,000 rainbow trout fry and 50,000 brown trout fry from the hatchery were stocked into public waters during 1998. In addition, 81,000 rainbow trout fry were sold to private dam owners for tourist fishing and private club fishing. Older fish were also produced and sold from the Pemberton hatchery in 1998. Approximately 10,000 rainbow trout yearlings and 3,000 brown trout yearlings were sold during the year, while a quantity of rainbow trout broodstock entering their second and third years of life (770 and 790 fish respectively) were sold from the hatchery or stocked for the recreational fishery.

Breeding Stock Levels

To maintain the trout stock for recreational fishing, hatchery releases are required in most waters as there is very little natural breeding due to high summer temperatures and limited suitable spawning areas. Native cobbler are self-sustaining. Introduced red-fin perch breed and grow rapidly but tend to over-populate waterways and stunt within a few years. Stocks of red-fin appear to be spreading due to deliberate unsanctioned releases in waterways that were previously free of the species. The apparent increase in the range of red-fin may impinge on the breeding success of native species including marron and could reduce the survival of trout fry.

Catch Projection for Year 1998/99

Not available.

General Comments

The stocking of trout in public waters throughout the south-west supports a significant and growing recreational sport fishery which adds substantially to the region's tourism value. Similarly, private stocking of privately owned dams in the south-west supports a specialist tourist sector by providing quality pay-fishing opportunities. The installation of eight cooling towers at the Pemberton hatchery has recently been completed and will ensure the availability of fry in the future by reducing the mortality of broodstock due to high water temperatures during summer.

Stocking programs may also be influenced in the future by a translocation evaluation of the environmental impact of trout stocking, initiated in 1997/98. This translocation review document, now being finalised, concludes that trout are much less of a threat to remaining populations of south-west native fish than red-fin perch. Stocking success with trout is also thought to be affected by the distribution and spread of red-fin perch as these fish prey directly on young trout. Trials are also planned to determine whether the stocking of yearling trout is a more cost-effective measure than stocking fry owing to the reduction in predation by red-fin. In addition, carp are being occasionally reported from the fishery, probably through escapes of ornamental fish. Carp could pose another threat to the quality of freshwater angling and fish habitats in the south-west.

A survey and logbook has been designed to access the scope, size and success of recreational freshwater fishing in the south-west. The implementation of the survey will depend on funding availability. Further information will also be compiled from fishing club logbooks and direct monitoring techniques.

Inner Shark Bay Recreational Fishery

Management Overview

The stocks of pink snapper in the eastern and western gulfs of Shark Bay are genetically separate from each other and from the wide-ranging ocean stock. The stocks do not interbreed or 'top up' one another through migration. This makes them especially vulnerable to over-fishing.

Ongoing research has shown that the pink snapper stocks had been severely depleted in the eastern gulf and all available information indicated a very high risk of stock collapse. Following extensive public consultation, the following management objectives for pink snapper were agreed with stakeholders for the eastern gulf:

- to stabilise the fishery at current levels;
- to rebuild the breeding stock of pink snapper to 100 tonnes.

New management arrangements were introduced in the eastern gulf in June 1998 in response to serious concerns over the depletion of pink snapper stock. These included:

- a three-year ban on the take of pink snapper;
- a mixed bag and landing limit of five fish implemented to protect other species (black snapper, cod, groper) from a possible transfer of effort and subsequent over-fishing.

The snapper research to support stock management is being conducted in both the eastern and western gulfs of Shark Bay and incorporates juvenile trapping surveys, planktonic egg surveys, tagging programs, and sampling of recreational catches.

Compliance and Community Education Overview

In June 1998, new recreational fishing management arrangements were introduced in the eastern gulf waters of Shark Bay in response to concerns over the sustainability of pink snapper stocks.

Staff from the Carnarvon and Denham Fisheries WA offices have modified their compliance and community education activities accordingly, with the focus moving to beachfront community education clinics and catch care awareness. Careful handling of fish to be released and the use of barbless hooks were also promoted.

An additional fisheries patrol team was relocated to the region over the peak tourist season to assist with the pink snapper compliance and education objectives.

Land patrols by officers were complemented by at-sea patrols using the new patrol vessel *John Brockman* in the inner gulfs of Shark Bay.

Research Overview

Research to support the management of Shark Bay pink snapper *(Pagrus auratus)* stocks was undertaken during the 1980s and included a survey of recreational catches in 1983. This research identified genetically separate stocks in each of the Shark Bay gulfs, which were different fish from those in the oceanic areas. Concerns about increasing recreational fishing pressure on the inner gulf stocks during the early 1990s, and the outcome of a research survey for juvenile snapper in November 1996, resulted in the development of a detailed research project beginning in June 1997. The specific purpose of this research is to provide 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. A further research project to provide information on the basic biology of black snapper *(Lethrinus laticaudis)*, the second most commonly taken target species in the inner bay area, is due to commence in July 1999 and will be reported in the future.

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

Fishery Status Report

Main Features

Stock assessment complete:
Preliminary assessment of pink snapper breeding stocks in two gulfs

Exploitation status:
Pink snapper:

Eastern gulf	*Over-exploited*
Freycinet Estuary	*Fully exploited*
Denham Sound	*Over-exploited*

Breeding stock levels:
Pink snapper:

Eastern gulf	*Inadequate but increasing*
Freycinet Estuary	*Adequate*
Denham Sound	*Inadequate (locally depleted)*

Catch current season (1998):

Pink snapper, recreational (estimated):	
Eastern gulf	*Approximately 3 tonnes (prior to closure)*
Western gulf	*Approximately 38 tonnes*
Pink snapper, commercial (estimated):	
Eastern gulf	*Less than 1 tonne (prior to closure)*
Western gulf	*Approximately 1 tonne*

Participation rate for year 1998:
34,000 fisher days (estimated) for all recreational fishing in Shark Bay

Boundaries and Access

The Shark Bay recreational pink snapper fishery falls within the Gascoyne region recreational sector, which comprises the coastline extending northwards from latitude 27° S to the point where longitude 114°50′ E intersects the coast (just south-west of Onslow).

The Shark Bay areas covered by this report comprise the sheltered inner gulf waters east of the Peron Peninsula and south of Cape Peron (the eastern gulf); west of the Peron Peninsula and south of Cape Bellefin (the Freycinet Estuary); and west of the Peron Peninsula between Cape Bellefin and Cape Inscription (Denham Sound). These latter two areas, where combined, are referred to as the western gulf (Shark Bay Recreational Figure 1).

Special bag and size limits apply to recreational fishing in these areas. In addition, a full closure to fishing for pink snapper in the eastern gulf was applied for three years from June 1998.

Annual Production

Main fishing method

Recreational	Rod and line.
Commercial	Handline, beach seine, haul net.

Landings

Prior to the Gascoyne Recreational Fishing Survey (GRFS), conducted between April 1998 and March 1999, recreational catch data was lacking for both gulfs. There is some anecdotal evidence that recreational catches were low in the early 1980s, rising sharply until 1995 (particularly in the eastern gulf), but declined in 1996. For 1998, the GRFS provides estimated catch figures for pink snapper of approximately 3 tonnes for the eastern gulf for the period April to June (prior to the closure of the fishery in that area), and approximately 38 tonnes for the western gulf (Denham Sound approximately 12 tonnes, Freycinet Estuary approximately 26 tonnes).

Commercial catches of pink snapper by the nine licensed fishing units of the Shark Bay Beach Seine and Mesh Net Managed Fishery, while relatively small, indicated an upward trend in both gulfs up to last year. For 1998, however, the catches were considerably less than 1 tonne for the eastern gulf (prior to the closure in June 1998), and approximately 1 tonne for the western gulf.

Participation level 1998

The full-scale recreational creel survey for the Gascoyne region as a whole (the GRFS), undertaken during the period April 1998 to March 1999, will be reported fully in future years. For the specific area within Shark Bay where pink snapper is the principal target species, the preliminary results from the 1998/99 survey indicate that there were approximately 34,000 fisher days expended, of which approximately 80% targeted the western gulf and oceanic stocks. Although the eastern gulf was totally closed to the take of pink snapper from June 1998, the effort in this sector was estimated to be 20% of the total effort expended in the inner bay.

Stock Assessment

In the absence of a long time-series of data for catches and recreational effort applied to inner bay snapper stocks, the assessment method adopted has been to directly assess the status of the breeding biomass and recruitment for each stock within the fishery. The 'daily egg production method' (DEPM) involves plankton net surveys to count newly released eggs and larvae, and this information, taken in conjunction with the spawning condition of adult females, has been used to back-calculate the total biomass of spawning adults. In addition, research trawl and trap surveys are being conducted to provide information on the abundance of 0+ age juvenile snapper in both gulfs.

Using the above data, the spawning biomass in 1997 and 1998 has been estimated as follows:

1997 (estimated):

Eastern gulf	approximately 4 tonnes
Freycinet Estuary	approximately 97 tonnes
	(no estimate for Denham Sound)

1998 (estimated):

Eastern gulf	approximately 14 tonnes
Western gulf	approximately 93 tonnes
	(including both Freycinet Estuary and Denham Sound)

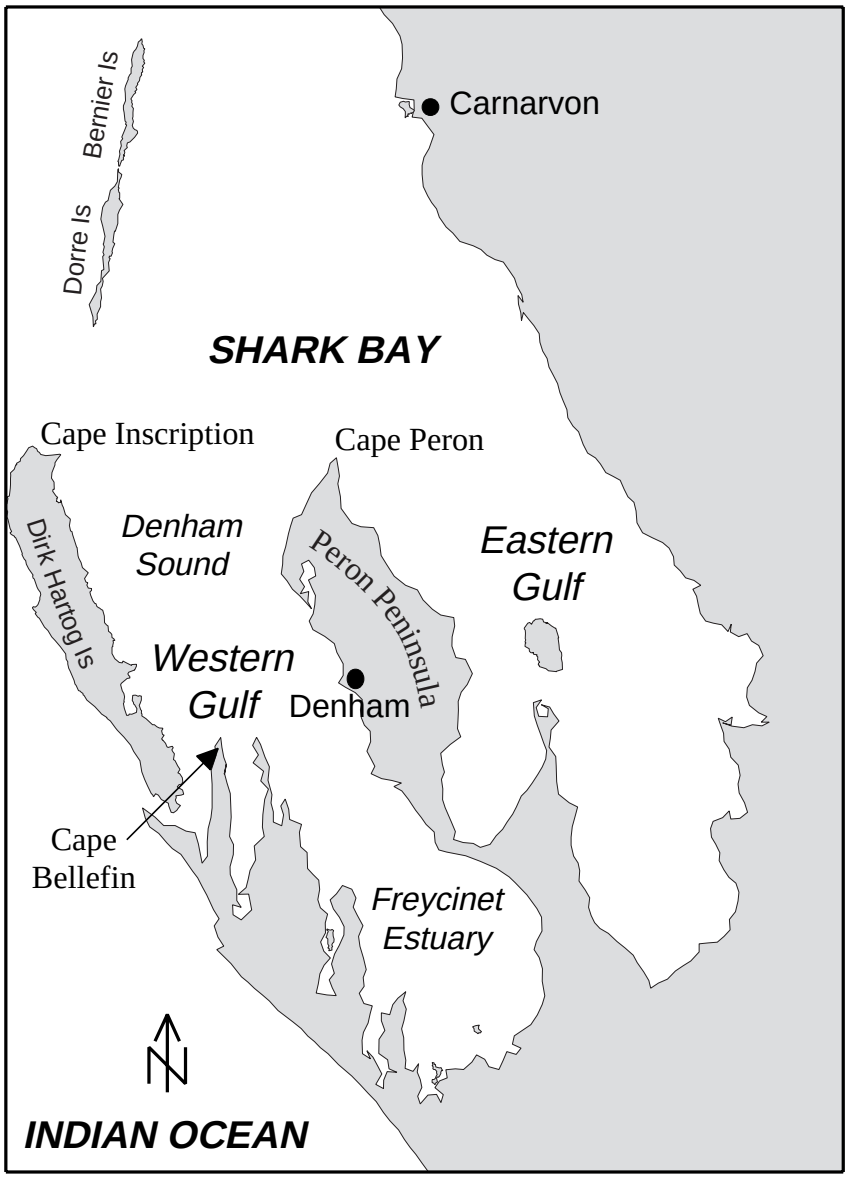
Recruitment surveys indicate that, in the eastern gulf, 0+ juveniles were more abundant in 1998 than in the previous two years, while in the western gulf, lower numbers of juveniles were encountered. These data, however, need to be treated with caution owing to the limited sampling on which they were based and the inherent difficulties in estimating schooling fish abundance.

The overall assessment is that the eastern gulf pink snapper stock remains over-exploited, based on spawning biomass estimates, and information on 0+ juvenile abundance from trawl and trapping surveys. The western gulf snapper stock is fully exploited, based on spawning biomass estimates, information on 0+ juveniles from trawl and trapping surveys, and estimates of annual recreational catch from the GRFS.

General Comments

In addition to the surveys on juvenile and adult abundance, the research on inner Shark Bay snapper includes segments which aim to increase understanding of the relationships among the various snapper populations in the region (genetics and tagging), and to obtain biological data on parameters such as growth rates and size at maturity for use in modelling population biology and assessing future fishery management options.

The management of the depleted eastern gulf stock through a total closure appears, on preliminary data, to be appropriate for rebuilding that stock. Additional management measures such as an increase in minimum size to 50 cm and a reduction of the bag limit to two/day would bring the Freycinet Estuary population back to a sustainable exploitation level and start the rebuilding of the Denham Sound population. The early indications of rebuilding the eastern gulf stock under the total fishing closure are encouraging.



Shark Bay Recreational Figure 1 Shark Bay, showing the recreational fishing areas of the inner gulfs.

Aquaculture and Pearl Production

General Overview

The State's commercial aquaculture industry continued to be dominated by South Sea pearl production in the north, algae production for beta carotene on the west coast and freshwater crayfish and mussels in the south. Development increased for species such as non-maxima pearl oysters, edible oysters and abalone.

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. Live shell is also traditionally used to stock farms in the Northern Territory.

Other Aquaculture Activities

The level of activity and interest in aquaculture continued, with a diverse range of aquaculture enterprises operating throughout Western Australia. These included the production of algae for beta carotene, mussels, yabbies, marron and trout. Development work and commercial production continued for marine finfish, abalone, edible oysters, pearl oysters of the species *Pinctada albina* and *Pinctada margaritifera,* barramundi and trochus. The State's first prawn farm was licensed at a site in Exmouth Gulf. Following health and quarantine clearances, a large number of juvenile redclaw of a superior genetic strain were brought into Western Australia for aquaculture purposes.

Aquaculture Development Initiative

During 1994, the Minister for Fisheries announced an aquaculture development initiative, supported by funding of $4.5 million over three years. Financial support for the initiative was subsequently extended with a further $8 million for the years 1997/98 to 2000/01.

During 1998/99, the agency continued to implement this initiative. Key activities included the completion of aquaculture infrastructure in Albany and Pemberton and the preparation of draft aquaculture plans for key regions such as Exmouth Gulf, Shark Bay, the Abrolhos Islands and the Recherche Archipelago. There were also significant resources committed to the assessment of licence applications in accordance with Ministerial Policy Guideline No. 8, 'Assessment of applications for authorisations for Aquaculture and Pearling in coastal waters of Western Australia', and the development of policy for species such as non-maxima pearl oysters and abalone and matters relating to translocation, performance criteria and access to broodstock. Marron farming regulations were also reviewed with the aim of simplifying the licensing framework.

A major strategy for aquaculture development in the Kimberley was released during the year. The strategy included development of an investment attraction package and preparation of environmental assessment documentation for development at Lake Argyle.

The agency maintained strong linkages with peak industry bodies and the relevant management advisory committees. Twelve aquaculture development projects were funded through the Aquaculture Development Fund during 1998/99, worth in excess of $150,000.

Major Achievements

- Continued implementation of the Government aquaculture development strategy.
- Completion of the Great Southern Aquaculture Park in Albany.
- Completion of the South West Freshwater Research and Aquaculture Centre in Pemberton.
- Approximately 50 pearling and aquaculture applications assessed to date in accordance with Ministerial Policy Guideline No. 8, 'Assessment of applications for authorisations for Aquaculture and Pearling in coastal waters in Western Australia'.
- Release of a major strategy for aquaculture development in the Kimberley.
- Marron farming regulations reviewed.
- Commencement of drafting for a new Pearling Act.
- Participation in the review of pearling legislation under National Competition Policy agreements.

Pearl Oyster Fishery

Management Overview

The pearl oyster fishery in Western Australia is based on the species *Pinctada maxima* for the subsequent production of pearls. 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 Exmouth Gulf to the northern waters of the Kimberley. One company generally transports 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 pubic consultation process in accordance with Ministerial Policy Guideline No. 8, 'Assessment of applications for authorisations for Aquaculture and Pearling in coastal waters of Western Australia'. The assessment of pearl farm lease applications was a major activity during 1998/99.

The wild-stock pearl oyster fishery is managed on a system of individual quotas with a total allowable catch (TAC). The status of stocks is reviewed each year by Fisheries WA in liaison with the Pearling Industry Advisory Committee (PIAC). During 1998/99, the TAC for the 1999 fishing season for Zone 2/3 was 457,000 shells (one quota unit equals 1000 shells).

The status of stocks in Zone 1 was also reviewed. A total allowable catch of 40,000 shells for the Exmouth Gulf component of the Zone 1 fishery was set for the 1999 season. A maximum size limit of 140 mm was also placed on 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. These arrangements were similar to those in 1998.

The seeding of hatchery-produced oysters was continued by some companies through licensees utilising hatchery options available to industry.

The annual production for pearls for 1997/98 was estimated at about $190 million. This is expected to rise for 1998/99, however production figures are not yet available.

The agency, with the Pearl Producers' Association and PIAC, dealt with a number of other management issues during 1998/99, including the consideration of guidelines for pearl divers' licences and planning for pearl farm leases. PIAC met on two occasions. The drafting of a series of Regulation amendments was finalised and drafting commenced for a new Pearling Act. Current and proposed new pearling legislation is currently being reviewed in accordance with National Competition Policy agreements.

Compliance and Community Education Overview

During 1998/99, a staff commitment equivalent to 4.6 officers was involved in compliance monitoring across all zones of this fishery. With the increased involvement of all companies in the production of hatchery-reared shell, emphasis has been placed on the monitoring and control of this product. 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. 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.

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 monitored by the system of hatchery and transport logbooks combined with a system for disease testing, quarantine and health certificate clearances. 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.

The move to a Vessel Monitoring System for this fishery which could enable real-time quota logbook data transfer has been postponed, with industry examining various system options.

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.

Officers continued to receive training to ensure ongoing compliance with the agency Occupational Health and Safety Policy for diving inspection duties. The purchase of a diving communications unit has improved the efficiency of dive inspections, simplifying the methods used to conduct dump site and nursery audits.

The focus will continue to shift towards monitoring compliance of hatchery shell regulations, with an increasing number of patrols targeting this area of the pearling industry. With some companies moving towards operating hatchery-reared shell in lieu of wild stock, the emphasis will be shifted to rigid monitoring of the number of shell operated, which will require a compliance presence on board operations vessels.

Research Overview

Research for managing the pearl oyster stocks across the North-West Shelf utilises detailed diver logbook records, at-sea sampling of catches and biological research information. This information is used annually to monitor the status of the stocks and to review and set catch quotas.

FRDC-funded research completed during the 1997/98 year provided detailed information on regional growth rates of oysters to complement previous studies on the biology and the exploitation levels applied to the stock. In addition to this core research, the Fisheries Research Division has received a major new FRDC grant to undertake research into the breeding (mother-of-pearl) component of the pearl oyster stocks. The Division's fish pathology group also provides a comprehensive disease testing program to ensure translocation protocols are met.

Data from the research program have been used to compile the following status report.

Fishery Status Report

Main Features

Stock assessment complete:
Yes

Exploitation status:
Fully exploited (within management parameters of diver safety and maximisation of value of pearl crop)

Breeding stock levels:
Increasing

Previous catch and effort projections for year 1998:
572,000 shell (quota all zones), with 15,000-19,000 dive hours in Zone 2

Catch and effort current season (1998):
565,322 shell taken over 20,593 dive hours (13,035 dive hours in Zone 2)

Estimated annual value (to fishers) for year 1998:
Total fishery and cultured pearl valued at $185 million

continued over

Catch and effort projection next year (1999):
572,000 shell (quota all zones) taken over an estimated 18,000-25,000 dive hours (all zones) (based on the effort range over the past five years)

Recreational component (1997):
Nil

Boundaries and Access

The four management zones (Pearl Figure 1) of the pearl oyster fishery are listed below.

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 - 11 licensees.

Pearl Oyster Zone 3: West of longitude 125°20′ E and north of latitude 18°14′ S - 2 licensees (plus 11 Zone 2 licensees).

Pearl Oyster Zone 4: East of longitude 125°20′ E to WA/NT border (all licensees have access).

Annual Production

Main fishing method
Diving.

Landings
The total catch is controlled by a quota system, with a 1998 total allowable catch for Zones 2/3 of 457,000 shell. The 1998 season represented the first year of the TAC returning to pre-1995 quota levels. During the seasons 1995-1997 the quota was raised by 55,000 shell due to the indication of an increased stock abundance suggested by significant increases in catch rate. The quota increase was initially proposed for a two-year period; however, this was extended to include a third year in 1997 due to continued high catch rates. The reported Zone 2/3 catch for 1998 was 457,266 shell (Pearl Table 1).

The Zone 1 quota for 1998 was 115,000 shell. The reported catch of 108,056 shell (Pearl Table 2) was below this due to the fact that one licensee did not take their full quota during 1998.

Fishing effort
Total effort for 1998 in Zone 2/3 was 14,499 dive hours, which represented a 14% decrease on the 1997 total effort of 16,893 dive hours (Pearl Table 1). However, there was also an 11% reduction in quota for the 1998 season. The Zone 2 effort was 13,035 hours, which was below the forecast range for Zone 2 of 15,000-19,000 hours. (Note that, as the result of a typographical error, this figure appeared in the *State of the Fisheries Report 1997/98* as the effort prediction for all zones, whereas in fact it was for Zone 2 only.) The total effort in Zone 1 was 6,094 dive hours, representing a 36% decrease on the 1997 total effort of 9,494 dive hours (Pearl Table 2).

Catch rate

Catch per unit effort in Zone 2/3 in 1998 was 31.5 shells/dive hour (shells/hr), which represented a small increase on the 1997 catch rate of 30.3 shells/hr, and a 10% increase on the 10-year (1987-1996) average of 28.5 shells/hr. This increase on the 10-year average is somewhat understated due to more stringent shell grading methods applied to a large sector of the industry in recent years, which has resulted in operators reducing the maximum size of shell taken (Pearl Table 1).

The Zone 1 catch per unit effort was 17.7 shells/hr in 1998, which represented a 52% increase from the 1997 figure of 11.6 shells/hr (Pearl Table 2). This was partly due to the effort being shifted from the Exmouth Gulf area, where low catch rates have been experienced in recent years, into a previously under-utilised area in the buffer zone between Zones 1 and 2.

Stock Assessment

The primary measure of stock availability in Zone 2/3 is catch per unit effort. The high level of catch rate recorded in recent years (1994-1996) had previously only been experienced during the late 1970s and early 1980s when the pearling fleet was fishing both culture and mother-of-pearl (MOP) shell. The reasons for the increase in catch rates during this period are believed to be a combination of high levels of recruitment and/or increased fishing efficiency from the introduction of global positioning system (GPS) navigation. The causes of the apparent increase in recruitment are probably favourable environmental conditions, and/or increased fertilisation success due to an increase in breeding stock at the time of breeding.

The 1998 Zone 2/3 catch rate remained similar to the 1997 level, and to those recorded prior to 1994, and reflects a more 'traditional' level of recruitment. The return to the 'normal' catch rates of the past two years follows the three-year period (1994-1996) during which the pulse of recruitment responsible for higher catch rates passed through the size range targeted by the fishery. Overall, the catch-rate data indicate that recruitment to the Zone 2/3 pearl oyster stock is at a level sufficient to maintain stock levels permitting safe and economic fishing operations.

The distribution of catch and effort in Zone 1 changed considerably during 1998 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 miles east to allow operators access to previously under-utilised grounds in the southern areas of Zone 2. As a result total shell caught in the Port Hedland region increased significantly (from 23,473 shell in 1997 to 70,465 shell in 1998), with the vast majority of shell caught in the buffer zone extension. Catch rates also improved from 14.4 shells/hr in 1997 to 26.4 shells/hr in 1998. There was a corresponding decline in total catch from Exmouth Gulf (72,244 shell in 1997 to 33,804 shell in 1998), obviously due to the 40,000 shell TAC and good catch rates from the Port Hedland region (buffer zone). Catch rates in Exmouth Gulf fell slightly in 1998 to 11.01 shells/hr, and remain an area of concern. However, the effects of management changes are unlikely to be apparent until at least the 1999 season. Very little fishing took place in the Onslow/Dampier area of Zone 1 during 1998, with catch rates similar to those recorded in 1997.

The steady decline in catch rates from Exmouth Gulf since 1993 (when the Zone 1 quota was increased from 55,000 to 115,000 shell) indicates that exploitation levels in this area may have been excessive. The 1998 management changes in Zone 1, which have been successful in reducing heavy fishing pressure in Exmouth Gulf, will be retained during the 1999 season to limit effort and encourage the rebuilding of pearl oyster stocks in this area. A maximum legal shell size limit of 160 mm will also remain in Exmouth Gulf to allow for increased recruitment into the broodstock. Catch rates will continue to be monitored closely, with factors such as searching/fishing patterns and diving conditions taken into account.

The Port Hedland region (particularly the buffer zone extension) is expected to again produce the majority of the 1999 Zone 1 quota.

Breeding Stock Levels

The greater proportion of pearl oysters do not become breeding females until they reach a size that is too large for pearling operations. Consequently, an animal is not subject to fishing mortality once it grows through the 'gauntlet' size targeted by industry. As the current quota set for the fishery is thought to be in balance with, and most likely less than, the production of the stock, breeding stock is most likely being maintained, if not increased, given the longevity of the species. This is especially true for Zone 2/3 in recent years with the good recruitment occurring in the mid-1990s. In contrast, heavy fishing pressure in some sectors of Zone 1, particularly Exmouth Gulf, is considered to have reduced flow-through of recruits to broodstock sizes. Current management arrangements in Exmouth Gulf are designed to ensure that breeding stocks in that sector are maintained in the longer term. A new FRDC-funded project to assess the status of mother-of-pearl stocks will provide more detailed information on breeding stock level.

Catch Projection for Year 1998

It is expected that the pearl oyster fishery will achieve its historical quota of 572,000 shell within the range of 18,000-25,000 dive hours experienced over the past five years (1994-1998).

Product Value for Year 1998

The value of cultured pearls and by-products is considered to be approximately $185 million for the 1998 year. A precise estimate of the value of product is, however, difficult to achieve due to the variable time lags between time of harvest and sale to offshore buyers and the costs incurred in marketing before sales occur.

General Comments

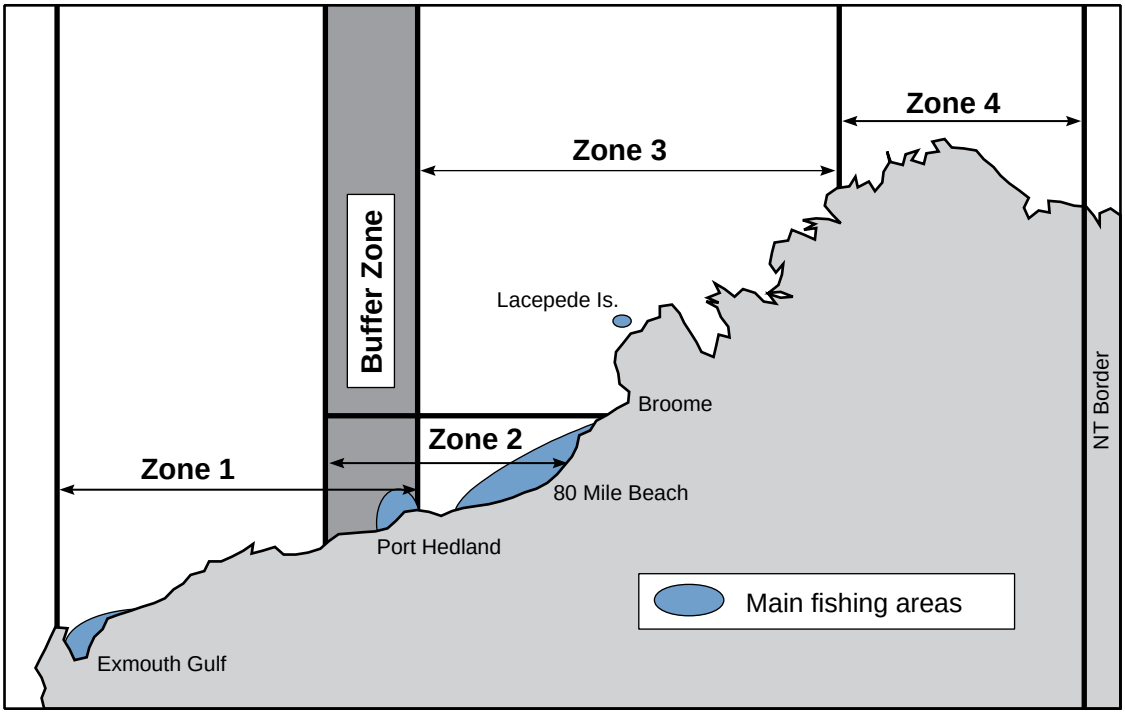
The pearl oyster stocks underpinning the fishery in Zone 2, although having returned to 'normal' recruitment levels, continue to provide a reliable level of production to support this major Western Australian industry. The provision to Zone 1 operators of access to previously unexploited areas in the Port Hedland sector has provided improved catches, however the reliability of recruitment in the area will only be known when fishing has occurred for a number of years. If catches cannot be maintained, this zone will possibly need to rely on hatchery-produced shell from the facilities established for that purpose, and work on a reduced wild-stock catch quota.

Pearl Table 1 Historical changes in pearl shell catch and effort - Broome area (Zones 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	0.0	20.9
1988	445,000	379,657	0	379,657	14,600	26.0	0.0	26.0
1989	445,000	445,364	0	445,364	18,625	23.9	0.0	23.9
1990	457,000	453,705	0	453,705	23,263	19.5	0.0	19.5
1991	457,000	460,608	0	460,608	21,657	21.3	0.0	21.3
1992	457,000	461,599	0	461,599	19,455	23.7	0.0	23.7
1993	457,000	457,186	0	457,186	14,733	31.0	0.0	31.0
1994	457,000	456,832	0	456,832	12,384	36.9	0.0	36.9
1995	512,000	511,633	0	511,633	12,217	41.9	0.0	41.9
1996	512,000	511,756	0	511,756	12,774	40.1	0.0	40.1
1997	512,000	512,314	0	512,314	16,893	30.3	0.0	30.3
1998	457,000	457,266	0	457,266	14,499	31.5	0.0	31.5

Pearl Table 2 Historical changes in 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



Pearl Figure 1 Map showing the boundaries of the management zones of the pearl oyster fishery.

Mussel Aquaculture

Management Overview

Fisheries WA manages mussel farming in Cockburn Sound following an agreement reached between the Minister for Fisheries and the Fremantle Port Authority in 1997/98. Tenure for the existing farming sites at the Kwinana Grain Terminal is due to expire in December 1999. As a result, Fisheries WA in liaison with industry has identified an alternative site at Southern Flats within Cockburn Sound. The suitability of the site has been assessed through a comprehensive consultation process involving a wide range of stakeholders. Subject to final approvals, relocation of mussel farming activities is expected to be completed by the end of 1999.

During 1998/99, the Australian Quarantine and Inspection Service (AQIS) approved the export status of three shellfish-growing areas in Western Australia in accordance with the procedures outlined in the Western Australian Shellfish Quality Assurance Program.

Industry Status Report

Main Features

Production current season (1997/98):
659 tonnes

Number of producers for year 1997/98:
14

Estimated annual value (to producers) for year 1997/98:
$1,750,000

Production projection next year (1998/99):
800 tonnes

Production areas

Mussel farms are found in Cockburn Sound, Warnbro Sound, Oyster Harbour, Princess Royal Harbour and King George Sound. Resource-sharing issues are a major constraint to access to lease sites in protected and productive areas. Additional lease area is being negotiated in the Southern Flats area of Cockburn Sound to give the Cockburn Sound mussel farmers more access to productive areas.

Annual Production

Production method(s)
Vertical rope and bag culture on longlines.

Production trends for year 1998/99
Increasing.

General Comments

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. A study reviewing the data on phytoplankton levels around the WA coastline, completed in 1997/98 by CSIRO and Curtin University in collaboration with Fisheries WA, will facilitate better planning for bivalve culture.

Marron Aquaculture

Management Overview

Changes made in 1995 to the regulations governing marron cultivation have resulted in more small farmers contributing to industry production. There have also been improvements in the production reporting system, which has resulted in a more realistic production report. During 1998/99, the marron regulations were further reviewed with the aim of simplifying the licensing framework.

Compliance and Community Education Overview

Aquaculture Development Officers and Fisheries Research Division staff continue to provide technical and development advice to the industry, as well as providing displays and information at field days, country shows and workshops. A number of new industry entrants were given in-field and administrative assistance during the year to obtain commercial licences.

Compliance service level to the industry from a Fisheries perspective was low in this period, however officers were associated with a number of investigations related to stealing of marron from farm dams. These investigations were carried out in conjunction with police.

Research Overview

Fisheries Research Division activities for marron farming during 1998/99 focused on providing expert technical advice to marron farmers on pond construction, pond management, broodstock management procedures and grow-out processes based on previous research findings. There has been a rapid expansion in the number of marron farms in the state and this is likely to continue.

In addition, basic research was completed to compare growth rates of blue and black marron and to assess the effect of replacing a commercial freshwater crayfish

feed with a more expensive trout feed. Attempts to maintain the captive breeding population of the depleted Margaret River sub-species have been hindered by poor reproductive output.

Information from the various research and extension activities has been compiled into the following status report.

Industry Status Report

Main Features

Production current season (1997/98):
42 tonnes

Number of producers for year 1997/98:
197

Estimated annual value (to producers) for year 1997/98:
$1,027,000

Production projection next year (1998/99):
40-50 tonnes

Production areas

Licensed purpose-built farms extend from east of Albany to Hutt River north of Geraldton, though the bulk of farms are concentrated in the higher-rainfall south-west coastal area. Legal-sized marron produced in farm dams can be sold through a licensed farmer or processor. Under-size farm marron can be sold by holding an unrestricted licence, which can only be obtained for a substantial area of pond development or on the performance criterion of a higher level of production per unit area.

Annual Production

Production method(s)
Semi-intensive farming in purpose-built earthen ponds; extensive farming in gully dams.

Production
The average industry annual yield of 600 kg/ha compares with 1,500-2,300 kg/ha/year from well constructed and managed semi-intensive ponds. For farm dams, the annual yield is about 100 kg/ha.

Extension and Information Transfer

Considerable effort has been made to ensure that information on aquaculture of marron is readily available to the public. Methods of communication included extension publications, seminars, workshops and field days. During 1998/99, a program of attendance at and detailed documentation of harvests and farming procedures was initiated to help evaluate the commercial applicability of agency extension advice. This will also indicate which site and management variables have the most influence on production.

General Comments

A significant number of new purpose-built marron farms have been developed during 1998/99 and should progressively contribute to expansion in State production. Development of a new farm to full production usually requires around three years. Many of these new farms will utilise the increased processing capacity now available through the Pemberton Aquaculture Producers (operating from a facility at the South West Freshwater Research and Aquaculture Centre). This processing group is now providing a coordinated marketing arrangement for many of the new producers.

Yabby Aquaculture

Management Overview

Yabby production has continued on an extensive basis by trapping from existing farm dams. Management and licensing arrangements have not changed significantly over the past year. Aquaculture Development Officers stationed in Geraldton, Narrogin and Albany are assisting industry development through the provision of information on production techniques and the results of FRDC-funded research.

In March 1999, the presence of the protozoan *Thelohania* was detected in Western Australian yabbies. Following investigation of the outbreak, it was determined that the disease had become widespread in Western Australia and was likely to have been within the State for a number of years. There is no public health issue associated with the disease, and arrangements for ongoing management are currently being developed.

Compliance and Community Education Overview

South-west freshwater aquaculture fisheries are serviced by Fisheries Officers based in Esperance, Albany, Bunbury, Mandurah, Fremantle and Geraldton to ensure continuation of a high level of awareness of, and compliance with, management rules.

Aquaculture Development Officers stationed at Geraldton, Narrogin and Albany provide extension services to farmers producing yabbies, as well as providing displays and information at country shows and workshops.

Low levels of compliance are directed at this industry group, however compliance officers were involved in disease control and monitoring during the recent *Thelohania* outbreak.

Research Overview

A major national research project to develop methods to enhance yabby production has been conducted over the past five years. This research, conducted at the Avondale experimental pond complex and at the joint Fisheries WA/University of Western Australia freshwater crayfish genetics facility, has enabled the development of a variety of methods to significantly enhance the production of marketable quality yabbies from farm dams, including evaluation of an all-male hybrid yabby. During 1998/99, these findings were promoted by research staff and Regional Services Aquaculture Development Officers through field days and seminars held in association with yabby processors and farmers' groups.

Data from this research, conducted in collaboration with industry organisations and individual farms, have provided the basis for the following industry status report.

Industry Status Report

Main Features

Production current season (1997/98):
231 tonnes

Number of producers for year 1997/98:
32 (licensed farmers or processors - most farmers do not require licences)

Estimated annual value (to producers) for year 1997/98:
$2,252,573

Production projection next year (1998/99):
250-300 tonnes

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. Unlicensed agricultural farmers may sell yabbies to licensed farmers/processors or permit licensed harvesters access.

Annual Production

Production method(s)
Harvesting of farm dams by baited traps.

Production
Extensive farming; self-sustaining farm dam populations; annual farm dam yields average 400-500 kg/ha.

Production trends
Increasing, subject to annual rainfall, to 500 tonnes by year 2000/01.

Extension and Information Transfer

Considerable effort has been made to ensure that research and development information for aquaculture of yabbies is readily available to the agricultural sector. In addition to responding to numerous inquiries, methods of communication included extension publications, seminars, workshops and field days.

General Comments

The annual production was approaching 300 tonnes in 1993/94, but then declined in 1994 and 1995 due to poor winter rainfall to refill farm dams. Stocks recovered 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.

Commercial production of 231 tonnes recorded for the last full financial year, 1997/98, represents a substantial increase over the revised figure of 150 tonnes for 1996/97. This increase may be ascribed to a number of factors including improved winter rainfall, increased participation rates, improved management techniques based on Fisheries WA research (monosex growout, higher feed rates, improved feeding regimes and regular trapping), and an improved data returns process.

The discovery of two significant diseases in a variety of farms was a major setback in 1998/99 although these pose no threat to consumers. Concern in some overseas markets over potential damage through burrowing activities of WA yabbies has been shown not to be well founded as a major survey revealed that most burrows were relatively shallow and would not impact on dam walls.

Trout Aquaculture

Industry Status Report

Main Features

Production current season (1997/98):
24.2 tonnes

Number of producers for year 1997/98:
8 (includes major pay-fishing dam operations)

Estimated annual value (to producers) for year 1997/98:
$196,038

Production projection next year (1998/99):
25-30 tonnes

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.

Annual Production

Production method(s)
Highly intensive pond culture for food, and extensive farming in large gully dams stocked for pay fishing.

Production
Up to 200,000 kg/ha/year in dedicated ponds; up to 1,500 kg/ha/year in nutrient-rich dams can be achieved.

General Comments

The Fisheries WA Pemberton 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.

Ornamental Fish Aquaculture

Management Overview

The production of a wide range of freshwater and marine ornamental fish species is a small but rapidly growing sector of the aquaculture industry in Western Australia. As at June 1999, 23 licences are on issue for the production of these species. During 1998/99, the agency published information on the opportunities for ornamental fish production in Western Australia, and also convened a session on ornamental fish aquaculture at the World Aquaculture Society Conference held in Sydney in April 1999.

Industry Status Report

Main Features

Production current season (1997/98):
183,480 fish

Number of producers for year 1997/98:
15

Estimated annual value (to producers) for year 1997/98:
$67,666

Production projection next year (1998/99):
Approximately 200,000 fish

Production Areas

State-wide.

Annual Production

Production method(s)
Dedicated small ponds and aquaria; breeding and rearing of juveniles for live sales.

Extension and Information Transfer

As with other aquaculture species, the Fisheries Research Division provides considerable advice on ornamental fish aquaculture and proactively promotes native fish as ornamentals and for mosquito control; however, most of this culture is for internationally well known exotic species (e.g. Cichlidae) associated with the aquarium trade. A major advisory publication on production of aquarium fish was released in 1998/99.

General Comments

Commercial production recorded for 1998/99 indicated considerable volatility in production for major aquarium fish groups.

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.

Fishcare WA

Community groups have been encouraged to play a role in fisheries management and conservation of the marine environment through Fishcare WA and the National Fisheries Action Program. Nine Fishcare WA projects valued at over $25,000 and nine Fisheries Action Program projects valued at over $274,000 were funded over the last year. This brings the total value of all grants made to Western Australian projects under the two programs since 1996 to $722,900. New projects funded in 1998/99 included the preparation of a management plan for a proposed Fish Habitat Protection Area at Cottesloe and a study of human impacts on marron populations in the south-west.

Marine Reserves and Marine Planning

The Government has resolved to proceed with the establishment of a number of new marine reserves and the preparation of management plans for a number of existing marine parks. The Minister for Fisheries and Fisheries WA both have a vital role in these processes. Fisheries WA manages fishing, pearling and aquaculture in all marine reserves.

During the year Fisheries WA has had input into the preparation of plans for the Swan River Marine Reserve and the Shoalwater Islands Marine Park and a draft plan for the Rowley Shoals Marine Park. It also worked with the Commonwealth and the Department of Conservation and Land Management to develop a Memorandum of Understanding for the collaborative management of the Rowley Shoals Marine Park and the Mermaid Reef Marine National Nature Reserve.

The agency has served on the Community Consultative Committee established to provide advice about planning for the proposed Jurien Bay Marine Reserve. This has included the preparation of advice about the possible effects of the proposed park on the fishing industry and the possible effects of fishing on the conservation values of the proposed park.

Fisheries WA is working with other relevant agencies to develop an 'all of Government' approach to marine planning. The agency has had an input into the development of Western Australia's position in relation to Australia's Oceans Policy, which was released by the Prime Minister in December.

Abrolhos Islands

Care of the Abrolhos Islands is vested in the Minister for Fisheries, who has acted to provide strong and sustainable management of this unique resource.

In December 1988 the Minister announced that the Government had agreed to the establishment of an independent authority to manage the Abrolhos Islands. The Abrolhos Islands Management Advisory Committee (AIMAC) will remain in place and continue its important role in caring for the Abrolhos until the management authority is established in the year 2000. Also in December 1998, the Minister launched the paper 'Management of the Houtman Abrolhos System'. This plan, which was prepared with the assistance of AIMAC, provides a blueprint for the conservation and use of the Abrolhos for the next five years. AIMAC has commenced work on implementing the key recommendations in the plan.

The Abrolhos Fish Habitat Protection Area (FHPA) was proclaimed on 16 February 1999. The gazettal of the FHPA paves the way for the increased protection of this important part of the marine environment. This is the first Fish Habitat Protection Area proclaimed under the *Fish Resources Management Act 1994*.

Major works have been completed at East Wallabi Island in order to improve public access to the Abrolhos. These works, which were undertaken a cost of $160,000, include the upgrading of the jetty near the landing area and the construction of public toilets.

A draft plan for sustainable tourism at the Abrolhos Islands was released for public comment. The plan will provide for increased public access to the Abrolhos in a manner which is consistent with the need to protect the environment.

Marine Environments

In 1998 the Environmental Protection Authority and Fisheries WA developed a Memorandum of Understanding and agreed on a Ministerial Policy Guideline for the translocation of living aquatic organisms. During 1998/99 Fisheries WA processed 38 applications from people wishing to translocate fish into and within Western Australia.

The Minister for Fisheries and Fisheries WA have adopted the National Bycatch Policy as the bycatch policy for Western Australia. In response to this initiative, Fisheries WA is working with industry to develop bycatch action plans for all commercial fisheries in the State. As part of this process research is being conducted into trawl bycatch, including a trial of the use of bycatch reduction devices in the Shark Bay prawn industry. A desk study into the impacts of trawling is also under way.

Cowaramup Bay near Margaret River has been set aside as a Reef Protection Area. This initiative was undertaken in cooperation with the local community. In the Reef Protection Area you may catch fish by line and take rock lobster and abalone in season, but all other marine life is protected.

In line with the agency's commitment to minimising adverse human impacts on the marine environment, quarantine and protection initiatives form an important element of the agency's activities. These include representation on the State Ballast Water Working Group, finalisation of a disease emergency response plan for the valuable pearling industry, and a significant input into the national process of risk assessment for imports of live and viable fish products.

Fisheries WA contributed during the year to a program to eradicate introduced black-striped mussels which had become established in three harbours in Darwin. Fisheries WA divers travelled to Darwin and assisted in the eradication project. In addition, Fisheries WA undertook inspections of all Western Australian boats which had been in the harbours during the period of the infestation to ensure this pest was not inadvertently introduced to Western Australian waters.

A Geographic Information System has been established to assist in developing our understanding of the marine environment. The system, developed by Fisheries WA in collaboration with the Department of Transport, presents information on 65 fisheries including commercial licence areas, principal fishing areas, closed areas, fishing seasons, annual catch and value and species distribution in Western Australian and Commonwealth waters.

Australian Fishing Zone Activities

The Australian Fishing Zone (AFZ) section provided ongoing monitoring, control and surveillance to four dedicated programs serviced on behalf of the Australian Fisheries Management Authority (AFMA). Fisheries Officers from the AFZ section are stationed in Perth and Broome.

The programs include two domestic tuna fisheries, the Western Tuna and Billfish Fishery and the Southern Bluefin Tuna Fishery. The other programs involve routine surveillance of the 200 nautical mile Australian Fishing Zone surrounding mainland Australia and its territories of Christmas and Cocos (Keeling) Islands and, in the sub-Antarctic region, Heard and McDonald Islands.

Negotiations between Australia and Japan at the Commission for the Conservation of Southern Bluefin Tuna stalled with Japan asking for extra experimental quota and Australia being unwilling to agree to the request on biological grounds. As a consequence there was no bilateral licensing allowing Japanese fishing inside the AFZ during the 1998/99 financial year. There was, however, continued surveillance of the AFZ in order to detect any illegal tuna fishing by foreign vessels.

Indonesian traditional fishermen are permitted to fish within a select area of the AFZ (north-western Australian waters) under conditions agreed in a Memorandum of Understanding between Australia and Indonesia. Officers conducted compliance patrols within the area, boarding and inspecting Indonesian fishing vessels and briefing masters on operational areas and fishing restrictions. Illegal Indonesian fishing vessels operating outside the authorised area were apprehended and escorted to the ports of Broome or Darwin. Officers operating from Royal Australian Navy (RAN) naval patrol vessels apprehended 17 Indonesian fishing vessels. The masters and crew of these vessels were prosecuted through the courts at Broome and Darwin.

The Australian overseas aid agency AusAid provided funding for implementation of an aid program in Indonesia designed to reduce incentives for Indonesion fishermen coming to Australian waters. Stage one of Project Wakatobi was completed in May 1999. The operation took place in the Tukangbesi Islands in south-eastern Sulawesi. AFZ officers began training selected local inhabitants in rudimentary monitoring, control and surveillance techniques to be used in the newly established Wakatobi Marine National Park. They also provided assistance in the construction of fish aggregating devices and seaweed mariculture projects. Further funding is now being sought so that the follow-up stages of the project can be completed.

On an opportunistic basis, Fisheries Officers accompanied RAN patrol vessels to the offshore territories of Christmas Island and Cocos (Keeling) Islands.

As part of the programs associated with domestic tuna, Fisheries Officers conducted land patrols which involved inspecting processor installations and fishing vessels in the coastal strip between Shark Bay and Esperance. Additionally, district Fisheries Officers liaised with fishermen and conducted fishing vessel inspections within their districts for and on behalf of the AFZ programs.

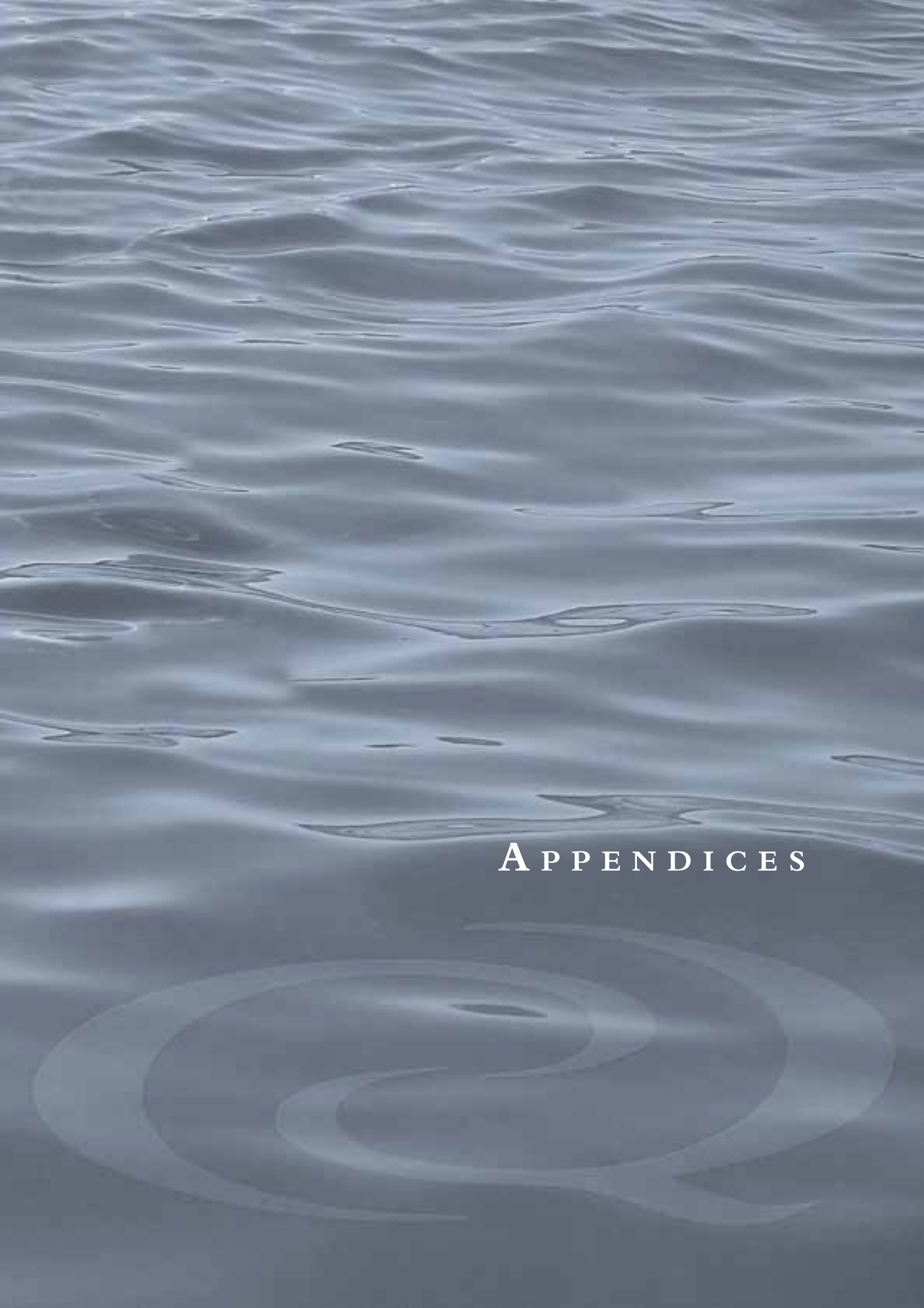
The last 12 months have seen an increase in effort and participants in the Commonwealth-managed Western Tuna and Billfish Fishery. Expected continued growth is helping to give impetus to the creation of a formal management plan for the fishery.

Two foreign fishing vessels which were apprehended for illegally fishing in the AFZ around Heard Island and McDonald Island (HIMI) during early 1998 were successfully prosecuted. The resultant fines and forfeitures totalled approximately $2.5 million. A further vessel apprehended in the HIMI area was sold subject to a mortgagee claim by a bank in Norway.

The charter vessel MV *Cape Grafton* was contracted by AFMA to carry out monitoring and surveillance patrols of the HIMI area. Two patrols each of 50 days' duration were carried out, the first in late 1998 and the second in early 1999, both led by officers from Fisheries WA. The commitment to the HIMI area will be ongoing.

Fisheries Officers monitored a number of fish off-loadings in Albany from the Australian fishing vessels *Austral Leader* and *Southern Champion*. These are the only two vessels licensed to take Patagonian toothfish in the Heard and McDonald Islands fishery. The fishery is managed by a total allowable catch mechanism which is divided between the two licensed vessels by means of individual transferable quotas.

In support of the fisheries section of the Food and Agriculture Organisation of the United Nations, and the Forum Fisheries Agency, AFZ Fisheries Officers assisted in delivering fisheries enforcement skills upgrading courses in the Solomon Islands, Fiji and the Federated States of Micronesia. The courses were delivered to enforcement officers from the Pacific island nations and included workshops on procedures for boarding and inspecting foreign fishing vessels. Many Pacific island nations rely on income derived from fishing activity within their respective fishing zones, and it is important that their enforcement officers develop and maintain high skill levels. Skills training in determining volumetric measurements of fish catches held in the freezer holds was also provided.



Appendices

APPENDIX 1: Stock Exploitation Status and Catch Projections for Major Commercial Fisheries (Appendix 9 from Annual Report 1998/99)

Fishery	Stock assessment complete	Exploitation status	Breeding stock levels	Previous catch projections (tonnes)	*Catch (tonnes) current season	Year	Catch or effort projection next season (tonnes)	Year	Comments current season catch
INVERTEBRATES									
Western rock lobster	Yes	Fully exploited	Increasing	10,000-11,000	10,463	97/98	13,000-14,000	98/99	The average catch achieved in 1998/99 was predicted from puerulus settlement three and four years previously. The breeding stock levels have improved significantly.
Esperance rock lobster	Yes	Fully exploited	Adequate	40-70	82	97/98	50-80	98/99	Catch figures and projections include the fishery's three management zones: Esperance, GAB and Albany.
Shark Bay prawn	Yes	Fully exploited	Adequate	1,155-2,063	2,185	98	1,611-2,183	99	Increased catches of king prawns may be due to variations in environmental conditions or increasing effective fishing effort.
Exmouth prawn	Yes	Fully exploited	King prawn adequate; Tiger prawn below optimum	771-1,276	1,058	98	771-1,276	99	Tiger prawn recruitment levels are responding to rebuilding measures.
Onslow prawn	No	NA	NA	30-265	61	98	61-132	99	Low summer rainfall decreased banana prawn catches.
Nickol Bay prawn	No	NA	NA	Banana prawn 10-100	89	98	Banana prawn 150-250	99	Low summer rainfall decreased banana prawn catches (rainfall relationship used to improve catch forecast).
Broome prawn	Yes	Fully exploited	Adequate	King prawn 35-140	King prawn 164	98	King prawn 36-164	99	Fishing season now extended and matched to lunar-phase-driven recruitment patterns in order to achieve the best catch rates.
Kimberley prawn	No	NA	NA	230-590	436	98	278-576	99	Higher than normal rainfall improved catches of banana prawns.
South-west trawl	NA	NA	NA	Not available	Prawns 18 Scallops 1.3	98	Not available	99	Prawn catch is mainly king prawns. Scallop catch given in meat weight.
Abalone Zone 1 (greenlip/ brownlip)	Yes	Fully exploited	Adequate	108.75 (Q) (540-635 days)	100.44 (669 days)	98	108.75 (Q) (540-670 days)	99	Increased number of days to take quota may be evidence of a decline which needs to be monitored.
Abalone Zone 2 (greenlip/ brownlip)	Yes	Fully exploited	Adequate	110 (Q) (650-850 days)	108.6 (658 days)	98	110 (Q) (650-850 days)	99	Stocks appear to be in good shape.
Roe's abalone	Yes	Fully exploited	Adequate	120 (Q) (750-1,100 days)	116 (789 days)	97/98	108 (Q Z3) 18 (Q Z1/2) (750-950 days Z3)	99/2000	Reported catch is for Oct 97-Sep 98. Catch projection is for Apr 99 to Mar 2000 as quota period has been aligned with Zones 1 and 2.
Shark Bay scallop	Yes	Fully exploited	Adequate	180-250	252	98	210-440	99	Annual variations in recruitment seem to be correlated inversely with the strength of the Leeuwin Current. Catch given in meat weight.
Abrolhos Islands & Mid-West trawl	No	Fully exploited	Adequate	90-150	42	98	80-120	99	Recruitment is dependent on environmental conditions each year. Catch given in meat weight.
AQUACULTURE									
Pearl oyster	Yes	Fully exploited	Increasing	572,000 oysters[1] (Q) (total) (15,000-19,000 dive hours Zone 2)	565,322 oysters (total) (13,0352 dive hours Zone 2)	98	572,000 oysters[1] (Q) (18,000-25,000[2] dive hours total)	99	1998 catch was close to the quota, with dive time in Zone 2 less than expected.

* Catch figures supplied for latest year available.

NA = No assessment.

Q = Quota management.

1 Pearl catch quota is in individual oysters.

2 A typographical error appeared in these figures in the identical table presented in the Fisheries WA Annual Report. These are the corrected figures.

APPENDIX 1: Stock Exploitation Status and Catch Projections for Major Commercial Fisheries (Appendix 9 from Annual Report 1998/99) (continued)

Fishery	Stock assessment complete	Exploitation status	Breeding stock levels	Previous catch projections (tonnes)	*Catch (tonnes) current season	Year	Catch or effort projection next season (tonnes)	Year	Comments current season catch
FINFISH									
Pilbara trawl	Yes#	Some species over exploited	Inadequate for red emperor in the west	2,300-2,700	2,512	98	2,300-2,600	99	Assessment only includes major species. 33% effort reduction in 1998.
Pilbara demersal trap & line	No	Fully exploited	Limited data	Not available	328	98	Not available	99	Low level of effort continuing.
Northern demersal	No	Fully exploited	Limited data	650	544	98	600-1,000	99	Low catch due to reduced effort.
Kimberley gillnet & barramundi	Yes#	Fully exploited#	Adequate#	28-47 (barramundi)	32 (barramundi)	97/98	25-40 (barramundi)	98/99	Barramundi catch only.
Shark Bay snapper	Yes	Fully exploited	Adequate	500-550 (Q)	567	98	550 (Q)	99	Improved markets in 1997 and 1998 led to higher than average catches.
WA salmon	Yes	Fully exploited	Adequate	1,700-5,000	2,801	98	1,800-4,900	99	Environmental factors (Leeuwin Current) influence recruitment and catch levels.
Australian herring trap	No	Fully exploited	Adequate	520-1,550	651	98	430-1,220	99	Low catch apparently due to unusual environmental impacts.
Southern demersal gillnet & longline	Yes#	Fully or over exploited	Stable	800-1,000	911	97/98	800-950	98/99	Management measures designed to reduce catch to improve breeding stocks are being progressively implemented.
West coast demersal gillnet & longline	Yes#	Fully or over exploited	Stable	350-450	477	97/98	350-450	98/99	Management measures designed to reduce catch to improve breeding stocks are being progressively implemented.
Cockburn Sound	NA	NA	Not appropriate	49-125	60	98	38-92	99	Finfish only (excludes bait fish).
Shark Bay beach seine & mesh net	Yes#	Fully exploited#	Adequate#	90-140 (whiting)	115 (whiting)	98	95-140 (whiting)	99	Whiting catch only.
Estuarine fisheries (west coast)	Yes#	Fully or over exploited	Not appropriate	Not available	490	98	Not available	99	Excludes Hardy Inlet. Includes fish and crustaceans.
Estuarine fisheries (south coast)	Yes#	Fully exploited	Not appropriate	280-480	365	98	220-480	99	Includes fish, molluscs and crustaceans.
Albany/King George Sound purse seine	Yes	Fully or over exploited	Decreasing (low)	3030 (Q) (2005-2215 boat days)	2085 (1565 boat days)	98	NA	99	These fisheries have been impacted by an exotic virus and stock levels reduced. Quotas set for 1999 are to be reviewed.
Bremer Bay purse seine	Yes	Fully exploited	Adequate	2250 (Q) (1060-1172 boat days)	2163 (1006 boat days)	98	NA	99	As for above.
Esperance purse seine	Yes	Under exploited	Adequate	1330 (Q) (490-600 boat days)	685 (543 boat days)	98	NA	99	As for above.
West coast purse seine	Yes	Fully exploited	Adequate	2000-3000	1832	98	NA	99	Catch of pilchards low due to stock availability in 1998. Virus impact makes projections for 1999 inappropriate.
Lake Argyle catfish	Yes	Fully exploited	Decreasing	101-138	141	97/98	102-142	98/99	

* Catch figures supplied for latest year available.
\# For key species only.
NA = No assessment.
Q = Quota management.

APPENDIX 2: Fisheries Research Division Staff Publications

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APPENDIX 2: FISHERIES RESEARCH DIVISION STAFF PUBLICATIONS (continued)

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APPENDIX 3: TABLE OF CATCHES FROM FISHERS' STATUTORY MONTHLY PRODUCTION RETURNS OF 1997/98

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 bycatch 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 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	559	559
Barracuda (Northern Pike)	2,463	2,463
Barramundi (Giant Perch)	20,423	34,288
Bigeye (not Tuna)	39,187	39,187
Boarfish	3,646	4,676
Bonefish (Pacific Bonefish)	130	130
Bonito	4,317	4,354
Bream, Black	23,527	23,527
Bream, Buffalo	85	85
Bream, mixed	131	131
Bream, Monocle	7,500	7,500
Bream, Robinson's	63,801	63,902
Bream, Sea	758	760
Bream, Silver (Tarwhine)	4,775	4,775
Bream, Western Yellowfin	20,333	20,341
Catfish, Sea (Golden Cobbler)	26,054	26,309
Chinaman Fish (not Cod)	10,589	11,342
Cobbler	56,399	78,294
Cobbler, Silver	57,473	144,147
Cod	113,730	119,619
Cod, Bar (Grey-Banded, 8-Bar)	1,096	1,100
Cod, Chinaman	5,710	5,854
Cod, Maori	27	27
Cod, Rankin	145,688	152,797
Cod, Spotted	39,563	39,624
Dart	6	6
Emperor, Blue-Lined (Grass, Black)	2,576	2,576
Emperor, Spot-Cheek	74	74
Emperor, Sweetlip	65,717	69,011
Flagfish (Spanish Flag)	185,374	185,518
Flathead, other	7,450	7,693
Flounder	3,271	3,274
Footballer (Footballer Sweep, Banded Sweep)	469	674
Foxfish (Hogfish, Pigfish)	13	13
Garfish, Sea	47,835	47,835
Groper, Baldchin	39,957	42,143
Groper, Blue	26,852	35,393
Gurnard	43	43
Hapuku	20,366	21,738
Herring, Australian	763,586	763,794
Herring, Perth	33,546	33,546
Javelin Fish	26,673	26,673
Jewfish, Westralian (Dhufish)	211,379	231,825
Jobfish	140,532	140,996

APPENDIX 3: TABLE OF CATCHES FROM FISHERS' STATUTORY MONTHLY PRODUCTION RETURNS OF 1997/98 (continued)

Catch category	Landed Weight (kg)	Live Weight (kg)
FISH (continued)		
Jobfish (Goldband Snapper)	89,301	89,301
Jobfish, Rosy	97,653	98,376
John Dory	40	40
Kingfish, Black (Cobia)	18,959	19,508
Kingfish, Yellowtail	933	991
Knifejaw	826	864
Leatherjacket	31,924	50,163
Ling, Pink (Rock Ling)	280	305
Long Tom	60	60
Mackerel, Blue	11,604	11,604
Mackerel, other	103,902	149,347
Mackerel, Scaly	383,267	383,267
Mackerel, Spanish	286,924	559,851
Mangrove Jack	15,627	15,709
Maori Seaperch (Maori Emperor)	195	195
Morwong	440	440
Mullet, Diamond Scale	292	292
Mullet, other	7,139	7,234
Mullet, Red	103,516	103,516
Mullet, Sea	392,437	392,691
Mullet, Yellow-Eye	177,846	177,846
Mulloway	38,279	40,279
Parrot Fish	6,265	6,282
Perch, Moses	54,778	54,978
Perch, Pearl	45,522	45,979
Perch, Red (Maroon Sea Perch)	10,246	10,274
Perch, Scarlet Sea (Saddletail)	136,814	136,867
Perch, Yellowtail	1,007	1,007
Perches, other	8,220	8,353
Pike, Sea	7,323	7,326
Pilchard	7,036,595	7,036,595
Queenfish	945	1,819
Red Emperor	351,122	354,656
Redfish	46,291	49,651
Redfish, Bight	8,502	9,422
Salmon, Western Australian	2,608,189	2,608,283
Samson Fish (Sea Kingfish)	126,986	138,467
Scad, Yellowtail	5,138	5,138
Shark, Blacktip	56,008	118,485
Shark, Bronze Whaler	224,658	369,506
Shark, Eastern School	34,211	54,395
Shark, Grey Nurse	4,375	6,927
Shark, Gummy	191,262	305,831
Shark, Hammerhead	55,817	92,903
Shark, other	178,706	290,605
Shark, Pencil	2,876	4,993
Shark, Spurdog	8,024	22,666
Shark, Thickskin	135,263	214,990
Shark, Tiger	15,030	23,892
Shark, Whiskery	135,591	203,799
Shark, White Pointer	250	833
Shark, Wobbegong	34,629	54,864
Skates and Rays, other	29,190	68,347
Snapper, Bullnose (Variegated Emperor)	216	216

APPENDIX 3: TABLE OF CATCHES FROM FISHERS' STATUTORY MONTHLY PRODUCTION RETURNS OF 1997/98 (continued)

Catch category	Landed Weight (kg)	Live Weight (kg)
FISH (continued)		
Snapper, Fingermark (Golden)	832	1,482
Snapper, Frypan	84,684	84,684
Snapper, Lenko (Deep Sea)	8	8
Snapper, Long Nose	11,308	11,378
Snapper, North West (Spangled Emperor)	153,314	170,539
Snapper, North West (L)	93,301	94,200
Snapper, North West (S)	503,387	503,387
Snapper, Pink	738,365	767,186
Snapper, Queen	57,698	71,060
Snapper, Red Spot Emperor	50,199	50,199
Snapper, Red (Swallowtail)	304,307	304,309
Snapper, Ruby	591	949
Sole	1,405	1,405
Sprat, Blue	55,930	55,930
Sweep	4,429	4,891
Sweetlip	79,368	80,376
Tailor	53,920	53,920
Threadfin	21,997	25,706
Threadfin Bream (Butterfish)	320,406	320,406
Threadfin, Giant	122,078	149,793
Trevalla, Deepsea	4,127	4,274
Trevally, Golden	17,145	17,592
Trevally, other (Skippy)	192,667	195,075
Trevally, Skipjack	8,893	8,950
Trout, Coral	24,931	25,897
Trout, Spotted (Duskytail Groper)	5,697	5,697
Tuna, Bigeye	78	90
Tuna, Mackerel	303	303
Tuna, Northern Bluefin	129	129
Tuna, other	17,998	18,533
Tuna, Skipjack (Striped)	897	1,195
Tuna, Yellowfin	2,137	2,335
Tuskfish, Bluebone	19,459	20,593
Whitebait	106,059	106,059
Whiting, Golden-Lined	5,399	5,399
Whiting, King George	76,074	76,084
Whiting, other	2,533	2,548
Whiting, Trumpeter	313	313
Whiting, Western Sand	196,293	196,598
Other fish varieties	160,448	169,985
Total Fish	**19,044,283**	**20,418,301**
CRABS		
Crab, Coral	1,155	1,155
Crab, King	17,488	17,488
Crab, Mud	2,148	2,148
Crab, Sand (Blue Manna, Blue Swimmer)	738,882	738,882
Crab, Snow	3,641	3,641
Crab, Spanner	330	330
Crab, Spiny	77,368	77,368
Total Crabs	**841,012**	**841,012**

APPENDIX 3: TABLE OF CATCHES FROM FISHERS' STATUTORY MONTHLY PRODUCTION RETURNS OF 1997/98 (continued)

Catch category	Landed Weight (kg)	Live Weight (kg)
PRAWNS		
Prawn, Banana	254,065	254,065
Prawn, Brown Tiger	854,544	854,544
Prawn, Coral	377,073	377,073
Prawn, Leader (Black Tiger)	82	82
Prawn, Western King	2,026,898	2,026,898
Prawn, Endeavour	211,705	211,705
Total Prawns	**3,724,367**	**3,724,367**
ROCK LOBSTERS		
Bugs	16,051	16,051
Rock Lobster, Southern	85,049	85,049
Rock Lobster, Tropical (Painted)	965	965
Rock Lobster, Western	10,462,919	10,462,919
Total Rock Lobsters	**10,564,984**	**10,564,984**
MOLLUSCS		
Abalone, Brownlip	9,226	23,065
Abalone, Greenlip	70,997	193,492
Abalone, Roe's	97,097	109,929
Cockles	9,615	9,615
Cuttlefish	81,684	81,684
Limpet	16	16
Mussel	8,917	8,917
Octopus	98,983	181,654
Oyster, Western Rock	2	14
Scallop, Saucer	325,140	1528,256
Squid	69,328	69,328
Total Molluscs	**771,005**	**2,205,970**
OTHER CLASSES		
Beche De Mer	135,415	383,635
Sea Urchin	36	42
Total Others Class	**135,451**	**383,677**
GRAND TOTAL	**35,081,102**	**38,138,311**

APPENDIX 4: GLOSSARY OF ACRONYMS

AbMAC	Abalone Management Advisory Committee
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AIMAC	Abrolhos Islands Management Advisory Committee
AIMWTMF	Abrolhos Islands and Mid West Trawl Managed Fishery
AQIS	Australian Quarantine and Inspection Service
CAESS	Catch and Effort Statistics System
CPUE	catch per unit effort
DEPM	daily egg production method
ENA	Extended Nursery Area
ENSO	El Niño/Southern Oscillation
ERLMF	Esperance Rock Lobster Managed Fishery
FAS	Fisheries Adjustment Scheme
FHPA	Fish Habitat Protection Area
FRDC	Fisheries Research and Development Corporation
GAB	Great Australian Bight
GPS	global positioning system
GRFS	Gascoyne Recreational Fishing Survey
GVP	gross value of production
HIMI	Heard Island and McDonald Island
IQF	individually quick frozen
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery
KGBMF	Kimberley Gillnet and Barramundi Managed Fishery
KGS	King George Sound
MAC	Management Advisory Committee
MOP	mother-of-pearl
NDSIMF	Northern Demersal Scalefish Interim Managed Fishery
NPF	Northern Prawn Fishery
PI	Performance Indicator
PIAC	Pearling Industry Advisory Committee
RAN	Royal Australian Navy
RFAC	Recreational Fishing Advisory Committee
RLIAC	Rock Lobster Industry Advisory Committee
SCEF	South Coast Estuarine Fishery
SRR	spawning stock–recruitment relationship
TAC	total allowable catch
VFLO	Volunteer Fisheries Liaison Officer
VMS	Vessel Monitoring System
WADGDLMAC	Western Australian Demersal Gillnet and Demersal Longline Management Advisory Committee
WCDGDLIMF	West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery
WCRLMF	West Coast Rock Lobster Managed Fishery