

STATE OF THE FISHERIES AND AQUATIC RESOURCES REPORT 2009/10



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

Fish for the future

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CONTENTS

OVERVIEW FROM THE CHIEF		Gascoyne Demersal Scalefish Fishery	
EXECUTIVE OFFICER.....	5	Status Report	122
EDITOR'S INTRODUCTION.....	6	Inner Shark Bay Scalefish Fishery Status	
HOW TO USE THIS VOLUME	7	Report	129
OVERVIEW OF THE STATUS OF KEY		Gascoyne and North Coast Blue	
FISHERIES AND STOCKS.....	11	Swimmer Crab Fishery Status Report	135
OVERVIEW TABLE	14	AQUACULTURE	142
Stock Status, Catch & Effort Ranges for		COMPLIANCE AND COMMUNITY	
the Major Commercial Fisheries.....	14	EDUCATION	143
WEST COAST BIOREGION.....	18	NORTH COAST BIOREGION	147
ABOUT THE BIOREGION	19	ABOUT THE BIOREGION	148
SUMMARY OF FISHING AND		SUMMARY OF FISHING AND	
AQUACULTURE ACTIVITIES	19	AQUACULTURE ACTIVITIES	148
ECOSYSTEM MANAGEMENT	19	ECOSYSTEM MANAGEMENT	149
ECOSYSTEM BASED FISHERIES		ECOSYSTEM BASED FISHERIES	
MANAGEMENT	21	MANAGEMENT	151
FISHERIES	19	FISHERIES	155
West Coast Rock Lobster Fishery Status		Northern Prawn Managed Fisheries	
Report.....	28	Status Report	155
Roe's Abalone Fishery Status Report ..	39	North Coast Nearshore and Estuarine	
Abrolhos Islands and Mid West, South		Fishery Status Report	165
West Trawl Managed Fisheries and		North Coast Demersal Fisheries Status	
South Coast Trawl Fishery Status Report	49	Report	172
West Coast Blue Swimmer Crab Fishery		Mackerel Managed Fishery Report:	
Status Report.....	54	Statistics Only.....	190
West Coast Deep Sea Crab (Interim)		Northern Shark Fisheries Status Report	192
Managed Fishery Status Report	62	Pearl Oyster Managed Fishery Status	
West Coast Nearshore and Estuarine		Report	199
Finfish Resources Status Report	65	Beche-de-mer Fishery Status Report..	205
West Coast Purse Seine Fishery Report:		AQUACULTURE	210
Statistics Only	78	COMPLIANCE & COMMUNITY	
West Coast Demersal Scalefish Fishery		EDUCATION	210
Status Report.....	80	SOUTH COAST BIOREGION.....	213
Octopus Fishery Status Report.....	90	ABOUT THE BIOREGION	214
AQUACULTURE	95	SUMMARY OF FISHING AND	
COMPLIANCE AND COMMUNITY		AQUACULTURE ACTIVITIES	214
EDUCATION	95	ECOSYSTEM MANAGEMENT	215
GASCOYNE COAST BIOREGION.....	99	ECOSYSTEM BASED FISHERIES	
ABOUT THE BIOREGION	100	MANAGEMENT	215
SUMMARY OF FISHING AND		FISHERIES	218
AQUACULTURE ACTIVITIES	100	South Coast Crustacean Fisheries	
ECOSYSTEM MANAGEMENT	101	Report: Statistics Only.....	218
ECOSYSTEM BASED FISHERIES		Greenlip/Brownlip Abalone Fishery	
MANAGEMENT	103	Status Report	221
FISHERIES	107	South Coast Nearshore and Estuarine	
Shark Bay Prawn and Scallop Managed		Finfish Resources Status Report.....	229
Fisheries Status Report.....	107	South Coast Purse Seine Fishery Report:	
Exmouth Gulf Prawn Managed Fishery		Statistics Only.....	244
Status Report.....	117		

CONTENTS

Demersal Gillnet and Longline Fisheries Status Report.....	246	ECOSYSTEM BASED FISHERIES MANAGEMENT	280
South Coast Demersal Line Fishery Report: Statistics Only	259	FISHERIES	282
AQUACULTURE	260	Marine Aquarium Fish Managed Fishery Report: Statistics Only.....	282
COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW	261	Specimen Shell Managed Fishery Status Report	284
NORTHERN INLAND BIOREGION.....	264	APPENDICES	287
ABOUT THE BIOREGION	265	APPENDIX 1	288
SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES	265	Fisheries Research Division staff publications 2009/10	288
ECOSYSTEM MANAGEMENT	265	APPENDIX 2	291
ECOSYSTEM BASED FISHERIES MANAGEMENT	265	Table of catches from fishers' statutory monthly returns for 2008/09.....	291
FISHERIES	267	Estimated Western Australian Aquaculture Production for 2008/09 ..	297
Lake Argyle Silver Cobbler Fishery Report: Statistics Only	267	APPENDIX 3	300
AQUACULTURE	269	Research Division – Other Activities .	300
COMPLIANCE & COMMUNITY EDUCATION	269	Pemberton Freshwater Research Centre activities 2009/10.....	300
SOUTHERN INLAND BIOREGION	269	Activities of the Fish Health Unit during 2009/10	302
ABOUT THE BIOREGION	272	Indian Ocean Territories Fishery Status Report	303
SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES	272	APPENDIX 4	308
ECOSYSTEM MANAGEMENT	272	Annual performance for commercial fisheries subject to export approval under the Australian Government's Environment Protection and Biodiversity Conservation Act 1999	308
ECOSYSTEM BASED FISHERIES MANAGEMENT	272	APPENDIX 5	318
Licensed Recreational Marron Fishery Report: Statistics Only	275	Fisheries Research Division staff adjunct positions and Supervision of students	318
AQUACULTURE	276	GLOSSARY OF ACRONYMS	319
COMPLIANCE AND COMMUNITY EDUCATION	276		
STATEWIDE.....	279		

OVERVIEW FROM THE CHIEF EXECUTIVE OFFICER

For over twenty years, the Department of Fisheries has published a State of the Fisheries Report each year to provide the public with an update of the status of the fish and fisheries resources of Western Australia that are managed by the Department. As part of successive Government's ongoing commitment to adopting sustainable development principles, during the past decade the scope of the information that has been reported has been increasing to also cover the status of other aquatic resources relevant to the Fish Resources Management Act (FRMA)¹. The level of reporting on these broader aspects has reached the point where it is now more appropriate that the name of this and future editions has been changed to State of Fisheries and Aquatic Resources to more accurately reflect this expanded scope.

The *State of the Fisheries and Aquatic Resources Report* essentially summarises the outcomes of Departmental activities undertaken during 2009/10 and preceding years. It documents recent changes to management or policy settings, compliance and education operations, the assessment and monitoring of stock levels and ecosystem condition. This document should, therefore, provide a valuable reference point for the current status of Western Australian aquatic resources including those of major importance to the commercial and recreational fishing sectors, the aquaculture industry, the tourism industry, and for those in the community interested in the health of the aquatic environment.

The report outlines the current risk status for the ecological resources (assets) within each of WA's six Bioregions by taking a bioregional, Ecosystem-Based Fisheries Management (EBFM) approach. This includes analyses and reports on the activities and processes undertaken by the Department to manage the broader aquatic environment, such as habitats and ecosystems. The report also details all the fisheries and fishing-related activities within each of the Bioregions to enable these issues to be considered.

Western Australia is one of the first fisheries jurisdictions in the world to fully implement a comprehensive EBFM framework. The move to adopt a regional approach to management planning and assessments is a logical extension from the 'Ecologically Sustainable Development (ESD) based' assessments that the Department has completed for each of WA's major fisheries during the past decade. EBFM provides a more holistic basis for the overall management of aquatic resources because it explicitly considers all ecological resources and community values within a Bioregion. The use of the EBFM framework is also expected to help facilitate development of regional marine plans and coordination with other State and Commonwealth government agencies.

This report documents that most of the risks to the aquatic ecological resources in Western Australia are currently at acceptable levels. The main areas where the ecosystems and their component species are considered to be under threat are restricted to the estuarine and river systems in the south west region and generally not the result of fishing related activities. Moreover, given the comprehensive systems of management that are in place, fishing in WA generally does not present an unacceptable risk to most of the marine, estuarine and freshwater ecosystems underpinning them. The overwhelming majority of Western Australian fisheries have also been assessed as posing only negligible or minor risks to bycatch species, protected species, habitats or the broader ecosystem. The small number of fisheries which have generated risks to these non-'capture species' such that direct management has been required, continue to meet their annual performance targets.

The report also documents that the majority of Western Australia's significant fisheries stocks continue to be in a healthy condition. For the managed fisheries, 93% had catches that are considered to be appropriate based on the status of the stocks involved and the current environmental conditions. Moreover, approximately 90% of fisheries are targeting stocks where the abundance is considered to be above the level where additional management is required.

For the few fisheries not yet at acceptable levels, additional management measures are in place or proposed. These measures include the new arrangements that were introduced to reduce the commercial and recreational catch and effort for West Coast Demersal Scalefish (including snapper and dhufish). The outcomes of the monitoring and survey programs to assess the impact of these arrangements on both catch levels and stock status will be reported in future editions.

A summary report from this document is included in the Department's *Annual Report* to Parliament, which includes the Department's non-financial (fishery) performance indicators. The *Annual Report* is available through the Department's website (www.fish.wa.gov.au).

I would like to take this opportunity to express my appreciation to all Departmental staff who contributed to this important, annual performance review of WA's aquatic resources. In addition, many commercial and recreational fishers, science collaborators and other stakeholders throughout the State are to be commended for their positive support for the Department's monitoring and research programs and management initiatives, without which such a high level of sustainability would not be achieved.



Stuart Smith
Chief Executive Officer

October 2010

¹ In the FRMA the definition of 'fish' means an aquatic organism of any plant or animal species (whether alive or dead) except for mammals, birds, reptiles and amphibians.

EDITOR'S INTRODUCTION

As outlined in the CEO's overview, this year's renamed *State of the Fisheries and Aquatic Resources Report 2009/10* reflects that the Department of Fisheries has now fully adopted an Ecosystem Based Fisheries Management (EBFM) framework as the basis for management of Western Australia's aquatic resources (Fletcher, *et al.*, 2010¹). Consequently, the format for this document has been updated so that it is consistent with this risk-based approach to resource management.

There is now a section at the beginning of each Bioregion that outlines each of the key ecological resources (assets) for the region and summarises their current risk status. The assets that are examined in each bioregion include each of the IMCRA² meso-scale ecosystems plus the key habitats, captured species and protected species categories. There is also a section for the external drivers, such as climate change, coastal development and introduced pests/diseases, which may affect the Department's ability to effectively manage WA's aquatic resources.

For each Bioregion there is still a set of individual fishery reports but these are being refocussed to become more resource-based rather than activity (sector)-based. Consequently, each report now contains descriptions of both the commercial and recreational activities that are accessing a particular ecological resource (asset). This has facilitated further consolidation of reports whereby a number of different fisheries accessing the same category of ecological assets are now covered in a single report (e.g. West Coast Nearshore and Estuarine Finfish). This is consistent with taking a Bioregional approach to the management of ecological assets and ensures that the aggregate catch harvested from each stock is clear and shows how it is being shared among fishing sectors. This structure should enable readers to more easily assess the interrelationships between fisheries and their cumulative effect within each Bioregion of the State. This trend will continue over coming years.

The long-standing involvement by our commercial, recreational and aquaculture stakeholders in specific research projects and monitoring programs, such as the provision of logbook data and biological samples, is acknowledged as being essential to the generation of many of the status reports presented in this document. The input from collaborating science groups is also acknowledged. There has been an increasing trend over the past decade for collaborative research projects to be undertaken to assist in the

development of new monitoring and assessment techniques or to help further our understanding of issues that affect management (e.g. determining the causes of the recent low rock lobster puerulus settlement levels).

While the *State of the Fisheries and Aquatic Resources Report 2009/10* provides the general public, interested fishers and other stakeholders with a ready reference source, it is also serves the purpose for the Department's various reporting requirements, including the need to annually report on the 'state of fisheries managed under' the FRMA³ to the Western Australian Parliament and to the Commonwealth Government, on the performance of fisheries under their EPBC Act.

The report is directly accessible on the Department's website (www.fish.wa.gov.au/docs/sof), where users are encouraged to download relevant sections for personal use. If quoting from the document, please give appropriate acknowledgment using the citation provided at the front of the report.

A summary version of this document is also available from the same website.

Finally, I would like to thank all of my Departmental colleagues across all Divisions who have assisted in the production of this volume and its many status reports. Particular thanks are due to Ms Karen Santoro who again had the unenviable job of coordinating the submission of the text from various authors, facilitating internal reviews, managing version control, undertaking the copy editing, final formatting and organising the publication and submission process.



Dr Rick Fletcher
Director – Fisheries Research

September 2010

1 W.J. Fletcher, J. Shaw, S.J. Metcalf & D.J. Gaughan (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34 (2010) 1226–1238

2 Commonwealth of Australia (2006) A guide to the Integrated Marine and Coastal Regionalisation of Australia - version 4.0 June 2006 (IMCRA v4.0).
<http://www.environment.gov.au/coasts/mbp/publications/imcra/pubs/imcra4.pdf>

³ Section 263 of the FRMA.

HOW TO USE THIS VOLUME

To obtain full benefit from the information provided in the updated *State of Fisheries and Aquatic Resources Report*, readers need to understand various terms and headings used in the text and summarised in the fishery status overview table (which also appeared in the Department of Fisheries *Annual Report 2009/10 to Parliament*) and especially those associated with the newly developed ecological resource level reports.

The terms and headings are a combination of the reporting structures outlined in the national Ecologically Sustainable Development (ESD) reporting structure (Fletcher *et al.* 2002)¹ and the more recent Ecosystem Based Fisheries Management (EBFM) framework (Fletcher *et al.*, 2010)². In addition to the explanations provided below, acronyms are expanded at their first occurrence in a section of the text and are also listed in a glossary at the end of the volume.

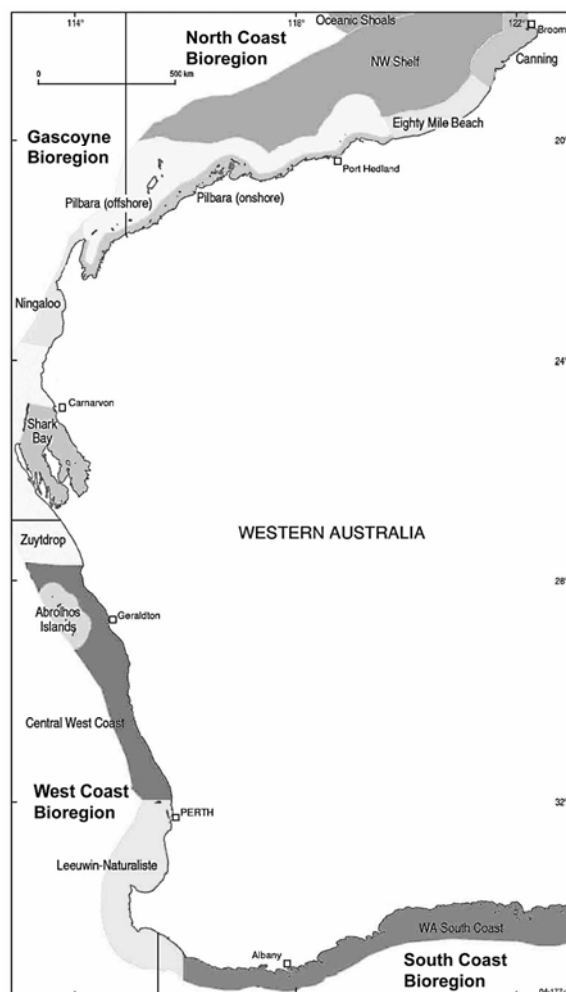


INTRODUCTION FIGURE 1

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

1 Fletcher, W.J., Chesson, J., Fisher, M., Sainsbury, K.J., Hundloe, T., Smith, A.D.M. and Whitworth, B. 2002. National ESD reporting framework for Australian fisheries: The 'how to' guide for wild capture fisheries. Fisheries Research and Development Corporation (FRDC) project 2000/145, ESD Reporting and Assessment Subprogram, Fisheries Research and Development Corporation, Canberra.

2 Fletcher, W.J., Shaw, J., Metcalf, S.J. & D.J. Gaughan (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34 (2010) 1226–1238



INTRODUCTION FIGURE 2

Map of Western Australia showing the general boundaries of the Bioregions referred to throughout this document and the meso-scale ecosystems based on IMCRA 4.0 boundaries³.

Bioregions

As noted above, with the adoption of the EBFM approach, readers need to note the fully bioregional structure of this report (see Introduction Figure 1). A 'Bioregion' refers to a region defined by common oceanographic characteristics in its marine environment and by climate/rainfall characteristics in its inland river systems.

The marine bioregional boundaries used here are broadly consistent with those of the A guide to The Integrated Marine and Coastal Regionalisation of Australia - version 4.0 June 2006 (IMCRA v4.0).³ except for the inclusion of the Gascoyne Coast as a separate Bioregion, reflecting its nature as the transition zone between tropical and temperate waters.

³<http://www.environment.gov.au/coasts/mcp/publications/imcra/pubs/imcra4.pdf>

HOW TO USE THIS VOLUME

The precise boundaries of the Bioregions reflect functional geographic separations and data recording systems. Each individual Bioregion has been provided with a general introduction outlining its aquatic environment, major commercial and recreational fisheries and aquaculture industries and now it also has a section that outlines the current status of each of the high level, ecological resources/assets located within each Bioregion.

Assessment of Regional Level Ecological Resources (Assets) in each Bioregion

Consistent with the adoption of the EBFM framework for each bioregion we have identified the high level set of ecological resources/assets that are to be managed under the FRMA (see Introduction Figure 2). The ecological resources/assets in each Bioregion include the ecosystems and their constituent habitats, captured species and protected species. The potential complexity of EBFM is dealt with by using a step-wise, risk-based approach to integrate the individual issues identified and information gathered into a form that can be used by the Department. Similarly, the levels of knowledge needed for each of the issues only need to be appropriate to the risk and the level of precaution adopted by management. Implementing EBFM does not, therefore, automatically generate the need to collect more ecological, social or economic data or require the development of complex 'ecosystem' models. Full details of how the EBFM process is undertaken are presented in Fletcher *et al*¹ (2010) with a summary description outlined below.

Ecosystems: Within each Bioregion, one or more ecosystems, as defined by the IMCRA process, were identified with some of these further divided into estuarine and marine ecosystems where relevant.

Habitats: The habitat assets in each Bioregion were at least divided into estuarine and marine categories and again where necessary they were further divided into estuarine, nearshore and offshore components.

Captured Fish: The captured fish were subdivided into finfish, crustaceans and molluscs with each of these further divided into estuarine/embayments; nearshore, inshore and offshore demersal and pelagic (finfish only) suites.

Protected Species: This category was subdivided into protected 'fish' (e.g. Great White Sharks) and protected 'non-fish' as defined in the FRMA (e.g. mammals).

¹ W.J. Fletcher, J. Shaw, S.J. Metcalf & D.J. Gaughan (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34 (2010) 1226–1238

Risk Assessment Status

The risks associated with each individual ecological asset are examined separately using formal qualitative risk assessment (consequence x likelihood) or more-simple problem assessment processes, as detailed in Fletcher (2005, 2010)². This enables the analysis of risk (using a five year time horizon) for objectives related to species, habitat and community structure/ecosystem sustainability, plus social and economic outcomes to be completed (Introduction Table 1).

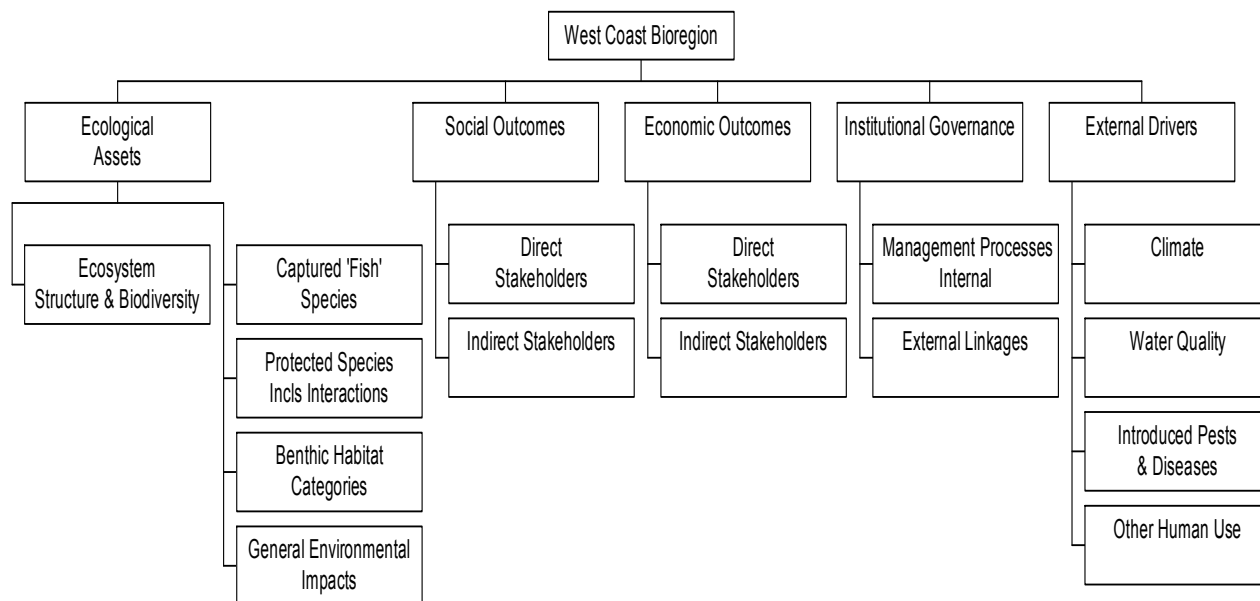
Internationally, risk has now been defined as “the uncertainty associated with achieving objectives” (ISO, 2009)³, therefore any uncertainties from a lack of specific data are explicitly incorporated into the assessment enabling the calculation of risk to be completed with whatever data are available. All risk scoring considers the level of current activities and management controls already in place or planned.

Within each Bioregion, the EBFM process identified many individual ecological assets, social, economic and governance issues and their associated risks. This complexity has been addressed by first assessing each of the individual risks and then consolidating these into bioregional or category level risks. The Department's primary objective is to manage the sustainability of the community's ecological assets from which economic or social outcomes are generated. Therefore the various ecological, social and economic risks and values associated with each of these ecological assets are integrated using a multi-criteria analysis into approximately 80 Departmental-level priorities distributed across the six Bioregions. These are now the basis of the Departmental Risk Register.

² Fletcher W.J. (2005) Application of Qualitative Risk Assessment Methodology to Prioritise Issues for Fisheries Management. *ICES Journal of Marine Research* 2005; 62:1576-1587

Fletcher W.J. (2010) Planning processes for the management of the tuna fisheries of the Western and Central Pacific Region using an Ecosystem Approach. *Forum Fisheries Agency, Honiara*. Facilitators version 6.1 January 2010, 61pp

³ AS/NZS ISO 31000 (2009) Risk management – Principles and guidelines. Sydney, Australia: Standards Australia.



INTRODUCTION FIGURE 3

The basic EBFM component tree framework. Each of the Bioregions has their own tailored EBFM component tree in which each of the ecological components have been subdivided into the set of ecological resources/assets relevant to that Bioregion.

INTRODUCTION TABLE 1

Risk Categories, descriptions and likely management responses (modified from Fletcher 2005¹).

Risk Category	Description	Likely Reporting Requirements	Likely Management Response
Negligible	Not an issue	Minimal	Nil
Low	Acceptable; no specific control measures needed	Justification required	None specific
Moderate	Acceptable; with current risk control measures in place (no new management required)	Full performance report	Specific management and/or monitoring required
High	Not desirable; continue strong management actions OR new and/or further risk control measures to be introduced in near future	Full performance report	Increases to management activities needed
Significant	Unacceptable; major changes required to management in immediate future	Full performance report	Increases to management activities needed urgently

¹ Fletcher W.J. (2005) Application of Qualitative Risk Assessment Methodology to Prioritise Issues for Fisheries Management. *ICES Journal of Marine Research* 2005; 62:1576-1587

HOW TO USE THIS VOLUME

Breeding stock status

Assessments of breeding stock can be undertaken using a number of techniques. The breeding stock is only directly measured for a small number of stocks. In most cases, the stock assessment methods use indirect measures and indicators.

Adequate: reflects levels of parental biomass of a stock where annual variability in recruitment of new individuals (recruits) to the stock is a function only of environmental effects or recruit survival, not the level of the stock.

Recovering: reflects situations where the parental biomass has previously been depleted to unacceptable levels by fishing or some other event (e.g. the virus attacks on pilchards in the 1990s) but is now recovering at an acceptable rate due to management action and/or natural processes.

Inadequate/declining: reflects situations where excessive fishing pressure (catch) or some external event has caused parental biomass to fall to levels where the breeding stock is depleted to levels that may affect recruitment.

Stock Assessment Method

Each report clearly identifies what type of assessment method(s) have been used to determine the status of breeding stocks. The main methods vary from the relatively simple analysis of catch levels and catch rates, through to more sophisticated analyses that involve sampling of the catch (fishing mortality), direct surveys and age structured simulation models.

Non-retained species

This refers to any species caught during a fishing operation which are not the target of, and are never retained by the fishing operation. These species can include both unwanted 'bycatch' species and interactions with 'protected' species. In each case, an explanation is provided of the situation and the level of risk to the stock from fishing operations.

Ecosystem effects

This refers to the indirect impacts of removing fish from the ecosystem, and physical interactions of fishing gear with the sea floor. Each fishery is considered in terms of its effects on the food chain and the habitat, and an assessment of current ecological risk ('negligible', 'low', 'moderate' or 'high') is provided.

Target catch (or effort) range

Target catch range: the range of annual catches, taking into account natural variations in recruitment to the fished stock, which can be expected under a fishing-effort-based management plan.

Target effort range: the range of annual fishing effort, assuming natural variability in stock abundance, required to achieve a total allowable catch under a catch quota management plan.

Where the annual catch or effort falls outside of this range, and the rise or fall cannot be adequately explained (e.g. environmentally-induced fluctuations in recruitment levels – like prawns), a management review or additional research to assess the cause is generally required.

External factors

This refers to known factors outside of the direct control of the fishery legislation which impact on fish stocks or fishing. An understanding of these factors, which are typically environmental (cyclones, ocean currents) but might also include, for example, market factors or coastal development, is necessary to fully assess the performance of the fishery.

Season reported

Readers should be aware that the individual fishery and aquaculture production figures relate to the latest full year or season for which data are available, noting the inevitable time-lags involved in collection and analysis. Therefore, the statistics in this volume refer either to the financial year 2008/09 or the calendar year 2009, whichever is the more appropriate. The estimates of the value of the fishery may vary from published estimates of GVP due to differences between financial year and entitlement year for a fishery, estimated value of secondary by products for individual sectors, and estimating the total value of several fisheries operating on a single resource.

Similarly, the statistics on compliance and educational activities are also for 2008/09, following the analysis of data submitted by Fisheries and Marine Officers.

In contrast, the sections on departmental activities in the areas of fishery management and new compliance activities are for the current year, and may include information up to June 2010.

Performance measures

Many of the State's significant fisheries have now undergone assessment and achieved environmental certification under the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Consequently, the *State of Fisheries and Aquatic Resources Report* also reports on the ecological performance of the relevant fisheries against the specific performance measures used or developed during the EPBC Act assessment process. These may vary among future editions as EPBC conditions change and individual fisheries determine the need and value of maintaining and resourcing such accreditation.

Within the individual fishery status reports, each of these performance measures is shown in a highlighted box to assist the reader. The results are also summarised in Appendix 4.

Common fish names

The common names of a small number of fish species may have changed in this volume. Where this has occurred, a reference is included to the common name formerly used for the same species. This situation reflects an initiative of the seafood sector to standardise marketing names across Australia, and it is likely that further changes will occur in future volumes.

OVERVIEW OF THE STATUS OF KEY FISHERIES AND STOCKS

Annual stock assessments, including analyses of trends in catch and fishing activity, are used each year to determine the status of each of the State's most significant fisheries and are presented in detail in the rest of this document. This section provides an overview of the outcomes of the Department's management systems by collectively examining the status of all the commercial fisheries and commercially harvested fish stocks in WA. The material presented in this section is based on the analyses and text presented in the Key Performance Indicators section of the Department of Fisheries Annual Report to the Parliament 2009/10.

The proportion of fish stocks identified as being at risk or vulnerable through exploitation

To measure the performance of management, the proportion of fisheries for which the breeding stocks of each of their major target or indicator species are being maintained at acceptable levels (or they are now recovering from a depleted state at an appropriate rate following management intervention), is measured annually.

For 2009/10, 36 fisheries had breeding stock assessments completed (see Overview Table 1). Within this group of 36 assessed fisheries, 30 involve stocks that were considered to have adequate breeding stock levels (83 per cent of fisheries). Two additional fisheries have breeding stocks considered to be recovering at acceptable rates (Shark Bay Snapper Fishery, Cockburn Sound Crab Fishery). Thus, while the crab stock within Cockburn Sound was still too low to open the fishery in 2008/09, it has continued to improve to the point where it will be open for the 2009/10 season.

In conclusion, a combined total of 89 per cent of fisheries have breeding stock management that is considered satisfactory (Overview Figure 1) this is an increase on the level that was measure in 2008/09 and continues an upward trend from the low point measured in 07/08.

For three of the remaining fisheries, the Temperate Shark Fishery (composed of the Southern and Western demersal gillnet and longline fisheries), the West Coast Demersal

Scalefish Fishery and the Tropical Shark Fishery (composed of the North Coast and Northern shark fisheries), all have stocks considered to be depleted. Finally, the south coast herring fishery continues to have an uncertain status.

For the southern shark fishery, two of the four target species (dusky whaler and sandbar) have breeding stock levels that will continue to be below acceptable levels for some time due to previous fishing activities (i.e. not from current fishing impacts). While previous management interventions should now be generating a recovery of both dusky and sandbar stocks this will need to be confirmed before their stock status can be revised.

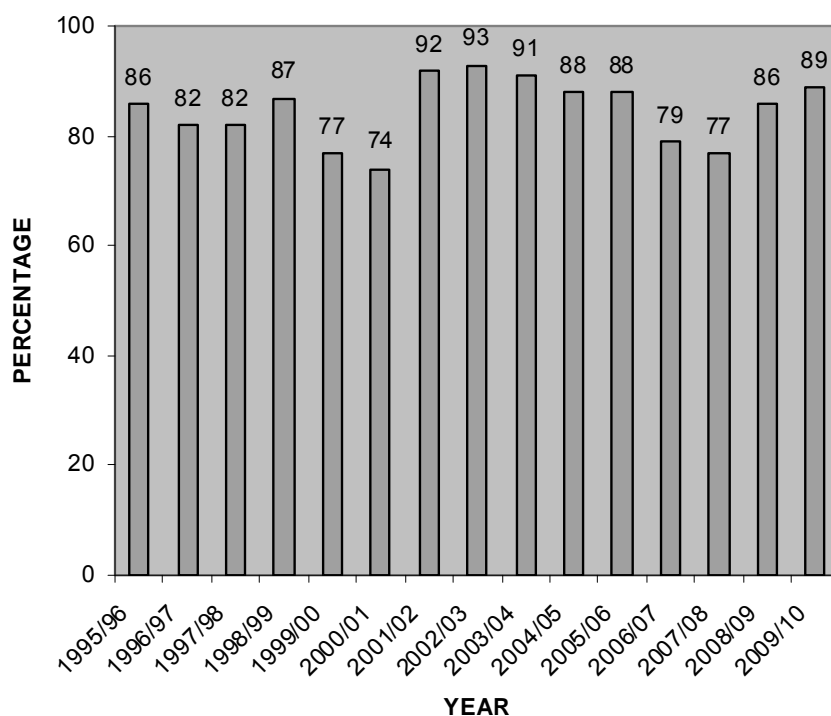
The new set of management arrangements which were introduced for the West Coast Demersal Scalefish Fishery over the past 18 months were designed to reduce the total level of fishing mortality and catch on these stocks by 50 per cent. These levels of reductions are expected to be sufficient to initiate stock recovery. The catches of this suite by the commercial sector (line fishery and the net fishery) have already been reduced to be below the target levels.

Management interventions to generate comparable reductions in the recreational and charter sector catches have also been introduced but their impact on the annual catch cannot be fully determined until they have been in place for over 12 months. Monitoring of the status of the indicator species and the catches taken by all three sectors is currently underway to determine if the current set of management arrangements are delivering the required reductions in catch and fishing mortality.

In the Northern Shark Fishery, whilst there has been a significant reduction in effort, the impacts on the breeding stock from previous activities will also continue to affect the recruitment to the breeding stock and catches of one of the target species remain above target levels.

New research has begun on the stocks of herring in the south-west region to determine whether the recent low catch levels are a result of changes to environmental conditions or a reduction in the breeding stock leading to lowered recruitment, or reduced fishing effort, or some combination of the above.

OVERVIEW



OVERVIEW FIGURE 1

The proportion (%) of commercial fisheries where breeding stocks of the major target species are both assessed and either adequate or recovering adequately to levels to ensure catches can be sustained at maximum levels within the range expected under typical environmental conditions.

The proportion of commercial fisheries where acceptable catches (or effort levels) are achieved

A target catch or effort range has also been determined for each of the major commercial fisheries (see Overview Table 1). This indicator provides an assessment of the success of the Department's management plans and regulatory activities in keeping fish catches at appropriate levels (including those in a recovery phase).

For most of the fisheries in WA, each management plan seeks to directly control the amount of fishing effort applied to stocks, with the level of catch taken providing an indication of the effectiveness of the plan. Where the plan is operating effectively, the catch by the fishery should fall within a projected range. The extent of this range reflects the degree to which normal environmental variations affect the recruitment of juveniles to the stock which cannot be 'controlled' by the management plan.

For quota-managed fisheries, the measure of success for the management arrangements is firstly that most of the Total Allowable Catch (TAC) is achieved, but additionally, that it has been possible to take this catch using an acceptable amount of fishing effort. If an unusually large expenditure of effort is needed to take the TAC, or the industry fails to

achieve the TAC by a significant margin, this may indicate that the abundance of the stock is significantly lower than anticipated. For these reasons, an appropriate range of fishing effort to take the TAC has also been incorporated for assessing the performance of quota-managed fisheries (see Overview Table).

Comparisons between the actual catches (or effort) with the target ranges have been undertaken for 30 of the 38 fisheries referred to in Overview Table 1. The fisheries for which there are target ranges account for most of the commercial value of WA's landed catch. The fisheries where ranges are unavailable include the four pilchard fisheries which are still rebuilding following an exotic virus attack and the effort levels to take the current quotas have not been established. For the mackerel and deep-sea crab fisheries, effort ranges are not yet available so catch ranges will continue to be used. Finally, some fisheries had negligible fishing activity for economic reasons and were therefore not assessed.

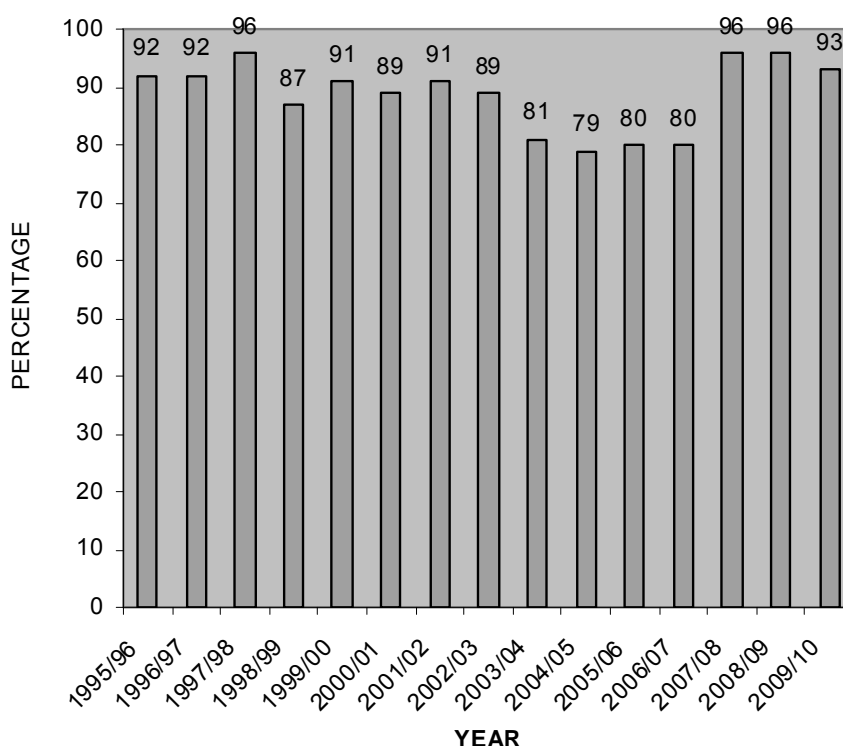
Of the 30 fisheries where 'target ranges' were available and a material level of fishing was undertaken in 2008/09, six were catch-quota managed [through a TAC allocated through Individually Transferable Quotas (ITQ)] with 24 subject to effort control management (including those with individually transferable effort 'quotas' or ITEs).

All of the ITQ-managed fisheries operated within their target effort/catch ranges or were acceptably below the effort range

(Roe’s abalone, pearl oysters). In the 24 effort-controlled fisheries, 22 produced catches that were within (14) or acceptably above (3) or below (5) their target catch ranges. The two fisheries identified where the catch levels were considered to be problematic were the Pilbara trawl fishery and the Northern Shark Fishery. Recent catches have been declining in the Pilbara trawl fishery and there are some questions whether this is due to reduced gear efficiencies following the introduction of protected species bycatch

reduction devices or changes to stock levels. In addition, the catch of sandbar sharks in the Northern Shark Fishery exceeded what is considered to be the appropriate level.

In summary, 28 (93 per cent) of the 30 fisheries assessed were considered to have met their performance criteria, or were affected by factors outside the purview of the management plan/arrangements (Overview Figure 2). This continues the high percentage (> 90%) of fisheries that have met this performance target in the last three years.



OVERVIEW FIGURE 2

The proportion (%) of commercial fisheries where the catch or effort reported is acceptable relevant to the target management range being applied.

OVERVIEW

OVERVIEW TABLE

Stock Status, Catch & Effort Ranges for the Major Commercial Fisheries

NA - Not assessed, Q - Quota management, TAC - Total Allowable Catch, TACC - Total Allowable Commercial Catch

Fishery/ Resource	Stock assessment method	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported - 2008/09 or 2009	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION						
West coast rock lobster	Length Based Population Dynamics Model	> early 1980s level	Adequate	7,800 catch limit for 08/09 season	7,595 t (includes Windy Harbour and Augusta)	Acceptable. Catch limits introduced to ensure breeding stock is maintained despite recent low puerulus settlements.
Roe's abalone	Catch Rates & Direct Survey	Effort (by zone) remains < maximum	Adequate	101.8 (Q) (620 – 750 days)	92.8 t (554 days)	Acceptable. Low effort due to increased fishing efficiency not increased stock.
Octopus	Catch Rates	CPUE > 70kg/day	Adequate	50 - 250	71 t	Acceptable.
Abrolhos Islands and mid west trawl	Direct Survey & Catch Rates	Fishing ceases at catch rate threshold.	Adequate	95 – 1,830	0	Surveys indicated low abundance and small meat size and poor quality so season did not open.
Cockburn Sound crab	Direct Survey	Residual stock above threshold	Recovering	Not Applicable	0	The fishery remained closed for 2008/09 due to insufficient recovery of the breeding stock.
Deep sea crab	Catch & Catch Rate	Catch range	Adequate	140 (Q)	138 t	Acceptable
Estuarine fisheries (west coast)	No	NA	NA	75 – 220 (Peel-Harvey only)	104 t	Acceptable
West coast beach bait	Catch	Catch range	Adequate	60 – 275 (whitebait only)	131 t	Acceptable
West coast purse seine	Catch	Acceptable catch range	Adequate	3,000 (Q)	45 t	NA

Fishery/ Resource	Stock assessment method	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported - 2008/09 or 2009	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION (continued)						
					367 t total	
West coast demersal scalefish	Fishing Mortality (F)	F < 3/2 M	Inadequate	< 449-469	303 t – West Coast Demersal Scalefish (Interim) Managed Fishery 64 t – West Coast Demersal Gillnet and Longline (Interim) Managed Fishery	Acceptable Commercial catches have been halved by limiting access and entitlement arrangements to maintain catch in the target range
GASCOYNE BIOREGION						
Shark Bay prawn	Direct Survey	Survey catch rates > minimum level	Adequate	1,501 – 2,330	1,228 t	Acceptable This range is being reviewed due to greater targeting of larger- sized prawns for economic reasons.
Exmouth Gulf prawn	Direct Survey	Survey catch rates > minimum level	Adequate	771 – 1,276	828 t	Acceptable
Shark Bay scallop	Catch Rates	Fishing ceases at threshold level	Adequate	1,250 – 3,000	3,391 t	Acceptable Catch predicted to be above range due to good recruitment
Shark Bay Crabs	Catch Rates	Catch rate > minimum level	Adequate	Under development	720 t	Acceptable but due to recent increases in total catches, a more detailed assessment is required
Shark Bay beach seine and mesh net	Catch Rates	Catch rate > minimum level	Adequate	235 – 335	251 t	Acceptable
Shark Bay snapper	Age structured Model	% unfished levels. Target 40%; Limit 30%	Recovering	277 (Q) (380 - 540 days)	224 t (435 days)	Acceptable. At current TAC spawning biomass projected to recover by 2014
NORTH COAST BIOREGION						
Onslow prawn	Catch	Catch range	Adequate	60 – 180	57 t	Acceptable
Nickol Bay prawn	Catch	Catch range	Adequate	90 – 300	126 t	Acceptable

OVERVIEW

Fishery/ Resource	Stock assessment method	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported - 2008/09 or 2009	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (continued)						
Broome prawn	Catch	Catch range	Adequate	55 – 260	Negligible	NA Very little effort this season
Kimberley prawn	Catch	Catch range	Adequate	240 – 500	238 t	Acceptable
Kimberley gillnet and barramundi	Catch Rates	Rates > minimum level	Adequate	25 – 40 (barramundi)	60 t	Acceptable Catches have increased due to increased effort. An assessment of these stocks will begin shortly.
Northern demersal scalefish	Age structured Model	% unfished levels. Target 40%; Limit 30%	Adequate	Total 600 – 1,000 (goldband <485) (red emperor <212)	Total 1,046 t (goldband 485) (red emperor 156)	Acceptable
Pilbara fish trawl	Age structured Model	% unfished levels. Target 40%; Limit 30%	Adequate	2,000 – 2,800	1,044 t	Not Acceptable Reduced catch may be due to 20 per cent reduction effort in Areas 1 and 2 and new net designs to deal with protected species issues. Formal analysis is required
Pilbara demersal trap and line	Age structured Model	% unfished levels. Target 40%; Limit 30%	Adequate	400 – 600 (trap) 50 – 115 (line)	455 t (trap) 123 t (line)	Acceptable The line catch increased due to higher catches of ruby snapper in offshore waters.
Mackerel	Catch	Catch range	Adequate	410 (Q) 246 - 410 (all except grey mackerel)	284 t	Acceptable
Tropical shark	Demographic and Catch	Under review	Depleted/ Uncertain	< 20 (sandbar)	Less than three licences operated.	Not Acceptable The catch of sandbar sharks exceeds limit.
Pearl oyster	Fished Area & Catch Rates	Area < 60% Rates > min.	Adequate	1,060,400 oysters (Q) (14,071 – 20,551 dive hours)	260,002 oysters (3,284 dive hours)	Acceptable Only 25 % of TAC caught due to uncertainty regarding global pearl markets
Beche-de- mer	Catch and Catch Rate	Catch range	Adequate	50 – 150	129 t	Acceptable

Fishery/ Resource	Stock assessment method	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported - 2008/09 or 2009	Catch (or effort) level acceptable and explanation if needed
SOUTH COAST BIOREGION						
South coast crustacean	No	NA	NA	50 – 80	39 t	Acceptable The acceptable catch range is currently being reviewed.
Abalone (greenlip/ brownlip)	Average size, Effort	Ave wt > min. Effort < max.	Adequate	213 (Q) (907 – 1,339 days)	199 t (1,205 days)	Acceptable
Estuarine fisheries (south coast)	Catch Rates	> Minimum level	Adequate	200 – 500	223 t	Acceptable
WA salmon	Catch	Catch Range	Adequate	1,200 – 2,800	753 t	Acceptable Low catches continue due to low effort from limited market demand
Australian herring	Catch	Catch Range	Uncertain	475 – 1,200	151 t	Acceptable Low catch due to low recruitment and effort resulting from poor markets.
Albany/King George Sound purse seine	Catch	Catch < TAC	Adequate	2,722 (Q)	1,351 t	NA
Bremer Bay purse seine	Catch	Catch < TAC	Adequate	1,500 (Q)	512 t	NA
Esperance purse seine	Catch	Catch < TAC	Adequate	1,500 (Q)	139 t	NA
Temperate Shark	Age Structured Model	Mature biomass is increasing	Gummy and whiskery sharks - adequate. Dusky and sandbar likely to be recovering	725 – 1,095 (key species only)	992 t	Acceptable
NORTHERN INLAND BIOREGION						
Lake Argyle catfish	Catch	Catch range	Adequate	95 - 155	Less than three licences operated	Acceptable

WEST COAST BIOREGION

ABOUT THE BIOREGION	19
SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES	19
ECOSYSTEM MANAGEMENT	19
ECOSYSTEM BASED FISHERIES MANAGEMENT	21
FISHERIES	28
AQUACULTURE	95
COMPLIANCE AND COMMUNITY EDUCATION	95

WEST COAST BIOREGION

ABOUT THE BIOREGION

The marine environment of the West Coast bioregion between Kalbarri and Augusta is predominantly a temperate oceanic zone, and is heavily influenced by the Leeuwin Current, which transports warm tropical water southward along the edge of the continental shelf. The fish stocks of the region are typically temperate, in keeping with the coastal water temperatures that range from 18°C to about 24°C. The Leeuwin Current is also responsible for the existence of the unusual Abrolhos Islands coral reefs at latitude 29° S and the extended southward distribution of many tropical species along the west and south coasts.

The Leeuwin Current system, up to several hundred kilometres-wide along the west coast, flows most strongly in autumn/winter (April to September) and has its origins in ocean flows from the Pacific through the Indonesian archipelago. The current is variable in strength from year-to-year, flowing at speeds typically around 1 knot, but has been recorded at 3 knots on occasions. The annual variability in current strength is reflected in variations in Fremantle sea levels, and is related to El Niño or Southern Oscillation events in the Pacific Ocean.

Weaker counter-currents on the continental shelf (shoreward of the Leeuwin Current), such as the Capes Current that flows northward from Cape Leeuwin as far as Shark Bay, occur during summer and influence the distribution of many of the coastal finfish species.

The most significant impact of the clear, warm, low-nutrient waters of the Leeuwin Current is on the growth and distribution of the temperate seagrasses. These form extensive meadows in protected coastal waters of the West Coast Bioregion, generally in depths of 20m (but up to 30 m), and act as major nursery areas for many fish species and particularly for the western rock lobster stock.

The west coast is characterised by exposed sandy beaches and a limestone reef system that creates surface reef lines, often about 5 kilometres off the coast. Further offshore, the continental shelf habitats are typically composed of coarse sand interspersed with low limestone reef associated with old shorelines. There are few areas of protected water along the west coast, the exceptions being within the Abrolhos Islands, the leeward sides of some small islands off the mid-west coast, plus behind Rottnest and Garden Islands in the Perth metropolitan area.

The major significant marine embayments of the west coast are Cockburn Sound and Geographe Bay. Beyond Cape Naturaliste, the coastline changes from limestone to predominantly granite and becomes more exposed to the influences of the Southern Ocean. Along the west coast, there are 4 significant estuarine systems – the Swan/Canning, Peel/Harvey and Leschenault estuaries and Hardy Inlet (Blackwood estuary). All of these are permanently open to the sea and form an extension of the marine environment except when freshwater run-off displaces the oceanic water for a short period in winter and spring.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

The principal commercial fishery in this region is the western rock lobster fishery which is Australia's most valuable single-species wild capture fishery. There are also significant commercial fisheries for other invertebrates including scallops, abalone, blue swimmer crabs and octopus.

Commercial fishers take a range of finfish species including sharks, dhufish, snapper, baldchin groper and emperors using demersal line and net methods. Beach based methods such as beach seining and near-shore gillnetting, and hand-hauled nets are used to capture whitebait, mullet and whiting in a restricted number of locations.

The West Coast bioregion, which contains the state's major population centres, is the most heavily used bioregion for recreational fishing (including charter based fishing). The range of recreational fishing opportunities includes estuarine fishing, beach fishing and boat fishing either in embayments or offshore for demersal and pelagic/game species often around islands and out to the edge of the continental shelf.

The principal aquaculture development activities in the West Coast Bioregion are the production of blue mussels (*Mytilus edulis*) and marine algae (*Dunaliella salina*) for beta-carotene production, and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands. The main mussel farming area is in southern Cockburn Sound, where conditions are sheltered and the nutrient and planktonic food levels are sufficient to promote good growth rates. Owing to the generally low productivity of the Western Australian coastline under the influence of the Leeuwin Current, areas outside embayments (where nutrient levels are enhanced) are unsuitable for bivalve aquaculture.

ECOSYSTEM MANAGEMENT

The marine benthic habitats and their associated biodiversity are largely protected along most of the West Coast from any physical impact of commercial fishing due to the extensive closures to trawling. These closures inside 200m depth were introduced in the 1970s and 1980s, in recognition of the significance of extensive areas of seagrass and reef as fish habitat (West Coast Ecosystem Management, Figure 1). The extent of these areas means that over 50% of the West Coast Bioregion inside 200 m depth could be classified as a marine protected area with an IUCN category of IV (Ecosystem Management Table 1; as per Dudley, 2008).¹

Protection of fish habitat and biodiversity is also provided by marine protected areas consistent with IUCN categories of I, II and III along the west coast including:

¹ Dudley, N. (editor) (2008) Guidelines for applying protected area management categories. IUCN, Gland, Switzerland.

WEST COAST BIOREGION

Fish Habitat Protection Areas (FHPAs) at the Abrolhos Islands, Lancelin Island Lagoon, Cottesloe Reef, and Kalbarri Blueholes; Reef Observation Areas within the Abrolhos Islands FHPA and closures to fishing under s.43 of the Fish Resources Management Act 1994 at Yallingup Reef, Cowaramup Bay, the Busselton Underwater Observatory, and around the wrecks of the Saxon Ranger (Shoalwater Bay) and

Swan (Geographe Bay); and marine conservation areas proclaimed under the Conservation and Land Management Act 1984 at Jurien Bay, Marmion, Swan Estuary, Shoalwater Islands, and the proposed Capes Marine Park between Cape Leeuwin and Cape Naturaliste (West Coast Ecosystem Management, Figure 2).

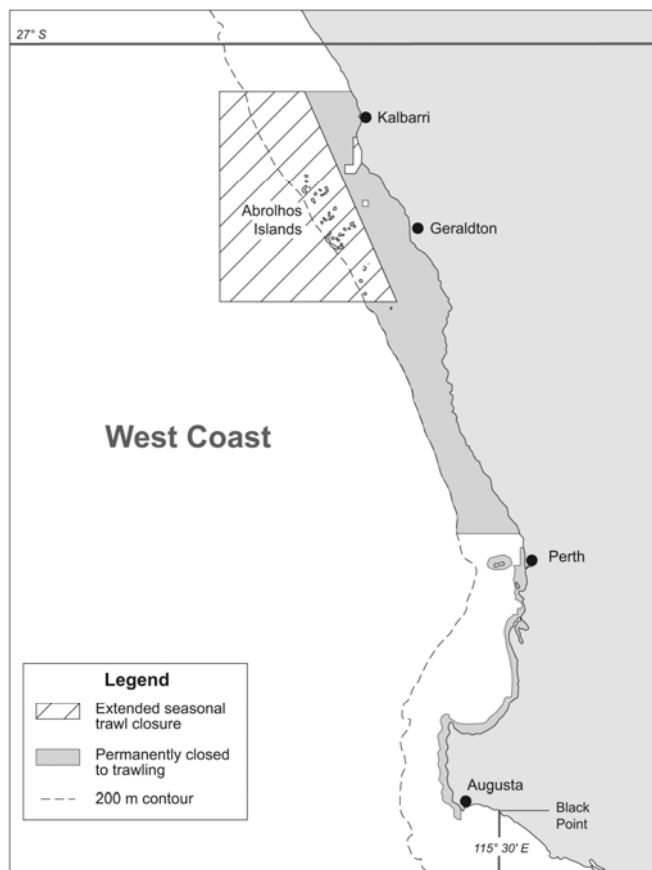
WEST COAST ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the West Coast Bioregion making up continental shelf waters (< 200 m depth) where habitats are protected from the physical disturbance of trawl fishing. The areas which are formally closed to trawling would be equivalent to meet the IUCN criteria for classification as marine protected areas as category IV. The area of habitat effectively protected refers to the area where trawling doesn't occur.

Total Area of Shelf	Area of shelf equivalent to IUCN marine protected area <= category IV (%)	Maximum area of actual trawling activity	Total area of habitat effectively protected (%)
19600 sq nm	11000 sq nm (56%)	300 sq nm	19300 sq nm (98%)

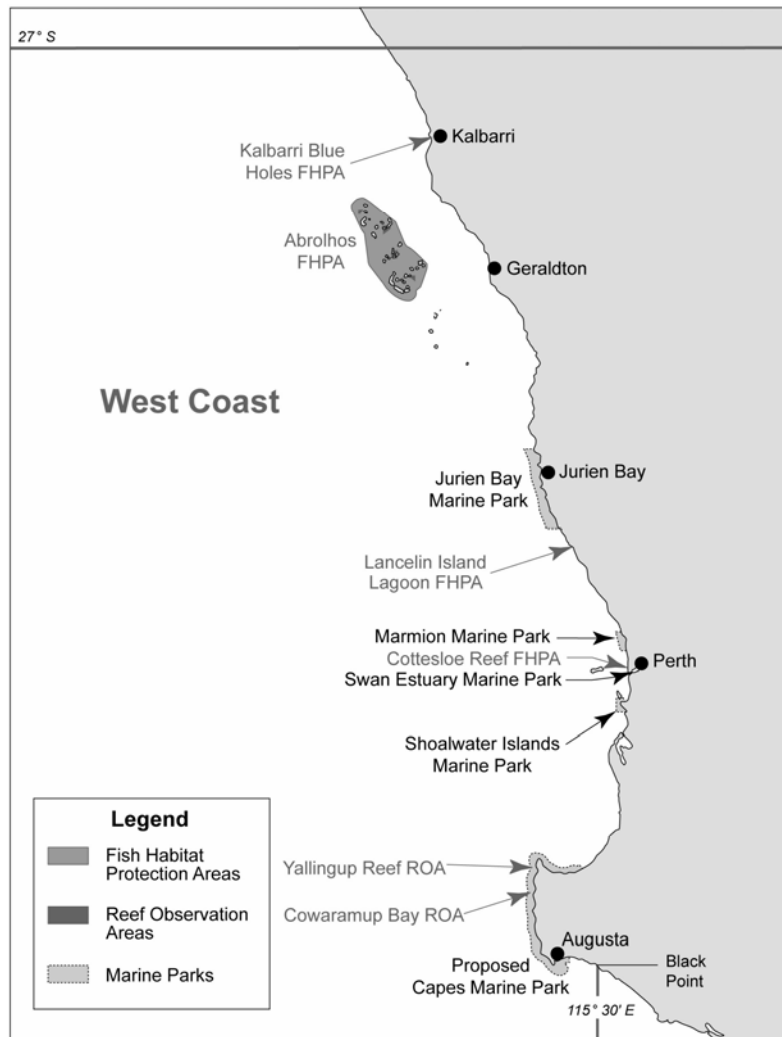
The Australian Government's Department of Environment, Water Heritage and the Arts (DEWHA) is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark

Bay. The draft South West Marine Bioregional Plan (MBP) was due for release in late 2009, and will include further proposed marine protected areas within the Commonwealth waters.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 1

Map showing areas of permanent and extended seasonal closures to trawl fishing in the west coast bioregion. The areas permanently closed are consistent with IUCN marine protected area category IV.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 2

Map showing current and proposed formal marine protected areas in the west coast bioregion various areas of which are either consistent with IUCN categories I, II, III, IV or V.

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets/Resources using the EBFM framework

Utilising the Integrated Marine and Coastal Regionalisation for Australia (IMCRA V. 4.0) scheme¹, the West Coast Bioregion has been divided into 3 meso-scale regions: the Abrolhos Islands, the Central West Coast and the Leeuwin-Naturaliste (West Coast Ecosystem Management Figure 3).

¹ Commonwealth of Australia (2006). A Guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0. Department of the Environment and Heritage, Canberra, Australia

This sub-regional scale of management has now been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, *et al.*, 2010²) see How to Use section for more details.

EBFM is a risk based management approach, which recognizes the social, economic and ecological values at a regional level and links between exploited fish stocks and the broader marine ecosystem, to ensure the sustainable management of all fisheries resources into the future. EBFM identifies these individual ('lower level') values, and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied.

² Fletcher, W.J., Shaw, J., Metcalf, S.J. & D.J. Gaughan (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34 (2010) 1226–1238

WEST COAST BIOREGION

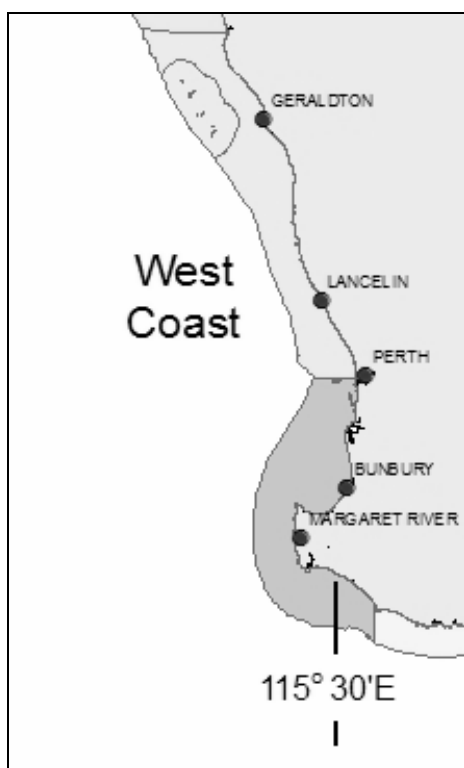
The West Coast was the first bioregion where the EBFM process, including the comprehensive risk assessment of each of the ecological assets was applied (see West Coast Ecosystem Management Table 2).

In terms of ecological assets (= resources), the Department utilises the following categories for the three IMCRA regions within the West Coast Bioregion:

- Ecosystem structure and biodiversity (on a meso-scale basis – subdivided into marine, estuarine/embayments);
- Captured fish species
- Protected species (direct impact – capture or interaction);

- Benthic habitat; and
- External impacts.

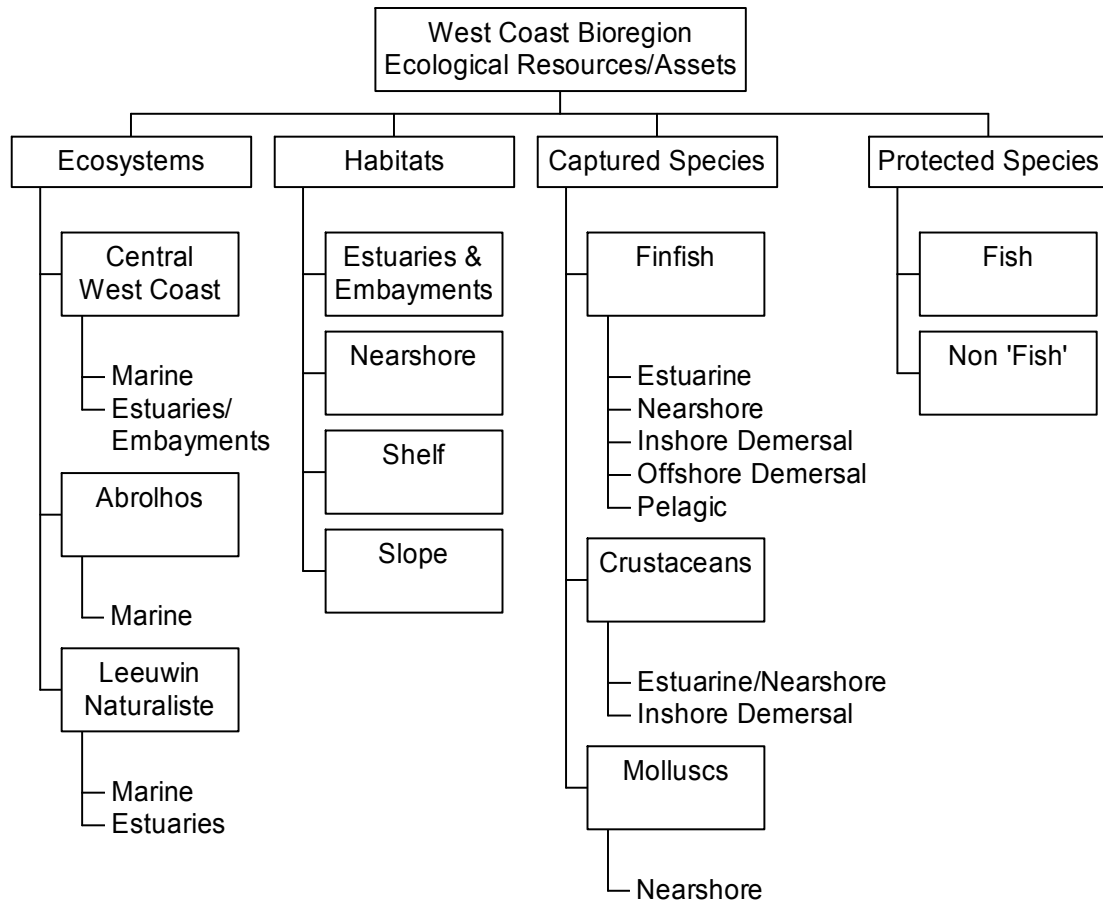
For some issues a finer level of division of the IMCRA ecosystems is used by the Department. This relates to recent management initiatives necessary to recognise different suites of exploited fish and invertebrates across the continental shelf. These sub-components are defined by depth contours (Estuarine/Nearshore 0-20m; Inshore 20-250m; Offshore >250m). The full set of ecological assets identified for ongoing monitoring are presented in West Coast Ecosystem Management Figure 4.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 3

Map showing the three main IMCRA ecosystems in the West Coast Bioregion: the Abrolhos Is.; the Central West Coast; the Leeuwin-Naturaliste.

Note- This is based on Map 2 in IMCRA v4.0.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 4

Component tree showing the ecological assets identified and separately assessed for the West Coast Bioregion.

Risk Assessment of Regional Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Figure 4 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (West Coast Ecosystem Management Table 2) provides an overview and cumulative assessment of the current risks to

the ecological assets of the West Coast Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

WEST COAST BIOREGION

WEST COAST ECOSYSTEM MANAGEMENT TABLE 2 - ANNUAL UPDATE OF RISK LEVELS FOR EACH WEST COAST ECOLOGICAL ASSET.

Risk levels in this Table are developed by combining the risks of lower level elements (usually indicator species) that make up each of these higher level (regional) components. Low and Moderate values are both considered to be acceptable levels of risk, whereby Moderate Risks will generally have some level of directed management actions associated with these which will be outlined in the detailed reports in the rest of the West Coast section. High and Significant risks indicate that the asset is no longer in a condition that is considered acceptable and additional management actions are required by the Department except where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing or related activities but by activities managed by other agencies.

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Abrolhos Islands	Marine	MODERATE	The Abrolhos Islands are protected within a 'Fish Habitat Protection Area', and are not considered to be at unacceptable risk from fisheries related activities. There are a number of research programs including monitoring of the health of coral communities at the Abrolhos Islands. This program, which utilises permanent transects located at each of the island groups collected important baseline information on coral communities, allowing researchers to quantify whether lobster fishing with pots results in damage to sensitive coral habitats, and to determine the vulnerability of coral communities at the Abrolhos to climate change. Surveys of the community structure of finfish are also underway within and outside of non-fishing areas.
Central West Coast	Marine	MODERATE	An assessment of the community structure and trophic level of all commercially caught fish species over the past 30 years through an FRDC project found no evidence of systematic changes that could be evidence of an unacceptable impact on this ecosystem (Hall and Wise, 2010). Further ecological research in deep waters, supported by funding from the Western Australian Marine Science Institution (WAMSI) and the FRDC, will compare fished and unfished areas using a deep water reference area. A key objective of this project will be to enable potential ecosystem impacts of lobster fishing to be quantified. Negotiation of a suitable reference area is near completion as are the sampling methodologies to effectively monitor benthic habitats in fished and unfished areas.
	Estuaries/ Embay.	SIGNIFICANT (non-fishing)	The estuaries and embayments within this area have been identified as being at significant risk, due to external factors (water quality issues due to high nutrient runoff from surrounding catchment) which have the potential to affect fish and other communities. Poor water quality within the Peel – Harvey and Swan-Canning estuaries, and Cockburn Sound are of particular concern.
Leeuwin Naturaliste	Marine	LOW	The impacts on the marine communities are relatively low in this region.
	Estuaries	HIGH (non-fishing)	External factors such as water quality issues in the Blackwood Estuary, due to high nutrient run-off from surrounding land, as well as acid-sulphate soil contamination are of concern to sustainable fish stocks and the ecosystem in general.

Captured fish species - Details of the analyses for these scores are located in the individual fishery reports.

Captured Species	Aquatic zone	Risk	Status and Current Activities
Finfish	Estuarine	SIGNIFICANT (non-fishing)	There is concern for some indicator fish stocks within estuaries in the West Coast Bioregion mainly due to external (non-fishing) factors (poor water quality).
	Nearshore (0-20m depth)	HIGH	With the increasing concerns for Australian herring, tailor and whiting in the nearshore regions, research projects are underway to assess these stocks and to develop methods to measure shore based fishing catch and effort.

Captured Species	Aquatic zone	Risk	Status and Current Activities
	Inshore demersal (20-250m depth)	SIGNIFICANT	Following assessments of the demersal indicator species (dhufish, pink snapper, baldchin groper), management actions designed to reduce both the commercial and recreational catch levels by 50% have been implemented. Determining catch shares for commercial and recreational users is now a major focus for management. A review will be undertaken in late 2010 to assess if the catch levels have been reduced to desired levels.
	Offshore demersal (>250m depth)	HIGH	The indicator species in this deepwater location are vulnerable to overfishing. Management arrangements for fishing in these depths, particularly for the recreational sector are still being finalised.
	Pelagic	LOW	There is still minimal capture of pelagic fish in this bioregion.
Crustaceans	Nearshore/ Estuarine	MODERATE	The stocks of crabs in Cockburn Sound are now in recovery since the closure of fishing occurred in 2007. Research on the other stocks of crabs is near completion.
	Shelf (Lobsters)	MODERATE	The stock levels of western rock lobster and prawns are both currently at appropriate levels. The strong management that is being applied to the rock lobster fishery should ensure the lobster spawning stock remains at acceptable levels despite recent low puerulus recruitment.
Molluscs	Nearshore	MODERATE	The stocks of abalone are conservatively managed with strong management controls on both commercial and recreational fishers. Allocations of access to all sectors through the IFM process were determined in 2009/10. Scallops are managed under an input controlled system and catch rate threshold.

Protected species - Details on the analyses for these scores are either located within the individual fishery reports or in the bioregional level analyses documented in the EBFM report for this Bioregion (Shaw et al., 2009¹).

Protected species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Turtles/ Seabirds	LOW	There is minimal impact from fishing activities on any turtle species within this bioregion and the trawl fishery has to operate using grids. Little Penguins are considered most at risk from boat strikes. Few other issues were identified.
	Mammals	LOW	Sea lion exclusion devices now implemented for rock lobster pots near sea lion breeding islands has reduced the level of risk to low levels. Reduction in fishing effort for lobsters has considerably reduced potential entanglement of whales.
Protected 'Fish' Species	Fish	LOW	Blue groper (Rottnest Island), Cobbler (Swan Canning) and Great White Sharks are within this category and are already unable to be landed.

Benthic habitat - Details on the analyses for these scores are located in West Coast Ecosystem Management Table 1 above and in the individual fishery reports.

Benthic Habitat	Category	Risk	Status and Current Activities
Estuaries and Embayments	Sand	SIGNIFICANT (non-fishing)	Estuarine and embayment habitats are threatened by various non-fishing factors (poor water quality, direct loss of habitat through coastal infrastructure and physical disturbance, e.g. dredging), sedimentation and smothering by algae. There are minimal impacts of fishing on these habitats
	Seagrass	MODERATE (non-fishing)	Seagrass habitat threatened from non-fishing related activities (coastal infrastructure and associated dredging (direct habitat loss, turbidity), eutrophication. Strong controls exist for direct destruction of seagrass.
Nearshore (0-20 m depth)	Sand	LOW	Minimal direct impacts (see Table 1) and high recovery rates.
	Seagrass	LOW	No destructive fishing methods allowed in these areas.

¹ Ecosystem Based Fisheries Management: Case Study Report – West Coast Bioregion. WAMSI Project 4.1 Milestone report. October 2009.

WEST COAST BIOREGION

Benthic Habitat	Category	Risk	Status and Current Activities
	Mangroves	LOW	No destructive fishing methods allowed in these areas
	Rocky Reef	LOW	Minimal direct impacts and high recovery rates.
	Coral Reef (Abrolhos)	LOW MODERATE	Minimal direct impacts. Regular monitoring of corals at the Abrolhos Is.
Inshore demersal (20-250 m depth)	Sand/ Seagrass/ Rocky Reef/ Coral Reef/ Sponge	LOW	Minimal direct impacts. See Ecosystem Table 1 for details
Offshore demersal (>250 m depth)	Sand/ Rocky Reef/ Sponge	LOW	Minimal direct impacts. See Ecosystem Table 1 for details

External Drivers - Details on some of the analyses used for these scores are located in the individual fishery reports plus there were whole of region assessments completed in the draft West Coast EBFM report.

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	MODERATE in short term HIGH in medium term	This still needs additional resources to monitor effectively. Port monitoring plans have been developed. These designs have been developed in conjunction with the Invasive Marine Pests Program within DAFF (Department of Agriculture Fisheries and Forestry).
Climate	MODERATE in short term HIGH in medium term	Projects to examine potential impacts on this bioregion are now underway or planned. Some climate change impacts on rock lobster biology had already been taken into account in the stock assessment process

Summary of Monitoring and Assessment of Ecosystem Assets

The Department of Fisheries Research Division's Biodiversity and Biosecurity Branch has a number of research and monitoring initiatives underway.

An ecological risk assessment undertaken on the western rock lobster fishery identified that the ecological impacts of removing rock lobster biomass was a moderate risk for deeper water reef community structure. A recently completed Fisheries Research and Development Corporation (FRDC)-funded project provided critical information on the relationships between rock lobster abundance, size distributions and benthic habitat characteristics in deep water. The project also provided preliminary data on the trophic role of rock lobster in deep water ecosystems.

Additional ecological research in deep waters comparing fished and unfished areas to assess the impacts of lobster fishing on the ecosystem is currently being supported by funding from the Western Australian Marine Science Institution (WAMSI) and the FRDC. A key objective of this project will be to enable potential ecosystem impacts of lobster fishing to be quantified. Negotiation of a suitable reference area and the development of sampling

methodologies to effectively monitor benthic habitats in fished and unfished areas are currently underway.

Research focusing on key habitats and their associated fish and invertebrate assemblages at the Houtman Abrolhos Islands has been expanded. This program is divided into two components the first of which, uses permanent coral transects located at each of the island groups to collect important baseline information on coral communities. This information allows researchers to quantify the effects of natural (i.e. climate change) and anthropogenic (i.e. fishing activities) impacts on sensitive coral habitats. The second component focuses on the establishment of baseline maps and information on the current distribution and composition of the fish, coral, algal and other communities within the Abrolhos Islands. This project was funded by state NRM in 2009. Detecting change will also need the development of cost effective indicators that can measure significant changes generated by either natural or anthropogenic causes that could affect the fisheries and other activities in this region.

The Biodiversity and Biosecurity Branch are involved in several studies that involve mapping of habitats in this bioregion. The focus of these projects is to map the dominant marine habitats, and conducting biodiversity surveys in order to build spatial habitat models of the marine environment.

Outputs from these habitat mapping and biodiversity surveys will assist in the identification of key marine indicators, and will support regional natural resource management groups in establishing marine ecosystem monitoring targets. The habitat maps produced will provide information on the distribution and extent of various substrates (e.g. reef versus sediment), relief, dominant vegetation types and different classes of sessile invertebrates.

In the West Coast bioregion, sampling mostly by other agencies (e.g. UWA, ECU, CSIRO) has focused on the Abrolhos Islands, Jurien Bay, Rottnest and Cape Naturaliste. Bathymetric and towed video surveys have been completed at all of these sites, as well as biodiversity sampling including research trawls using the RV *Naturaliste* and Baited Remote Underwater Video Stations (BRUVS). This work is being coordinated through the WAMSI Node 4 project 4.1

The Department continues to undertake research to assess the impacts on fisheries from other activities and determine appropriate management responses. The Department also inputs into the Western Australian Environmental Protection Authority's environmental impact assessment process when a development proposal has the potential, if implemented, to impact on the aquatic environment.

The Department also continues to actively engage with the natural resource management groups within the West Coast to promote sustainable use of the aquatic environment, and has 'introduced aquatic organism incursion' and 'fish kill incident response' programs to minimise risks to the marine environment through the introduction of exotic aquatic organisms, or other incidents which have the potential to have an adverse effect.

A Natural Heritage Trust project, which commenced in 2006, is evaluating the extent of introduced marine species in Western Australian waters and developing strategies to minimise further introductions. This project has developed considerable information on the status of introduced marine species (IMPs) in WA. Outputs in 2010 from this funding include the development of a community-based IMP monitoring program and the preliminary design and testing of

an underwater camera system to assess biofouling on vessels less than 12 m.

Other completed work by biosecurity staff include a survey of the Careening Bay Naval waters at Garden Island, for the possible presence of the invasive mussel *Perna viridis*. Other ongoing work by biosecurity staff include: a project for capacity building funded by an FRDC Tactical Research Fund grant which involved staff travelling to established biosecurity institutions in Australia and New Zealand and the development of a dive slate of potential IMPs for the Albany region for use by recreational divers and funded by the Atlantic Eagle Fund.

A bycatch risk assessment method to rapidly assess the cumulative risk to sustainability of multiple fisheries was developed based on data up to and including 2009. The method draws on other techniques already published in scientific literature and adds a new cumulative ranked estimate of total catch across multiple fisheries. The Ranked Risk Assessment of Multiple Fisheries (RRAMF) allows ranking of bycatch species within each fishery and to accumulate the ranks across multiple fisheries incorporating the relative impact of each fishery. Another feature of this study is that it does not present a single risk result for each species, rather it shows a range of scores based on a variety of combinations of double-weighted parameters used in the risk assessment. The RRAMF method was tested on the West Coast and Gascoyne Coast Bioregions of Western Australia using fishery independent data for general teleost and elasmobranch bycatch; and fishery dependent data for threatened, endangered and protected species (TEPs). The analyses are in the final stages of completion and will be written up as a Fisheries Research Report.

A trial has begun of using a camera placed on a demersal gillnet vessel to investigate the efficacy of electronic monitoring to (a) identify protected species interactions, and (b) determine by-product and target species catches. The experiment is still in the equipment-testing phase, however, it is expected that the technique will produce information useful for management.

FISHERIES

West Coast Rock Lobster Fishery Status Report

S. de Lestang, A. Thomson and M. Rossbach.

Management input from J. Kennedy, G. Baudains and A. Steele

Main Features			
Status		Current Landings (Season 2008/09)	
Stock level	Acceptable	Commercial catch	7593 t
Fishing Level	Acceptable	Recreational catch	225 t

Fishery Description

Commercial

The West Coast Rock Lobster Managed Fishery (WCRLF) targets the western rock lobster, *Panulirus cygnus*, on the west coast of Western Australia between Shark Bay and Cape Leeuwin, using baited traps (pots). This is an input controlled fishery that was one of the first limited entry fisheries in the world plus it has used a sophisticated ITE based system for over 20 years. With annual production historically averaging about 11,000 t this has been Australia's most valuable single species wild capture fishery and was the first fishery in the world to achieve Marine Stewardship Certification (MSC).

Recreational

The recreational rock lobster fishery primarily targets western rock lobsters using baited pots and by diving.

Governing legislation/fishing authority**Commercial**

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995

West Coast Rock Lobster Management Plan 1993

Other subsidiary legislation

West Coast Rock Lobster Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational

Fish Resources Management Act 1994

Recreational Fishing Licence

Consultation processes**Commercial**

Rock Lobster Industry Advisory Committee (RLIAC)

Western Australian Fishing Industry Council (WAFIC)

Meetings between the Department of Fisheries and industry;
Western Rock Lobster Council

Recreational

RecFishWest

Boundaries**Commercial**

The fishery is situated along the west coast of Australia between Latitudes 21°44' to 34°24' S. The fishery is managed in 3 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 Aboorhos Islands.

Recreational

The recreational rock lobster fishery operates on a state-wide basis and encompasses the take of all rock lobster species. Fishing is concentrated on western rock lobsters in inshore regions in depths of less than 20 meters between North West Cape and Augusta. The majority of recreational lobster fishing occurs in the Perth metropolitan area and Geraldton.

Management arrangements**Commercial**

The fishery is divided into three zones, which distributes effort across the entire fishery, reducing concentration of effort and the potential for unacceptable exploitation rates. This also permits the implementation of management controls aimed at addressing zone-specific issues, including different restrictions in the northern and southern regions of the fishery.

This fishery is managed using a total allowable effort (TAE) system and associated input controls. The primary control mechanism is the number of pots licensed for the fishery, together with a proportional usage rate, which creates the TAE in pot days. Unitisation in the fishery and transferability provisions allow market forces to determine the most efficient use of licences and pot entitlements. This is known as an individually transferable effort (ITE) management system. The total number of pots (subsequently changed to units) in the fishery was set at 68,961 in the early 1990s. In 1993/94 the usage rate of these units as pots was reduced to 82%. This was further reduced in the northern part of the fishery to 74% for part of the season beginning in 2005/06 to keep the TAE at a sustainable level (see below).

The management arrangements also included the protection of females in breeding condition, a minimum size limit of 77 mm carapace length applied from 15 November to 31 January, and a minimum of 76 mm from 1 February to 30 June. A maximum size limit for female lobsters was re-

imposed in 2002/03 that prohibits the take of female lobsters larger than 105 mm from waters between 21°44' S and 30° S (northern region) and those larger than 115 mm between 30° S and 34°24' S (southern region), excluding waters east of 115°08'. Gear controls, including escape gaps and a limit on the size of pots, also play a significant role in controlling exploitation rates. The season opens on 15 November and closes on 30 June, with the Abrolhos Islands zone operating from 15 March to 30 June.

Additional effort reductions were introduced in 2005/06. In the northern coastal region pot usage was reduced to 74% from 15 November – 14 March and 82% from the 15 March to 30 June. The northern zone was also closed to fishing from 15 January – 9 February, with no fishing on Sundays (15 March – 30 June), Christmas Day and New Year's Day. Pot usage in Zone A was also reduced to 74% for the first four weeks of the season (15 March – 15 April), before returning to 82% for the remainder of the season. In the southern region pot usage remained at 82% all season, the season began 10 days later (24 November), 3-day moon closures occurred from 1 February to 30 June (1 day prior to the full moon, the day of the full moon and the day after the full moon) and the fishery was closed for Christmas Day and New Year's Day.

With the ongoing decrease in puerulus settlement, and given that the 2006/07 puerulus settlement was the second lowest on record at the time, further measures were introduced prior to the start of the 2008/09 season. At the commencement of the season the arrangements for Zone C was a pot usage of 74% and Sunday closures all season, for Zone B there was a pot usage of 66% and Sunday closures all season, and for Zone A, a pot usage of 66% and Sunday closures from 1 April until the end of the season. For Zone C, where moon closures were in place (from February until the end of the season), when the Sunday fell the day prior to or after the moon closure, it resulted in a four-day closure.

However, as a further precautionary measure with the continuing low puerulus settlement early in the 2008/09 settlement period, further pot reductions were implemented just after the start of the season. As of 30 November 2008 the pot usage was subsequently reduced to 62% for Zone C and 54% for Zones B and A.

With negligible puerulus settlement occurring by January of 2009, additional effort reductions were implemented. These amendments were designed to limit the 2008/09 season's catch to 7,800 tonnes. They were; a closure to rock lobster fishing in all zones on Saturdays, Sundays and Mondays from 1 March (moon closures in Zone C were abolished), a further reduction to the unit values to 50% in Zone C and 42% in Zone A and Zone B, and the closure of the Big Bank area, and a reduction in the legal maximum length for female rock lobsters in Zone A and B to 95mm and an increase in the legal minimum length in Zone C to 77mm as of 15 March 2009. It was also decided not to open the Big Bank area for this season.

On 23 April 2009, having reviewed the effectiveness of these measures, the restriction on fishing on Mondays was removed, and fishers were permitted to operate on Mondays from 4 May 2009 onwards for the remainder of the season.

Recreational

The recreational component of the western rock lobster fishery is managed under fisheries regulations, which impose a mix of input and output controls on individual recreational fishers. These arrangements are designed to complement the management plan for the commercial fishery.

Input controls include the requirement for a recreational rock lobster fishing license. Fishers are restricted to 2 pots per license holder, although the total number of licenses is not restricted. The pots must meet specific size requirements and have gaps to allow under-size rock lobsters to escape. Divers are also restricted to catching by hand, snare or blunt crook in order that the lobsters are not damaged. Fishing for rock lobsters at the Abrolhos Islands is restricted to potting.

An open season runs from 15 November to 30 June each year, with a shorter season (15 March to 30 June) at the Abrolhos Islands. Night-time fishing for lobsters by either diving or potting is prohibited. Management regulations on minimum size limits, protection of breeding females and the maximum size of females that can be taken are the same as those for commercial fishers.

In 2007/08 a daily bag limit of 8 lobsters per fisher per day was used to control individual catches, and limits the ability of recreational fishers to accumulate large quantities of lobsters. A daily boat limit of 16 provided further control on high individual catches where there are 2 or more people fishing from the same boat. In November of 2008, these limits were amended, with the daily bag limit changing to 6 lobsters per fisher per day, the boat limit amended to 12 per boat per day, and a possession limit introduced - limiting the number of rock lobsters permitted in a person's possession to 24 rock lobsters. There is also a requirement for recreationally-caught lobsters to be tail-clipped in order to stop these animals from being sold illegally as part of 'shamateur' activity.

Integrated Fisheries Management

In March 2008, through the Integrated Fisheries Management process, the Minister determined that the allocated shares of the sectors of the West Coast Rock Lobster Fishery would be 95% to the commercial Sector, 5% to the recreational sector and one tonne to customary fishers. The 2009/10 season will be the first season where these shares were formally allocated for all sectors.

Research summary

Research activities focus on assessing stock sustainability, forecasting future catch and breeding stock levels. This involves fishery-dependent and independent monitoring of breeding stock levels and puerulus settlement. Industry performance is monitored through compulsory catch and effort records from both fishers and processors, comprehensive data from the voluntary logbook scheme, and a commercial monitoring program, all of which are used for modelling and stock assessment.

An environmental management strategy was developed for use in the assessment of the broader ecosystem impacts of rock lobster fishing in the context of ESD and MSC certification. This strategy includes research into the ecosystem effects of rock lobster fishing in deep water. A Fisheries Research and Development Corporation (FRDC)

WEST COAST BIOREGION

funded project to examine the effects of western rock lobster fishing on the deep-water ecosystem off the west coast of Western Australia has recently been completed. This project provided critical baseline data on the relationships between the abundance and size distributions of rock lobster and the different benthic habitats located in deeper waters, plus preliminary data on diets and the trophic role of rock lobster within these depths. Further ecological research in deep waters will be based on comparing fished and unfished areas using research closures. This research is supported by the WAMSI and a new FRDC project that started in 2009. The aims of this project include negotiating a suitable closed area in deep water to assess the ecological impacts of fishing, developing cost-effective methods to monitor benthic communities in deep water and the collection of baseline information on lobster stocks, habitats and community structure to facilitate comparisons between fished and unfished areas. The ultimate outputs of this project will enable any impacts of lobster fishing on deepwater ecosystems to be quantified.

A second project examining lobster populations between fished and unfished zones is ongoing at Rottne Island. This project consists of annual sampling using pots and underwater dive surveys at Armstrong Bay and Parker Point sanctuary zones. Results from the first three years after the no-take regions were implemented have shown a rapid increase in lobster numbers within the protected areas. This study also aims to provide additional information on growth, natural mortality and size/sex-specific catchability.

A risk assessment workshop to examine the low puerulus settlement was held in April 2009. The workshop focused on examining the 'likelihood' of factors that could have caused the decline in puerulus settlement. The workshop concluded that the decline in settlement could have been caused by changes in environmental conditions and productivity in the eastern Indian Ocean, or a decline in the abundance of the rock lobster breeding stock, particularly in the northern region of the fishery, or a combination of these two factors. A report on this workshop can be found on the Departments website (<http://www.fish.wa.gov.au/docs/op/op071/fop71.pdf>).

The six projects listed below were funded by the Fisheries Research and Development Corporation (FRDC) to investigate various aspects of the possible causes and factors associated with the low puerulus settlements of 2007-08 and 2008-09.

- Project 1. Identifying factors affecting the low western rock lobster puerulus settlement in recent years.
- Project 2. Evaluating source-sink relationships of the Western Rock Lobster Fishery using oceanographic modelling.
- Project 3. Evaluating the use of novel statistical techniques for determining harvest rates and efficiency increases in the Western Rock Lobster Fishery.
- Project 4. Evaluation of population genetic structure in the western rock lobster.
- Project 5. Assessing possible environmental causes behind the reduced colonization of puerulus collectors by a wide suite of species.
- Project 6. A joint funded project between the FRDC and the

Marine National Facility - RV *Southern Surveyor*. Biological Oceanography of the Western Rock Lobster – Winter / Spring Dynamics.

Concern about the status of the breeding stock in the Big Bank region resulted in an additional independent breeding stock survey being conducted in this area to generate baseline information to assess the effects of the closure in this area.

A stock assessment workshop took place from 20 – 24 May 2010 at the Hillarys facility. Along with the need for regular review of the 2010 stock assessment, the objectives of the workshop met the conditions set by the Marine Stewardship Council's auditors for the Western Rock Lobster Fishery (WRLF) certification. The reviewers concluded that while the structure of the current model was appropriate the spatial complexity could be reduced. The reviewers also advised that more of the data sources and parameters should be incorporated within the model to improve the estimates of precision. A major outcome of the workshop was the development of an ITQ version of the model that incorporated many of the suggested changes made by the reviewers. This model is currently being tested and will eventually be used for stock assessment of the fishery. A report on this workshop will be available in late 2010.

To assess the economic performance of the fishery a Seafood CRC project was submitted for possible funding. This project would look at updating the maximum economic yield assessment, in light of having an ITQ management system, and ways to incorporate the economic assessment into the stock assessment model.

For the recreational component of this fishery, an annual mail-based survey of participants has been used to estimate the annual catch and effort for the past 20 years. The trends generated by these data, together with data on puerulus settlement, are used to predict the recreational catch and effort in following seasons. Since 2000/01, telephone diary surveys of recreational rock lobster fishers have also been undertaken in most years. Estimates of recreational catch using this method are compared to the estimates from mail surveys. Phone diary surveys are considered to be more accurate than those from mail surveys because they eliminate the recall bias in the mail surveys and additionally, there is a higher participation rate in the survey from random sample selection. Sample sizes for the phone diary surveys have been increased since the 2006/07 survey to improve the accuracy of the result.

A project has commenced that aims to identify the parameters derived from mail surveys that need to be adjusted such that a catch estimate comparable to the diary survey estimates is generated. Thus, the estimates of effort obtained from the mail survey may alter in the future but comparison between seasons should not be affected.

Retained Species

Commercial landings (season 2008/09):

7593 tonnes

Lobsters: Trends in the annual catches from the West Coast Rock Lobster Managed Fishery are shown in West Coast Rock Lobster Figure 1. The predicted 2008/09 catch for the

WCRLF, forecast from puerulus settlement 3 to 4 years previously, was 9250 t. Due to additional management changes which were introduced in response to poor puerulus settlement in 2008/09 the catch landed by the WCRLF for the 2008/09 season was just 7593 t. This was 31.0% lower than the long-term average catch (1981/82 to 2006/07) of 11,005 t and 14.9% lower than the previous season's 8920 t. In 2008/09, the catches in A, B and C Zones were 1,339, 2588 and 3,667 t, respectively, with A Zone 30.6% down, B Zone 14.9% down and C Zone 7.8% lower than the previous season.

Octopus: Octopus are also caught in rock lobster pots, generally in shallow water (<40 m), and a catch rate of 0.03 octopus per pot lift was recorded in the 2008/09 voluntary research log book data. This was 25% above the average of 0.024 per pot lift over the historical range (1985/86 to 2003/04).

This catch rate translates to an estimated 120,337 octopus caught in all regions of the fishery during 2008/09. Octopus catches were estimated for A, B and C Zones as 16,562, 49,087, and 54,688, respectively.

The catch rate of octopus (incidental landings) is an indicator for this fishery, and at 0.03 octopus per pot lift achieved the performance measure of being within 10% of the historical range $\pm 10\%$ (0.013–0.033 octopus per pot lift).

Recreational catch estimate (season 2008/09):

225 tonnes

Based on the first 2 phone diary surveys (2000/01 and 2001/02), previous mail survey based catch estimates back to the 1986/87 season were adjusted downwards by the average ratio of 1.9. While a subsequent comparison undertaken in the 2005/06 season produced a different ratio, to maintain consistency from year to year the 1.9 conversion factor to adjust the mail survey data has been used until a more reliable conversion factor can be determined.

The recreational catch of western rock lobster for 2008/09 was estimated at 225 t based on the adjusted mail survey, with 162 t taken by potting and 63 t by diving. This represents close to 3% of the total catch of lobsters.

Comparative catch estimates for 2007/08 were 206 t, with 147 t by potting and 59 t by diving. The estimated recreational catch in 2008/09 was therefore 9% above the 2007/08 catch. The 2008/09 season catch estimate was at the lower limit of the catch prediction confidence limits (i.e. 200 – 350 t) produced by the model constructed using adjusted mail survey catch estimates.

Fishing effort/access level

Commercial

In 2008/09 the numbers of vessels fishing for lobster were 107 in A Zone, 89 in B Zone and 199 in C Zone. Thus, in comparison to the 460 active boats in 2007/08, a fleet of 395 vessels fished in 2008/09, which was a reduction of 14%.

The nominal fishing effort was 4.6 million pot lifts in 2008/09 – 43% lower than the 8.1 million pot lifts for 2007/08 and the lowest level since the 1950s (West Coast Rock Lobster Figure 1). This decline in nominal pot lifts is due to the sustainability package adopted by the fishery in the 2008/09 season.

The 2008/09 nominal effort for A, B and C Zones was 0.48, 1.52 and 2.6 million pot lifts respectively, which was 76.4, 13.9 and 40.0% lower than the previous season's pot lifts.

Recreational

A total of 41,986 licenses were sold that permitted fishing for lobsters during some part of the 2008/09 season (made up of specific rock lobster licenses plus umbrella licenses) with an estimated 25,050 (60%) utilized for lobster fishing. This was very close to the forecasted number of 25,000. Sales of licenses and associated usage figures are substantially higher in years of anticipated good recruitment into the fishery, which in turn results in those years producing a relatively higher overall recreational rock lobster catch due to a combination of increased lobster abundance and higher fishing effort. The number of licenses used for rock lobster fishing in 2008/09 was 10% higher than the number of active licenses (22,800) for the 2007/08 season.

The average rates of usage by active pot and diving fishers (i.e. excluding all those who held a license but failed to use it) were 28 and 10 days respectively during the 2008/09 fishing season. These rates were similar in the 2007/08 fishing season.

Finally, the average diary-adjusted catch taken by active pot and diving fishers were 19 and 11 lobsters respectively during the 2008/09 fishing season. In the 2007/08 season the average number of lobsters caught by pot and dive fishers was 19 and 10 respectively.

In addition to long-term trends in license usage, the annual recreational catch in Zone C has also been shown to be related with puerulus settlement indices recorded on the Alkimos collectors 3 to 4 years earlier.

Stock Assessment

Assessment complete: **Yes**

Assessment method: **Size-structured simulation model**

Breeding stock levels: **Adequate**

Targeted commercial catch next season (2009/10): **5,500 \pm 10% tonnes TACC**

Projected recreational catch next season (2009/10): **265 tonnes**

The stock assessment process for this fishery utilises the broad range of fishery data and fishery-independent monitoring outlined in the research summary above.

Indices of egg production are the main indicators for assessing the health of the lobster stock. Prior to 2008/09 these were empirically based measures presented as the north and south coastal fishery-dependent breeding stock indices. These indices were based on commercial monitoring data and

WEST COAST BIOREGION

the fishery-independent breeding stock survey (IBSS) indices. Since 2008/09 the development of a fully integrated stock-assessment model that incorporates information these data sources along with other information has enabled more robust and spatially comprehensive estimates of egg production to be generated. These model based indices are now used for assessing the health of this stock and their continued use was a key recommendation from the recent stock assessment review of the fishery (May 2010).

The current focus for stock assessment has been to determine the effects of four years of low puerulus settlements on future catches and breeding stock levels and assess the effect of different management measures in mitigating any negative impacts.

The proposed management arrangements, which have been updated from the changes implemented in 2005/06, 2008/09 and 2009/10 which include reductions in the pot usage rate, the protection of setose and maximum size females, the closure of Big Bank and a number of temporal closures, the overall breeding stock projected five years into the future should remain at, or above, the target levels of the early – mid 1980s with a probability greater than 75% (West Coast Rock Lobster Figures 2, 3 and 4).

A performance measure for the fishery is that the egg production index for the three zones are projected to be above their respective threshold levels (that estimated to be the early-mid 1980s levels) five years into the future with a probability greater than 75%. The fishery has therefore met this performance measure.

Catch per Unit Effort (CPUE)

A second assessment measure in this fishery is the catch per unit of effort (CPUE) achieved annually by the fishery (West Coast Rock Lobster Figure 5). This provides a broad indicator of variations in the abundance of the legally catchable stock.

Commercial

The downward trend from the 1970s to the 1980s reflects the increasing effort during this period (West Coast Rock Lobster Figure 1), which automatically leads to lower CPUE. This trend was reversed in the early 1990s through a substantial management-induced reduction in effort (i.e. pot usage was reduced to 82% of the unit holding).

Typically short-term fluctuations in abundance have represented the cyclical nature of puerulus settlement, which is reflected in the legal-sized abundance (CPUE) 3 to 4 years later. In the 2008/09 fishing season however the increase in CPUE to 1.68 kg/pot lift (around 52% higher than the previous year) relates more to the significant reduction in effort levels during this season. It should be noted that the catch rate does not directly reflect the overall abundance of lobsters, as legal catches are only a proportion of the overall biomass due to the large biomass of under-size animals and breeding females, which are fully protected.

Recreational

The average recreational pot and diving diary-adjusted catch rates were 0.70 and 1.05 lobsters per person per fishing day

in the 2008/09 fishing season. These catch rates are very similar to the 0.68 lobsters for potting and 0.99 lobsters for diving in the 2007/08 fishing.

Juvenile Recruitment and Catch Prediction

Post-larval (puerulus) recruitment to the fishery is monitored on a lunar monthly basis. Recruitment levels are affected by fluctuations in environmental conditions such as strength of the Leeuwin Current and the frequency and intensity of low-pressure systems generating westerly winds. Annual indices of puerulus settlement for 2009/10 were at very low levels at nearly all sampling sites (West Coast Rock Lobster Figure 6). This was the second lowest settlement on record, and factors such as environmental and/or breeding stock that may be contributing to this decline are being investigated (see Research summary). The low 2009/10 settlement will first impact on catches during the “reds” of 2012/13 and the ‘whites’ of 2013/14.

Non-Retained Species

By-catch species impact:

Low

Fishery-independent monitoring on commercial vessels records the catch rates of fish and invertebrate by-catch species caught during normal rock lobster fishing operations. Approximately 41,904 fish and invertebrates other than rock lobster and octopus were captured during the 2008/09 fishing season, of which most were released (Table 1). This is 52% less than last year’s catch and is due to the reduced effort in the fishery.

Protected species interaction:

Low

Previously, the WCRLF interacted with the Australian sea lion, *Neophoca cinerea*, resulting in the accidental drowning of an estimated small number of sea lion pups in rock lobster pots, as the pups attempted to retrieve from the traps the bait or rock lobsters contained in them. Such incidents were restricted to shallow waters (< 20 m) and to areas within 30 km of the mainland sea lion breeding colonies on the mid-west coast.

In order to eliminate these accidental drownings, from November 15, 2006 all pots fished in waters less than 20 m within approximately 30 km of the 3 breeding colonies, i.e. just north of Freshwater Point to just south of Wedge Island, were fitted with an approved Sea Lion Exclusion Device (SLED). Video trials have indicated that this device does stop sea lion pups from entering lobsters pots and drowning.

Approved SLED designs include an internal rigid structure, directly under the pot neck and an external design across the top of the pot, both of which ensure that the diagonal distance from the SLED to the neck of the pot is not greater than 132 mm. Further information on the SLED management package is available at

<http://www.fish.wa.gov.au/docs/pub/SeaLionExclusionDevices/index.php>

Monitoring of commercial pots in the SLED zone in 2007/08 – 2008/09 showed that over 95% of pots checked had an approved SLED.

The performance measure for this fishery is that no increase in the rate of capture of sea lions occurs. During the 2008/09 western rock lobster season, no sea lion captures were reported, whereas the historical level is just over three sea lions per season. The fishery has therefore met this performance measure

Turtle deaths as a direct result of interaction with the lobster fishery are very rare. Of the 6 turtle species that occur in the waters of the western rock lobster fishery, only the entanglement of leatherback turtles (*Dermochelys coriacea*) was concluded to be above a negligible risk, and this was still rated as a low risk. Given the significant reductions in effort and hence pot ropes in the water since this assessment was completed, the current risk is probably now even lower.

The performance measure for the fishery is that there is no increase in interactions with turtles. In 2008/09, no leatherback turtles were reported to have been entangled in lobster fishing gear. This incident rate is below the historical range of between two and five entanglements per season over the preceding five seasons. The fishery has therefore met this performance measure.

There are occasional reports of a whale becoming entangled with pot ropes. The humpback whale is the predominant species that interacts with the WCRLF, during its northward migration to the North West Shelf breeding grounds in June to August. Owing to the fishery's closed season, there is a limited period for interaction; however, with the increasing population of whales, until recently more interactions were considered likely to occur in the future but the large reduction in effort levels means that this increased may no longer eventuate.

Interactions are reported by industry to the Department of Environment and Conservation (DEC) and a specialist team is used to disentangle the animal, with a very high success rate. The western rock lobster fishing industry has developed a code of practice to minimise the interaction with whales in conjunction with DEC and SeaNet. The environmental management strategy adopted for the WCRLF requires monitoring of, and attempts to, minimise accidental interaction with these species wherever practicable.

The performance measure for the fishery is that there is no increase in the rate of interactions with whales and dolphins (entanglements). Over the recorded history (1989–2008), commercial lobster fishing has resulted in zero to four whale/dolphin interactions per season. One whale entanglement was recorded during the 2008/09 lobster season, which was successfully disentangled; therefore the fishery met this performance measure.

Ecosystem Effects

Food chain effects:

Moderate

Overall, the fishery is unlikely to cause significant trophic ('food web') cascade effects, as the protected sub-legal-sized lobsters and breeding stock components form a relatively constant significant proportion of the biomass which remains from year-to-year, and the catch, particularly in inshore areas, is less than the annual variability in biomass due to natural recruitment cycles. However, the rock lobster-specific ecological risk assessment completed in 2008 considered that, due to the lack of information, the removal of lobster in deep-water regions might be having some level of impact on the surrounding ecosystem. This forum subsequently classed this as a moderate risk. Consequently it has become a focus of research, with preliminary work, funded by FRDC now completed and a second WAMSI/FRDC project has been initiated to expand on these preliminary findings.

Habitat effects:

Low

The legislated design of rock lobster pots, the materials they are made from and the strict control of replacement pots prevent 'ghost fishing' problems arising. A study of human impacts on the marine environments of the Aboholhos Islands estimated that potting might impact on less than 0.3% of the surface area of fragile habitat (corals) at the Aboholhos, where fishing is only allowed for 3½ months of the year. Generally, throughout the coastal fishery, rock lobster fishing occurs on sand areas around robust limestone reef habitats, covered with coralline and macro-algae such as kelp (*Ecklonia* spp.). This type of high-energy coastal habitat is regularly subjected to swell and winter storms and so is considered highly resistant to damage from rock lobster potting. The significant recent reductions in fishing effort will also have reduced these risks even further.

Social Effects

Commercial

The western rock lobster fishery is an important sector of Western Australia's economy, with the commercial catch from the current reporting season valued ex-vessel at \$191 million. Employment is seasonal, the fishing season covering seven and a half months from 15 November to 30 June.

A total of 395 vessels and 1094 people were engaged directly in fishing for rock lobsters in 2008/09. During the year, 6 main processing establishments, located in the Perth metropolitan area (3) and Geraldton (1), Ledge Point (1) and Cervantes (1) serviced practically every location where fishing occurred.

Recreational

With around 25,000 people taking about 400,000 individual lobsters annually, this fishery represents a major recreational activity and provides a significant social benefit to the Western Australian community.

WEST COAST BIOREGION

Economic Effects

Estimated annual commercial value (to fishers)

for year 2008/09: \$191 million

The price that commercial fishers received for the western rock lobster in 2008/09 was an estimated average of \$25.10/kg in all zones of the fishery. This was 3.29% increase on the \$24.30/kg paid in 2007/08. The overall value of the fishery declined marginally from the previous season's value of \$217 million as a result of the lower landed weight recorded.

The bulk of the product was exported to Japan, Taiwan, Hong Kong/China, United States and some into Europe.

Fishery Governance

Commercial

Current Fishing (or Effort) Level: Acceptable

Commercial catch limit (08/09): 7,800 tonnes

**Commercial catch target (09/10):
5,500 tonnes \pm 10%**

Between 1975/76 and 2008/09 commercial catches have averaged 10,951 and ranged from 7,593 t in 2008/09 to 14,523 t in 1999/2000. The variations in catches result primarily from varying levels of recruitment, which have been largely associated with the environmental conditions experienced by western rock lobster larvae and post-larvae, and levels of fishing effort. The record low puerulus settlement in 2008/09 which followed a series of low levels resulted in catch limits being imposed to generate a carry-over rather than continuing the historical strategy of catching a similar proportion of the available stock each year. For the 2008/09 season this involved restricting the catch to below 7,800 t which required significant effort reductions were instigated for both the whites (ca. 35%) and reds (ca. 60%) portions of the season. A similar strategy was adopted for the 2009/10 season with the catch target at 5,500 t with 10 % tolerance limits. These actions are designed to ensure a carryover of lobsters should occur into what would have otherwise have been low catch years (2010/11 and 2011/12).

Recreational

Current Fishing (or Effort) Level: Acceptable

**Target recreational catch limit (08/09):
400 tonnes**

**Target recreational catch limit (09/10):
290 tonnes**

Between 1986/87 and 2008/09 recreational catches have varied between 115 t in 1987/88 to 468 t in 2002/03. Variation of these catches results primarily from variable levels of recruitment, which are driven by the environmental conditions as described above. From 2008/09 onwards the commercial and recreational sectors have been managed under the principles of Integrated Fisheries management (IFM), which allocates the commercial and recreational sectors 95 and 5% of the total catch, respectively. Under this arrangement the limit recreational catch for 2008/09 based on

a commercial catch of 7593 t is 400 t.

The recreational catch estimate for the 2008/09 season was 225 \pm 25 t (95% confidence interval of the mean) which was well below their limit catch of 400 t.

New management initiatives (2009/10)

To achieve the 5,500 t catch limit for the 2009/10 season another series of additional effort restrictions were developed. These additional measures included substantial reductions in pot usage values within each zone, four day fishing periods per week for parts of the season, and for some zones substantial closures were implemented during the season.

Given the complexity of the effort control arrangements and the significant interventions needed within the season, the management system for the fishery was reassessed. The Minister made an in-principle decision to move the fishery to quota control for the 2010/11 season.

External Factors

The variations in western rock lobster catches both commercially and recreationally are largely a result of variable levels of puerulus settlement due to changes in the Southern Oscillation (El Niño or La Niña events in the Pacific Ocean) and their effect on the Leeuwin Current. A positive relationship exists between Leeuwin Current strength and levels of puerulus settlement. The southward-flowing Leeuwin Current also affects the spatial distribution of puerulus settlement along the coast. Catches are also dependent upon the environmental conditions at the time of fishing.

The fishery has been affected now by seven years of El Niño or neutral conditions, which has generally resulted in average or below average puerulus settlement due to the weaker Leeuwin current strength. The 2009/10 settlement levels were a slight improvement on 2008/09, however, this collection was still the second lowest settlement ever recorded. The factors that may be contributing to this low settlement are being examined (see Research Summary).

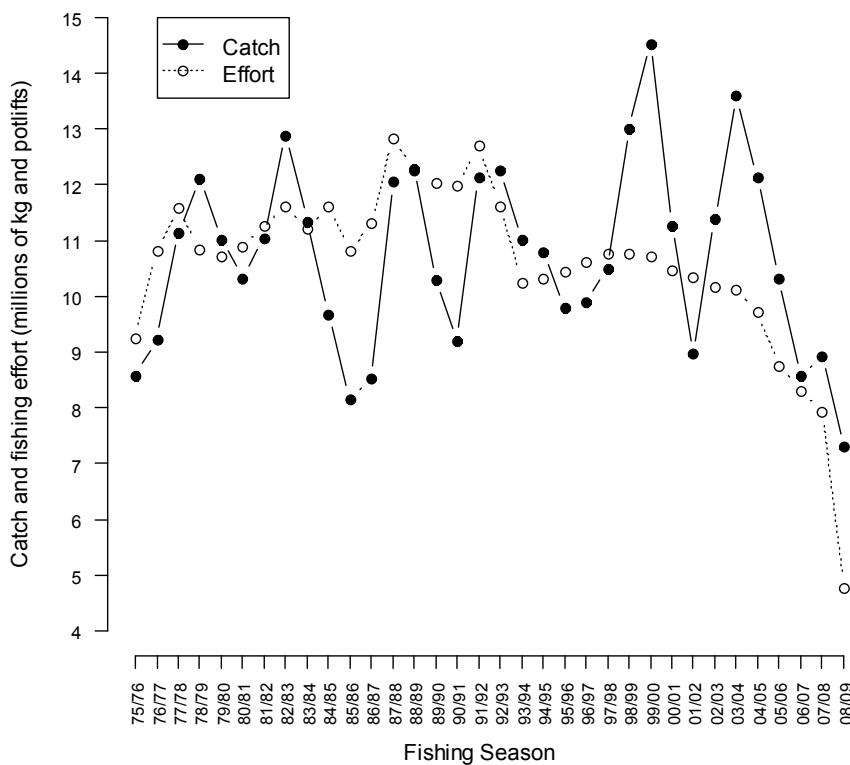
Increases in water temperatures over the last 30-40 years, which may be related to climate change, appear to be affecting some of the biological parameters such as size at maturity and size of migrating lobsters. These changes are being taken into account in the stock assessment model and therefore in the future stock assessment of the fishery. An article describing the relationship between climate change and lobster biology has recently been published in an international journal.

The economic performance of the fishery is being strongly affected by the value of the Australian dollar (affecting the price of lobsters), fuel and labour costs.

WEST COAST ROCK LOBSTER TABLE 1.

Catch rate of by-catch in lobster pots recorded during observer monitoring programs in 2008/09. The total number caught is an estimate based on the catch rate and the total number of pot lifts in 2008/09 fishing season.

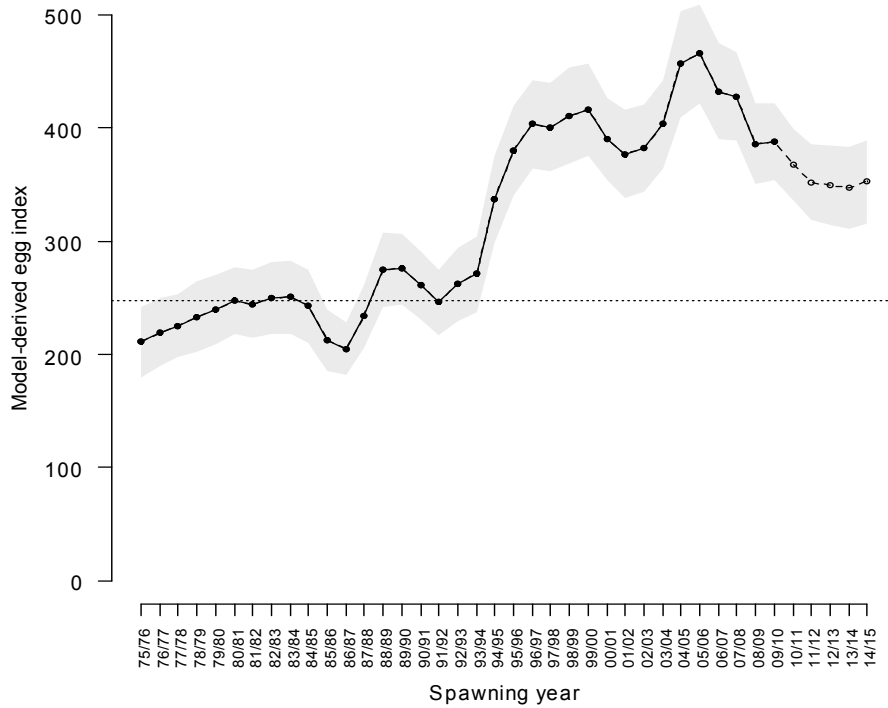
Bycatch Species	Catch/1000 Pot Lifts	Estimated Total Number Caught (whole fishery)
Baldchin Groper (<i>Choerodon rubescens</i>)	0.64	2,908
Break Sea Cod (<i>Epinephelides armatus</i>)	1.57	7,063
Cuttlefish (<i>Sepia sp.</i>)	0.64	3,250
Eel (Muraenidae)	0.37	1,161
Leatherjacket (Monacanthidae)	0.09	415
Port Jackson Shark (<i>Heterodontus portusjacksoni</i>)	0.74	6,697
Scorpion Fish (Scorpaenidae)	0.37	1,661
Unknown fish	1.47	6,647
Wobbegong shark (<i>Orectolobus spp.</i>)	1.84	8,309
Wrasse (Labridae)	0.55	2,492
Total		41,904



WEST COAST ROCK LOBSTER FIGURE 1

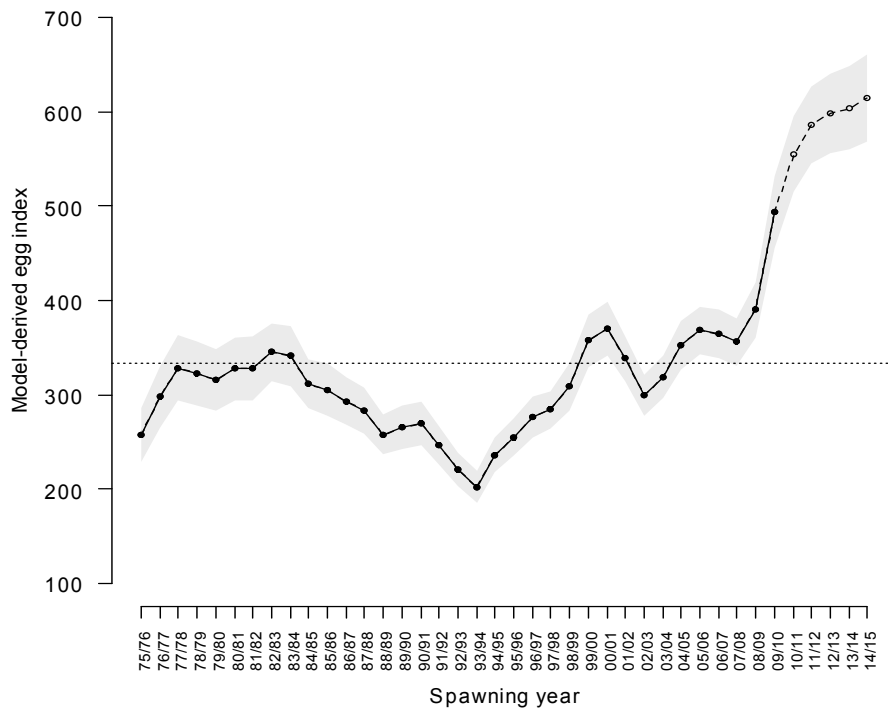
Annual catch (millions of kg) and nominal fishing effort (millions of pot lifts) from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2008/09.

WEST COAST BIOREGION



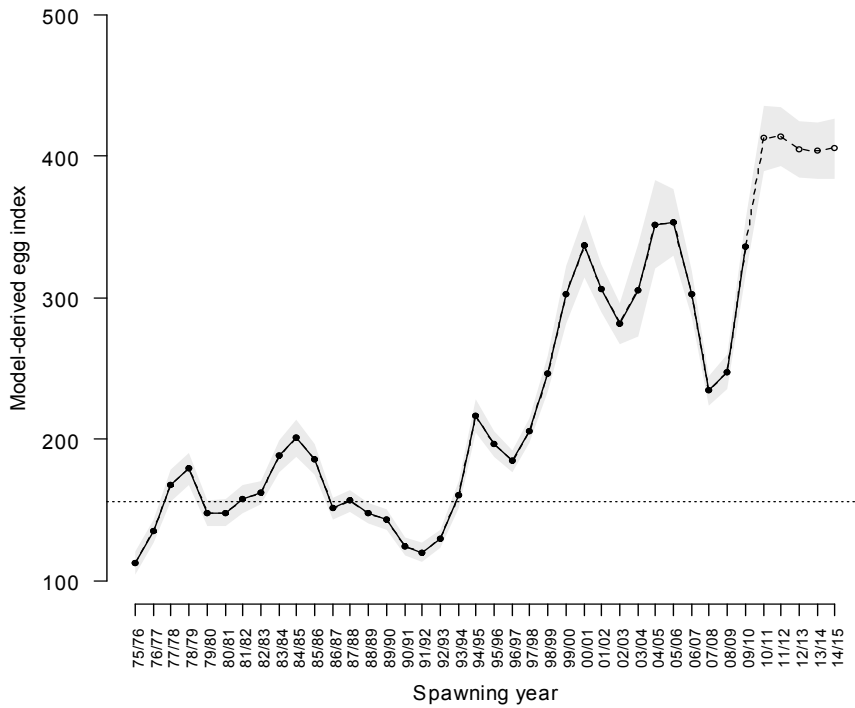
WEST COAST ROCK LOBSTER FIGURE 2

Mean and 50% confidence region (in grey) model-derived egg production index for the Abrolhos zone of the fishery (A zone). The horizontal dotted line represents the 1980's threshold.



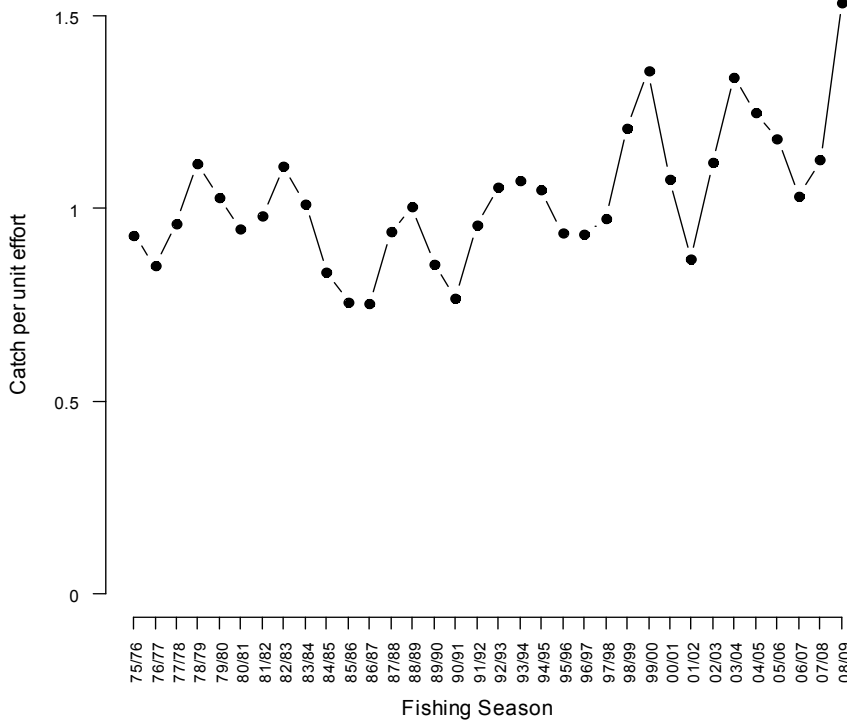
WEST COAST ROCK LOBSTER FIGURE 3

Mean and 50% confidence region (in grey) model-derived egg production index for the northern coastal zone of the fishery (B zone). The horizontal dotted line represents the 1980's threshold.



WEST COAST ROCK LOBSTER FIGURE 4

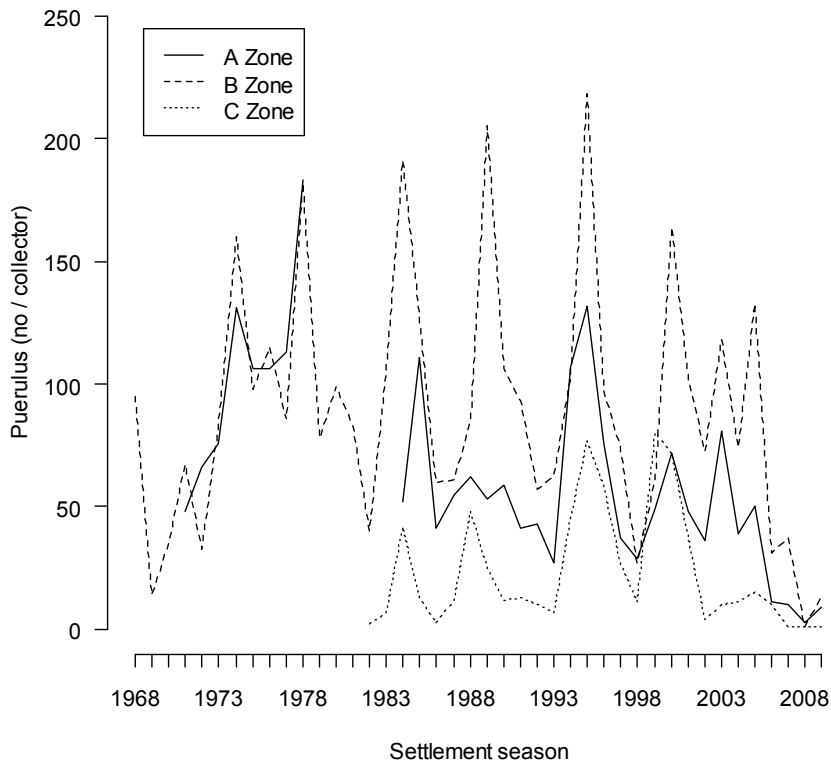
Mean and 50% confidence region (in grey) model-derived egg production index for the southern coastal zone of the fishery (C zone). The horizontal dotted line represents the 1980's threshold.



WEST COAST ROCK LOBSTER FIGURE 5

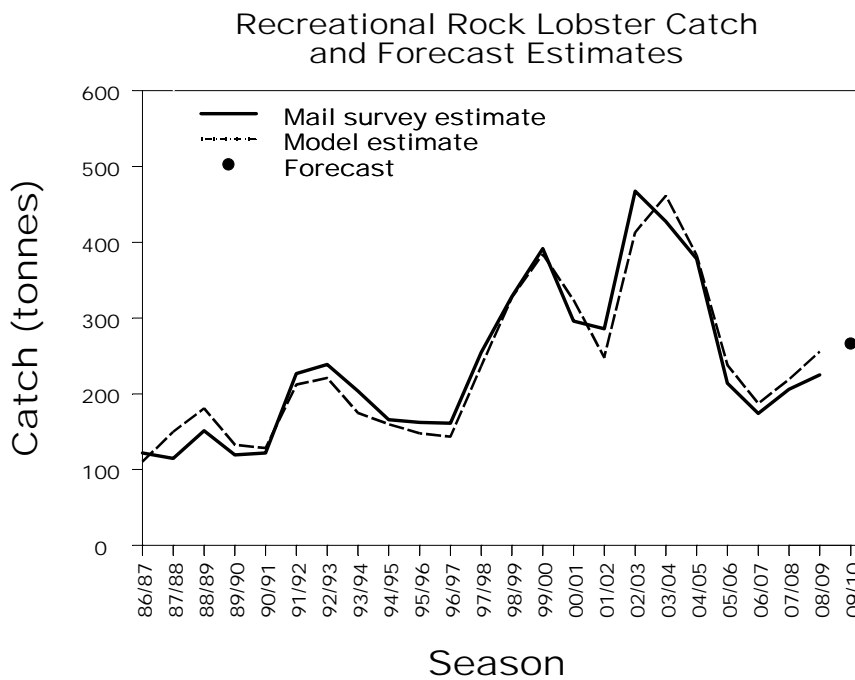
Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1975/76 to 2008/09.

WEST COAST BIOREGION



WEST COAST ROCK LOBSTER FIGURE 6

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



WEST COST ROCK LOBSTER FIGURE 7

Estimates of the recreational rock lobster catch since 1986/87 using adjusted mail survey results, and model estimates of catches in 2008/09 based on puerulus settlement 3 to 4 years earlier and expected licence usage.

Roe's Abalone Fishery Status Report

A. Hart and J. Brown

Management input from M. Holtz

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial Catch	
		West Coast	36 t
		Other	57 t
Fishing level	Acceptable	Recreational Catch	
		West Coast	49 t
		Other	14 t

Fishery Description

The Western Australian Roe's abalone (*Haliotis roei*) fishery is a dive and wade fishery, operating in shallow coastal waters along WA's western and southern coasts. Roe's abalone are found in commercial quantities from the South Australian border to Shark Bay, although they are not uniformly distributed throughout this range.

The commercial fishery harvest method is a single diver working off a 'hookah' (surface-supplied breathing apparatus) using an abalone 'iron' to prise the shellfish off rocks. Abalone divers operate from small fishery vessels (generally less than 9 metres in length).

The recreational fishery harvest method is primarily wading and snorkeling, with the main focus of the fishery being the Perth metropolitan stocks (West Coast Fishery).

Governing legislation/fishing authority

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995

Abalone Management Plan 1992

Ministerial Policy Guideline no. 10

Abalone Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational Fishing Licence

Consultation process

Meetings between the Department of Fisheries and commercial abalone industry

Recreational Fishing Advisory Committee

Boundaries

Commercial

The Abalone Management Plan covers all Western Australian coastal waters, which are divided into 8 management areas.

Commercial fishing for Roe's abalone is managed in 6 separate regions from the South Australian border to Busselton Jetty – Areas 1, 2, 5, 6, 7 and 8 (Roe's Abalone Figure 1).

Recreational

The recreational abalone fishery regulations relate to three zones: the Northern Zone, the West Coast Zone, and the Southern Zone (Roe's Abalone Figure 2). The West Coast Zone is the centre of the fishery and includes the metropolitan fishery.

Management arrangements

Commercial

The commercial Roe's abalone fishery is managed primarily through output controls in the form of total allowable commercial catches (TACCs), set annually for each area and allocated to license holders as individual transferable quotas (ITQs).

The overall TACC for 2009 was 101.8 t whole weight (note this small species is generally landed in the whole condition). The TACC is administered through 25,180 ITQ units, with a minimum unit holding of 800 units generally applying, although some Roe's abalone licences are permitted to operate below this minimum in recognition of historical fishing practices.

The licensing period (fishing year) runs from 1 April to 31 March of the following year.

The legal minimum length for Roe's abalone is 60 mm shell length in most parts of the fishery. However, industry initiated commercial minimum lengths of 75 mm and 70 mm apply in Area 1 (WA/South Australia border to Point Culver) and Area 7 (Cape Bouvard to Moore River) respectively.

A comprehensive Ecologically Sustainable Development assessment of the commercial fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of Roe's abalone. Boxed text in this status report provides the annual assessment of performance for this issue.

WEST COAST BIOREGION

Recreational

The recreational Roe's abalone fishery is managed under a mix of input and output controls. Recreational fishers must purchase a dedicated abalone recreational fishing licence or an umbrella licence (which covers all licensed recreational fisheries). These licences are not restricted in number. The West Coast zone (Perth) of the recreational fishery is restricted to an average total allowable recreational catch (TARC) of 40 t.

The fishing season in the Northern and Southern Zones extends from 1 October to 15 May. The West Coast Zone is only open for 6 Sundays annually, commencing on the first Sunday in November, and the daily allowed fishing time is 60 minutes (between 7.00 a.m. and 8.00 a.m.). Prior to 2006, daily fishing time was 90 minutes.

These restrictive management controls on the west coast are necessary to ensure the sustainability of an easily accessible (and therefore vulnerable) stock located adjacent to a population in excess of 1.6 million people (including Geraldton).

For Roe's abalone, the minimum legal size is 60 mm shell length, the daily bag limit is 20 per fisher, and the household possession limit (the maximum number that may be stored at a person's permanent place of residence) is 80.

Research summary

Commercial

Commercial abalone divers provide daily catch information on the total weight of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. These data are used to assist in research, compliance and management matters.

The main abundance index is an annual standardized catch per unit effort (CPUE) model that takes into account diver, sub-area and month of fishing, as well as technological improvements that aid fishing efficiency. The standardized CPUE data are used in a decision-rule framework for quota setting for each area of the fishery.

Current research is focused on stock assessment using catch and effort statistics, fishery-independent surveys of Perth metropolitan stocks, and digital video imagery (DVI) surveys by industry divers, who survey selected sites with an underwater video camera. Size and density of Roe's abalone across the near-shore sub-tidal reef habitat is measured annually at 11 indicator sites between Mindarie Keys and Penguin Island. Nine of these are fished while the other 2 are the Waterman's Reserve Marine Protected Area (MPA), and the Cottesloe Fish Habitat Protection Zone.

Recreational

Current annual recreational catch and effort estimates are derived from an annual field survey (West Coast Zone / Perth metropolitan fishery), and an occasional telephone diary survey covering the entire state (2007 was the last year of a state-wide survey).

The field survey estimates the catch and effort from each distinct Roe's abalone stock within the Perth fishery, and estimates are based on average catch (weight and numbers), catch rates (derived from 1,100 interviews in 2009), and fisher counts conducted by Fisheries Volunteers and research

personnel from shoreline vantage points and aerial surveys. This method provides a comprehensive assessment, but is too resource-intensive to be applied routinely outside of the Perth metropolitan area.

The telephone diary survey estimates the catch of all 3 species on a state-wide basis, however is not completed every year. In 2007, around 500 licence holders were randomly selected from the licensing database, with selection stratified by licence type (abalone or umbrella) and respondent location (country or Perth metropolitan area). The licence holders were sent a diary to record their fishing activity and were contacted every 3 months by telephone for the duration of the abalone season, or at the end of the season for those only involved in the Perth abalone season.

Retained Species

Commercial production

Season 2009: 92.8 tonnes whole weight

Metro only: 36 tonnes whole weight

The TACC for the 2009 quota year was 101.8 t whole weight for Roe's abalone. The 2009 catch of 92.8 t whole weight (Roe's Abalone Table 1) was similar to 2008 and about 90% of the TACC. The overall TACC was not caught because Area 1 of the fishery (Roe's Abalone Figure 1) was not fished in 2009, and catches in Area 5 were below the TACC (80% of TACC caught) due to unfavourable weather. Total TACC is not usually caught in this fishery because of weather-related issues in the marginal regions (Area 1 and Area 8) of the fishery.

Recreational catch

Season 2009: Roe's Metro Fishery 48.6 tonnes

**(Season 2007): Roe's rest of state 14 tonnes
(40% of total catch)**

The recreational catch for Roe's abalone from the Perth metropolitan area in 2009 was 48.6 t (Roe's Abalone Table 2). This is an increase of about 10% from 2008 and the highest catch weight since this time series was started in 1999. The higher catch resulted from a combination of good weather conditions, a 5% increase in license numbers (Roe's Abalone Figure 3), and discontinuation of daylight savings resulting in the fishery start time being shifted backward by one hour, with the resultant increase in light and temperature attracting more fishers.

Based on the Perth recreational fishery for 2009 (49 t), and using the 2007 phone diary estimate for the rest of the state (14 t), recreational fishing represented about 40% of the total (commercial and recreational) Roe's abalone catch (155 t) across the state in 2009.

Fishing effort/access level

Commercial

Total effort for dedicated Roe's abalone divers in 2009 was 554 diver days (lower than last year's effort of 585 diver days) and is the lowest effort on record (Roe's Abalone Table 1). The low effort in recent years is a combination of high

abundance, lower quota being set and improved fishing efficiency. For example, the use of Internet weather prediction services to plan the fishing schedule has resulted in fishing efficiency increases of between 10 and 17%.¹

Recreational

For the 2009 season, around 26,000 licences were issued. This was a 5% increase over the 2008 figure of 24,500 licenses (Roe's Abalone Figure 3). Overall license numbers were stable for 6 years between 2001 and 2006, but have increased by 21% in the last 3 years (Roe's Abalone Figure 3).

Effort in the Perth fishery for 2009 was 19,718 hours, a 36% increase on 2008 effort of 14,490 hours (Roe's Abalone Table 2). Overall, effort has increased almost 100% between 2006 and 2009 and reflects a combination of improved weather conditions for fishing, and increasing license numbers. Since 2006, daily season length has been shortened from 1.5 hours to 1 hour and although this initially affected catch, it has had a negligible longer-term impact, with effort in 2009 being the highest for over 10 years (Roe's Abalone Table 2).

Effort estimates for recreational abalone fishing from the 2007 telephone diary survey were 13,400 days (10,500 – 16,200 days) in the Perth metropolitan area, 6,300 days (3,800 – 8,800 days) on the west coast (excluding the Perth metropolitan area), and 4,900 days (1,700 – 8,000 days) on the south coast (Roe's Abalone Table 3).

Stock Assessment

Assessment complete: Yes

Assessment method: Catch Rates / Direct Survey

Breeding stock levels: Adequate

CPUE and TACC assessment: The commercial divers' catch rates are the principal indicator of the abundance of legal-sized abalone and are assessed annually. As a result of a recent review¹, the standardised CPUE (SCPUE) for the roe's abalone fishery is now the principal indicator of the abundance of legal-sized abalone. This indicator replaces the raw CPUE data used in previous state of the fisheries reports, however the raw CPUE data has been retained for comparative purposes this year.

The SCPUE for dedicated Roe's abalone divers in 2009 was 29.0 kg/hr, which was similar to the 2008 catch rate of 28.6 kg/hr (Roe's Abalone Table 1) and the long-term average catch rate which is 29 kg/hr. This suggests that, overall, stocks are at average levels. However, market preferences for large-sized abalone have impacted on Area 8, where only a limited area of habitat is able to produce large-sized animals, therefore the TACC has been maintained at the reduced level of 9 t in 2010 and 2009. Also, the exploratory quota in Area 1

(previously 9.9 t) has been reduced to 5 t in 2009 because environmental factors (loss of habitat due to sand encroachment) continue to reduce the available stock. These changes, coupled with average overall stock levels, have resulted in maintenance of the lower TACC of 101.8 t for 2010 (Roe's Abalone Table 1).

The catch rate of recreational fishers in the Perth metropolitan fishery of 27 abalone/hour in 2009 was 5% lower than the 2008 catch rates (Roe's Abalone Table 2). This is most likely due to a slightly lower abundance and higher overall catch.

Stock surveys: Densities of sub-legal animals (less than 60mm in size) on the platform habitat of the fished stocks increased from 51 in 2009 to 54 abalone m⁻² in 2010 (Roe's Abalone Table 4). This is the highest level since surveys began in 1997, and was primarily due to increases in 0+ (1 - 16 mm) and 1+ (17 - 32 mm) animals, which relates to higher settlement levels in 2008 and 2009. These animals will reach legal size in three to four years time. On the subtidal habitat, densities of sub-legal animals increased from 9.4 to 11.3 abalone m⁻², which is also the highest density since the survey began in 1997.

Densities of legal-sized animals (60+ mm) on the platform habitat were slightly lower in 2010 (17 m⁻²), compared to 19 m⁻² in 2009 (Roe's Abalone Table 4), and are at their lowest levels in 10 years. This reflects the large recreational catch of 44 and 49 t in 2008 and 2009 respectively.

In the subtidal habitat, legal-sized densities were 16 abalone m⁻² in 2009, slightly higher than 2008, and are the highest level recorded (Roe's Abalone Table 4). With the increased abundance of sub-legal animals from 2008 to 2010, densities of legal-sized animals are expected to increase in the next two to four years.

Densities of legal-sized Roe's abalone in the MPA (Marine Protected Area) are about 90% higher on the platform habitat, compared with the fished stocks (Roe's Abalone Table 4). However, the difference is less evident for sub-tidal stocks. On average, densities of legal-sized Roe's abalone in subtidal stocks are about 70% higher in the MPA. For sub-legal animals, densities are, on average, 40% higher in the MPA.

Breeding stocks: Size at sexual maturity (50% of animals mature) of Roe's abalone in the Perth metropolitan area is approximately 40 mm (2 to 3 years of age). Preliminary growth data for these same metropolitan Roe's abalone indicate that they have a minimum of 1 year's spawning before reaching 60 mm – the minimum legal size at which Roe's abalone are harvested anywhere in Western Australia.

This is considered to provide adequate protection for the breeding stock under normal environmental conditions, especially since the commercial fishery's legal minimum size in Area 7 (the Perth metropolitan area) is 70 mm – which is 10 mm larger than that used by the recreational sector. In Area 1, the commercial fishery's legal minimum length is 75 mm.

¹ Hart A, Fabris F, Caputi C (2009). Performance indicators, biological reference points and decision rules for Western Australian abalone fisheries (*Haliotis* sp.): (1) Standardised catch per unit effort. Fisheries Research Report No. 185. Department of Fisheries, Western Australia. 32p.

The main performance measure for the fishery relates to the maintenance of adequate breeding stocks in each area of the fishery. This is assessed using a combination of the level of quota achieved and the effort required to achieve the quota, both of which reflect stock abundance.

In 2009, catch and standardised CPUE were within the agreed ranges in all areas fished, indicating that overall breeding stock levels were adequate (Roe's Abalone Table 5). Adverse weather conditions limited the fishing in the remote Area 1 and, to a lesser extent, in Area 5 (80% of TAC caught).

Non-Retained Species

Bycatch species impact: **Negligible**

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

Protected species interaction: **Negligible**

The only potential protected species interaction in this fishery would be with the great white shark (*Carcharodon carcharias*) while fishing in some of the more open-water locations. Some Roe's abalone divers are adopting the 'shark shield' technology generally used by greenlip/brownlip divers for their personal protection.

Ecosystem Effects

Food chain effects: **Negligible**

Commercial abalone diving occurs over a small proportion of the total abalone habitat of the Western Australian coastline. In view of the relatively low exploitation rates and consequent maintenance of a high proportion of the natural biomass of abalone, it is considered unlikely that the fishery has any significant effect on the food chain in the region.

Habitat effects: **Negligible**

The fishing activity makes minimal contact with the habitat, which typically consists of hard rock surfaces in a high wave energy environment. As abalone feed on drift algae, their removal is unlikely to result in any changes to the algal growth cover in areas fished.

Social Effects

There are 26 vessels commercially fishing for Roe's abalone, employing approximately 50 people across WA. The dispersed nature of the Roe's abalone fishery means that small coastal towns from Kalbarri to Eucla receive income from the activity of divers.

Around 26,000 licences were issued that would have allowed fishers to participate in the recreational abalone fishery (Roe's Abalone Figure 4). The recreational fishery provides a major social benefit to those sectors of the community that appreciate the abalone as a delicacy.

Economic Effects

Estimated annual value (to commercial fishers)

for 2009: \$2.3 million

The estimated average price for Roe's abalone in 2009 was \$24.50/kg, a decrease from \$26/kg in 2008. On the basis of the average price, the fishery was worth approximately \$2.3 million – a decrease from the 2008 value of \$2.6 million. Overall, the price of Roe's abalone has dropped by over 50% since 2000, when it was \$55/kg whole weight. This is due to the value of the Australian dollar, which increased from \$US0.58 in 2000 to >US\$0.90 in mid-2008, although dropped back to \$US0.7 to \$US0.8 in the later part of 2008. In 2009, the value of the Australian dollar increased again to be primarily above US\$0.90. The other factor in the decline in prices is competition from abalone produced by aquaculture.

Fishery Governance

Commercial Target SCPUE range:

28 – 33 kg per hour (all areas combined)

Target effort range: 620 – 750 diver days

In 2009, as a result of a review of performance indicators in abalone fisheries¹, a new governance range was developed for the roe's abalone fishery, based on standardised CPUE (SCPUE). This replaces the old governance range based on effort in diver days fished, which has been retained for comparative purposes.

To assess whether the catch quota set is appropriate (sustainable) relative to the stock available, Roe's abalone catches should be taken within the range of SCPUE recorded over the 1999 – 2006 fishing years (28 – 33 kg per hour; Roes Abalone Table 1). This range reflects the acceptable variation in catch rates due to weather and recruitment cycles. Roes Abalone Table 5 shows performance measures of each individual ar

The old governance range of 620 – 750 diver days (also from 1999 – 2006) does not account for changes in fishing efficiency, which are now incorporated into the SCPUE calculations. Consequently, the effort value of 554 diver days in 2009 (Roes Abalone Table 1) falls below the expected effort range, suggesting stocks are at historically high levels. However this is not the case, stocks are at average levels.

Recreational (West Coast)

Target Catch range: 35 – 45 tonnes

In 2009, as a result of the introduction of a Total Allowable Recreational catch (TARC) in the West Coast zone of 40 tonnes, a new governance range based on total catch was developed. This range takes in the permitted maximum variations of ± 5t around the 40 t catch.

The 2009 west coast recreational roe's abalone catch of 48.6 t was above the governance range of 35 – 45 tonnes. Consequently, a reduction in the number of fishing days from 6 to 5 has been proposed for the 2010 season, in order to keep the 5-year moving average at 40 tonnes.

New management initiatives (2009/10)

Following an examination of the Roe's abalone fishery by the Integrated Fisheries Allocation Advisory Committee a Total Allowable Recreational catch (TARC) of 40 tonnes was introduced for the West Coast Zone in January 2009.

Management of this TARC will involve monitoring the 5-year moving average of the estimated catch, with adjustments to fishing rules (e.g. number of days) to ensure the 40 t TARC is maintained. In practice, this is likely to involve maximum variations of $\pm 5t$ around the 40 t catch.

A working group was also set up in July 2009 to examine the future management arrangements for this fishery.

External Factors

The main external factor influencing the Roe's commercial abalone fishery has been the decline in beach price and overall economic value. The small size of Roe's abalone means that, as a fishery product, it is in direct competition with small hatchery-produced greenlip abalone. In the recreational fishery, weather conditions have a significant effect on catch rates and total catch of recreational fishers.

ROE'S ABALONE TABLE 1

Roe's abalone catch and effort¹ by quota period with raw and standardised catch per unit effort (SCPUE)

Quota period ²	Roe's TACC kg whole weight ³	Roe's caught kg whole weight	Diver days ⁴ (Roe's divers only)	Raw CPUE (roei divers) kg per day)	SCPUE (kg per hour)
1990	105,000	116,447	936	112	
1991	101,000	109,489	832	118	
1992	105,000	111,341	735	134	27.3
1993	128,000	115,281	832	123	29.4
1994	125,960	117,835	908	113	27.7
1995	125,960	114,501	1,047	98	25.5
1996	125,960	118,715	1,004	106	28.8
1997	126,790	118,738	855	120	30.2
1998	93,960 ⁵	86,425	695	108	27.9
1999 ⁶	119,900	112,949	659	149	29.5
2000	115,900	107,735	647	144	28.7
2001	107,900	99,174	685	126	30.0
2002	107,900	100,471	700	125	28.6
2003	110,900	96,005	723	118	29.0
2004	110,900	107,593	736	126	28.0
2005	112,700	96,496	672	131	31.3
2006	112,700	98,370	625	136	33.2
2007	109,700	90,750	585	142	28.5
2008	106,700	93,197	580	143	28.6
2009	101,800	92,838	554	152	29.0
2010	101,800				

Notes

1. Data source: quota returns.
2. The length of quota period has varied with management changes and, for simplicity, has been recorded against the nearest calendar year.
3. Standard conversion factors for meat weight to whole weight for Roe's abalone were 2.5 prior to 2000 and 3.0 from 2000.
4. Effort (diver days) for dedicated Roe's divers only.
5. Reduced quota for a 6-month season.
6. In 1999, fishing restrictions (100 kg daily catch limit) in the Perth metropolitan area were lifted. This had the immediate effect of doubling the catch rate (kg/day) in that area.

WEST COAST BIOREGION

ROE'S ABALONE TABLE 2

Summary of effort (fisher hours), catch rate (abalone per hour), average catch per fisher, catch (number of abalone and tonnes whole weight) and mean whole weight (g) for the Perth recreational Roe's abalone fishery, from annual field surveys.

Year	Field Survey					Mean weight (g)
	Effort (hours)	Catch rate	Catch per fisher	Catch (number)	Catch (tonnes)	
1999	16,449	23	17.4	383,600	35.3	92
2000	15,818	21	16.7	330,300	30.2	91
2001	17,727	27	18.8	481,300	44.1	92
2002	18,127	22	17.9	401,500	36.0	90
2003	17,963	26	18.6	442,400	42.6	96
2004	14,614	24	19.0	342,900	31.7	93
2005	12,328	21	17.8	262,700	24.3	92
2006	10,435	29	18.9	297,000	30.2	101
2007	12,433	28	18.4	338,000	34.4	102
2008	14,490	29	18.2	420,000	44.4	106
2009	19,718	27	17.8	517,000	48.6	94

ROE'S ABALONE TABLE 3

Summary of telephone diary surveys of effort (fisher days), catch rate (abalone per fisher day) and catch (tonnes whole weight) for the Roe's abalone recreational fisheries in 2004, 2006, and 2007.

Location	Year	Effort	Roe's	
			Catch Rate	Catch (tonnes)
Perth Metro ¹	2004	17,200 (14,000 – 20,500)	17.8	28 (25 – 31)
	2006	12,600 (9,900 – 15,500)	18.2	23 (20 – 26)
	2007	13,400 (10,500 – 16,200)	17.6	24 (19 – 29)
West Coast ¹ (excluding Metro)	2004	10,100 (6,500 – 13,600)	11.0	10 (7 – 14)
	2006	8,000 (4,700 – 11,300)	14.7	12 (7 – 17)
	2007	6,300 (3,800 – 8,800)	14.1	9 (6 – 12)
South Coast ²	2004	2,700 (1,700 – 3,700)	6.2	2 (1 – 3)
	2006	2,800 (1,600 – 3,900)	6.3	2 (1 – 2)
	2007	4,900 (1,700 – 8,000)	10.8	5 (1 – 9)

1. Both areas are within the West Coast bioregion.

2. Survey area is South Coast bioregion (i.e. east of Black Point).

ROE'S ABALONE TABLE 4

Mean densities (abalone/m²) of sub-legal (<60 mm shell length) and legal-sized Roe's abalone (60 mm and over) from 9 monitoring sites (fished stocks) and the Marine Protected Area (MPA) in the Perth fishery. The platform habitat is primarily the recreational fishery, while the sub-tidal habitat is primarily the commercial fishery. Data has been standardised by a GLM (Generalized Linear Models) analysis, as the sites are not the same for all years.

Year	Platform habitat				Sub-tidal habitat			
	Fished stocks		Waterman's Reserve (MPA)		Fished stocks		Waterman's Reserve (MPA)	
	<60	60+	<60	60+	<60	60+	<60	60+
1997	32	29	44	26	4.2	12	9	21
1998	42	27	51	37	5.2	13	11	29
1999	47	26	52	26	3.8	7	12	27
2000	45	24	29	35	2.7	10	8	31
2001	44	25	38	34	3.7	10	8	28
2002	35	27	42	39	3.2	10	7	31
2003	29	24	36	41	4.5	11	4	25
2004	31	21	33	52	3.8	9	5	20
2005	32	20	43	39	5.0	9	9	22
2006	33	19	49	38	6.8	9	6	20
2007	35	19	42	35	5.6	11	7	23
2008	42	21	69	37	7.2	15	7	19
2009	51	19	67	38	9.4	15	11	24
2010	54	17	77	32	11.3	16	8	23

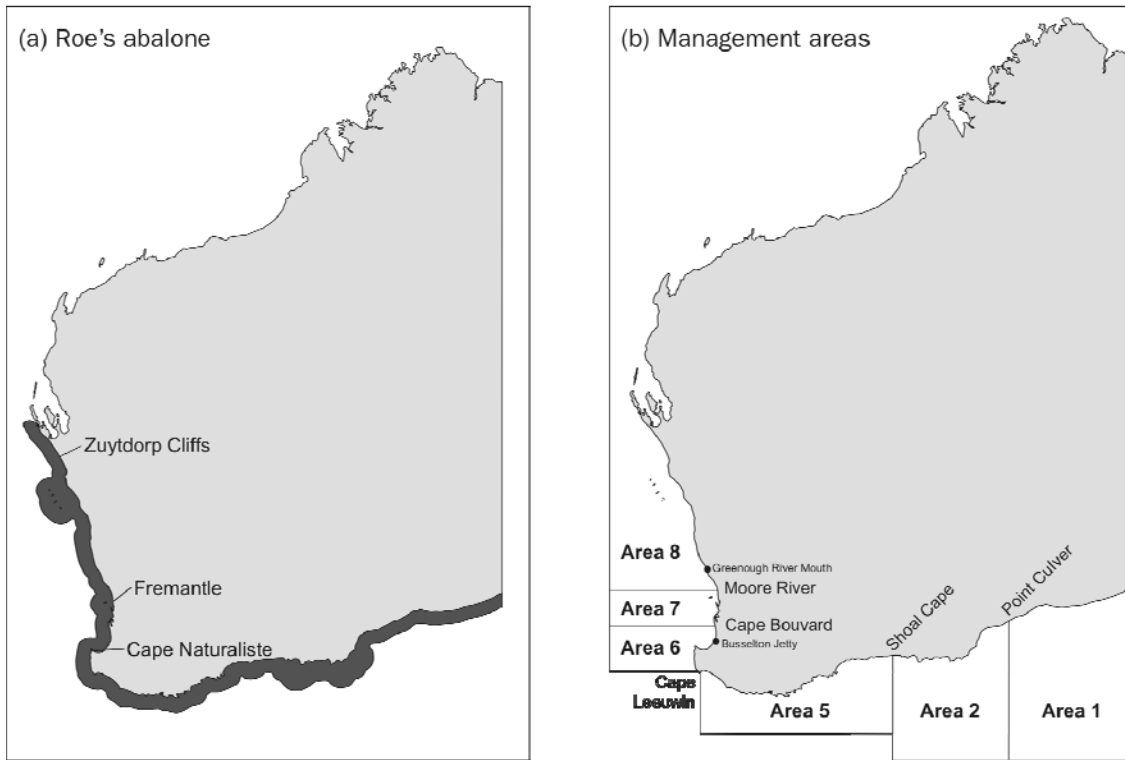
ROE'S ABALONE TABLE 5

Assessment against agreed performance measures for 2009.

Performance Indicator	Performance Measure ¹	2009 Values	Assessment/Comments
Area 1			
Total catch (TACC)	5,500 kg	0	Exploratory quota – no fishing in 2009.
Effort range (Diver days)	14 – 43	0	See above.
Area 2			
Total catch (TACC)	19,800 kg	19,770	Met – 99.9% of quota caught.
Standardised CPUE	20 – 31	25	Met – within agreed ranges.
Area 5			
Total catch (TACC)	20,000kg	16,077	Met – 80% of quota caught.
Standardised CPUE	18 – 27	23	Met – within agreed ranges.
Area 6			
Total catch (TACC)	12,000 kg	12,000	Met – 100% of quota caught.
Standardised CPUE	18 – 26	21	Met – within agreed ranges.
Area 7			
Total catch (TACC)	36,000 kg	35,996	Met – 99.9% of quota caught.
Standardised CPUE	28 – 42	39	Met – within agreed ranges.
Area 8			
Total catch (TACC)	9,000 kg	8,995	Met – 99.9% of quota caught.
Standardised CPUE	16 – 24	19	Met – within agreed ranges

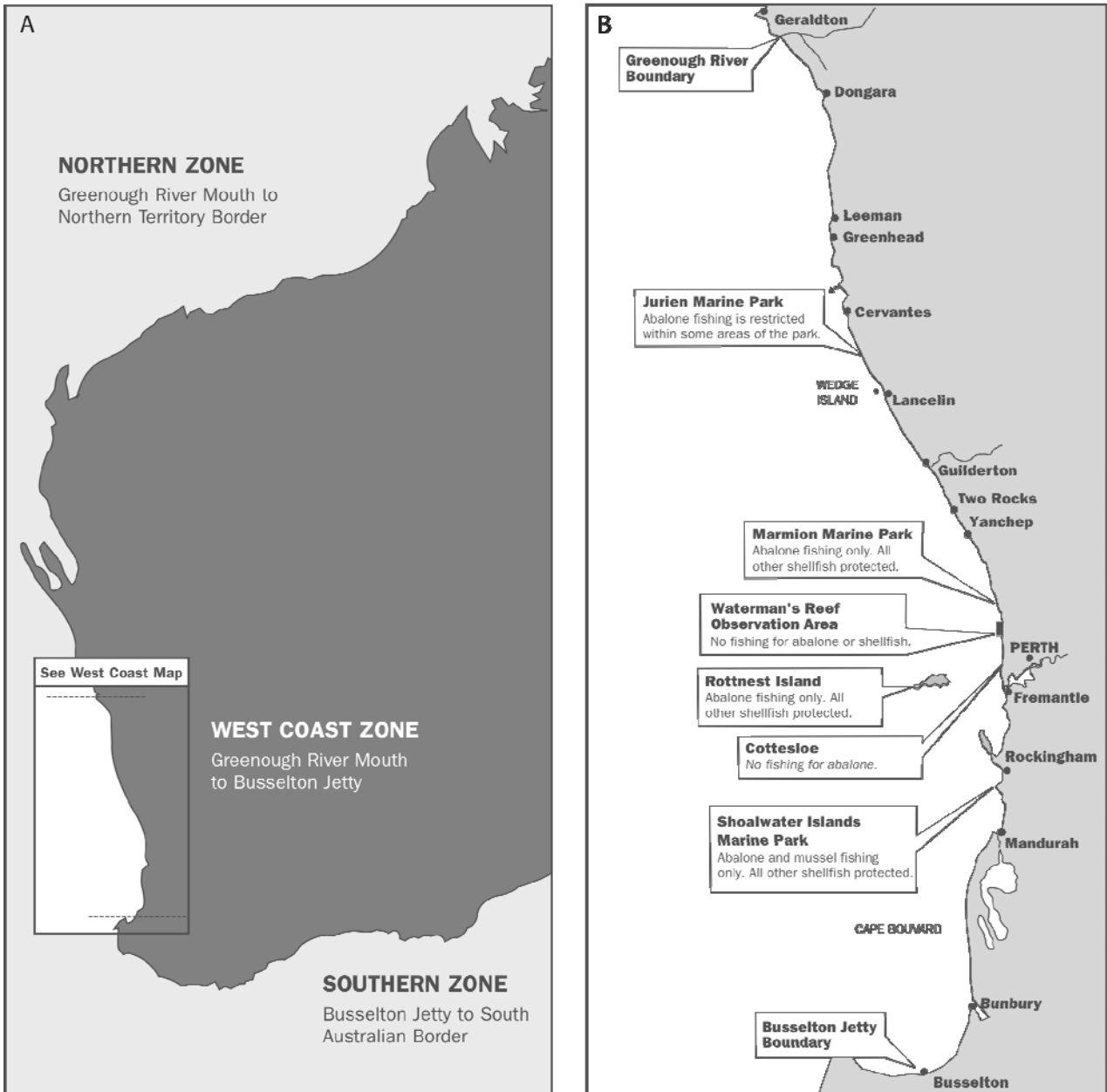
1. With the exception of Area 1, the standardised CPUE (SCPUE) performance measure replaces the effort ranges (in diver days) used in previous state of the fisheries reports. The range in SCPUE represents the Target (upper) and Limit (lower) biological reference points as developed in the following document. Hart A, Fabris F, Caputi C (2009). Performance indicators, biological reference points and decision rules for Western Australian abalone fisheries (*Haliotis* sp.): (1) Standardised catch per unit effort. Fisheries Research Report No. 185. Department of Fisheries, Western Australia. 32p.

WEST COAST BIOREGION



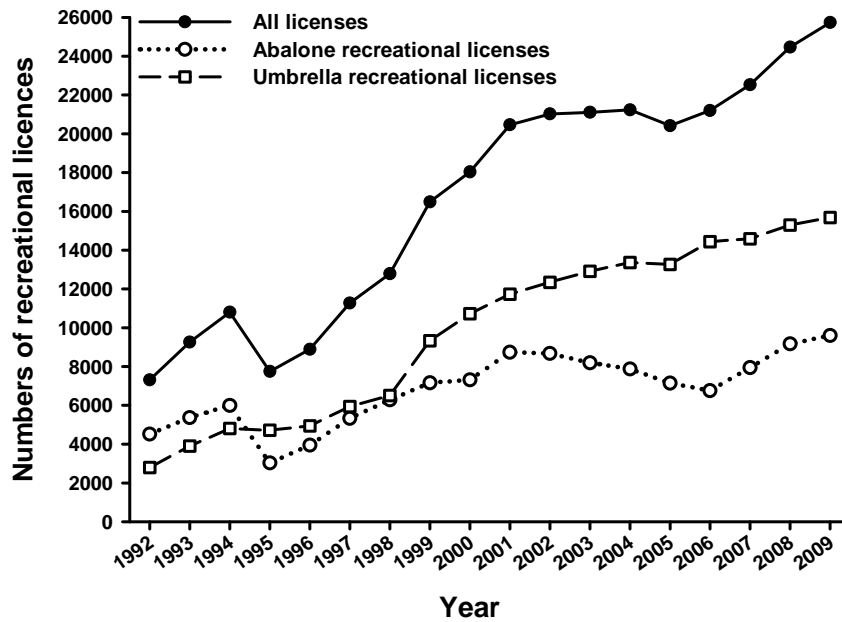
ROE'S ABALONE FIGURE 1

Maps showing (a) the distribution of Roe's abalone in Western Australia, and (b) the management areas used to set quotas for the commercial fishery.



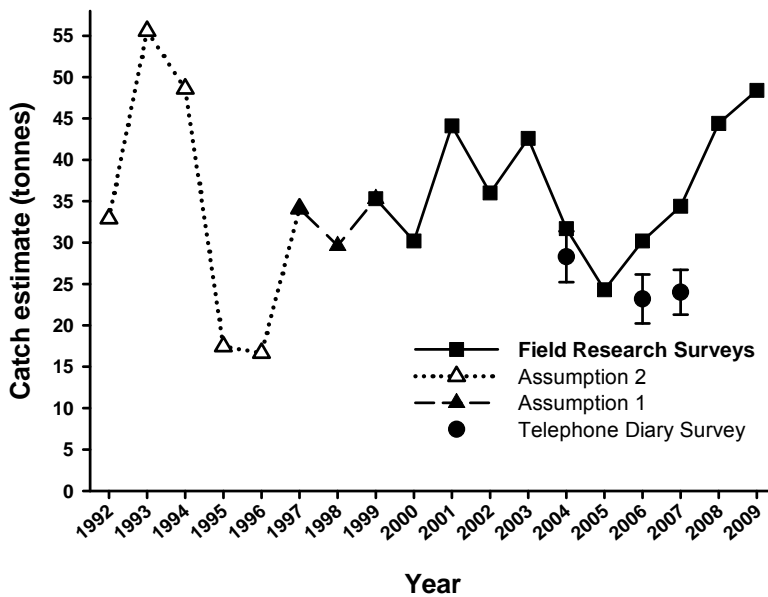
ROE'S ABALONE FIGURE 2

Maps showing (a) the recreational fishing boundaries for abalone, and (b) the West Coast (Perth Fishery) zone, showing conservation areas within this zone.



ROE'S ABALONE FIGURE 3

The number of licences issued in the recreational abalone fishery, by licence type, for the period 1992 to 2008.



ROE'S ABALONE FIGURE 4

Catch estimates for the Perth recreational abalone fishery for the period 1992 to 2008, including backwards projections through time, based on two assumptions. Error bars are SE.

Assumption 1: assumes that the mean weight of abalone taken during 1997 and 1998 is equal to the average of the 2 mean weight values measured for 1999 and 2000 (i.e. 91.6 g, averaged from 92 g in 1999 and 91.3 g in 2000). Numbers caught are estimated using the field survey technique (Roe's Abalone Table 2).

Assumption 2: assumes that effort from 1992 to 1996 is the average percentage of the potential effort utilised for the years 1997 to 2000; that the catch rate for the years 1992 to 1996 is the average of the annual catch rates for the years 1997 to 2000; and that the mean weight of abalone taken from 1992 to 1996 is the same as applied to 1997 and 1998 in Assumption 1.

Note that the recreational season totalled 16 days in 1993, 12 days in 1992 and 1994, 5 days in 1996 and 6 days in 1995 and 1997 – 2006. In 1992 – 1994, fishing was permitted for 2 hours per season day (7 a.m. to 9 a.m., Saturdays and Sundays). From 1995 – 2005, permissible fishing time per season day was 1.5 hours (7 a.m. to 8.30 a.m., Sundays only). In 2006 - 2009, permissible fishing time per season day was 1 hour.

Abrolhos Islands and Mid West, South West Trawl Managed Fisheries and South Coast Trawl Fishery Status Report

M Kangas, E. Sporer and S. Brown

Management input from R Gould

Main Features

Status		Current Landings	
Stock level	Acceptable	AIMWTMF:	Scallops 0 t (whole weight)
		SWTMF:	Scallops 21 t (whole weight)
Fishing level	Acceptable		Prawns 7 t
		SCTF:	Scallops, 71 t (whole weight)

Fishery Description

The Abrolhos Islands and Mid West Trawl Managed Fishery (AIMWTMF) is based on the take of saucer scallops (*Amusium balloti*), with a small component targeting the western king prawn (*Penaeus latisulcatus*) in the Port Gregory area.

The South West Trawl (SWTMF) Fishery includes two of the State's smaller scallop fishing grounds – Fremantle and north of Geographe Bay. It is a multi-species fishery.

The South Coast Trawl Fishery (SCTF) principally targets scallops (*Amusium balloti*) and associated by-products, although in years of low scallop catches licensees have an option to use other trawl gear to target fish species. Scallop landings for the fishery have varied dramatically over the years, depending primarily on the strength of recruitment. While the managed fishery area covers a large section of the coastal waters, the operations of the fleet are effectively restricted to very small areas of higher scallop abundance.

Each of these fisheries operates using low opening otter trawl systems.

Governing legislation/ fishing authority

Abrolhos Islands and Mid West Trawl Management Plan 1993

Abrolhos Islands and Mid West Trawl Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption) for AIMWTMF.

South West Trawl Management Plan 1989

South West Trawl Managed Fishery Licence (MFL)

Trawling Prohibition (Whole of State) Notice 1992 (Order)

Surface Trawl Net Fishery (South Coast) Notice 1992

Trawling for Scallops (South Coast) Notice 1992

Condition 73 and/or 79 on Fishing Boat Licences

Consultation process

Meetings between the Department of Fisheries and industry.

Boundaries

AIMWTMF: *'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'*.

SWTMF: *'all the waters of the Indian Ocean adjacent to Western Australia between 31°43.38'27" south latitude and 115°08.08' 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 MFL's)
Zone B	from 32°16' S to 115°08' E	(12 MFL's)
Zone C	north-east of Cape Naturaliste	(0 MFL's)
		Closed to trawling)
Zone D	Comet Bay off Mandurah	(3 MFL's)

SCTF: Off the south coast of Western Australia in state waters east of 115° E longitude (Cape Leeuwin, Condition 73). Condition 79 provides for the use of demersal trawl nets for taking scallops within the Recherche Archipelago. Four fishing boat licences have both conditions.

Management arrangements

The AIMWTF operates under an input control system, with 15 licences (after one licence was removed via a Fishery Adjustment Scheme in 2009), a maximum total net headrope capacity restriction, specified net mesh size, along with seasonal closures and significant spatial closures protecting all near-shore waters and sensitive reef areas. Bycatch reduction devices (grids) to release large species are fully

WEST COAST BIOREGION

implemented in the AIMWTF as a licence condition. The fishery operates to a catch rate threshold level of 250kg meat weight per 24 hours trawling to cease fishing but given low stock levels and meat weights there was no fishing in 2009 (see research summary for details).

The SWTMF is a gear based rather than a managed fishery which operates under an input control system that limits boat numbers, gear sizes and fishing areas. There is a total of 14 MFLs operating in this fishery, some in more than one zone. The fishing season operates between 1 January and 15 November in Zones A and B. Zone D season is open to fishing all-year-round and access to Zone C ceased in 2002. The management plan also includes large closures to protect sensitive coastal habitats (including seagrass beds) and nursery areas such as Cockburn Sound, Warnbro Sound and inshore Geographe Bay.

The SCTF is managed primarily under an input control system with 4 licences to operate in the fishery. There are also seasonal closed areas in specified parts of the fishery.

The Departments' vessel monitoring system (VMS) monitors the activities of all boats including compliance with the spatial closures.

The Australian Government Department of Environment, Water, Heritage and the Arts has assessed the AIMWT fishery under the provisions of the Environment Protection and Biodiversity Conservation Act 1999 and has accredited the fishery for a period of five years, allowing product from the fishery to be exported from Australia. The comprehensive Ecological Sustainable Development assessment of this fishery identified that maintaining an acceptable breeding stock level of the target scallop species was the key performance indicator for the fishery. Boxed text in this status report provides the annual assessment of performance against this indicator for this issue.

Research summary

Research monitoring of the scallop stocks for all fisheries is undertaken using daily logbooks. The logbooks are validated by processor returns. In the AIMWTF these, together with an annual pre-season survey, provide the information required for assessing the fishery. Advice on the status of stocks and appropriate season opening and closing dates is provided to industry.

During the previous (2008) season it was reported that one area (the "Wallabi area") had small size scallop shell generating small size and poor quality meat during the period when these should be near optimum. Consequently, the predicted catch level for the 2008 season was not reached. In consultation with industry it was decided that it would be essential to undertake scallop sampling before the 2009 season commenced to enable an assessment of scallop meat size and quality before industry commenced fishing. The first of these surveys was undertaken in February 2009 which identified poor meat quality and small size, which when combined with the relatively low catch prediction industry determined that there would be no value or profit initiating fishing operations in 2009. Three additional surveys were undertaken in 2009 (May, July and August). The poor meat size and condition of scallop persisted so fishing did not begin all during the 2009 season.

Retained Species

Commercial landings (season 2009)

AIMWTF:	Scallops, no fishing
SWTMF:	Prawns 7 tonnes Scallops 21 tonnes whole weight Fish 3 tonnes
SCTF:	Scallops, 71 tonnes whole weight

AIMWTF

No scallop landings were recorded for the 2009 season in this fishery as no fishing was undertaken due to small meat size and poor quality of scallops and the moderately low catch prediction (350-500 t whole weight) (West and South Coast Scallop Figure 1).

SWTMF

The total recorded landings for this fishery were separated into invertebrate and fish species. Included in the invertebrate landings are 7 t of western king prawns, 21 t of scallops (whole weight) and 2 t of crabs (*Portunus pelagicus*). The catch of king prawns was low but in line with low catches since 2006. The decline in prawn catches is in part due to low effort. The reported scallop landings show an increase compared to recent years (since 2004) and a return to normal scallop landings seen since 1993.

Observations by fishers indicate improved recruitment with an expected increase in catches for the 2010 season. The fishery also retains a mixture of fish species of which the most abundant species recorded was 2 t of whiting. All other landings of fish species were less than 1 t each.

SCTF

The scallop catch was 71 tonnes (whole weight) which was higher than last year's catch of 23 t. There is generally low effort expended in the fishery and variable recruitment (West and South Coast Scallop Figure 2). By-product species landings were negligible.

Recreational catch:

Nil

Fishing effort/access level

AIMWTF

No fishing occurred in the AIMWTF in 2009 (see research summary for details).

SWTMF

A total of 125 days were fished in the SWTMF (all zones) which is similar to last year. There are 14 boats licensed to fish in this fishery but not all boats actively fish. The low level of effort reflects the marginal fishing economics and viability of boats.

SCTF

The annual effort expended in the SCTF is mostly affected by scallop recruitment levels. Exploratory fishing is undertaken by skipper(s) to estimate stock abundance of scallops and to assess if it is economically viable to continue fishing. As a consequence, the level of effort utilised each year closely follows stock abundance and catch levels. For the 2009 season only two boats fished for scallops between January and October recording a total of 111 scallop fishing days.

Stock Assessment

Assessment complete:

AIMWTMF:	Yes
SWTMF and SCTF:	Not assessed

Assessment method:

AIMWTMF:	Direct survey, catch rate
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Breeding stock levels:

AIMWTMF:	Adequate
SWTMF and SCTF:	Not assessed

Projected catch range next season (2010)

AIMWTMF:	Scallops 1400 – 2150 tonnes
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The annual fishing season arrangements in the AIMWTMF are set so that the majority of the mature scallops are able to spawn before fishing occurs. Breeding stocks are therefore protected to ensure that recruitment is dependent only on environmental conditions each year. Because this fishery was not opened for fishing in 2009 due to low predicted scallop abundance, small size and poor quality meat all the stock would have contributed to the breeding stock.

This fishery is highly variable, being dependent on sporadic recruitment, which appears to be strongly influenced by environmental conditions, e.g. the Leeuwin Current. A pre-season survey is undertaken annually. The survey index provided a catch prediction of 1775 tonnes whole weight providing a catch range 1400 to 2150 tonnes whole weight for the 2010 season.

Non-Retained Species

Bycatch species impact:	Low
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The AIMWTF trawl fleet operates over a small portion of the licensed fishing area, focusing on scallop aggregations in several different areas or fish grounds and fishing activity is dependent on how widespread settlement is each season. Scallops settle on relatively bare sand habitats. In 2009, no fishing occurred.

In the SWTMF trawling for scallops is focused on a few small offshore areas, while the prawn catch is mainly taken from Comet Bay. An extensive study (Laurenson et al. 1993,¹) of the environmental effects of this fishery has shown that the fishery has minimal impact on bycatch species' populations.

The large-mesh (100 mm) trawl gear used in the SCTF takes minimal bycatch. The areas trawled by the boats also

represent a very small percentage of the fishing area within the legislated boundary, therefore bycatch species impact is considered to be minimal.

Protected species interaction:	Low
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While turtles do occur in the Abrolhos Islands, these species are towards the southern extent of their range, and do not breed in the Abrolhos Islands area because water temperatures are too low. Consequently, interactions with turtles were always minimal and now that grids are compulsory in the fishery, their capture should be negligible.

Few other protected species occur in this area. For the SWTMF and SCTF protected species that are susceptible to capture by trawling do not occur regularly in the fishing areas.

Ecosystem Effects

Food chain effects:	Low
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The total biomass taken by these fisheries is generally very small. Moreover, due to the high natural variability of scallop stock abundance it is unlikely that any predators are highly dependent on this species.

Habitat effects:	Low
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The fishers generally operate over a very small proportion of the licensed area and therefore the total area impacted by trawling is small. Trawling is not extensive and confined to trawl grounds where fishable scallop abundance is significant.

The areas associated with scallops are sandy habitats and trawling activity does not impact these significantly.

The main performance measure for the AIMWTF fishery relates to maintaining breeding stocks of scallops. This is done in two ways; by setting the season fishing period according to the catch prediction and by closing the fishery at a threshold catch rate level. No fishing took place in 2009 due to small meat size and meat quality and predicted very low catches.

The fishery therefore met this performance measure.

Social Effects

The estimated employment for the year 2009 was nine in the SWTMF and 10 in the SCTF.

¹ Laurenson, L.J.B., Unsworth, P., Penn, J.W. and Lenanton, R.C.J. 1993b. The impact of trawling for saucer scallops and western king prawns on the benthic communities in coastal waters off south-western Australia. Fisheries Research Report No. 100, Fisheries WA.

WEST COAST BIOREGION

Economic Effects

Estimated annual value (to fishers) for year 2009:

AIMWTMF	Nil
SWTMF:	\$0.2 million
SCTF:	\$0.3 million

For the SWTMF and the SCTF the estimated value of the scallop catch is based on wholesale price per kilogram obtained from these fisheries, which is \$4.50/kg whole weight or \$22.50/kg meat weight. Meat weight is approximately 20% of the whole weight.

Fishery Governance

Target catch range:

AIMWTMF: 95 – 1,830 tonnes whole weight

Current fishing level: Acceptable

Except for a small number of years (see External Factors for details) the historic catch range for this fishery is 95 – 1,830

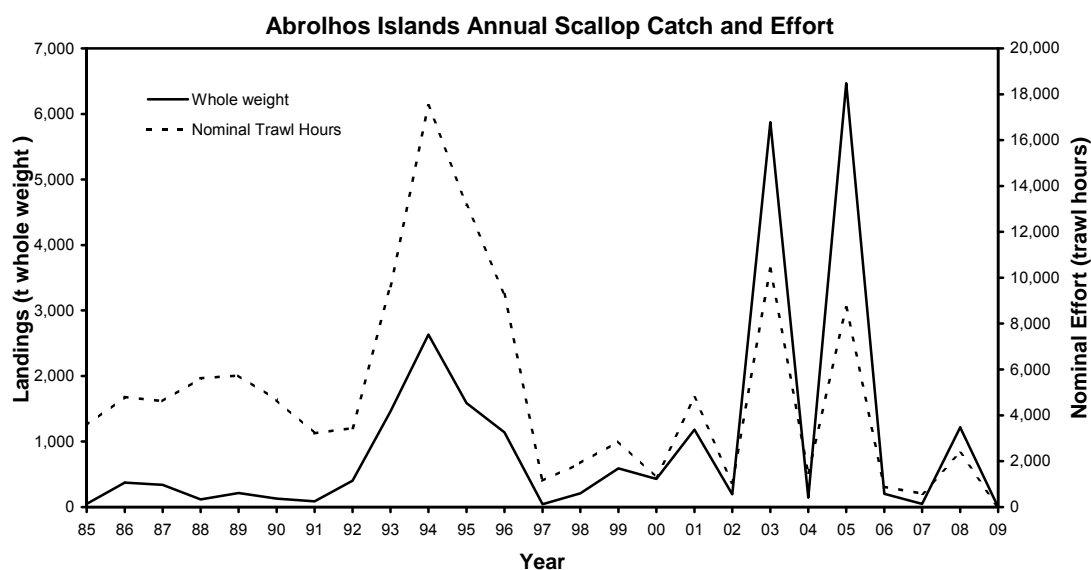
tonnes whole weight. The catch in 2009 was predicted to be low and due to poor meat size and quality no fishing took place.

New management initiatives (2009/10)

Nil

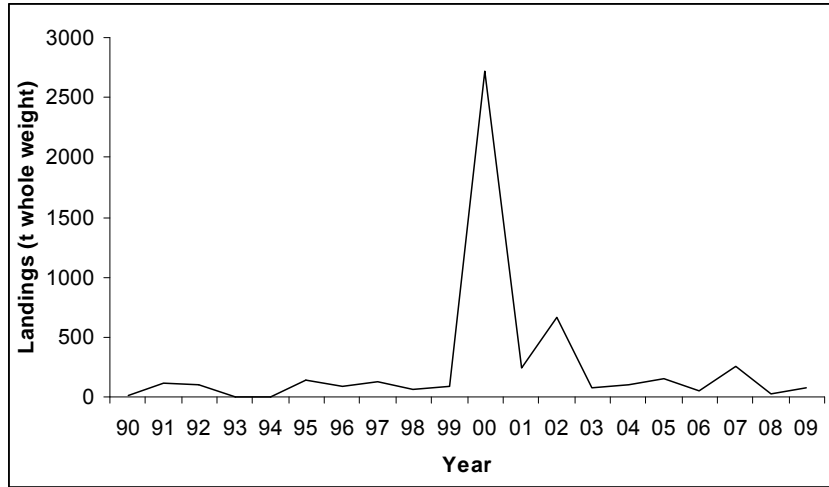
External Factors

High variability in the level of recruitment highlights the dependence of recruitment success upon environmental conditions, such as the Leeuwin Current, rather than spawning stock levels. The relationship between environmental factors and recruitment success is being evaluated for all these regions. This high variability in recruitment results in the level of fishing activity and quantity of catch within these fisheries to be variable and in addition, in recent times, the cost of fishing has affected fishing levels. Meat quality and size (for marketing purposes) is also important in the current economic climate and is a factor in determining the amount of effort expended in addition to stock abundance levels.



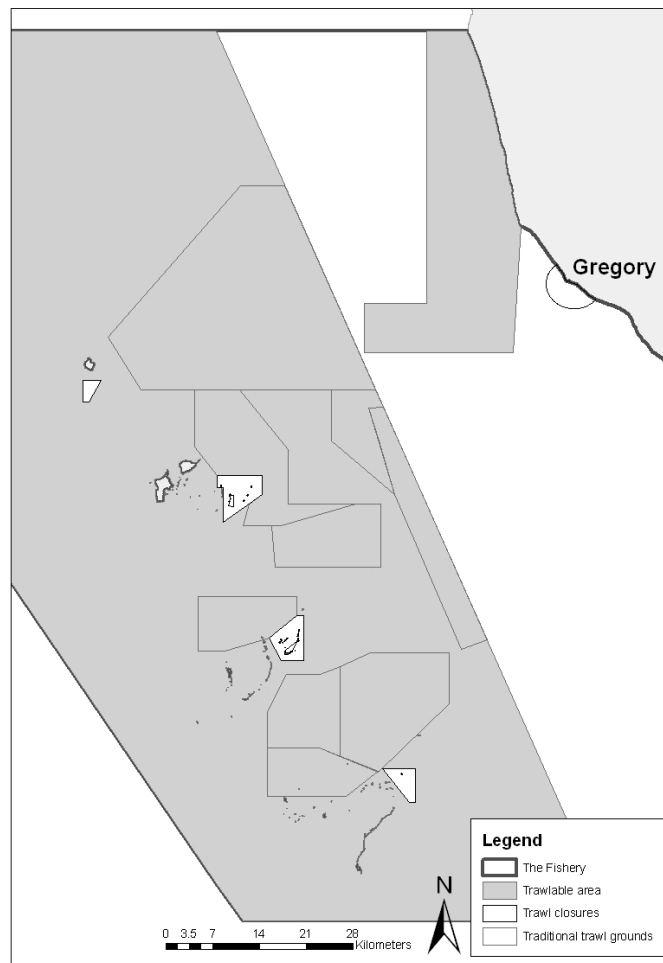
WEST AND SOUTH COAST SCALLOP FIGURE 1

Annual Scallop Landings And Nominal Effort For The Abrolhos Islands And Mid West Trawl Managed Fishery, 1985 – 2009.



WEST AND SOUTH COAST SCALLOP FIGURE 2

Annual Scallop Landings For South Coast Fishery, 1990 – 2009.



WEST AND SOUTH COAST SCALLOP FIGURE 3

Boundaries of the Abrolhos Islands and Mid West Trawl Managed Fishery, no fishing in 2009.

West Coast Blue Swimmer Crab Fishery Status Report

D. Johnston and D. Harris

Management input from N. Harrison

Main Features

Status		Current Landings	
Stock level		Commercial catch (08/09)	74 t
Cockburn Sound	Recovering	Cockburn Sound	Fishery closed
Peel-Harvey Estuary	Acceptable	Peel-Harvey Estuary	46 t
		Catch by other commercial fisheries	28 t
Fishing Level		Recreational catch	
Cockburn Sound	Fishery closed		Approximately 60 - 70% of total catch
Peel-Harvey	Acceptable	Peel-Harvey Estuary (Nov 07 - Oct 08)	107-193 t

Fishery Description

The blue swimmer crab (*Portunus pelagicus*) is found along the entire Western Australian coast, in a wide range of inshore and continental shelf areas, from the inter-tidal zone to at least 50 metres in depth. However, the majority of the commercially and recreationally fished stock is concentrated in the coastal embayments between Geographe Bay (in the south) and Port Hedland (in the north).

The commercial blue swimmer crab fisheries within the West Coast bioregion are the Cockburn Sound Crab Managed Fishery, the Warnbro Sound Crab Managed Fishery, Area I (the Swan and Canning Rivers) and Area II (the Peel-Harvey Estuary) of the West Coast Estuarine Managed Fishery and Area I (Comet Bay) and Area II (Mandurah to Bunbury) of the Mandurah to Bunbury Experimental Crab Fishery. Originally, commercial crab fishers in WA used set (gill) nets or drop nets, but most have now converted to purpose-designed crab traps. Blue swimmer crabs are also retained as by-product by trawlers operating in Comet Bay (Area D of the South West Trawl Managed Fishery), and occasionally by trawlers operating in the waters from Fremantle to Cape Naturaliste (Area B of the South West Trawl Managed Fishery).

Recreational crabbing in the West Coast bioregion is centred largely on the estuaries and coastal embayments from Geographe Bay north to the Swan River and Cockburn Sound. They represent the most important recreationally fished inshore species in the southwest of WA in terms of participation rate. While the majority of recreational fishers use either drop nets or scoop nets, diving for crabs is becoming increasingly popular.

There are separate reports for crab fisheries in the Gascoyne and North Coast bioregions.

Governing legislation/fishing authority

West Coast Estuarine Fishery (Interim) Management Plan 2003

Cockburn Sound (Crab) Management Plan 1995

Warnbro Sound (Crab) Management Plan 1995

South West Trawl Management Plan 1989

Exceptions to the Fish Traps Prohibition Notice 1990 and Fish Traps Restrictions Notice 1994

Exemptions under Section 7 of the *Fish Resources Management Act 1994*

Consultation process

Meetings between the Department of Fisheries and the commercial fishing sector (WAFIC)

Meetings between the Department of Fisheries and the Recreational Fishing Advisory Committee (RFAC) and Recfishwest

Boundaries

The Cockburn Sound (Crab) Managed Fishery encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island, and back to John Point on the mainland.

The Warnbro Sound (Crab) Managed Fishery includes Warnbro Sound itself and adjacent waters, extending from Becher Point to John Point.

The West Coast Estuarine Fishery encompasses the waters of the Swan and Canning Rivers and the waters of the Peel Inlet and Harvey Estuary, together with the Murray, Serpentine, Harvey and Dandalup Rivers.

The Mandurah to Bunbury Developing Crab Fishery covers the waters south of the Shoalwater Islands Marine Park (32°22'40" S) to Point McKenna near Bunbury (33°18' S), and offshore to 115°30' E. The fishery is further divided into two zones. A single northern zone (Area 1) 80-pot exemption (valid as at 30 June 2008) authorises crab fishing in a specified area of Comet Bay between 32°22'40" S and 32°30' S. Historically, four 60-pot exemptions were permitted to be operated in the southern zone (Area 2) (in the waters between Cape Bouvard and the southern boundary of the fishery). However, as at 30 June 2008, only two 60-pot exemptions were valid. The area separating the 2 zones (waters between 32°30' S and Cape Bouvard) is closed to commercial crab fishing.

The Geographe Bay fishery was officially closed on 21 January 2005 to reduce conflict between the recreational and commercial fishing sectors and commercial fishing in the Leschenault Estuary at Australind ceased in 2000.

Management arrangements

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the *Fish Resources Management Act 1994*. Individual fisheries are managed under an input control system, primarily through the regulation of vessel and trap numbers. Supplementary controls cover retainable species and associated minimum size limits, gear specifications and seasonal and daily time restrictions.

The principal management tool employed to ensure adequate breeding stock in the commercial crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. Except for male crabs in Shark Bay, which mature at 115 mm carapace width, blue swimmer crabs become sexually mature below 100 mm carapace width. The legal minimum size range varies between 127 – 130 mm carapace width in the fisheries of the West Coast bioregion – well above the size at sexual maturity (86-98 mm carapace width).

Recreational fishing for blue swimmer crabs in Western Australia is managed through a series of input and output controls. As with commercial fishing, the principal management tool employed to sustain an adequate breeding stock involves maintaining minimum size limits well above the size at sexual maturity. A minimum legal size limit of 127 mm carapace width applies in State waters, along with a bag limit of 20 crabs per person or 40 crabs per boat. However, from November 1, 2007, the recreational bag limits in the West Coast bioregion have been halved to 10 crabs per person and 20 crabs per boat.

Restrictions also govern gear types that can be used to take blue swimmer crabs, along with localised spatial and temporal closures. Interim management measures have been introduced in August 2007 to include a seasonal closure to both commercial and recreational fishers in the Peel-Harvey Estuary for the months of September and October to protect pre-spawning female crabs.

Following several years of rapidly-depleting commercial blue swimmer crab catches in Cockburn Sound, the Minister for Fisheries closed the fishery to both commercial and

recreational fishing in December 2006. Commercial fishers were prohibited from taking crabs in the whole of the Cockburn Sound Managed Crab Fishery, while recreational fishers were prohibited from taking crabs south of a line from Woodman Point across to Garden Island. The closure remained in place for the 2008/09 season.

Following a partial recovery of crab stocks a review of the management arrangements for Cockburn Sound commenced in early 2009. The review was undertaken by a working group comprising representatives from WAFIC, Recfishwest and the Department of Fisheries. The review resulted in new management arrangements being implemented December 2009.

A voluntary Fisheries Adjustment Scheme resulted in the number of licenses in the Swan/Canning River (Area 1 of the West Coast Estuarine Fishery) being reduced from 4 to 2 in July 2005. A further licence was removed from the fishery in early 2008, and the final licence is expected to be resumed in 2010.

Research summary

Data for the assessment of blue swimmer crab stocks in the West Coast bioregion are obtained from a variety of sources. Commercial catch and effort is assessed using fishers' compulsory catch and effort returns, voluntary daily log books from fishers in the Mandurah to Bunbury Inshore Experimental Crab Fishery, and data from on-board catch monitoring conducted by the Department of Fisheries' research staff.

Annual trawl programs conducted in Cockburn Sound provide information on the status of the spawning stock and subsequent strength of recruitment, along with data on the general crab population.

Studies are currently being undertaken to investigate the relationships between environmental variables and the success of spawning of blue swimmer crab stocks. In Cockburn Sound, a stock-recruitment-environment model has been developed which correlates water temperature, in the pre-spawning months of August and September, and the size of the breeding stock with the following season's commercial catch.

Following the closure of the Cockburn Sound crab fishery in December 2006, research funding (from the Development and Better Interest Fund) was granted to:

- undertake additional sampling in Cockburn Sound to provide a finer resolution to the assessment of recruitment and breeding stocks during the recovery of the Cockburn Sound crab stock. From this data the recruitment index that drives a catch prediction model for the Cockburn Sound commercial blue swimmer crab fishery has been revised to more accurately estimate recruitment strength and the residual stock from the previous year and which determines the potential catch during the stock recovery;
- maintain the Cockburn Sound commercial catch monitoring program during the fishery closure;
- develop a commercial catch monitoring program in Warnbro Sound and the Swan River;

WEST COAST BIOREGION

- examine the genetic relationship between the Cockburn Sound stock and those in Warnbro Sound and the Swan River;
- develop a commercial catch monitoring program in the Peel-Harvey Estuary and Comet Bay (Area 1 of the Mandurah to Bunbury Inshore Experimental Crab Fishery);
- develop a fishery-independent sampling program to assess the status of the Peel-Harvey crab stock; and
- undertake a 12-month recreational survey in the Peel-Harvey Estuary between November 2007 and October 2008 to provide an estimate of total recreational catch and effort. Data collection during this study has been completed and the data is currently being analysed.

Retained Species

Commercial landings (season 2008/09):

Cockburn Sound	fishery closed
Peel-Harvey Estuary	46 tonnes
Other commercial fisheries	28 tonnes

The total commercial catch of blue swimmer crabs taken in Western Australian waters during the 2008/09 financial year was 847 t (West Coast Blue Swimmer Crab Figure 1) – a 10% decrease on the 947 t taken in 2007/08. Total landings from the West Coast bioregion declined 41% over the same period from 126 t in 2007/08 to 74 t in 2008/09.

The commercial catch from the Peel-Harvey Estuary (Area 2 of the West Coast Estuarine Fishery) for 2008/09 was 46 t. This represents a 49% decrease on the 90 t in 2007/08 (West Coast Blue Swimmer Crab Figure 3).

The Mandurah to Bunbury Inshore Experimental Crab Fishery reported an annual catch for 2008/09 of 10 t, representing a 50% decrease on the 20 t reported for the 2007/08 financial year (West Coast Blue Swimmer Crab Figure 4).

The Cockburn Sound (Crab) Managed Fishery remained closed for the 2008/09 financial year.

Recreational catch estimate:

Peel-Harvey Estuary (Nov 2007 - Oct 2008)
107-193 tonnes

Recreational catch for West Coast Bioregion:
approximately 60-70% of total catch

Most of the recreational blue swimmer crab fishing in Western Australia occurs in the West Coast bioregion. Departmental surveys have estimated recreational catches of blue swimmer crabs in this bioregion to be in the vicinity of 60-70% of the total catch.

A 12 month recreational catch and effort survey in the Peel-Harvey Estuary was completed in October 2008. This survey covered fishing from boats, shore, canals, and houseboats. Recreational catch for the Peel-Harvey Estuary from November 2007 to October 2008 was estimated to be

between 107-193 t, which represents a significant decline in recreational catch estimate of 251-377 t from the last survey undertaken in 1998/99. Boating has become the dominant fishing method with a decline the amount of scoop netting undertaken. The majority of fishers are now also Mandurah locals rather than people from the metropolitan area.

Recent surveys produced relatively consistent recreational catch estimates for Cockburn Sound of 18 t, 23 t and 18 t for the 2002, 2003 and 2004 calendar years respectively. However, the recreational catch for the 2005/06 financial year was estimated to be just 3 t. The Minister for Fisheries closed the Cockburn Sound crab fishery to recreational fishing in December 2006, south of a line between Woodman Point and the northern end of Garden Island. The closure remained in effect during the 2007/08 financial year. A recreational survey quantifying catch and effort in the West Coast bioregion has been conducted between 2007/08 and 2009/10. Analysis of the data will be carried out in the second half of 2010.

A 12-month survey of recreational fishing in the Swan/Canning Estuary Basin between August 1998 and July 1999 estimated the total recreational blue swimmer crab catch to be 7.3 t. This compares with a commercial catch during the 1998/99 financial year of 24 t. In subsequent years, commercial catches have ranged between 10 t and 20 t, but no further recreational surveys have been undertaken.

Both the Leschenault Inlet and Geographe Bay are now exclusively for recreational use. Previous surveys have found the annual recreational blue swimmer crab catch from Geographe Bay to be between 7 – 11 t per year.

Fishing effort/access level

The Cockburn Sound (Crab) Managed Fishery remained closed for the 2008/09 financial year.

Commercial fishers in the Peel-Harvey Estuary reported 48,762 trap lifts during the 2008/09 season – a 16% decrease on the 57,940 trap lifts reported the previous year (West Coast Blue Swimmer Crab Figure 3).

Commercial effort in the Mandurah to Bunbury Inshore Experimental Crab Fishery also fell in 2008/09, with a total of 17,306 trap lifts reported compared to 24,006 trap lifts the previous year (West Coast Blue Swimmer Crab Figure 4). The annual fishing effort in both of these fisheries has been found to follow variations in the abundance of the resident crab stock.

Stock Assessment

Assessment complete: **Yes**

Assessment method:

Cockburn Sound **Direct survey**

Other West Coast fisheries **Catch rate**

Breeding stock levels:

Cockburn Sound **Recovering**

Other West Coast fisheries **Adequate**

Catch rates from fisheries within the West Coast bioregion generally provide an index of abundance that can be used to assess individual fishery performance from year-to-year. Direct surveys of recruitment and breeding stock have been conducted in Cockburn Sound for about 10 years and are now being developed for Peel-Harvey.

Cockburn Sound: No commercial fishing for blue swimmer crabs took place in Cockburn Sound during 2008/09 as the fishery remained closed.

Historically, natural variations in stock abundance have resulted in large fluctuations in the annual commercial blue swimmer crab catch from Cockburn Sound (e.g. 362 t in 1996/97 versus 92 t in 2001/02). This fluctuation relates largely to variable recruitment, although the shift by commercial fishers from set nets to crab traps in the mid-1990s initiated a marked increase in mean annual crab landings.

Following the second highest annual catch on record in 2000 (340 t), however, the catch declined over the next few years to the point where the low stock abundance required closure of the fishery (in December 2006).

Like many other blue swimmer crab fisheries, adequate protection to the breeding stock in Cockburn Sound had relied primarily on a minimum legal size set well above the size at sexual maturity, which would allow female crabs to spawn at least once before entering the fishery. However, a combination of biological, environmental and fishery-dependent factors contributed to the collapse and include: 1) vulnerability to environmental fluctuations as this species is at the southern extreme of its temperature tolerance, 2) a life cycle contained within an embayment and is self-recruiting, 3) a change in fishing method from gill nets to traps which increased fishing pressure on pre-spawning females in winter and reduced egg production to one age class, 4) four consecutive years of cooler water temperatures resulting in poor recruitment and 5) continued high fishing pressure during years of low recruitment resulting in low breeding stock.

Research trawling has been conducted in Cockburn Sound since 1999 to collect data on juvenile blue swimmer crab abundance for use in a catch prediction model. The number so recruits and the residual stock from the previous year correlate strongly with catch levels the next year.

While a modest improvement in recruitment to the Cockburn Sound crab stock was evident from 2006 to 2008 during the fishery closure (recruitment indices of 0.124, 0.358 and 0.497 for 2006, 2007 and 2008 respectively), recruitment in 2009 was still low (recruitment index of 0.468). However, the absence of fishing pressure resulted in a substantial increase in residual (2+) stock (residual index increased from 0.301 in 2006 to 5.76 in 2009). The recovery of the combined residual stock and recruitment index was sufficient to warrant a limited level of fishing in Cockburn Sound during the 2010 fishing season.

Peel Harvey: The mean annual catch rate for 2008/09 in the Peel-Harvey estuary was 0.94 kg/trap lift, the equal lowest mean annual catch-rate since the conversion from set nets to crab traps in the late nineties. It follows the record 2007/08 catch rate of 1.56 kg/trap lift (West Coast Blue Swimmer Crab Figure 3).

The commercial trap catch and catch rate presented are measures based on the weight of commercially retained crabs. The substantial decline in these indices recorded in 2008/09 does not necessarily reflect a similar decline in the overall abundance of crabs in the Peel-Harvey Estuary. However the fishery will be monitored closely in 2009/10 in view of the low catch in 2008/09.

A large breeding stock in 2007 produced a successful recruitment in March-June 2008. However, above average early and extended rainfall between April and July 2008 flushed the already recruited sub-adult cohort out of the estuary and impeded further recruitment of juveniles into the estuary. This resulted in slower than average growth between the onset of rains in April, through to November when the 2008/09 season commenced. Consequently, crabs were potentially a moult behind. Very large numbers of these sub-adults entered the estuary in November and December 2008, such that competition for available resources resulted in a lower proportion than usual successfully moulting through to legal size over the 2008/09 summer. Consequently, significantly greater numbers of undersize crabs (<127mmCW) were captured in commercial traps during 2008/09, potentially impeding the numbers of size crabs entering traps. Following a later than average moult time possibly combined with food limitation, the muscle tissue in many crabs remained under-developed and crabs were therefore lighter than usual.

In response to the lower quality, lighter crabs, some commercial fishers had difficulty in marketing and chose to retain crabs at a higher size (130-135 mm CW) than the legal minimum size of 127 mm CW. This practice lowered the annual catch as crabs measuring 127-135mm CW traditionally form a significant proportion of the commercial blue swimmer crab catch from the Peel-Harvey fishery. Consequently, while commercial fishers reported high numbers of crabs in their traps, both numbers of retained crabs and mean catch weights were down.

A recreational survey conducted in the Peel-Harvey Estuary during 2007/08 estimated that the recreational take accounted for approximately 60 % of the total catch. Consequently, it is recognized that commercial catch data alone may not provide an accurate indication of the status of crab stocks in this estuary.

Mandurah-Bunbury: Mean annual trap catch rates in the Mandurah to Bunbury Inshore Experimental Crab Fishery have increased steadily since the commencement of exploratory fishing along the coast south of Mandurah to Bunbury in 2002. This increase reflects more efficient fishing of the region crab stocks as the commercial operators' knowledge of the spatial and temporal distribution of resident stocks and localized environmental influences increased over time. The mean catch rate for 2008/09 in the Mandurah to Bunbury fishery was 1.15 kg/trap lift – a marginal increase on the 2007/08 catch rate of 1.10 kg/trap lift (West Coast Blue Swimmer Crab Figure 4).

Monthly monitoring surveys conducted aboard commercial vessels in the Mandurah to Bunbury fishery have indicated a high percentage of female crabs in the catch from this fishery, especially during the peak period of commercial fishing from April to August, and this will need to be closely monitored to avoid overfishing the breeding stock.

Non-Retained Species

Bycatch species impact: **Negligible**

The shift from using set nets to traps in most blue swimmer crab fisheries has resulted in a substantial reduction in bycatch from dedicated crab fishing. Pots are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled.

Small numbers of fish are infrequently captured in crab pots, but the fishers are not permitted to retain them. The low number of fish caught and returned by crab fishers is considered to pose a negligible risk to these stocks.

Discarded bycatch from trawl fisheries taking crabs as a by-product is dealt with in the status reports that are specific to each trawl fishery.

Protected species interaction: **Negligible**

The crab trap longline system used in the targeted crab fisheries has little possibility of interacting with protected species. The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.

Ecosystem Effects

Food chain effects: **Low**

As the commercial take of crabs represents a relatively small portion of the biomass, which is effectively renewed annually and subject to high levels of natural variation in abundance, secondary food chain effects are likely to be minimal in these fisheries.

Habitat effects: **Negligible**

Fishing with traps results in limited habitat disturbance, with only minor dragging of traps on the bottom occurring during trap retrieval. Sand and associated biota do not get brought to the surface in commercial blue swimmer crab traps, as the mesh used on traps is sufficiently large to allow the escape of any sand-dwelling macro-benthos.

Although seagrasses are occasionally brought to the surface with the trap, the infrequent nature of this occurrence, and the small amount of living seagrass removed, results in minimal habitat damage.

Social Effects

During 2008/09, approximately 23 people were employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast bioregion. Employment numbers have been adversely affected by the closure of the Cockburn Sound Crab Fishery in November 2006, which accounts for as many as 14 commercial fishers.

Blue swimmer crabs also provide a highly popular recreational fishery, particularly in the Peel-Harvey and

Geographe Bay region, where they dominate the inshore recreational catch. Recreational fishing in this region has also been affected by the closure of the Cockburn Sound crab fishery.

Economic Effects

Estimated annual value (to fishers) for year 2008/09: \$0.52 million

The economic value of commercial blue swimmer crab fishing to the State of Western Australia for the 2008/09 season was estimated to be \$4.2 million – down slightly on the \$4.4 million generated in 2007/08.

With no catch from the Cockburn Sound crab fishery, and reduced catches in the Peel-Harvey Estuary and Area II of the Mandurah to Bunbury Inshore Experimental Crab Fishery, the blue swimmer crab catch in the West Coast bioregion for 2008/09 was valued at around \$520,000. Most West Coast fishers were able to maintain an increased beach price (averaging around AUS\$7/kg live weight) for blue swimmer crabs sold at local markets due to the Cockburn Sound closure maintaining a tightening of local supply. The poor quality of the catch from the Peel-Harvey Estuary, however, led to a reduction in beach price (circa \$5.50/kg live weight) for crabs from this fishery. While most of the catch from the West Coast bioregion was sold through local markets, the increase in beach prices was also supported by the continued cultivation of interstate markets.

Fishery Governance

Target catch (or effort) range: Under review

In the light of recent recruitment failures in the Cockburn Sound fishery, the target range will need to be reviewed when the fishery is re-opened.

Current fishing (or effort) level

Cockburn Sound: Not Applicable

Other West Coast Bioregion fisheries: Under Development

New management initiatives (2009/10)

As a result of the bi-partisan commitment to close the Swan River to commercial fishing, the Department will be implementing a Compulsory Fisheries Adjustment Scheme to complete this initiative. The final licence is expected to be resumed in 2010.

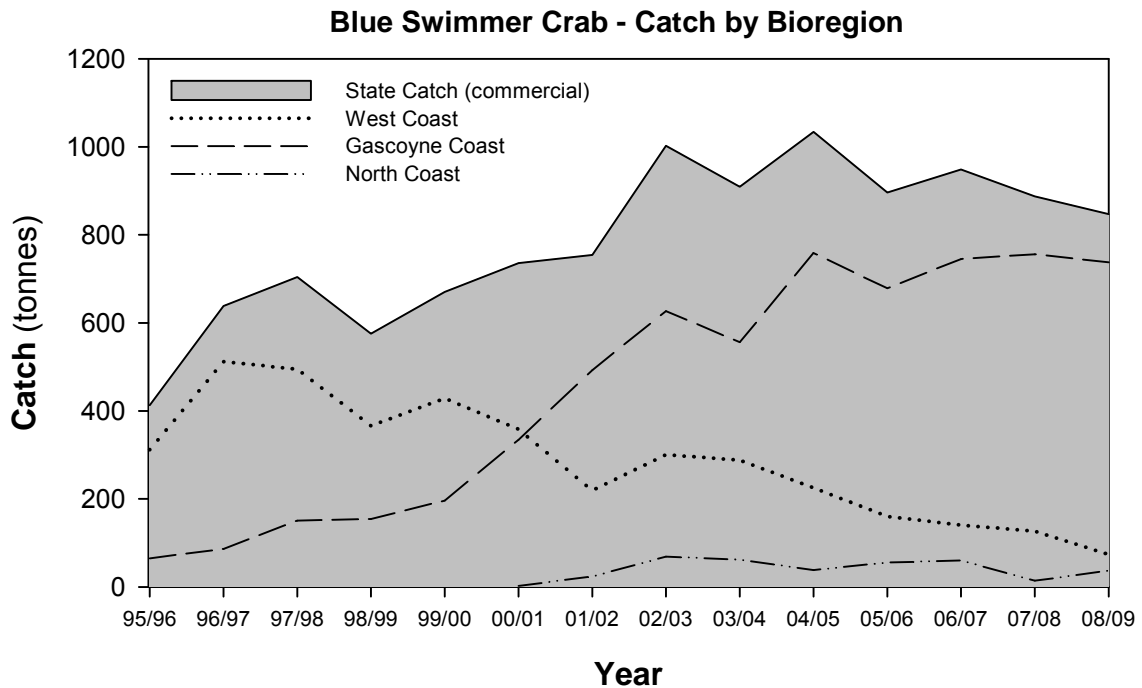
As an outcome of the review into the management arrangements for Cockburn Sound the following changes will be implemented in December 2009 for this fishery.

- Limited open season 15 Dec to 31 March (both recreational and commercial)
- Increase in commercial size limit for blue swimmer crabs from 130mm to 140mm
- 20% pot reduction in the commercial fishery

External Factors

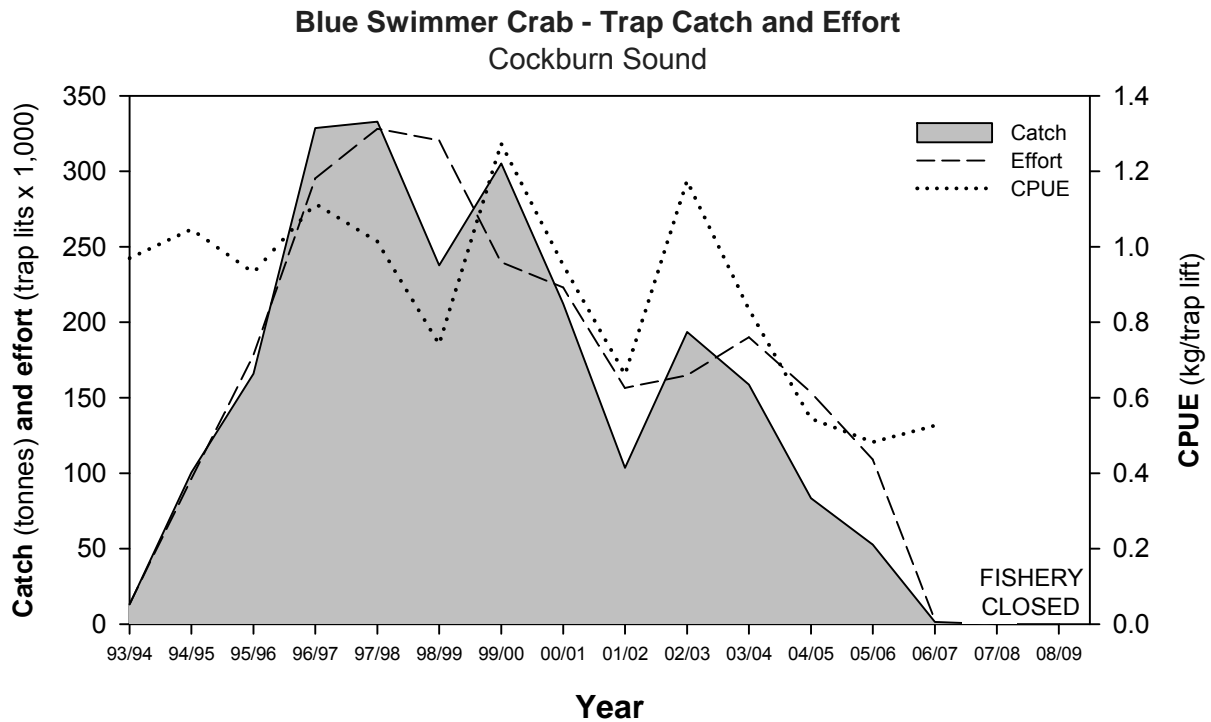
The Mandurah to Bunbury Developing Crab Fishery underwent its final review by the Developing Fisheries Assessment Committee (DFAC) in mid-2007 as part of the ‘Developing New Fisheries’ process. The Department of Fisheries is considering the recommendations of the DFAC and intends to make clear recommendations in 2010 regarding the future viability of a fishery in this region.

Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of these variations are not fully understood, it is considered most likely due to environmental influences (e.g. water temperature) both on spawning success and larval survival through to recruitment. The relationship between environmental factors, recruitment and catch is being further evaluated as data becomes available.



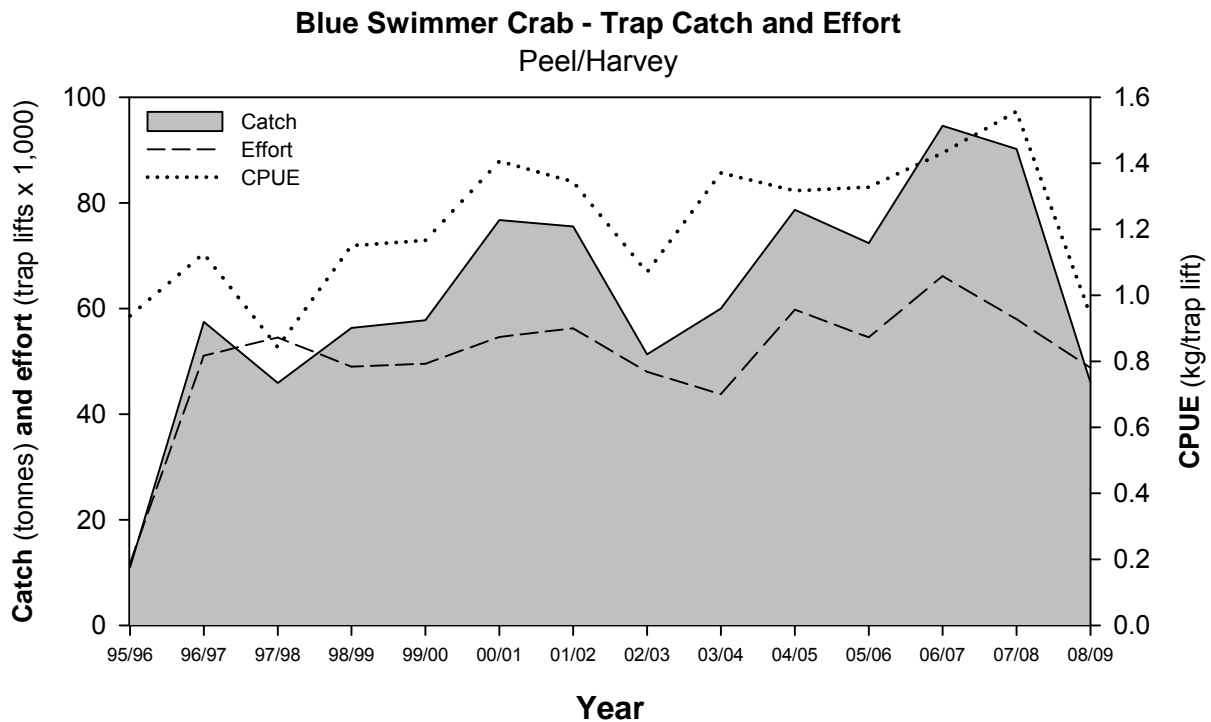
WEST COAST BLUE SWIMMER CRAB FIGURE 1

State and bioregion commercial catch history for the blue swimmer crab (*Portunus pelagicus*) in Western Australia since 1995/96.



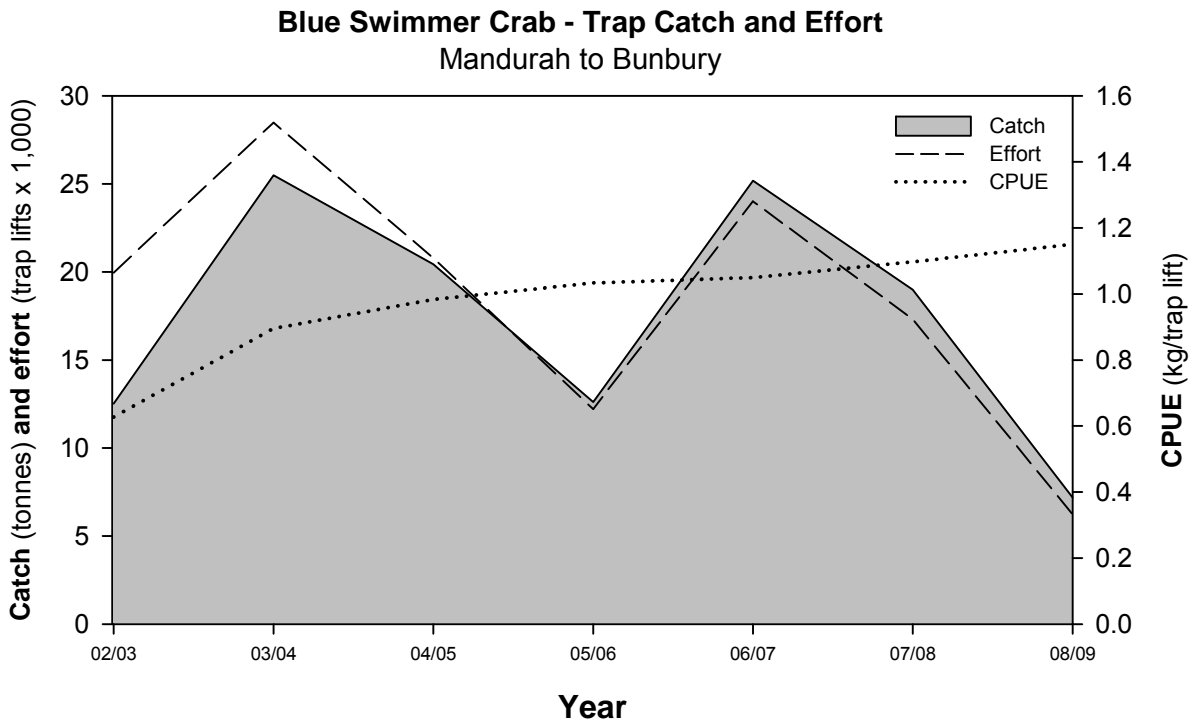
WEST COAST BLUE SWIMMER CRAB FIGURE 2

Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in the Cockburn Sound Crab Fishery between 1993/94 and 2008/09 using traps.



WEST COAST BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in Area 2 of the West Coast Estuarine Fishery (the Peel-Harvey Estuary) between 1996/97 and 2007/08 using traps.



WEST COAST BLUE SWIMMER CRAB FIGURE 4

Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in the Mandurah to Bunbury Inshore Experimental Crab Fishery between 2002/03 and 2008/09.

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

A. Thomson and P. Unsworth

Management input by K. Nardi

Main Features

Status		Current Landings	
Stock level	Acceptable	Crystal Crabs	136 t
Fishing Level	Acceptable	Champagne Crabs	2.3 t

Fishery Description

The West Coast Deep Sea Crustacean (Interim) Managed Fishery targets Crystal (Snow) Crabs (*Chaceon albus*), Giant (King) Crabs (*Pseudocarcinus gigas*) and Champagne (Spiny) Crabs (*Hypothalassia acerba*) using baited pots operated in a long-line formation in the offshore waters of the West Coast.

Governing legislation/fishing authority

Fish Resources Management Act 1994

Fish resources Management Regulations 1995

West Coast Deep Sea Crustacean Fishery (Interim) Management Plan 2007

Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation) - Export approval through until May 2013.

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The boundaries of this fishery are all the waters lying north of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150m isobath out to the extent of the Australian Fishing Zone.

Management arrangements

The West Coast Deep Sea Crustacean (Interim) Managed Fishery is a quota based 'pot' fishery. The fishery mostly operates in depths of 500-800 metres, with the only allowable method for capture being baited pots ('traps'). These are operated in 'long-lines', which have between 50 and 100 pots attached to a main line marked by a float at each end.

The Department of Fisheries has in place, regulations to protect breeding females by the establishment of appropriate minimum size limits. For the principal target species Crystal Crab, a minimum of 120mm carapace width applies and for the lesser targeted species, Champagne and Giant crab, a minimum size of 92 and 140mm carapace length respectively applies.

The interim management plan came into effect on the 1 January 2008. This plan introduced a number of key management changes such as the removal of management zones in the fishery, removing part-time permits and initiating a quota management system, with individual transferable quota for each existing permit holder. There are currently seven permits operating in the fishery. Each permit has a 20 tonne limit for Crystal Crabs (annual quota of 140 tonnes) and a 2 tonne limit for Giant and Champagne Crabs combined (annual combined quota of 14 tonnes).

A comprehensive Ecologically Sustainable Development (ESD) assessment of this fishery determined that performance should be measured annually against measures relating to the breeding stocks of deep sea crabs. These have now been defined as the catch level remaining within an acceptable range.

Research summary

Research for this fishery has involved assessing the current status of the west coast deep sea crab stocks based on commercial catch returns, log book information and at-sea research monitoring of the catch. The annual total Crystal Crab catch from 2000 to 2008 have been historically used to monitor this fishery for ecologically sustainable development assessment. However, since the quota system has come into operation in 2008 performance measures based on whether the quota is achieved and the catch rate and effort required to achieve the catch will be required.

Retained Species

Commercial landings (season 2009):

Crystal Crab	136 tonnes
Champagne Crab	2.3 tonnes

A catch of 136 t of crystal crabs was taken in the fishery in 2009 – similar to the catch taken in the 2008 season (139 t) (Deep Sea Crab Figure 1). A small catch of 2.3 t Champagne Crab was taken in 2009 which was the first catch of this species since 2006.

Recreational catch estimate (season 2009) Nil

Fishing effort/access level

Effort decreased by 10% from an estimated 90,000 pot lifts in the 2008 season to 81,000 pot lifts in the 2009 season. The effort estimate in this fishery is based on detailed catch and effort research logbook returns, which are required to be completed by fishers in this fishery during its developmental status.

Stock Assessment

Assessment complete **Yes**

Assessment method **Catch rate**

Breeding stock levels **Adequate**

The standardised catch per unit of fishing effort (CPUE) for crystal crabs increased by 8%, from 1.23 kg/pot lift in 2008 to 1.33 kg/pot lift in 2009 (Deep Sea Crab Figure 2). The long-term CPUE dataset for the fishery shows a decrease in the early years of the fishery, presumably in response to depletion of accumulated biomass. Catch rates have been relatively stable since 2003. However it is not clear how changes in CPUE in this fishery are influenced by efficiency increases resulting from improvements by fishers in the type of gear that they use and the way that they deploy it, compared to variations in the catchability and local abundance levels of the crabs. The change to quota management in 2008 and removal of zones have also affected the catch rate.

Crystal crabs are known to be very slow-growing, as are most other deep-water species. Preliminary estimates suggest that the males attain maturity at around 12 years and reach legal minimum size at about 14 years. Ageing estimates are not available for females, but size at maturity information shows that they mature well below the legal size limit and probably moult once after reaching maturity, which means that their contribution to the fished biomass is small and that egg production in the fishery is well protected by the legal size limit provided that there are sufficient males.

The performance measure is whether the catch remains within the range 100-250 t. This criterion was met. As the fishery has moved to catch quota, the performance measure needs to be revised to include whether the quota has been achieved and the effort required to achieve the quota.

Non-Retained Species

Bycatch species impact **Low**

The gear used in this fishery generates minimal bycatch and the design of the pots is such that they do not 'ghost fish' if lost.

Protected species interaction **Negligible**

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

Ecosystem Effects

Food chain effects **Negligible**

Catches of the 3 species of deep sea crabs landed represent a very small biomass, and any impact of fishing on the general food chain is expected to be minimal. Most of the commercial crystal crab catch is taken between 500 to 800 metres in depth. A rough estimate of the amount of ground between 500 – 1,000 m over the distributional range of crystal crabs is about 50,600 km². Assuming that all the ground is equally productive, means that at catch levels experienced in the past season roughly 3 kilograms of crabs are being removed each year per square kilometre of ground.

Habitat effects **Low**

Crab potting is considered to have a low impact on the largely soft mud habitat over which the fishery operates.

Social Effects

This fishery is based on mobile vessels that employ a skipper and two or three crew. The product is landed live at ports between Carnarvon and Fremantle, generating some additional economic activity and benefits. There were three vessels operating in 2009.

Economic Effects

Estimated annual value (to fishers)

for year 2009 **\$2.1 million**

The beach value of the fishery was about \$2.1 million in 2009, based on an average beach price of \$15/kg for crystal crab. The majority of the catch is exported live to south-east Asia.

Fishery Governance

Current fishing (or effort) level **Acceptable**

Because of the TAC, the catch in the crystal crab fishery is now lower than it has been for several years. This is a relatively new commercial fishery that has only been fished on a full-time basis since 2000 and the target is a long-lived species.

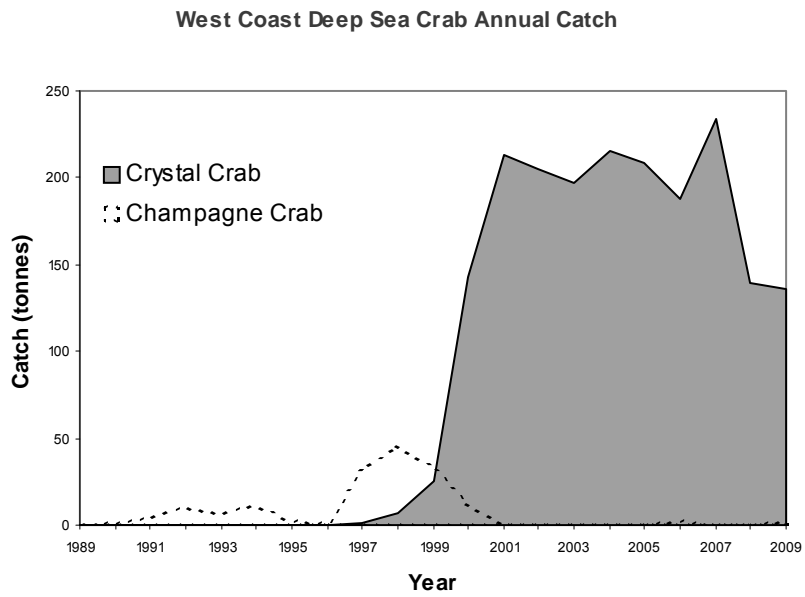
Target catch range **100-140 tonnes**

The TAC for the fishery has been set well below landings of recent years and is at the lower end of the target catch range for the WTO assessments. A preliminary effort range to achieve the TAC, based on the steady range of catch rates since 2001, is 70 – 100,000 pot lifts. This effort range will be adjusted as more data becomes available from this fishery whilst under quota management.

New management initiatives (2009)

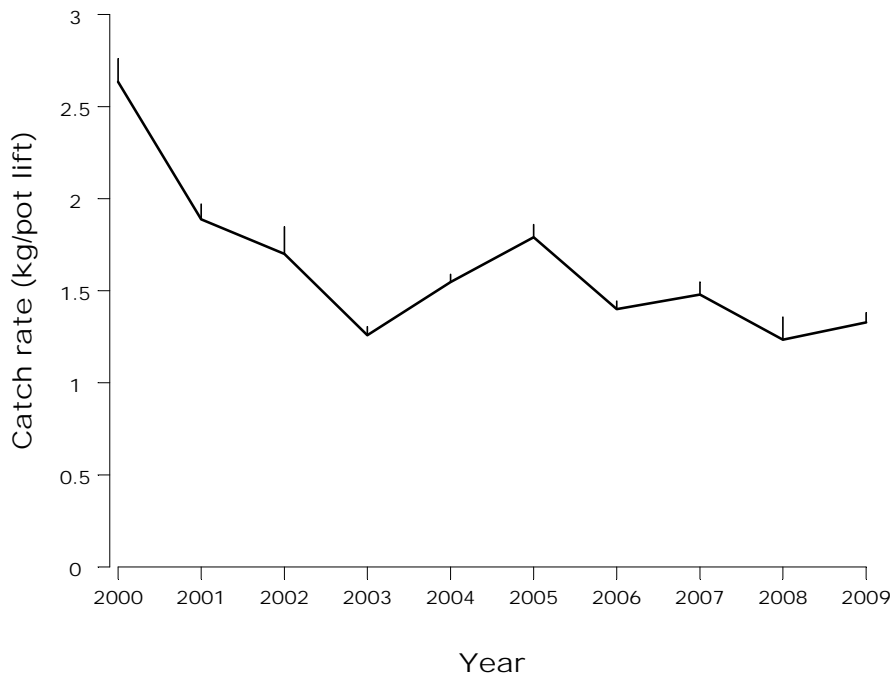
The fishery has recently (2008) moved to output controls. New initiatives in pot design are being considered in 2010.

WEST COAST BIOREGION



WEST COAST DEEP SEA CRAB FIGURE 1

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



WEST COAST DEEP SEA CRAB FIGURE 2

Standardized catch per unit effort since 2000 for crystal crabs.

West Coast Nearshore and Estuarine Finfish Resources Status Report

K. Smith and J. Brown

Management input from N. Harrison and A. Warmbrunn

Main Features

Status		Current Landings (2009)	
Stock levels		Commercial total	827 t (finfish only)
Australian herring	Uncertain	South West Coast Salmon Fishery	494 t (salmon only)
Tailor	Acceptable	West Coast Beach Bait & South West Beach Seine Fisheries	
Southern sea garfish	Acceptable		131 t (whitebait only)
Whiting species	Not assessed	West Coast Estuarine Fisheries	36 t (finfish only)
Sea mullet	Acceptable	Recreational	not available for current year.
Whitebait	Acceptable	Most recent survey 2000/01	940 t (key species only)
Black bream (Swan-Canning)	Acceptable		
Black bream (other estuaries)	Not assessed		
Cobbler (Swan-Canning)	Not acceptable		
Cobbler (Peel-Harvey)	Acceptable		
Cobbler (Leschenault)	Not assessed		
Perth herring	Not assessed		
Fishing Level	Acceptable		

Fishery Description

Commercial - Nearshore

Commercial fishers target a large number of finfish species in nearshore and estuarine waters of the West Coast Bioregion using a combination of gill nets, haul nets and beach seines.

The Cockburn Sound (Fish Net) Managed Fishery uses gill nets in Cockburn Sound. The main targets are southern sea garfish (*Hyporhamphus melanochir*) and Australian herring (*Arripis georgianus*).

The South West Coast Salmon Managed Fishery operates on various beaches south of the metropolitan area. This fishery uses seine and haul nets, mainly to target salmon (*Arripis truttaceus*) and herring.

The West Coast Beach Bait Managed Fishery operates on various beaches from Moore River (north of Perth) to Tim's Thicket (south of Mandurah). The South West Beach Seine Fishery operates on various beaches from Tim's Thicket southwards to Point D'Entrecasteaux (south coast), with most effort in Geographe Bay (Cape Naturaliste to Preston Beach). These seine net fisheries both target whitebait (*Hyperlophus vittatus*), but blue sprat (*Spratelloides robustus*), sea mullet (*Mugil cephalus*), yellow-finned whiting (*Sillago schomburgkii*), southern sea garfish and yellow-eye mullet (*Aldrichetta forsteri*) are also taken in small quantities.

A number of commercial beach net fishers currently operate outside the metropolitan area under an Exemption that allows them to fish in the waters of the West Coast Demersal

Scalefish (Interim) Managed Fishery. These fishers mainly use haul net and beach seine nets to target sea mullet, mulloway (*Argyrosomus hololepidotus*), Australian herring, yellow-finned whiting and southern sea garfish. These fishing operations will be managed within in the proposed West Coast Inshore Net Fishery.

Commercial - Estuarine

West Coast Estuarine (Interim) Managed Fishery (WCEF) operates in the Swan/Canning and Peel/Harvey Estuaries. It is a multi-species fishery targeting blue swimmer crabs (*Portunus pelagicus*) and numerous finfish species. The blue swimmer crab component of the fishery is reported in the West Coast Blue Swimmer Crab Fishery status report. The finfish component is described in this report. The methods used by commercial fishers to target finfish in West Coast estuaries are gill nets and haul nets.

The Hardy Inlet commercial fishery, although not included in the WCEF interim management plan, is also reported here as it shares the characteristics of the other west coast estuarine fisheries.

Recreational

Most finfish caught recreationally in West Coast estuaries and nearshore waters are taken by shore or boat-based line fishing. The most commonly targeted recreational species include Australian herring, tailor (*Pomatomus saltatrix*), whiting (various species), southern sea garfish, silver trevally (*Pseudocaranx* spp.) and black bream (*Acanthopagrus*

WEST COAST BIOREGION

butcheri) (estuaries only).

A relatively small amount of recreational net fishing occurs in the West Coast Bioregion, mainly to target sea mullet.

Governing legislation/fishing authority

Commercial

West Coast Estuarine Fishery (Interim) Management Plan 2003

West Coast Estuarine (Interim) Managed Fishery Permit

Cockburn Sound (Fish Net) Management Plan 1995

Cockburn Sound (Line and Pot) Management Plan 1995

Fish Resources Management Act 1994 and subsidiary legislation

Closed waters and Permitted Gear Orders under Section 43 of the *Fish Resources Management Act 1994*

Condition 19 on a Fishing Boat Licence

Condition 17 on a Commercial Fishing Licence

Directions to Licensing Officers

West Coast Demersal Scalefish Fishery (Interim) Management Plan 2007

West Coast Demersal Scalefish (Interim) Managed Fishery Permit

West Coast (Beach Bait Fish Net) Management Plan 1995

South-West Coast Salmon Fishery Management Plan 1982

South-West Coast Salmon Managed Fishery Licence

Proclaimed Fishing Zone Notice (South-West Coast) 1975

Salmon Block Net Prohibition Notice 1996

Salmon and Snapper Purse Seining Prohibition Notice 1987

Condition 68 on a Fishing Boat Licence

Commonwealth *Government Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation processes

Commercial

Meetings between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council).

Recreational

Regional Recreational Fishing Advisory Committees and Recfishwest.

Boundaries

Commercial

WCEF: The management plan encompasses all estuaries in the West Coast Bioregion between 27° S and 33°11' S. Complex closures exist for both the Swan/Canning and Peel/Harvey commercial fisheries (refer to management

plans, related legislation and regulations).

Waters of Hardy Inlet and the Blackwood River are open to commercial fishing upstream from a line connecting Point Irwin to the Irwin Street boat ramp to a line drawn across the river from the eastern boundary of Sussex Location 133 (approximately Great North Road).

Leschenault Estuary: Closed to Commercial fishing

The Cockburn Sound (Fish Net) Managed Fishery operates within Cockburn Sound.

West Coast Beach Bait Managed Fishery: From Moore River (north of Perth), to Tim's Thicket (south of Mandurah).

South West Beach Seine Fishery: From Tim's Thicket south to Point D'Entrecasteaux, with most effort reported in Geographe Bay (Cape Naturaliste to Preston Beach).

South-West Coast Salmon Managed Fishery: all waters north of Cape Beaufort.

(Proposed - West Coast Inshore Net Fishery – Moore River to Zuytdorp Cliffs, south of Shark Bay)

Recreational

Recreational line fishing is permitted in most areas within estuaries and nearshore waters of the West Coast Bioregion. Some spatial closures exist, including closures in marine reserves and around industrial structures.

A small number of areas within estuaries and nearshore waters of the West Coast Bioregion are open to recreational netting. Recreational net fishers must hold a licence. Recreational net fishing regulations are complex – please refer to the '*Recreational Net Fishing Guide*' for details.

Management arrangements

Commercial

The west coast nearshore and estuarine commercial fisheries are managed primarily through input controls in the form of limited entry and gear restrictions, as well as seasonal and time closures, area closures and size limits. Finfish fishing methods are restricted to gill nets, seine nets and haul nets.

Recreational

Recreational fishers in west coast estuaries and nearshore waters take a diverse array of finfish species. Size and possession limits apply to these species when caught recreationally in the West Coast Bioregion. Refer to the '*Recreational Fishing Guide - West Coast Bioregion*' for details.

As many recreationally targeted species are also targeted by the commercial sector, resource-sharing issues are a major consideration in future management arrangements.

Key species

Tailor, black bream and yellow-finned whiting are assigned to the 'medium risk' category. Australian herring, southern sea garfish, sea mullet and Perth herring (*Nematalosa vlaminghi*) are assigned to the 'low risk' category. Cobbler (*Cnidogobius macrocephalus*) is assigned to the 'medium risk' category, except in the Swan-Canning estuary, where a total fishing ban is in effect until 2017.

Research summary

Monitoring of fisheries and fish stocks in West Coast estuaries and nearshore waters is based on commercial catch and effort statistics (CAES) from compulsory monthly returns, recreational catch and effort data from voluntary recreational fisher log books (Research Angler Program) and recreational fishing surveys, fishery-independent surveys using beach seine nets to monitor annual juvenile recruitment by various fish species (including herring, whiting and mullet) and research angling to monitor annual juvenile tailor recruitment.

While commercial catch levels are determined annually from data reported in compulsory commercial returns, recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted.

A 12-month, state-funded NRM research project designed to provide more rigorous monitoring and assessment of the status of Australian herring and tailor commenced in mid-2009. Volunteer anglers and commercial fishers provided samples of these species to enable researchers to determine the age structure of recreational and commercial catches in the West Coast Bioregion. This information will be used to assess the feasibility of ongoing age-based assessments and to develop methods, if appropriate, to monitor levels of annual fishing mortality for herring and tailor in the West Coast Bioregion.

The NRM-funded project is also examining aspects of stock structure, including sources of recruitment to the West Coast herring and tailor stocks. The majority of West Coast tailor landings are taken by recreational fishers in the metropolitan area. Monitoring of juvenile recruitment since the mid-1990s has identified two significant 'pulses' of 0+ recruits that arrive each year. Limited data suggests that these pulses are products of both local and remote (i.e. outside Perth metropolitan waters) spawning events. Research is currently underway to examine source(s) of recruitment to the metropolitan tailor fishery, which may also assist in explaining the highly variable annual recruitment to this fishery. The proportions of herring in the West Coast fishery that originate from nursery sites in the West Coast and South Coast Bioregions is also being examined.

Retained Species

Total commercial finfish landings (2009):

723 tonnes in nearshore waters

104 tonnes in estuarine waters

Commercial landings by fishery (2009):

South West Coast Salmon: 494 tonnes (salmon)

WC Beach Bait + SW Beach Seine:

131 tonnes (whitebait)

West Coast Estuarine + Hardy Inlet:

36 tonnes (finfish)

The commercial catches reported in West Coast Nearshore and Estuarine Table 1 are taken by estuarine fisheries and beach-based fisheries using gill nets, haul nets and beach

seines. Minor quantities of the same species that are taken by other methods (e.g., purse seine, demersal gill nets and long-lines) are not included in Table 1. Catches by all methods and all fisheries are included in the catches reported for key species in the following sections and in individual stock assessments.

In 2009, the total commercial catch of finfish by estuarine and beach-based fisheries in the West Coast Bioregion included approximately 24 species. The majority of the catch consisted of Australian salmon (60% by weight), which was caught primarily by the South West Coast Salmon Managed Fishery, and whitebait (16%), which was caught primarily by the South West Beach Seine Managed Fishery.

Excluding salmon and whitebait, the remaining finfish landings in 2009 were composed of approximately equal contributions by estuarine (103 t) and nearshore beach-based fisheries (93 t).

Key finfish species:

Commercial nearshore species

Australian herring: Since 2000, 83% of total commercial landings of Australian herring in WA have been taken in the South Coast Bioregion, with the remaining 17% taken in the West Coast Bioregion. Within the West Coast Bioregion, 62% of landings were taken in the Geographe Bay/Bunbury area, 21% taken in Cockburn Sound and 8% taken in the Peel-Harvey estuary.

Since 2000, the total state annual commercial catch of herring steadily declined from 818 t in 2000 to 184 t in 2009. Annual landings in both bioregions followed a similar downward trend – declining from 700 t to 151 t in the South Coast and from 143 t (in 2001) to 32 t in the West Coast Bioregion. The downward trend in the West Coast mainly reflected declining catches in the Geographe Bay/Bunbury area. Landings of herring in Cockburn Sound declined only slightly, and landings in the Peel-Harvey estuary and in coastal waters north of Perth increased slightly over this period.

Total WA commercial landings of herring peaked at 1401 t in 1991, when 1329 t was taken in the South Coast Bioregion. In the West Coast Bioregion, the total annual commercial catch reached an historical peak of 150 t in 1988 and again in 1992.

Whitebait: All commercial landings of whitebait are taken in the West Coast Bioregion. Total landings have declined slightly since the 1990s when historic peaks of about 330 t occurred in 1990 and 1997 (West Coast Nearshore and Estuarine Figure 1). The decline mainly reflects declines in landings in the metropolitan and Mandurah areas following effort reductions in these areas. Landings in the Geographe Bay/Bunbury area have been relatively stable. Since 1995, landings from the Geographe Bay/Bunbury area have comprised 94% of total landings. The total West Coast commercial catch of whitebait was 136 t in 2009 of which the West Coast Beach Bait and South West Beach Seine Fisheries landed 96%. Substantial variations in whitebait landings appear to occur in response to environmental factors including ENSO and Leeuwin Current fluctuations.

WEST COAST BIOREGION

Sea garfish: Since 1995, about 55% of total commercial landings of sea garfish in WA have been taken in the West Coast Bioregion, with 30% from the South Coast, 10% from the Gascoyne and 5% from the North Coast Bioregions. From 1995 to 2009, the total annual commercial catch of sea garfish in the West Coast Bioregion ranged between 11 and 44 t. In this period, annual catches were quite variable, but the overall trend was downward. The declines are partly due to a reduction in commercial effort. Approximately 85% of total commercial landings of garfish each year in the West Coast over this period have been taken in Cockburn Sound. In 2009, 92% of West Coast landings were taken in Cockburn Sound.

The annual landings of sea garfish in Cockburn Sound increased gradually after 1980 to reach a peak of 37 t in 1999 and have since steadily declined. A minimum annual catch of 9 t was reported in 2008. The 2009 catch was 14 t.

Sea mullet: From 2000 to 2009, 42 % of total commercial landings of sea mullet in WA were taken in the West Coast Bioregion, with 45% from the Gascoyne, 12% from the South Coast and 1% from the North Coast Bioregions.

Since 2000, the total annual commercial catch of sea mullet in the west coast has steadily declined from 179 t in 2000 to 80 t in 2009. The decline is partly due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of various fishery adjustment schemes (licence buy-backs) operating since 1990. The historical peak in sea mullet landings within the West Coast Bioregion was 429 t in 1988, reflecting the much higher level of commercial effort that previously targeted this species. From 2000 to 2009, 48% of total commercial landings of sea mullet in the west coast region were taken in the Peel-Harvey estuary and 21% taken in the area of the proposed West Coast Inshore Net Fishery (Moore River to Zuytdorp Cliffs).

Yellow-eye mullet: From 2000 to 2009, 87 % of total commercial landings of yellow-eye mullet in WA were taken in the West Coast Bioregion, with the remaining 13% taken in the South Coast Bioregion. Since 2000, the total annual commercial catch of yellow-eye mullet in the west coast has steadily declined from 64 t in 2000 to 17 t in 2009. The decline is partly due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of various fishery adjustment schemes (licence buy-backs) operating since 1990. The historical peak in yellow-eye mullet landings within the West Coast Bioregion was 514 t in 1988, reflecting the much higher level of commercial effort that previously targeted this species. From 2000 to 2009, 80% of total commercial landings of yellow-eye mullet in the west coast region were taken in the Peel-Harvey estuary.

Yellow-finned whiting: From 2000 to 2009, 74 % of total commercial landings of yellow-finned whiting in WA were taken in the Gascoyne Bioregion, with 25% taken in the West Coast and 1% taken in the South Coast Bioregion. The total annual commercial catch of yellow-eye mullet in the west coast has steadily declined from 66 t in 2001 to 23 t in 2009. The decline is partly due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of various fishery adjustment schemes (licence buy-backs) operating since 1990. From 2000 to 2009, the Hardy Inlet, the Peel-Harvey estuary and Geographe Bay each contributed 20-25% of total commercial landings in the west

coast region.

Australian salmon: Since 2000, 67% of total commercial landings of Australian salmon in WA have been taken in the South Coast Bioregion, with the remaining 33% taken in the West Coast Bioregion. Within the West Coast Bioregion, 62% of landings were taken in the Geographe Bay/Bunbury area and 37% taken in the Capes/Augusta area.

Total WA landings of salmon have been declining since 1995. This trend reflects declining catches on the south coast, where the annual catch has steadily declined from an historical peak of 4046 t in 1995 to 258 t in 2009. By contrast, in the West Coast Bioregion the catch trend has been stable with annual landings fluctuating between 0 (in 2000) and 1364 (in 1968). West Coast catches of 1316 t in 1995 and 1194 t in 2006 were close to the historical peak reached in 1968. In 2009, total West Coast landings of salmon were 495 t.

Tailor: Since 2000, about 80% of total WA commercial landings of tailor have been taken in the Gascoyne Bioregion, 13 % in the West Coast and 7 % in the South Coast Bioregions. In 2009, the total state commercial catch of tailor was 25 t, which was mostly caught in Shark Bay. The total West Coast catch was 5 t in 2009.

In the West Coast bioregion, the majority of commercial tailor landings are reported from the Peel-Harvey Estuary (65% of landings since 2000), where 4 t was reported in 2009. Over the past decade, tailor landings in this estuary have fluctuated between <1 t to 8 t.

Key finfish species

Commercial estuarine species

Perth herring: From 2000 to 2009, almost 100% of total commercial landings of Perth herring in WA were taken in the West Coast Bioregion. Over this period, total landings have declined from 11 t in 2000 to approximately 1 t in 2009. Since 2000, 75% of landings were reported from the Swan-Canning estuary and 17% from the Peel-Harvey estuary. Historically, the majority of landings of this species were caught in the Swan-Canning estuary. Commercial targeting of Perth herring in this estuary ceased in 2007. The minor quantities taken in 2008 and 2009 were from the Peel-Harvey estuary.

Recent landings of Perth Herring are very low compared to historical landings. From 1963 to 1988, annual commercial catches of Perth herring in the Swan-Canning Estuary were consistently >40 t, including a historical peak of 150 t in 1968-69. Total West Coast landing peaked at 239 t in 1978. Declining landings are partly due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of various fishery adjustment schemes (licence buy-backs) operating since 1990. However, declining stock abundance is also believed to be a contributing factor.

Cobbler: In WA, commercial targeting of cobbler is essentially restricted to estuaries. Each estuary hosts a discrete breeding stock of cobbler, which is genetically distinct to other estuarine populations and also distinct to cobbler populations in adjacent ocean waters.

From 2000 to 2009, 95% of commercial landings of cobbler

were caught in estuaries of the South Coast Bioregion, with the remaining 5% from the West Coast Bioregion. Over this period, total annual landings in the West Coast Bioregion ranged from <1 t to 8 t, with 90% of these landings caught in the Peel-Harvey estuary. In 2009, 8 t of cobbler was caught in the Peel-Harvey Estuary, which was almost 100% of the total catch in West Coast Bioregion.

Historically, commercial catches of cobbler in West Coast estuaries were much higher. Landings peaked at 298 t in 1961 in the Peel-Harvey Estuary, at 158 t in 1958 in Leschenault Estuary and at 56 t in 1960 in the Swan-Canning estuary. Landings in the Hardy Inlet have always been relatively low.

In the Peel-Harvey Estuary, cobbler landings during the 1950s, 1960s and 1970s were frequently >100 t. Landings in the 1970s (1970-79) averaged 127 t per year. However, annual landings fell dramatically from 233 t to 49 t between 1980 and 1982. From 1983 to 1996, annual landings ranged from 3 to 74 t. Since 1996, annual landings have ranged from <1 t to 10 t. In 2009, landings were 8 t, which was the highest catch since 1999 when 10 t were reported.

In the Swan/Canning Estuary, annual cobbler landings during the 1960s and 1970s were frequently >20 t (average catch 31 t per year for period 1959-1977). However, landings fell dramatically from 76 t to 7 t between 1976 and 1978. From 1978 to 1996, annual landings ranged from 1 to 10 t. After 1997, annual catches in the Swan-Canning Estuary were <800 kg. A prohibition to catch cobbler in the Swan-Canning Estuary was introduced on the 6 July 2007 in order to protect the stock.

In the Leschenault Estuary, a period of relatively high cobbler landings occurred from 1955 to 1965 (average 45 t per year, 1955-65). Landings declined from 17 t in 1978 to 2 t in 1979. From 1979 until the closure of the commercial fishery in 2000/01, annual catches of cobbler ranged from <1 t to 6 t.

Declining landings are partly due to an ongoing reduction in commercial effort in estuaries since 1990. However, decreasing stock abundance is also believed to be a contributing factor in each estuary.

Black bream: Black bream is an estuarine species. Each estuary hosts a discrete breeding stock of bream, which is genetically distinct to other estuarine populations.

From 2000 to 2009, 95% of commercial landings of black bream were caught in the South Coast Bioregion, with the remaining 5% from the West Coast Bioregion. In the West Coast Bioregion, total landings over this period were mainly caught in the Swan-Canning estuary (68% of landings) and in Hardy Inlet (31%). Since 2000, total annual West Coast landings of bream have ranged from 1 to 5 t, including approximately 1 t taken in 2009.

Historically, the Swan-Canning Estuary and Hardy Inlet have contributed the vast majority of commercial bream landings in the West Coast Bioregion. Occasional landings were previously taken in the Leschenault Estuary (<2 t per year), prior to the closure of that fishery. Annual landings of bream in the Peel-Harvey Estuary have always been negligible.

Historically, commercial landings of black bream have always been relatively low compared to landings of other

estuarine target species. Landings peaked at 8 t in 1996 in the Swan-Canning estuary and peaked at 4 t in 1983 in Hardy Inlet. Commercial targeting of bream in the Swan-Canning estuary has been negligible since 2007, resulting in the Hardy Inlet now being the only (albeit minor) commercial bream fishery in the West Coast Bioregion.

Recreational catch estimate (2009): NA

Most recent catch estimate (2000/01):

940 tonnes (key species only)

The recreational catch levels of finfish in nearshore and estuarine waters of the West Coast Bioregion were not estimated for 2009. The most recent estimates are from the National Recreational and Indigenous Fishing Survey conducted in 2000/01 (West Coast Nearshore and Estuarine Table 2). The exception is Hardy Inlet, where a creel survey was conducted in 2005/06¹. While the dominant species in the nearshore catch are probably similar to those caught in 2000/01, the current catch and effort levels by nearshore recreational fishers may have changed substantially since this survey. Therefore, current total catch level cannot be estimated.

Overall, the most abundant species in the retained catch (nearshore and estuarine combined) in 2000/01 were Australian herring (48% by number), whiting (various species, excluding King George) (24%), tailor (9%), southern sea garfish (3%), King George whiting (*Sillaginodes punctata*) (2%) and trevally (*Pseudocaranx* spp.).

The regions of highest catches were southern metropolitan, Mandurah and Geographe Bay/Bunbury, each of which contributed about 20% of all retained fish. In nearshore waters, 61% of retained fish were taken by shore fishers.

Surveys of boat-based recreational fishing in the West Coast Bioregion estimated catches of key nearshore species in 1996/97 and 2005/06 (West Coast Nearshore and Estuarine Table 3). Boat-based landings of many nearshore species typically declined between these surveys. This trend could indicate a decline in abundance of nearshore species. However, since landings of demersal species typically increased between surveys, it may also reflect a shift in effort by boat-based fishers towards targeting of demersal species instead of nearshore species.

The total landings of nearshore species in 1996/97 and 2005/06 were not estimated because catches by shore-based recreational fishers, who catch the majority of nearshore finfish, were not surveyed.

Approximate recreational catch shares (by weight):

The recreational catch share of total finfish landings in nearshore and estuarine waters of the West Coast Bioregion cannot be determined for the current year. Approximate catch shares have been estimated where data are available.

¹ Prior SP and Beckley LE. 2006. Creel survey of the Blackwood Estuary, 2005-06. Final report to South West Catchments Council (Project C3-01).

WEST COAST BIOREGION

Key species

8-16% of West Coast Australian salmon catch

5-10% of West Coast sea mullet catch

70% of West Coast Australian herring catch

95% of West Coast tailor catch

70% of West Coast southern sea garfish catch

65-85% of West Coast King George whiting catch

85-90% of West Coast black bream catch

Estuaries

95% of total finfish catch in Swan-Canning estuary

30% of total finfish catch in Peel-Harvey estuary

50% of total finfish catch in Hardy Inlet/Blackwood River system

100% of total finfish catch in other West Coast estuaries

Fishing effort/access level

Commercial

Since the early 1990s, the number of licences in nearshore and estuarine commercial fisheries has been substantially reduced via Voluntary Fishery Adjustment Schemes. The removal of licences has eliminated a significant amount of latent effort (inactive licences) that previously existed in these fisheries.

Fishing effort in nearshore and estuarine fisheries is sometimes reported as the number of units of access (vessels, teams, licencees, etc). These measures of effort provide a general indication of effort changes over time and are often the only types of effort data available throughout the history of each fishery. Where possible, effort is also calculated as the number of days fished by each method. It is considered that 'method days fished' generally provides a more accurate measure of the effort undertaken in each fishery.

Licence holders in the west coast estuaries that are open to commercial fishing are endorsed to fish a single estuary system only.

Peel-Harvey Estuary: During the 1980s, fishing effort (number of method days fished) averaged 5,372 days per year, but this included a period of rapid decline between 1988 and 1990. Effort then stabilised and averaged 3,463 days per year from 1990 to 2000. After another pronounced decline between 1998 and 2000, effort again stabilised, with an average of 2,045 days fished per year between 2000 and 2008. Since 2000, 43% of commercial effort (method days) has been spent targeting finfish in this estuary. There are currently 11 licences in the fishery. Since 2000, the mean number of active fishing units per month has been about 8.

Swan-Canning Estuary: The mean number of active fishing units per month declined from about 25 in the mid-1970s to 1 in 2009. The majority of total commercial effort in 2009 and other recent years has been spent targeting blue swimmer crabs.

Hardy Inlet: The mean monthly number of fishing units has declined from 3 in the 1970s to 1 in 2000 and subsequent years, including 2009. Virtually all commercial effort in 2009 and other recent years has been spent targeting finfish.

Cockburn Sound (Fish Net) fishery: Since the early 1990s, there has been a progressive decline in the number of commercial licences operating in Cockburn Sound as a result of Voluntary Fishery Adjustment Schemes. In the Cockburn Sound (Fish Net) fishery, the number of licences fell from six in the early 1990s to one in 2003 and subsequent years. The total number of method days fished declined from 474 in 2000 to 117 in 2009. All effort by this fishery is spent targeting finfish.

Moore River to Kalbarri (Proposed West Coast Inshore Net Fishery): The total number of method days fished in this region by shore-based net fishers (gill nets, haul nets and beach seines only) is relatively stable at about 450 method days per year. In 2009, 9 licencees reported finfish landings by netting methods in this region.

South West Coast Salmon Fishery: Since 2000, the number of method days fished (gill nets, haul nets and beach seines only) per year has ranged from 26 (in 2000) to 917 (in 2002). In 2009, there were 12 teams licenced to capture salmon in the West Coast Bioregion. However, only 7 of these 12 teams reported salmon catches.

West Coast Beach Bait and South West Beach Seine Fisheries: In 2009, 14 licencees reported landings of whitebait.

Recreational

Recent estimates of shore-based recreational fishing effort for the West Coast Bioregion are unavailable. Two 12-month surveys undertaken in 1996/97 and in 2005/06 estimated the total effort expended by boat-based recreational fishers in the West Coast Bioregion. The boat-based recreational line fishing effort increased 15.5% from 1996/97 (1,348,000 fisher hours) to 2005/06 (1,557,000 fisher hours). These estimates included effort expended on all species, including demersal and nearshore species. The proportion of boat-based effort spent targeting nearshore finfish during these surveys is unknown.

The 2000/01 National Recreational and Indigenous Fishing Survey, which included all methods and Bioregions, provided the most comprehensive recent information on recreational fishing effort in the West Coast Bioregion. About 95% of the nearshore and estuarine 'fishing events' that were targeting finfish during the survey used line fishing (bait or lure). About 75% of line fishing events in both nearshore and estuarine waters were shore-based. In nearshore waters, the estimated line fishing effort (either bait or lure) in 2000/01 comprised 946,841 shore-based and 308,673 boat-based fishing events during the 12-month survey period.

Stock Assessment

Assessment complete:	Yes
Assessment method:	Catch rates
Breeding stock levels:	
Australian herring	Uncertain
Tailor	Acceptable
Southern sea garfish (Cockburn Sound)	Acceptable
Whiting species (not King George)	Not assessed
Sea mullet	Acceptable
Whitebait	Acceptable
Black bream (Swan-Canning)	Acceptable
Black bream (other estuaries)	Not assessed
Cobbler (Swan-Canning)	Not acceptable
Cobbler (Peel-Harvey)	Acceptable
Cobbler (Leschenault)	Not assessed
Perth herring	Not assessed

Key finfish species - nearshore

Australian Herring (Uncertain): Australian herring form a single, genetically homogeneous breeding stock across southern Australia. Spawning occurs mainly along the lower west coast of WA. Eggs and larvae are dispersed by the Leeuwin Current to coastal nurseries distributed from the West Coast Bioregion to Victoria. A strong current can result in high annual recruitment outside the West Coast Bioregion due to greater larval dispersal. Herring caught in the South Coast Bioregion are mainly pre-spawning fish undergoing a westward migration to the West Coast Bioregion, where they will spawn during May-June. These fish originate from juvenile nurseries in the South Coast Bioregion, South Australia and (to a lesser extent) Victoria. Herring caught in the West Coast Bioregion are a combination of these fish, plus fish originating from local juvenile nurseries in the West Coast Bioregion.

Since 2000, commercial catch and catch rates suggest declining availability of herring in the South Coast Bioregion and in southern parts of the West Coast Bioregion (Capes, Geopraphe Bay and Bunbury regions) but stable or increasing availability in Perth metropolitan waters. Voluntary recreational logbook fisher catch rates also suggest a stable trend in the availability of Australian herring in Perth metropolitan waters from 2006 to 2009 (West Coast Nearshore and Estuarine Figure 2). Declining catches in the southern areas reflect the reduced availability of fish due to declining recruitment in the southern areas. Stable metropolitan catch rates possibly reflect more stable levels of annual recruitment in this area.

The cause of low recruitment in the South Coast Bioregion in recent years is not known. The effect of low South Coast stock abundance on the status of the entire stock is uncertain. Research is underway to examine the extent of connectivity

of herring populations between Bioregions, including annual variations in connectivity.

Tailor (Acceptable): Catch rates from a volunteer angling program in the Swan-Canning estuary provide an indicator of the strength of annual tailor recruitment to the lower West Coast fishery. Since this angler-based recruitment index began in 1996 there have been highly variable levels of annual recruitment (West Coast Nearshore and Estuarine Figure 3). Relatively strong recruitment occurred in 1996 and 2008.

Southern sea garfish (Acceptable): Commercial catch rates suggest a slight decline in availability of sea garfish in Cockburn Sound since the early 1990s. However, catch rates suggest a stable trend in availability since 2000. The 2009 catch was slightly above the average of annual landings over the 1996-2008 period (West Coast Nearshore and Estuarine Figure 4).

Sea mullet (Acceptable): Commercial catch rates in the Peel-Harvey Estuary suggest a stable trend in the availability of sea mullet in the West Coast Bioregion since 1990 (West Coast Nearshore and Estuarine Figure 5). Peel-Harvey catch rates are assumed to be representative of regional availability. A single breeding stock of sea mullet occurs in the West Coast Bioregion.

Whitebait (Acceptable): The 2009 total catch of 131 t of whitebait by West Coast Beach Bait and West Coast Beach Seine fisheries was within the target catch range (60-275 t). An additional 5 t of whitebait was taken by other West Coast fisheries. Highly variable annual catches are characteristic of this fishery. The large variations in catch level being strongly correlated with the environmental conditions in the previous year have continued.

Key finfish species - estuarine

Black bream (Acceptable - Swan-Canning): In the Swan-Canning Estuary, commercial and recreational catch rates suggested an increase in black bream availability between 1990 and 2000, followed by a slight decline from 2000 to 2006 (Smith 2006). Voluntary recreational logbook fisher catch rates suggest a stable trend in the availability of black bream in this estuary from 2005/6 to 2008/9 (West Coast Nearshore and Estuarine Figure 6). Black bream in other West Coast estuaries are not assessed.

Cobbler (Acceptable – Peel-Harvey; Not acceptable - Swan-Canning): Commercial catch rates suggest a stable trend in the availability of cobbler in the Peel-Harvey Estuary since 1990 (West Coast Nearshore and Estuarine Figure 5). Cobbler in the Swan-Canning Estuary was assessed via catch rate trends until a fishing ban was imposed in 2007. Cobbler in Leschenault Estuary has not been assessed since the commercial fishery closure in 2000.

Perth herring (Not assessed): Perth herring was assessed via commercial catch rate trends in the Swan-Canning Estuary until cessation of fishing for this species in 2007. Catch rates suggested a major decline in the availability of Perth herring after 1980. Swan-Canning catch rates are assumed to be representative of regional availability. A single breeding stock of Perth herring occurs in the West Coast Bioregion. Limited evidence suggests regional

WEST COAST BIOREGION

abundance remains relatively low compared to historical levels. However, insufficient information is available to assess current stock status. The development of fishery-independent monitoring methods is required for this species. Environmental degradation in the upper reaches of estuaries resulting in low spawning success is believed to be the main cause of low abundance.

Non-Retained Species

Bycatch species impact: **Low**

The small-scale commercial fisheries in nearshore and estuarine waters mainly use gill, seine and haul nets that are deployed in a targeted manner. Few non-target species are taken. Mesh size regulations ensure that target species caught by these methods are within an appropriate size range. Minimal discarding occurs because virtually all fish taken can be retained and marketed.

Recreational fishers mainly use line-based methods in nearshore and estuarine waters. This method can result in the capture and release of a significant number of non-target species and undersized fish. The risks associated with post-release mortality vary considerably among species. In general, fish in nearshore and estuarine waters are captured from shallow depths and suffer less barotrauma-related injuries than deep water species.

Protected species interaction: **Negligible**

No protected species are susceptible to capture by the fishing gear used in these commercial fisheries. Commercial fishers are required to report all interactions with protected species.

Recreational fishers using line-fishing methods are unlikely to capture protected species. Interactions are expected to be insignificant.

Ecosystem Effects

Food chain effects: **Low**

Current levels of commercial effort are relatively low. Excessive removal by commercial and recreational fisheries of certain species, such as whitebait, Australian herring or salmon, from the food chain could potentially impact on prey and predator species including larger fish, cetaceans and seabirds.

Habitat effects: **Low**

The operation of gill nets and haul nets over predominantly sand and mud bottoms is unlikely to have any impact on these habitats in estuaries and nearshore waters. Similarly, the line fishing methods used by recreational fishers have a negligible impact on the bottom substrates. Anchoring by recreational fishing vessels may have localised impacts on habitats such as seagrass.

Social Effects

Commercial - nearshore

During 2009, there were 2 commercial fishers operating in the Cockburn Sound (Fish Net) Managed Fishery. Landings from this fishery are used to supply restaurant and retail sectors in the Perth metropolitan area.

In 2009, there were 3-7 commercial fishers per month operating within the West Coast Salmon Fishery during the salmon season. There were 12 -23 commercial fishers per month employed in various fisheries targeting herring during the main herring fishing season. Herring and salmon fishers in the West Coast Bioregion supply local bait and human consumption markets.

Commercial - estuarine

In 2009, there was an average of 14 commercial fishers per month operating in the West Coast Estuarine fishery, largely supplying fresh fish to meet demand for locally-caught product.

Recreational

The estuaries and nearshore waters of the West Coast Bioregion are key areas for recreational fishing and other activities such as snorkelling. Therefore fish resources have a high social value in the region.

Economic Effects

Estimated annual commercial value (to fishers)

for 2008/09: \$ 618,514

Fishery Governance

Commercial:

Current Fishing (or Effort) Level:

West Coast Estuarine Fishery Acceptable

Cockburn Sound (Fish Net) Fishery Acceptable

South West Salmon Fishery Acceptable

West Coast Australian herring fisheries

Acceptable

West Coast Beach Bait and South West Beach

Seine Fisheries Acceptable

Target commercial catch range:

West Coast Estuaries:

75 – 220 tonnes (Peel/Harvey only)

Cockburn Sound (Fish Net) Fishery:

30 – 112 tonnes (finfish only)

South West Salmon Fishery:

1200 – 2800 tonnes (includes south coast landings)

West Coast Australian herring fisheries:	70 – 185 tonnes
Whitebait fisheries:	60 – 275 tonnes
Recreational:	
Current Fishing (or Effort) Level	NA
Target catch range:	Not developed

New management initiatives (for the next year)

Development of new management arrangements for the West Coast Inshore Net Fishery operating in nearshore waters from north of the Moore River to the Zuytdorp Cliffs south of Shark Bay. The proposed fishery is a haul net and beach seine fishery. Targeted species are mullet, whiting, herring and tailor.

Implementation of new management arrangements for the South-West Beach Seine (SWBS) Fishery (Bunbury sector).

External Factors

Nearshore

A number of the species in this suite are known to have their abundance levels affected by annual variation in coastal currents (particularly the Leeuwin and Capes Currents) that appear to influence the recruitment patterns of larvae of nearshore species such as whitebait, tailor, herring and salmon and thus their subsequent recruitment into each fishery (Lenanton et al, 2009¹).

The abundance of nearshore species is likely to be affected by the quantity and quality of coastal habitats that are available for spawning, feeding and/or nursery areas. For example, loss of seagrass in Cockburn Sound is likely to have reduced sea garfish abundance. Since the 1950s, approximately 80% of the seagrass meadows in Cockburn Sound have been lost as a result of environmental degradation (Cockburn Sound Management Council 2005²).

Fluctuating market demand is a significant factor affecting the annual commercial catch level of many species.

Estuaries

West Coast estuaries are highly modified, and often degraded, environments. In these estuaries, the impacts of environmental factors on stock abundances are likely to be at least as important as fishing pressure. Anecdotal reports suggest that habitat and climatic changes have altered the composition and abundance of fish communities in west coast estuaries, although lack of historical monitoring makes many of these changes difficult to quantify. However, in the Swan-Canning Estuary, abundant fishery data provides evidence of marked declines in fish abundance since 1990 or earlier (Smith 2006³). Stock declines in West Coast estuaries are most pronounced among 'estuarine-dependent' species, i.e. those that rely on estuarine habitats for spawning, feeding and/or nursery areas (e.g. cobbler, Perth herring, black bream).

¹ Lenanton R C, Caputi N, Kangas M & Craine M 2009 The ongoing influence of the Leeuwin Current on economically important fish and invertebrates off temperate Western Australia – has it changed? *Journal of the Royal Society of Western Australia* 92: 111–127.

²Cockburn Sound Management Council. 2005. Environmental Management Plan for Cockburn Sound and its Catchment. Department of Environment, Perth.

³Smith KA. 2006. Review of fishery resources and status of key fishery stocks in the Swan-Canning Estuary Fisheries Research Report 156. Department of Fisheries, Perth.

WEST COAST BIOREGION

WEST COAST NEARSHORE AND ESTUARINE TABLE 1

Total annual catches from the nearshore and estuarine commercial fisheries in the West Coast Bioregion, 2005 to 2009.

Species	Scientific name	Catch (tonnes)				
		2005	2006	2007	2008	2009
Australian salmon	<i>Arripis truttaceus</i>	790.1	1193.4	622.9	333.4	494.6
Whitebait	<i>Hyperlophus vittatus</i>	158.2	231.2	99.1	57.9	135.8
Sea mullet	<i>Mugil cephalus</i>	111.6	98.4	99.6	94.8	80.4
Australian herring	<i>Arripis georgianus</i>	83.1	43.6	41.5	34.7	32.4
Yellow-eye mullet	<i>Aldrichetta forsteri</i>	36.2	26.6	37.0	26.2	17.4
Yellow-finned whiting	<i>Sillago schomburgkii</i>	34.1	31.7	22.4	21.5	22.4
Sea Garfish	<i>Hyporhamphus melanochir</i>	19.1	11.1	11.5	11.0	15.6
Blue sprat	<i>Spratelloides robustus</i>	12.0	10.3	14.5	13.7	7.1
Perth herring	<i>Nematalosa vlaminghi</i>	9.8	4.1	5.6	0.7	1.5
Cobbler	<i>Cnidoglanis macrocephalus</i>	3.5	0.7	0.8	6.9	8.3
Tailor	<i>Pomatomus saltatrix</i>	4.0	1.8	1.7	1.5	5.3
King George whiting	<i>Sillaginodes punctata</i>	2.5	2.0	0.9	5.1	1.7
Yellowtail scad	<i>Trachurus novaezelandiae</i>	3.5	1.5	2.2	2.5	1.2
Black bream	<i>Acanthopagrus butcheri</i>	4.9	2.4	0.9	1.0	1.1
Trevally	Carangidae	0.9	1.5	1.6	0.7	1.4
Other finfish	Teleostei	4.6	3.0	2.8	1.1	0.7
Other baitfish (not Whitebait)	Clupeidae	1.8	0.1	1.6	0.7	0
Sharks and rays	Elasmobranchii	0.3	0.3	0.1	0	0
TOTAL		1280.2	1663.6	966.5	613.3	826.7

WEST COAST NEARSHORE AND ESTUARINE TABLE 2

Estimated total catches of key species by recreational fisheries in nearshore and estuarine waters in the West Coast Bioregion in 2000/01 (Henry and Lyle 2003¹).

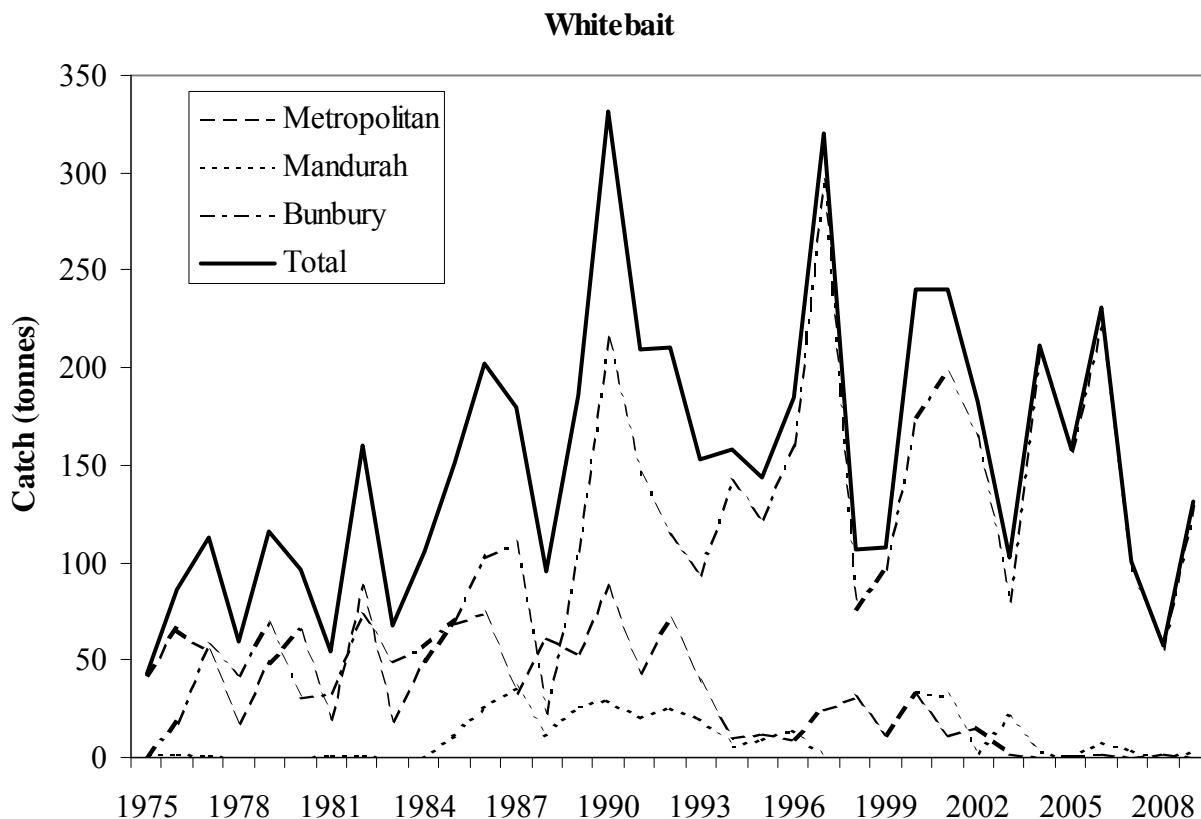
Species	Scientific name	2000/01 Catch (tonnes)
Australian herring	<i>Arripis georgianus</i>	438
Tailor	<i>Pomatomus saltatrix</i>	187
Whiting	<i>Sillago</i> spp.	154
King George whiting	<i>Sillaginodes punctata</i>	60
Trevally	<i>Pseudocaranx</i> spp.	42
Southern sea garfish	<i>Hyporhamphus melanochir</i>	35
Black bream	<i>Acanthopagrus butcheri</i>	24
TOTAL		940

¹ Henry GW and Lyle JM. 2003. The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

WEST COAST NEARSHORE AND ESTUARINE TABLE 3

Total annual catch estimates (+ standard error) (tonnes) of key nearshore species by boat-based recreational fishers in the West Coast Bioregion in 1996/97 and 2005/06 (Sumner *et al.* 2008 ¹).

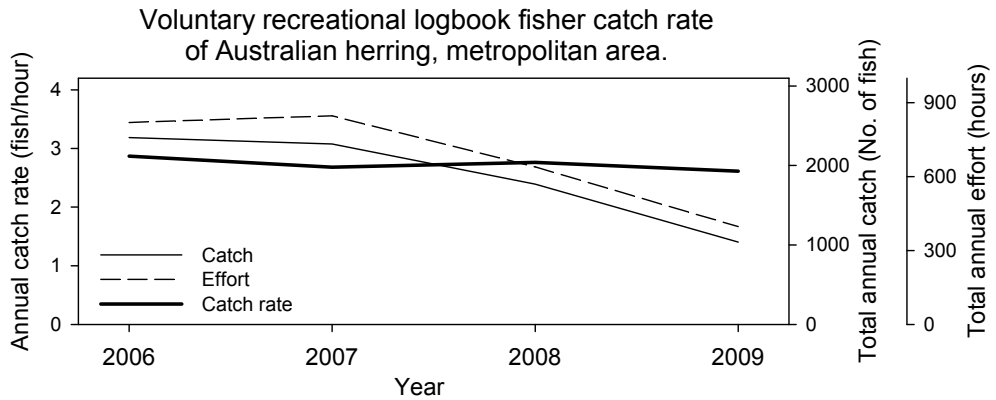
Species	Scientific name	1996/07 Catch (se)	2005/06 Catch (se)
Whiting	<i>Sillago</i> spp.	58 (9)	46 (3)
Australian herring	<i>Arripis georgianus</i>	46 (7)	40 (2)
Trevally	<i>Pseudocaranx</i> spp.	38 (10)	34 (4)
King George whiting	<i>Sillaginodes punctata</i>	28 (4)	19 (1)
Snook	<i>Sphyaena novaehollandiae</i>	23 (11)	9 (2)
Australian salmon	<i>Arripis truttaceus</i>	12 (5)	17 (3)
Tailor	<i>Pomatomus saltatrix</i>	14 (4)	3 (0.7)
Southern sea garfish	<i>Hyporhamphus melanochir</i>	7 (2)	2 (0.2)

**WEST COAST NEARSHORE AND ESTUARINE FIGURE 1**

Annual catches of whitebait along the West Coast, by fishing region, 1975 –2009

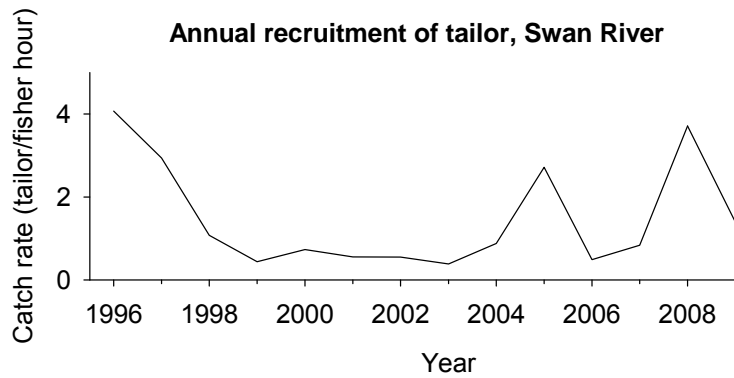
¹ Sumner NR, Williamson PC, Blight SJ and Gaughan DJ. 2008. A 12-month survey of recreational boat-based fishing between Augusta and Kalbarri on the West Coast of Western Australia during 2005-06. Fisheries Research Report 177. Department of Fisheries, Perth.

WEST COAST BIOREGION



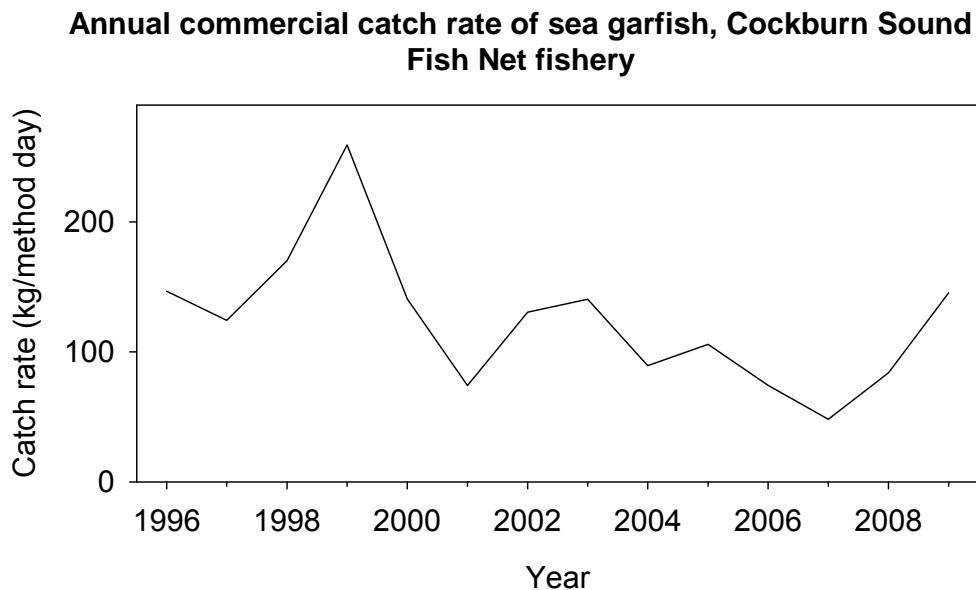
WEST COAST NEARSHORE AND ESTUARINE FIGURE 2

Total annual catch, effort and catch rate of Australian herring by voluntary recreational logbook fishers in Perth metropolitan area (shore fishing only), 2005 – 2009.



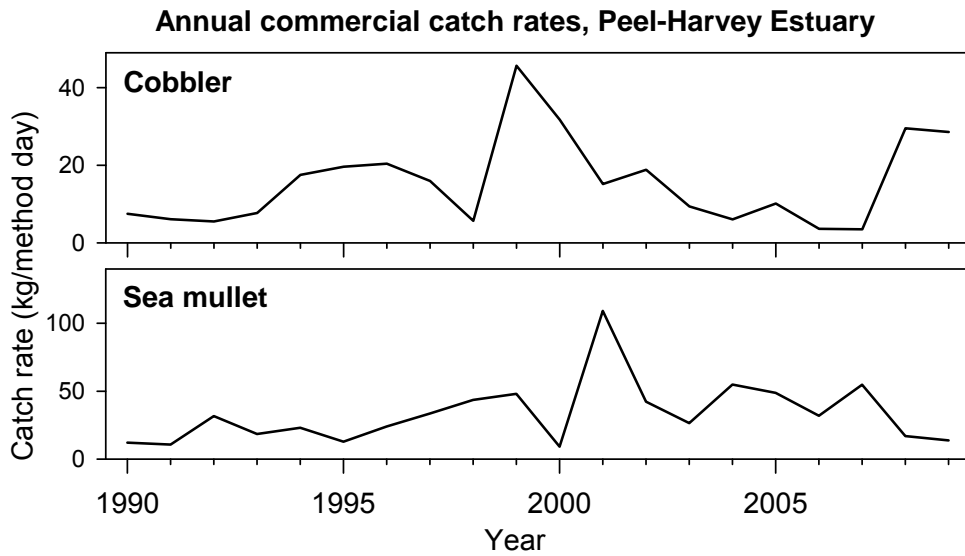
WEST COAST NEARSHORE AND ESTUARINE FIGURE 3

The annual recruitment index for the lower west coast Tailor fishery over the period 1996 – 2009, derived from volunteer angler catch rates of age 0+ juveniles in the Swan Estuary.



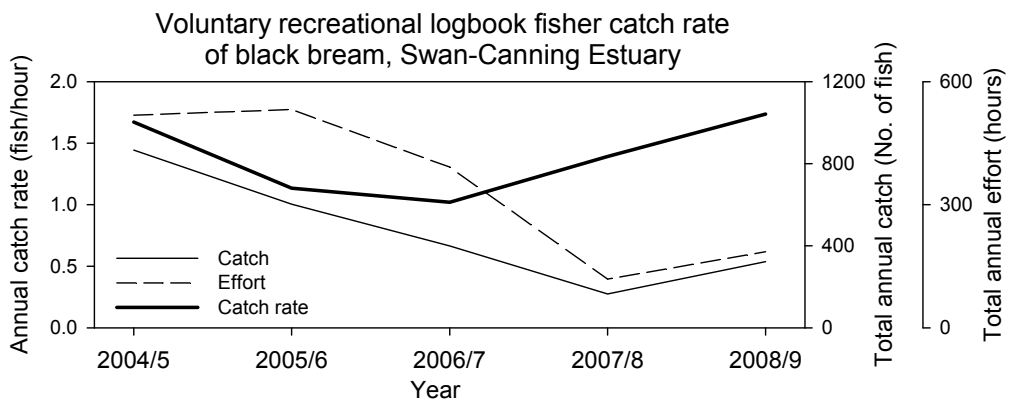
WEST COAST NEARSHORE AND ESTUARINE FIGURE 4

Standardised annual commercial catch rate of sea garfish in Cockburn Sound (Fish Net) Fishery, 1996 – 2009.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 5

Standardised annual commercial catch rates of cobbler and sea mullet in Peel-Harvey Estuary Fishery, 1990 – 2009.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 6

Total annual catch, effort and catch rate of black bream by voluntary recreational logbook fishers in Swan-Canning Estuary, 2004/5 – 2008/9.

West Coast Purse Seine Fishery Report: Statistics Only

B. Molony and E. Lai

Management input from N. Moore

Fishery Description

The West Coast Purse Seine Fishery mainly captures pilchards (*Sardinops sagax*) and the tropical sardine *Sardinella lemuru* (hereafter referred to as sardinella) by purse seine in the West Coast Bioregion. Smaller catches of Perth herring (*Nematalosa vlaminghi*), yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus teres*) are also reported.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

West Coast Purse Seine Management Plan 1989

Fisheries Notice 312 Purse Seine Prohibition

Fisheries Notice 571 Pilchard Fishing Prohibition

Fisheries Notice 476 Net Hauling Restrictions

West Coast Purse Seine Managed Fishery Licence

Fishing Boat Licence Condition 93 (specific to the Southern and Northern Development Zones)

Fishing Boat Licence Condition 176 (Pilchard Authorisation)

Consultation Process

Meetings between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council).

Boundaries

There are three defined fisheries. The Perth metropolitan fishery operates between 33° S and 31° S latitude. The Southern Development Zone covers waters between 33° S and Cape Leeuwin. The Northern Development Zone covers waters between 31° S and 22° S.

Management arrangements

This fishery is managed through a combination of input and output controls incorporating limited entry, capacity setting and controls on gear and boat size.

Access to the Perth Metropolitan fishery is limited to 12 licences that must fish in accordance with the *West Coast Purse Seine Management Plan 1989*. Both pilchards and sardinella are the main target species in the Metropolitan fishery. There are three fishing boat licences with a specific condition that permits the taking of fish using a purse seine net that is hauled by the use of a power block within specific waters of the Southern Development Zone. Two of those fishing boat licences may also retain pilchards. A further three fishing boat licences permit the taking of fish using a

purse seine net that is hauled by the use of a power block in the Northern Development Zone and sardinella is the main target species.

Currently, a notional combined total allowable catch (TAC), covering both the Perth metropolitan fishery and the Southern Development Zone, is set for pilchards and another for other small pelagic species. For the 2009/10 licensing period (1 April 2009 – 31 March 2010) a notional TAC of 2,328 t for pilchards, with separate TAC of 672 t for the other small pelagic species (including sardinella) is in place. The Northern Development Zone has a separate notional TAC. Reaching or exceeding the notional TACs will trigger a management response.

Landings and Effort

Effort levels remain low in 2009. Total catches were 45.2 t, down from 139 t in 2007, 121.3 t in 2008¹ and well below the 4,000 t catches recorded in the mid to late 1990s (West Coast Purse Seine Figure 1).

Fishery Governance

Target commercial catch range: 0 – 3,000 tonnes

Current Fishing (or Effort) Level: Acceptable

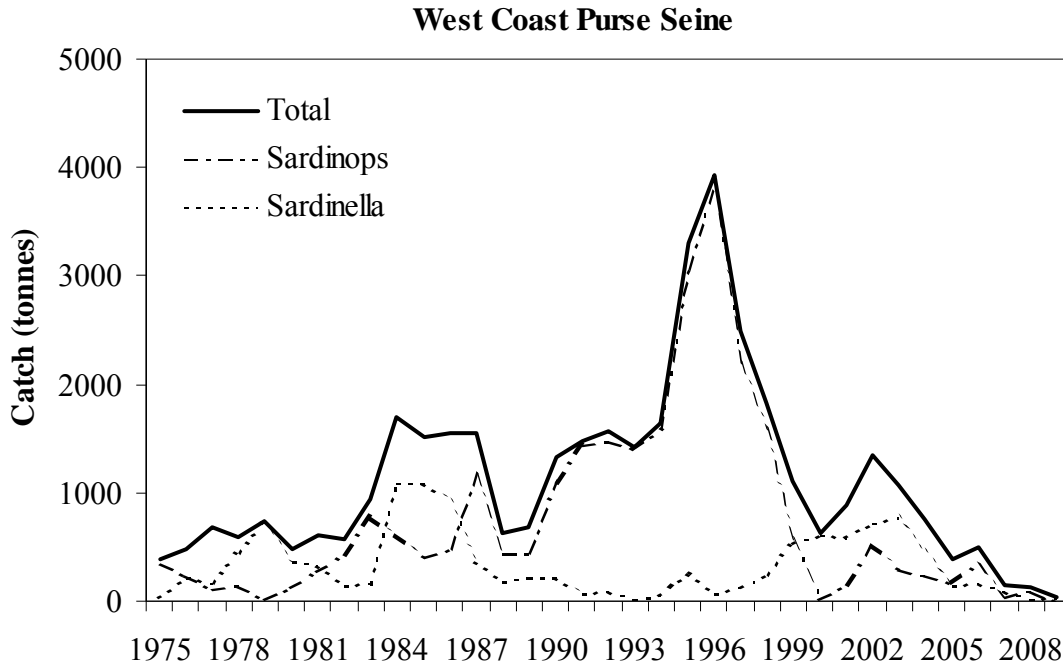
Recently, total catch and effort have varied among years due to factors other than stock size (e.g. demand, economics). In addition, fishers have reported that the presence of schools is not as predictable as in previous years.

New management initiatives (2010/11)

The Department is planning to develop a new management plan for this fishery which will incorporate the Southern and Northern Development zones along with the Perth metropolitan fishery into a single West Coast Purse Seine fishery.

The implementation of the new management plan will move the fishery to a formal quota system with tradeable, individually transferable quota (ITQ) units and a TAC. The ITQ unit values will be reviewed annually and changed as required, depending on stock levels.

¹ The 2008 total differs from that reported in the State of the Fisheries 2008/09 Report due to the late submission of returns.



WEST COAST PURSE SEINE FIGURE 1

Annual catches of pilchards (*Sardinops*) and *sardinella* in the West Coast Purse Seine Fishery, 1975 –2009.

West Coast Demersal Scalefish Fishery Status Report

D. Fairclough, E. Lai and C. Bruce

Management input from N. Harrison, N. Moore and C. Syers

Main Features				
Status		Current Landings		
Stock level	Inadequate	Commercial sector:		
		WCDSIMF (2009)	303 t	
		DGDLF (2008/09)	77 t	
		Total	380 t	
Fishing Level		Indicator species	WCDSIMF	DGDLF
Commercial:	Acceptable		(2009)	(2008/09)
Recreational:	Unacceptable in 2005/06 (last available complete estimate)	Pink Snapper	110 t	9 t
		West Australian Dhufish	48 t	15 t
		Baldchin Groper	11 t	3 t
		Recreational sector (2005/06, last estimate)		
		Indicator species:		
		Pink Snapper	40 t	
		West Australian Dhufish	186 t	
		Baldchin Groper	28 t	
		Charter sector (2009)		
		Indicator species:		
		Pink Snapper	10 t	
		West Australian Dhufish	9 t	
		Baldchin Groper	7 t	

Fishery Description

The West Coast Demersal Scalefish Fishery (WCDSF) includes mostly line-fishing operations by commercial, charter and recreational sectors. Up to about 100 species, mostly from the west coast inshore demersal scalefish suite, are caught in the fishery each year, with fishers in each sector primarily targeting West Australian Dhufish (*Glaucosoma hebraicum*) and Pink Snapper (*Pagrus auratus*). Substantial catches are also taken of other species in this suite, such as Baldchin Groper (*Choerodon rubescens*), Red Throat Emperor (*Lethrinus miniatus*) and Bight Redfish (*Centroberyx gerrardi*). A range of species is taken in offshore waters that belong to the west coast offshore demersal scalefish suite, including Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneios*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.

Commercial

A limited number of commercial fishers operate in the West Coast Demersal Scalefish (Interim) Managed Fishery (WCDSIMF). Fishers use handlines and droplines to target demersal species. However, fishers in the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF), the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF), the West Coast Rock Lobster Managed Fishery, the Cockburn Sound Pot and Line Fishery and Commonwealth Western Deepwater Trawl Fishery operators also catch demersal species. Note, the WCDGDLF and the part of the JASDGDLF that operates within the boundaries of the WCDSF is referred to collectively as the demersal gillnet and demersal longline fisheries (DGDLF) in this section.

Fishing and Aquatic Tour Industry (Charter)

Demersal scalefish are targeted by the fishing activities of the charter boat industry in the West Coast Bioregion. Line fishing is the main method used by operators licensed to fish in that sector. A small number of fishing tour operators also cater for recreational diving charters.

Recreational

Recreational fishers that target demersal species in the WCDSF are almost exclusively boat-based. Line fishing is the main method used by recreational fishers, although spear fishing also occurs, but mainly in shallow waters, i.e. < 20 m deep.

Governing legislation/fishing authority

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995

Commercial

Fishing Boat Licence

West Coast Demersal Scalefish (Interim) Management Plan 2007

West Coast Demersal Scalefish Interim Managed Fishery Permit

Fishing and Aquatic Tour Industry (Charter)

Fish Resources Management Regulations 1995 and recreational fishing regulations

Fishing Tour Operator Licence, Restricted Fishing Tour Operators Licence and/or Aquatic Eco-Tourism Licence

Recreational

Recreational fishing regulations

Consultation process**Commercial**

Meetings between the Department of Fisheries and permit holders in the West Coast Demersal Scalefish Interim Managed Fishery.

The Western Australian Fishing Industry Council

Fishing and Aquatic Tour Industry (Charter)

Recreational Fisheries Advisory Committee (RFAC)

Charter Boat Owners & Operators Association

Recfishwest

Recreational

RFAC and a network of 12 Regional Recreational Fishing Advisory Committees

Recfishwest

Boundaries**Commercial fishery**

The WCDSIMF encompasses the waters of the Indian Ocean just south of Shark Bay (at 26°30'S) to just east of Augusta (at 115°30'E) and extends seaward to the 200 nm boundary of the Australian Fishing Zone (AFZ). The commercial

fishery is divided into five management areas comprising four inshore zones and one offshore zone. The inshore zones, i.e. Kalbarri, Mid-West, Metropolitan and South-West, extend outwards to the 250 m depth contour, while the Offshore zone extends from the 250 m depth contour to the boundary of the AFZ (West Coast Demersal Scalefish Figure 1). The Metropolitan Inshore zone was closed to commercial operators in the WCDSIMF and WCDGLF (West Coast Demersal Scalefish Figure 1) in November 2007.

Fishing and Aquatic Tour Industry (Charter) and Recreational fishery

The boundaries applicable to the charter and recreational sectors in the West Coast Bioregion encompass the waters of the Indian Ocean just south of Shark Bay (at 27°00'S) to just east of Augusta (at 115°30'E) and extend seaward to the 200 nm boundary of the AFZ (West Coast Demersal Scalefish Figure 1). The exact latitudes and longitudes delineating the tour management zones of the charter fishery are listed in Schedule 15 of the Fish Resources Management Act 1994.

Management arrangements**Commercial**

The West Coast Demersal Scalefish (Interim) Managed Fishery was established in January 2008, following the introduction of the *West Coast Demersal Scalefish (Interim) Management Plan 2007*. Access to the Fishery is restricted to 61 Interim Managed Fishery Permit holders. Gear and other restrictions apply (in the form of maximum numbers of lines and hooks and arrangements regulating the carriage of lines and fish) and boats are monitored under the Vessel Monitoring System (VMS).

Each of the four inshore management areas is allocated a maximum number of hours of fishing time that may be fished on an annual basis. Units are allocated to permits and provide entitlement in "hours" of fishing time. The use of VMS allows fishing effort to be monitored and entitlement acquitted accordingly. The total capacity of the Fishery restricts fishing effort at a level to ensure that the demersal scalefish catch limits are not exceeded. The capacity can be adjusted, as required.

The primary management objective is to maintain scalefish catches to at least 50 % of those of scalefish catches recorded in the West Coast Bioregion during 2005/06. The catch in each management zone also should not exceed 50 % of the 2005/06 catch in that zone. Additional specific management objectives (50 % of the 2005/06 catch) are set for each indicator species (Pink Snapper, Western Australian Dhufish and Baldchin Groper) in the WCDSIMF and in each zone in which they are an indicator. The status of the three indicator species are used to indicate the status of the entire west coast demersal suite of scalefish species.

Fishers are required to report their catch using daily/trip statutory fishing returns, which provide the Department of Fisheries with fine-scale reporting (10nm x 10nm blocks) for enhanced catch and effort analyses.

WEST COAST BIOREGION

Fishing and Aquatic Tour Industry (Charter)

There are three types of fishing and aquatic tour licence categories.

Fishing Tour Operators Licence: The focus is on fishing activities where fish can be taken home at the end of the tour.

Restricted Fishing Tour Operators Licence: The focus is on eco-tourism activities, such as snorkelling or scuba diving, with fishing only allowed for the purpose of a meal eaten during the course of the tour. No fish can be taken home at the end of the tour and any fishing for a meal must be done with a handline. Fishing rods are not permitted on this tour category.

Aquatic Eco-Tourism Operators Licence: The focus is entirely on eco-tourism activities and fishing is strictly prohibited.

Within each category, there is the provision for a boat-based operation (boat size larger than 7.5 m), a combination land/aircraft/boat (boat size less than 7.5 m) based operation and a land-based operation. Except where extraordinary circumstances can be demonstrated by the applicant, new Fishing Tour Operators Licences are no longer granted. Applications for Restricted Fishing Tour Operators Licences and Aquatic Eco-Tourism Operators Licences are still considered. Currently, the consideration of any Tour Operator's Licence Application is carried out in accordance with Regulations 128B and 128J of the Fish Resources Management Regulations 1995 and Ministerial Policy Guideline No. 12 'Assessment of Applications for the Granting, Renewal or Transfer of Fishing Tour Operators Licences and Aquatic Eco-Tourism Operators Licences'. All fishing is subject to recreational fishing regulations (see below).

Catches reported in this document are from records of fishing from all vessels operating under the Fishing Tour Operators Licence and those vessels that fished operating under the Restricted Fishing Tour Operators Licence.

Recreational

The recreational fishery for west coast demersal scalefish is managed using input (e.g. size limits, seasonal spawning closures for particular species and spatial closures) and output controls (e.g. limits on the numbers of fish that can be taken by individuals and boats).

A suite of new management arrangements was introduced during 2009/10 aimed at reducing the recreational take of demersal scalefish in the West Coast Bioregion by at least 50% from 2005/06 levels. Fishing for "high risk" demersal scalefish will be prohibited during a two month closed season between 15 October and 15 December. From 15 December 2009 the existing boat limit for "high risk" species will be revoked and the "high risk" species category (combined daily bag limit of four fish) will be separated into a "high risk demersal" species category (combined daily bag limit of two fish) and a "pelagic" species category (combined bag limit of two fish).

The individual daily bag limit for dhufish will be reduced from 2 to 1 fish and a boat limit of two dhufish will apply on a private recreational boat. A boat limit of six dhufish will

apply on a licensed charter boat. The minimum legal size limit for pink snapper will increase from 45 cm to 50 cm when taken from the waters of the West Coast Bioregion, south of Lancelin.

To assist in minimising the effects of barotrauma, boat fishers will also be required to carry a 'release weight' to fish for, or be in possession of demersal scalefish in the waters of the West Coast Bioregion. From 2 March 2010 all persons fishing from a powered boat anywhere in the state will be required to hold a Recreational Fishing from Boat Licence or fish in the company of a licence holder. The Recreational Fishing from Boat Licence will provide a state-wide database of recreational boat fishers for survey purposes.

Research summary

Research in the WCDSF is focused on monitoring the status of the indicator species for the fishery, which are West Australian Dhufish, Pink Snapper and Baldchin Groper. They were chosen both because of their importance to the fishery, but also because of their inherent vulnerability to fishing, e.g. they are long-lived, have low natural mortality and are relatively slow growing. Their status is used to indicate the status of the entire west coast inshore demersal suite of scalefish species.

Fish frames of the indicator species are collected from both recreational and commercial fishers in the different zones of the West Coast Bioregion (West Coast Demersal Scalefish Figure 1). Otoliths are used to determine age compositions for each zone and, from which, estimates of fishing mortality are calculated which enables the status of the stocks to be determined.

Surveys of boat-based recreational fishing continued in 2009.

Catch and effort data both for the commercial and charter sectors were monitored from fishers' daily/trip logbooks, which provide fine-scale data from 10 nm × 10 nm and 5 nm × 5 nm blocks, respectively. Onboard validation of logbook entries will be conducted in the future.

Estimates of the number of individuals of demersal species caught as bycatch by the Rock Lobster fishery were determined from at-sea monitoring in 2008/09. Full details are reported in the Rock lobster fishery status report.

A WAMSI-funded project is underway to investigate the stock structure of West Australian Dhufish, Pink Snapper and Baldchin Groper in the West Coast Bioregion and is a collaboration between the Department of Fisheries, CSIRO and Murdoch University. The project is using both genetic and otolith microchemistry techniques, but is also examining oceanographic influences on larval dispersal.

A project to investigate site-fidelity of adult Pink Snapper to Cockburn Sound spawning aggregations commenced in 2009, using acoustic telemetry techniques.

Surveys of the numbers of Pink Snapper eggs in Cockburn Sound were conducted to produce an estimate of spawning stock biomass using a daily egg production model.

A State NRM-funded project focused on small juvenile West Australian Dhufish (< 150 mm in length) also commenced in early 2010.

Retained Species

Commercial production

WCDSIMF (2009)	303 tonnes
DGDLF (2008/09)	77 tonnes
Total	380 tonnes

Indicator species

WCDSIMF (2009)	
Pink Snapper	110 tonnes
West Australian Dhufish	48 tonnes
Baldchin Groper	11 tonnes
DGDLF (2008/09)	
Pink Snapper	9 tonnes
West Australian Dhufish	15 tonnes
Baldchin Groper	3 tonnes
Total	
Pink Snapper	119 tonnes
West Australian Dhufish	63 tonnes
Baldchin Groper	14 tonnes

Mackerels, bluefin tunas, sharks and rays are not permitted to be retained by fishers in the West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF). Catches of these species are reported elsewhere.

Landings

As permits are issued for the calendar year, commercial catches will now be reported in the same way. This is in contrast to years prior to the commencement of the WCDSIMF, for which, catches were reported according to financial year.

In 2009, 303 t of scalefish were caught by commercial fishers in the WCDSIMF, which was 110 t less than in 2008, of the total catch, 281 t comprised demersal species. The lower overall catch would have been influenced by the introduction of the entitlements in the latter year and the effects that had on fishing behaviour as permit-holders rearrange their fishing activities under the new management plan. Commercial catches in the Kalbarri, Mid-west, South-west and Offshore zones in 2009 were 118, 116, 63 and 6 t, respectively, and those zones comprised 112, 101, 62 and 6 t of demersal species.

The WCDSIMF catch in 2009 consisted of 72 scalefish species or species groups, 51 of which belong to the west coast inshore and offshore demersal scalefish suites and 21 are from either the west coast pelagic or nearshore scalefish suites. Six species comprised 87 % of the total catch and included the three demersal indicator species, *i.e.* Pink Snapper (110 t), West Australian Dhufish (48 t) and Baldchin Groper (11 t). The other three species/species groups were the Redthroat Emperor (41 t), Redfish (*Centroberyx* spp 42 t) and the pelagic Samson Fish (16 t). Catches of species from the west coast offshore demersal suite, such as Eightbar

Grouper and Hapuku, were each less than 2 t.

Catches of scalefish in the DGNDLF in 2008/09 (77 t) comprised 64 t of demersal species. These catches have declined from those of demersal species in 2007/08 (84 t) (West Coast Demersal Scalefish Table 1).

West Australian Dhufish: The total WCDSIMF catch of 48 t of dhufish in 2009 was 27 t less than in 2008. Of that, approximately 3, 30 and 15 t were caught in the Kalbarri, Mid-West and South-west zones, respectively (West Coast Demersal Scalefish Figure 2). The catch of dhufish in the DGDLF was 14.5 t in 2008/09, which is less than in 2007/08 (19.9) (West Coast Demersal Scalefish Table 1).

Pink Snapper: The WCDSIMF catch of Pink Snapper in 2009 (110 t) was lower than in 2008 (141 t). The vast majority of Pink Snapper was caught in the Kalbarri (66 t) and Mid-west zones (41 t), with only 3 t taken in the South-west zone (West Coast Demersal Scalefish Figure 3). In the DGDLF, the catch of Pink Snapper fell from 14 t in 2007/08 to 8.6 t in 2008/09 (West Coast Demersal Scalefish Table 1).

Baldchin Groper: In 2009, approximately 11 t of Baldchin Groper was landed, almost exclusively in the Mid-west (10 t) and Kalbarri zones (1 t), with approximately 8 t of that being caught by WCDSIMF entitlement holders operating within the boundaries of the Abrolhos Zone A of the West Coast Rock Lobster Fishery (Abrolhos zone). The total catch is similar to the 12 t taken in 2008 and below the limit of 17 t for the WCDSIMF (West Coast Demersal Scalefish Figure 4). The DGDLF catch of Baldchin Groper increased slightly to 3.2 t in 2008/09 from 2 t in 2007/08 (West Coast Demersal Scalefish Table 1).

Last available recreational catch estimate (excluding charter, 2005/06)

Dhufish:	186 tonnes
Pink Snapper:	40 tonnes
Baldchin Groper:	28 tonnes

The last published creel survey was conducted in 2005/06 which estimated that 186 t of dhufish and 28 t of baldchin groper were retained, similar to the catch levels of these species by the commercial sector during the same period. The 40 t of pink snapper retained by recreational boat fishers in this period was much lower than the commercial sector (278 t) in that year.

Subsequently, creel based surveys of boat-based recreational fishers in the Metropolitan zone of the West Coast Bioregion were undertaken in 2007/08; for the whole Bioregion in both 2008/9 and 2009/10. Analyses of these data are still being completed using the updated techniques suggested by an independent review of the recreational estimation techniques that occurred in 2009/10. In addition to publishing the estimates for the new surveys, the Department will re-analyse the historical recreational catch and effort data and generate new estimates of recreational catch and effort for the West Coast Demersal Scalefish fishery. Using the new analysis methods, it is likely that historical recreational catch estimates will increase and there will be wider confidence limits around these estimates.

WEST COAST BIOREGION

Charter catch (2009)

Pink Snapper:	10 tonnes
West Australian Dhufish:	9 tonnes
Baldchin Groper:	7 tonnes

The charter boat catches of Pink Snapper and West Australian Dhufish in 2009¹ were lower than in the 2007/08 financial year, i.e. 10 vs 22 and 9 vs 15 t, respectively, while those of Baldchin Groper were similar to 2007/08 (7 vs 8 t) (West Coast Demersal Scalefish Table 2). Those three species were the highest ranked in terms of catch, while catches of other species, where weights could be determined, did not exceed 4 t.

Fishing effort/access level

Commercial

Permit holders in the WCDSIMF are allowed to fish from 1st January to 31st December each year and are allocated entitlements (hours) to fish in specific zones of the fishery in that year. Entitlements based on hours were allocated for the first time for the 2009 fishing year.

Previously only statutory logbooks were required which produced estimates of effort as days fished, i.e. the sum of the days on which each vessel fished in each zone. This did not reflect the number of hours fished. The total number of days fished in 2008 (2,435) and 2009 (1,445) is markedly lower than in the financial years prior to the WCDSIMF, e.g. 8,486 days in 2006/07.

Commercial fishers now report the hours spent searching and fishing, the length of their fishing sessions and their trips in statutory daily/trip logbooks. The calculation of effort and the most appropriate measure for use in the calculation of catch per unit effort (CPUE) will be reviewed in 2012, as part of the next stock assessment.

In 2009, 46 permitted vessels fished for approximately 14,700 hours. In the Kalbarri zone, 4,056 fishing hours were reported by 17 vessels, while 8,015 (35 boats) and 2,623 hours (8 boats) were reported for the Mid-west and South-west zones, respectively. Note that some vessels have entitlements to fish in more than one zone.

Recreational

Total recreational fishing effort for the West Coast Bioregion is not yet available for 2009.

Fishing and Aquatic Tour Industry (Charter)

During 2009², 67 charter licenses reported having undertaken charter fishing operations on 14,731 days which represents about 67 % of the effort in the 2007/08 financial year.

¹ At the time of writing this report, 90 % of charter fishery logbooks had been submitted for 2009.

² At the time of writing this report, 90 % of charter fishery logbooks had been submitted for 2009.

Stock Assessment

Assessment complete

Yes (last full assessment 2007/08)

Assessment method (Full) (Intervening Period)	Fishing mortality Catch by sector
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Breeding stock levels

Pink Snapper:	Inadequate
West Australian Dhufish:	Declining
Baldchin Groper:	Declining

Assessments of the status of the stocks in the WCDSF are conducted primarily from the determination of estimates of rates of fishing mortality (F), using a range of methods, for each of the indicator species (West Australian Dhufish, Pink Snapper and Baldchin Groper). The estimates of F for these indicator species are used to reflect the status of the entire inshore demersal suite of species in the West Coast Bioregion. In addition to periodic assessments of fishing mortality, annual monitoring of fishery status is achieved by comparing catch and effort data (if available) in each sector of the fishery with catch limits for those sectors.

Age compositions of the indicator species derived from samples collected in 2007/08, were dominated by fish less than 15, 10 and 15 years of age, respectively, for dhufish, snapper and baldchin. Using the resultant F values and other ancillary information within a weight of evidence based approach, indicated that the breeding stocks for both dhufish and baldchin were declining while that of pink snapper was considered to be inadequate. Two independent external reviews supported these conclusions. For further details see the State of the Fisheries Report 2008/09.

There is limited biological information for targeted offshore demersal species (Eightbar Grouper, Bass Groper, Hapuku, Blue-eye Trevalla and Ruby Snapper). These deepwater species are particularly vulnerable in the west coast Bioregion to overfishing, as the limited knowledge of their biology indicates that they are long-lived and would therefore have low rates of natural mortality and productivity (Wakefield and Newman, 2008³; Wakefield et al., 2010⁴). In addition, some aggregate to spawn and most suffer barotrauma due to the depths in which they are fished (> 250 m). Risk to the stocks of these species is considered to be medium.

³ Wakefield, C.B., & Newman, S.J. (2008) Age estimation and reproductive status of an exceptionally large blue-eye trevalla (*Hyperoglyphe antarctica*, Centrolophidae) captured off the south coast of Western Australia. *Cybius*, 32, 321-324.

⁴ Wakefield, C.B., Newman, S.J. & Molony, B.W. (2010) Age-based demography and reproduction of hapuku, *Polyprion oxygeneios* (Polyprionidae), from the south coast of Western Australia: implications for management. *ICES Journal of Marine Science*, 67, 1164-1174.

Using the assessments of the indicator species as outlined above, the ecological risks to the suites of inshore and offshore demersal species in the West Coast Bioregion are currently assessed as being high and medium/high respectively (see Fletcher, *et al.*, 2010¹ for details). The inshore suite also has high risks associated with meeting the social and economic objectives for the community. This combination of factors means that this suite of species has been assigned an urgent priority for Departmental actions. The urgent priority and high ecological risk associated with the inshore demersal suite indicates that this suite will require a high level of monitoring and assessment. The offshore suite is currently considered to have a medium level priority.

Non-Retained Species

Bycatch species impact **Medium**

Line fishing for demersal species using baited hooks is highly selective. Other species that are caught but not retained during demersal fishing activities (this includes inedible species e.g. Silver Toadfish and small species, such as wrasses) are often susceptible to the effects of barotrauma and the substantial numbers of these released fish may not survive.

Protected species interaction **Negligible**

As line fishing is highly selective, interactions with protected species are minimal. Commercial and charter fishers are required to record protected species interactions in their logbooks. During 2009, charter vessels interacted twice with grey nurse sharks and twice with Albatrosses. Each animal was released alive.

Ecosystem Effects

Food chain effects **Low**

An FRDC study examined the last 30 years of catch data by all commercial fisheries in this region and found no evidence of any shift in community structure of this suite of species or in the relative proportion of different trophic levels in the catch.

Habitat effects **Negligible**

The main fishing method used in the commercial and recreational fishery for demersal species (line fishing), has little physical impact on the benthic environment.

Social Effects

Commercial

A total of 61 permits to fish in the WCDSIMF were used on 46 permitted vessels in the fishery during 2009 and, on average, employed one crew member.

Fishing and Aquatic Tour Industry (Charter)

Licenses to fish in the charter sector of the WCDSF are reissued on a financial year basis. Thus, data is presented for the last two financial years. In 2008/09, there were 131 charter operators who were licensed to operate in the West Coast bioregion via a Fishing Tour Operators Licence and 21 who held a Restricted Fishing Tour Operators Licence and/or an Aquatic Eco-Tourism Operators Licence, while in 2009/10, 125 were licensed only to fish and 23 to fish and run eco-tours. The number of people employed in the charter industry has not been estimated.

Recreational Fishing

Approximately 70,000 recreational fishing from boat licenses have been issued across the state since 2nd March 2010.

Economic Effects

Estimated annual value (to commercial fishers)

for year 2009 **\$2.94 million**

The estimated value of the WCDSIMF in 2009 (\$2.94 million) was less than that of the previous reported financial year, i.e. 2007/08 (\$3.4 m), as a result of the reduction in effort and catch. Catches of West Australian Dhufish and Pink Snapper contributed \$828,000 (\$17.06/kg) and \$1,034,000 (\$9.47/kg), respectively, to the fishery, while Redthroat Emperor contributed \$325,000 (\$7.99/kg), Bight Redfish \$272,000 (\$7.29/kg) and Baldchin Groper \$136,000 (\$12.10/kg). Prices per kg vary with supply and demand and are based on the average price in 2009. Values reported are for the fishing year of 2009, not financial year.

Fishery Governance

Commercial

Current Fishing (or effort) level **Acceptable**

Catch (or effort) limit range:

WCDSIMF **449-469 tonnes**

WCDGDLF/JASDGNLF (West Coast Bioregion)
80 tonnes

All commercial **< 550 tonnes**

The catch limit for demersal species in the WCDSIMF for 2009 (449-469 t) was based on 50 % of the 2005/06 catch of wetline fishers in the Kalbarri, Mid-west and South-west zones and also allows ca. 30 t to be taken in the Offshore zone. Acceptable catch levels for each of the indicator species in each zone in which they are an indicator are similarly based on 50 % of their 2005/06 catches (West Coast Demersal Scalefish Table 3). Note that there is now no longer any commercial wetline or gillnet/longline fishing in the Metropolitan zone.

¹ W.J. Fletcher, J. Shaw, S.J. Metcalf & D.J. Gaughan (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34 (2010) 1226–1238

WEST COAST BIOREGION

The total commercial catch of demersal species in the WCDSIMF of 303 t in 2009 was below the catch limit, reflecting the restrictions placed on effort in the fishery. Similarly, the total catch of each indicator species in the WCDSIMF and of all species in each zone was below their respective limits (West Coast Demersal Scalefish Table 3). The catch of each indicator species in each zone was below its limit for that zone, except in the case of Pink Snapper in the Kalbarri and the Mid-west zones, where the catch was approximately the same as the limit.

For the purposes of Integrated Fisheries Management, commercial catches of scalefish species by the WCDSIMF and DGDLF in the West Coast Bioregion in 2009 would have been likely to be below the acceptable catch level for that year.

Recreational/charter

Current Fishing level

To be determined

Catch (or effort) limit range (2009/10):

< ca. 200 tonnes

The proposed catch limit range for the suite of demersal species in the recreational and charter sectors in the West Coast Bioregion for the 2009/10 year is at most 50 % of the 2005/06 level, i.e. < 200 tonnes. The level of reduction to the recreational catch will be dependent on the effect the changes to the management had on those sectors.

New management initiatives

Commercial

A review of the first year of operation of the Fishery since the introduction of entitlements will occur during the latter half of 2010. Formal decision rules will be developed to determine how the various target catch reductions by the different commercial sectors will be most efficiently achieved.

Recreational/Charter

A review of the effectiveness of the newly introduced recreational arrangements to achieve the 50% reduction in catch from 05/06 levels will be made during the latter half of 2010. The formal Integrated Fisheries Management arrangements for this fishery are expected to be finalised.

External Factors

Recruitment success of both West Australian Dhufish and Pink Snapper is highly variable and influenced by environmental factors. Thus, the stocks of those species and catches in the fishery mainly rely on a limited number of strong recruitment years. This is likely to be similar for other long-lived species in the WCDSF.

Cockburn Sound is the only known spawning aggregation location for Pink Snapper in the West Coast Bioregion. Furthermore, juveniles use the area as a nursery for approximately one and a half years following settlement, before leaving Cockburn Sound. Ongoing industrial development in the area may have detrimental effects on the environmental conditions that are important for both spawning and juvenile survival and thus influence future recruitment success from Cockburn Sound to the West Coast Bioregion.

The Commonwealth Western Deepwater Trawl Fishery fishes in waters along the west coast of Australia in waters from the 200 m isobath to the boundary of the AFZ and between approximately Exmouth and Augusta. This fishery overlaps the WCDSF and has obtained substantial catches, in several years, of demersal species of interest, e.g. Ruby Snapper *Etelis carbunculus* and Deepwater Flathead *Platycephalus conatus*. The geographical overlap of catches by the two fisheries indicates that they are likely to be fishing the same stocks.

The Commonwealth's South-west Marine Bioregional Plan incorporates the aim of introducing marine reserves, which are likely to contain areas closed to fishing. This has the potential to restrict access to fishing in parts of the West Coast Bioregion to all sectors, i.e. commercial, recreational and charter.

WEST COAST DEMERSAL SCALEFISH TABLE 1.

Catches of the demersal gillnet and demersal longline fisheries in the West Coast Bioregion (WCB) from 2006/07-2008/09, which comprises those of the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery and the part of the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery that operates in the WCB.

	2006/07	2007/08	2008/09
West Australian Dhufish	19.2	19.9	14.5
Pink Snapper	16.8	14.0	8.6
Baldchin Groper	3.7	2.0	3.2
Other scalefish	85.8	61.6	51.1
Demersal species	96.3	83.6	64.2
Total scalefish	125.5	102.4	77.4

WEST COAST DEMERSAL SCALEFISH TABLE 2.

Catches of West Australian Dhufish, Pink Snapper and Baldchin Groper by charter fishers in the West Coast Bioregion between 2005/06 and 2009.

	2005/06	2006/07	2007/08	2009
West Australian Dhufish	20.5	18	15	9
Pink Snapper	17	24	22	10
Baldchin Groper	10	11	8	7

WEST COAST DEMERSAL SCALEFISH TABLE 3.

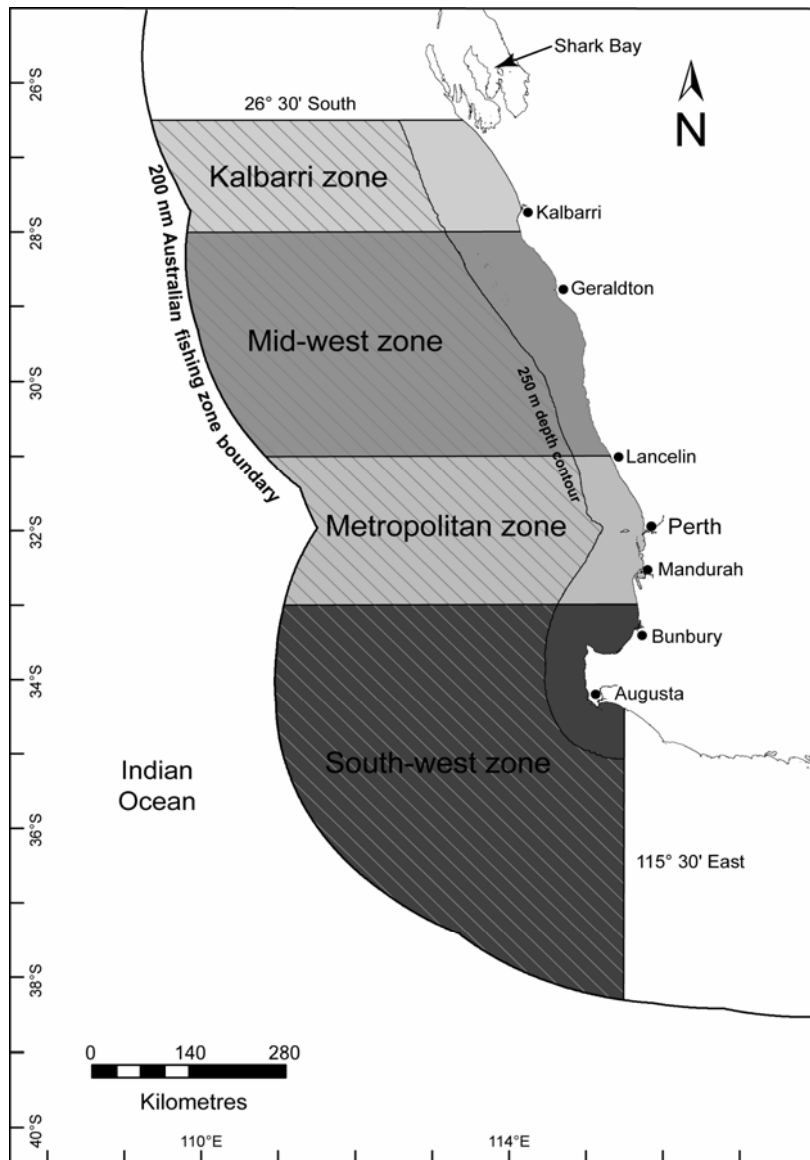
Acceptable catch levels for each zone and the indicator species in each zone of the WCDSIMF and their totals.

	Zone				Total WCDSIMF ^A
	Kalbarri	Mid-west	South-west	Offshore	
WCDSIMF	150	197	82	20-40	449-469
West Australian Dhufish	-	44	19	-	72
Pink Snapper	65	43	12		120
Baldchin Groper		g ^B			17

^ATotal catch limit for the WCDSIMF represents the sum of the limits in each zone. Indicator species are taken not only in zones where they are an indicator. Thus, the total catch limit for indicator species for the WCDSIMF is, in some cases, greater than the sum of the zones.

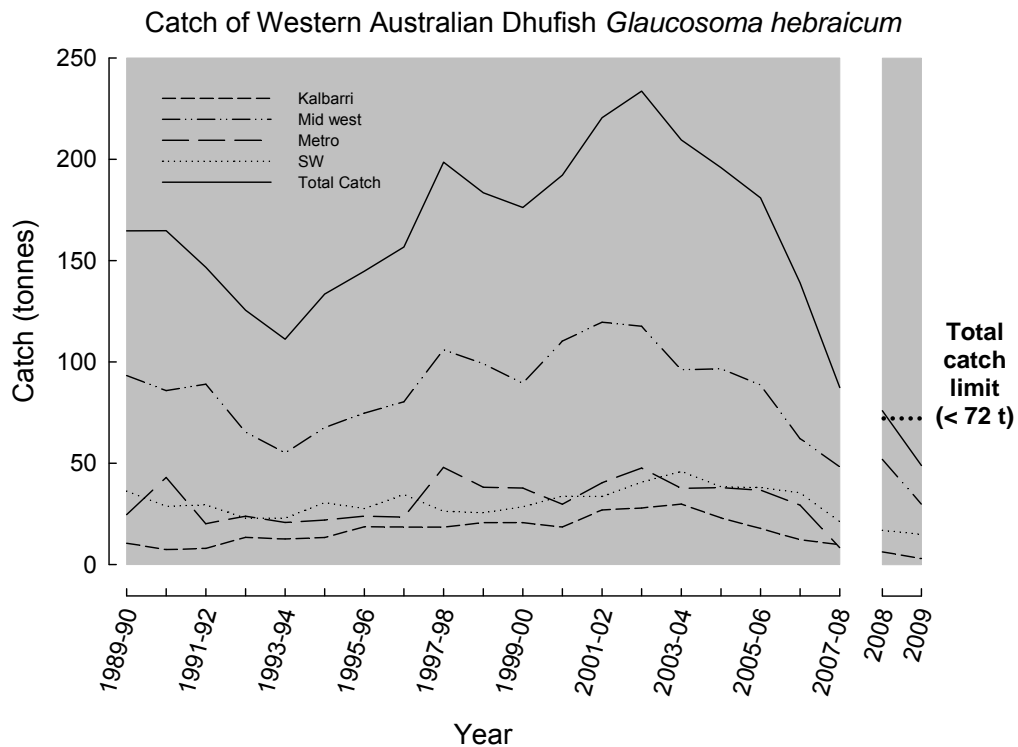
^BThe limit for Baldchin Groper represents the limit for the area of the Rock lobster fishery Zone A (Abrolhos Islands), where this species is an indicator.

WEST COAST BIOREGION



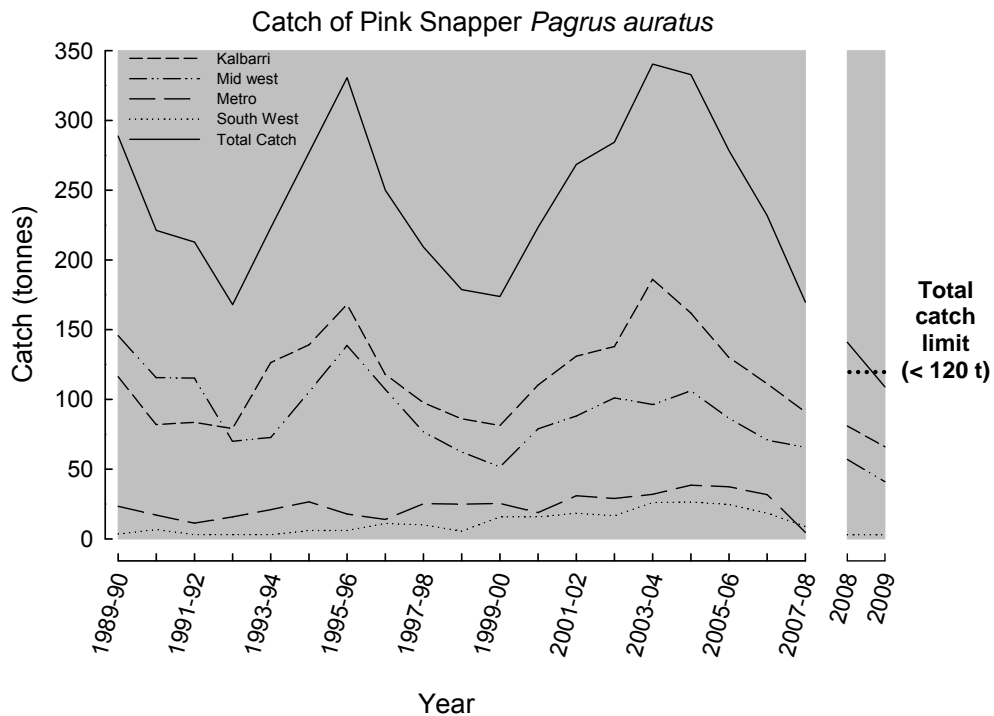
WEST COAST DEMERSAL SCALEFISH FIGURE 1

Map showing the boundaries of the West Coast Demersal Scalefish Fishery. Note the northern boundary of 26°30' S applies to the commercial fishery and is the proposed future boundary for the charter and recreational fishery. The Kalbarri, Mid-west, Metropolitan and South-west zones applicable to the recreational and charter sectors extend from the coast seawards to the Australian Fishing Zone boundary (AFZ), while for the commercial sector those four zones extend from the coast to the 250 m depth contour. The commercial fishery also comprises an offshore zone, which encompasses the waters from the 250 m depth contour outwards to the boundary of the 200 nm AFZ and from 26°30' S to 115°30' E.



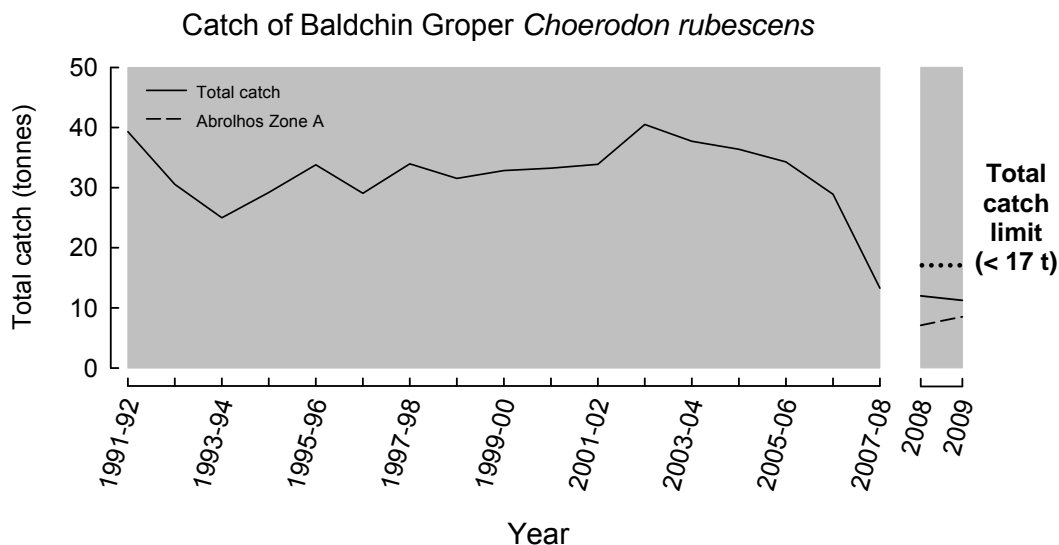
WEST COAST DEMERSAL SCALEFISH FIGURE 2

Total catch and catch by zone of West Australian Dhufish *Glaucosoma hebraicum* by commercial wetline fishers in the West Coast Bioregion between 1989/90 and 2007/08 and in the West Coast Demersal Scalefish (Interim) Managed Fishery in the calendar years 2008 and 2009.



WEST COAST DEMERSAL SCALEFISH FIGURE 3

Total catch and catch by zone of Pink Snapper *Pagrus auratus* by commercial wetline fishers in the West Coast Bioregion between 1989/90 and 2007/08 and in the West Coast Demersal Scalefish (Interim) Managed Fishery in the calendar years 2008 and 2009.



WEST COAST DEMERSAL SCALEFISH FIGURE 4

Total catch of Baldchin Groper *Choerodon rubescens* by commercial wetline fishers in the West Coast Bioregion between 1991/92 and 2007/08 and total catch in the West Coast Demersal Scalefish (Interim) Managed Fishery and catch in the Abrolhos Zone A of the Western Rock Lobster fishery in the calendar years 2008 and 2009.

Octopus Fishery Status Report

A. Hart and D. Murphy

Management input from R. Gould and M. Coloper

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial – Statewide	71 t
Fishing level	Acceptable	Recreational – Statewide (2001 estimate)	17 t

Fishery Description

The octopus fishery in Western Australia primarily targets *Octopus cf. tetricus*, with occasional bycatch of *O. ornatus* and *O. cyanea* in the northern parts of the fishery, and *O. maorum* in the southern and deeper sectors.

Fishing activities targeting octopus in Western Australia can be divided in four main categories. The West Coast Rock Lobster Managed Fishery (WCRLF) harvests octopus as a by-product, and currently accounts for the majority of total octopus landings. The Cockburn Sound (Line and Pot) Managed Fishery (CSLPPF), uses unbaited or passive (shelter) octopus pots; the Developmental Octopus Fishery (DOF) uses both passive shelter pots and active (trigger pots) traps to selectively harvest octopus. Recreational octopus fishing consists of by-catch from recreational lobster and crab pots, and targeted octopus fishing, mostly by SCUBA divers. In addition to these 4 main sectors, numerous trawl and trap fisheries land small amounts of octopus as a by-product.

Governing legislation/fishing authority

Cockburn Sound (Line and Pot) Management Plan 1995
 Instrument of Exemption (Section 7(3)(c) of the *Fish Resources Management Act 1994*)
 West Coast Lobster Management Plan 1993

Consultation process

Meetings between the Department of Fisheries and industry
 Developing Fisheries Advisory Committee

Boundaries

Recreational octopus fishing is permitted to operate throughout Western Australian waters, with the exception of

reserves and sanctuaries. Each commercial fishing sector is limited spatially to the boundaries inherent in their legislative instruments. Octopus caught in the WCRLF are restricted to the boundaries of that fishery (between latitude 21° 44' S and 34° 24' S). Octopus catch in the CSLPF is limited to Cockburn Sound. Octopus caught in the DOF are limited to the boundaries of the developmental fishery, which is an area bounded by Coral Bay in the north and Esperance in the south. Within this area however, spatial separation of the DOF "Exemption holders" ensures they are each restricted to a section of the coast that excludes the others.

Management arrangements

The keeping of octopus as a by-product in the WCRLF is permitted without catch restrictions or size-limits, however the catch rate of octopus within the fishery is monitored as a performance indicator to ensure it is maintained within historical levels (see WCRLF status report). The CSLPF is managed through input controls in the form of limited entry and gear restrictions, with a permitted maximum number of octopus pots allowable under the license conditions. The DOF is also managed through limited entry (currently only 5 exemption holders) and limits on octopus pot allocation specific for passive (shelter) and active (trigger) octopus traps. Effort is also spatially controlled, with each exemption holder allocated a specific area of coast.

The current recreational bag limit for octopus is 15 octopus, with a boat possession limit of 30 octopus. The *Recreational Fishing (Permitted Fishing Methods) Notice (527)* currently permits recreational fishers to use unbaited octopus traps when fishing from a boat (note that recreational fishers cannot dive from shore using traps to take octopus). However, the *Fish Traps Prohibition Notice 1994 (677)* prohibits all persons from taking fish by means of fish traps, with the exception of those persons that hold a recreational fishing licence and are using a rock lobster trap.

A comprehensive Ecologically Sustainable Development assessment of this fishery has also been undertaken to identify any potential sustainability risks requiring direct management. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Current research is focused on reporting of annual catch and effort statistics from commercial fisheries, reported on a monthly basis. A daily catch and effort logbook for the DOF was implemented in 2003 and gradually introduced to the DOF between 2003 and 2007. The logbook provides details of the octopus fishing operations such as the depth, habitat, pot types used and soak times (the period of time pots remain in the water until next pull). Details on catch include catch size categories and estimates of undersize catch. The location of the fishing gear is recorded with a GPS position to enable a more precise spatial breakdown of fishing activities and the identification of fishing zones. In 2008 and 2009, two student projects investigating aspects of biology and ecology of *Octopus cf. tetricus* were also completed.

The department has also successfully obtained a research grant from the Fisheries Research and Development

Corporation for a project titled "Innovative development of the *Octopus tetricus* fishery in Western Australia". Results from this project will inform industry and management on the viability of an expanded DOF.

Retained Species

Commercial landings (season 2009):

71 tonnes (live weight)

Recreational catch estimate (season 2001):

17 tonnes (live weight)

Landings

Commercial: In 2009 the total commercial octopus catch was 71 t live weight, a decrease of 37% over last years catch of 112 t, mainly due to the lower effort and therefore lower catch, from the WCRLF (Octopus Figure 1).

On a sector-specific level, octopus catch from the WCRLF declined from 68 to 31 tonnes; catch from the CSLP also declined slightly, from 20 to 17 t, while the catch from the DOF remained steady at 21 tonnes (Octopus Figure 1).

The developing octopus fishery (DOF) has steadily risen from 4% of the total catch in 2001 to 30% in 2009 (Octopus Table 1). At the same time, share of catch from the lobster fishery has declined from 86% to 44%, primarily as a result of effort reductions.

Recreational: No annual estimate of recreational catch exists for octopus. In 2001, the national recreational and indigenous fishing survey¹ estimated a total catch of 25,600 octopus in WA. Using an average weight of 0.7 kg, this amounts to a total catch 17 tonnes.

Fishing effort/access level

Commercial: Fishing effort in the commercial octopus fishery is measured as the amount of days fishing in which octopus was caught. Total octopus effort in the WCRLF in 2009 was 18,300 days, a 38% reduction from 29,400 days in 2008 (Octopus Table 1). Days fished in the CSLP and DOF were 208 and 217 respectively, a decrease of 6% and 10% from 2009 (Octopus Table 1). Overall there has been a decline in octopus effort from early 2000s (2001 to 2006) compared to the late 2000s (2006 to 2009).

Stock Assessment

Assessment complete:	Preliminary
Assessment method:	Catch rate
Breeding stock levels:	Adequate

Catch per unit effort: The catch per unit effort (CPUE) from the three main sectors (WCRLF, CSLP, DOF) are the principal indicator of abundance of octopus.

The CPUE for octopus from the WCRLF was 1.7 kg/day,

¹ Henry, G.W. and Lyle, J.M. (eds). 2003. The national recreational and indigenous fishing survey. FRDC project no. 99/158. NSW Fisheries Final Report Series No. 48.

WEST COAST BIOREGION

which was a decline from the 2008 estimate of 2.3 kg/day (Octopus Figure 2). Otherwise it has been fairly stable between 2001 and 2008, varying between 2.3 and 2.9 kg/day.

The CPUE for octopus in the CSLP and DOF sectors was 82 and 99 kg/day respectively. CPUE has increased over time in both these sectors, from 30 kg/day in 2001 (Octopus Figure 2). This pattern is assumed to reflect increases in fishing efficiency, rather than abundance increases, primarily as a result of the developmental nature of these sectors.

A standardised CPUE analysis for the CSLP and DOF was also undertaken, based on daily catch and effort logbook data, and more precise estimates of effort. This methodology is still under development, however preliminary trends have been estimated and are compared with the raw CPUE.

SCPUE for shelter pots has shown a slight increasing trend between 2005 and 2009, but has been stable around 0.09 kg/pot in the last two years (Octopus Figure 3). SCPUE for trigger pots is only available for 2008 and 2009, but also shows a stable level, around 0.9 kg/pot. Overall, there is about a 10-fold difference in catching efficiency of the two pot types.

The initial performance measures for the fishery relate to breeding stock maintenance as indicated by catches remaining in the range 50 – 250 t and catch rate remaining above 70 kg/day in the CSLP and DOF sectors. Both the catch and catch rate measure was met.

Target catch ranges and performance indicators will be reviewed as more information becomes available

Non-Retained Species

Bycatch species impact: Negligible

For the WCRLF, octopi are themselves bycatch. The selective method of fishing used for the CSLP and DOF results in a minimal level of bycatch of other species.

Protected species interaction: Negligible

There are currently no protected species known to be taken in this fishery.

Ecosystem Effects

Food chain effects: Negligible

This fishery harvests only a small amount of octopus per annum. The effect from this harvesting on the rest of the ecosystem, given that the catch is spread over a wide region, would be insignificant.

Habitat effects: Negligible

Rock lobster potting in the WCRLF occurs primarily on sand areas around robust limestone reef habitats covered with coralline and macro-algae, and these habitats are considered resistant to lobster potting due to their regular exposure to high-energy swell and winter storms. In the CSLP and DOF, octopus-specific pots are set in similar areas, and rather than impacting on existing habitat, actually provide habitat and shelter for the octopus.

Social Effects

Each octopus fishing vessel employs between 2 and 3 people, with octopus catch in 2009 being landed by 240 vessels, although the vast majority of these landings were small (< 100 kg), as they were by-catch in the WCRLF. Only 11 vessels landed greater than 500 kg. There is also a substantial processing and value-added component to the octopus catch with factories in Fremantle and Geraldton.

Economic Effects

Estimated annual value (to fishers)

for year 2009: \$710,000

The estimated annual value for 2009 was \$710,000 based on an average product price of \$13/kg (head off) or \$10/kg live weight. This is a beach price value and supports a substantial processing and value-adding sector.

Fishery Governance

Target catch range: 50 – 250 tonnes

This is a preliminary target range due to the developing nature of the fishery. Current fishing level of 88 tonnes is within the target range.

New management initiatives (2009/10)

Progress on the movement of the DOF into an interim managed octopus fishery was made in 2009/10. It is likely that this will be gazetted in 2010/2011. Pot allocations are likely to be based on an initial exemption granted to a license holder to expand its scale of operation by allowing other fishes to fish on that company's behalf using an increased number of trigger traps. The need to extend this exemption was in part due to the lack of a formal legislated management structure for the fishery.

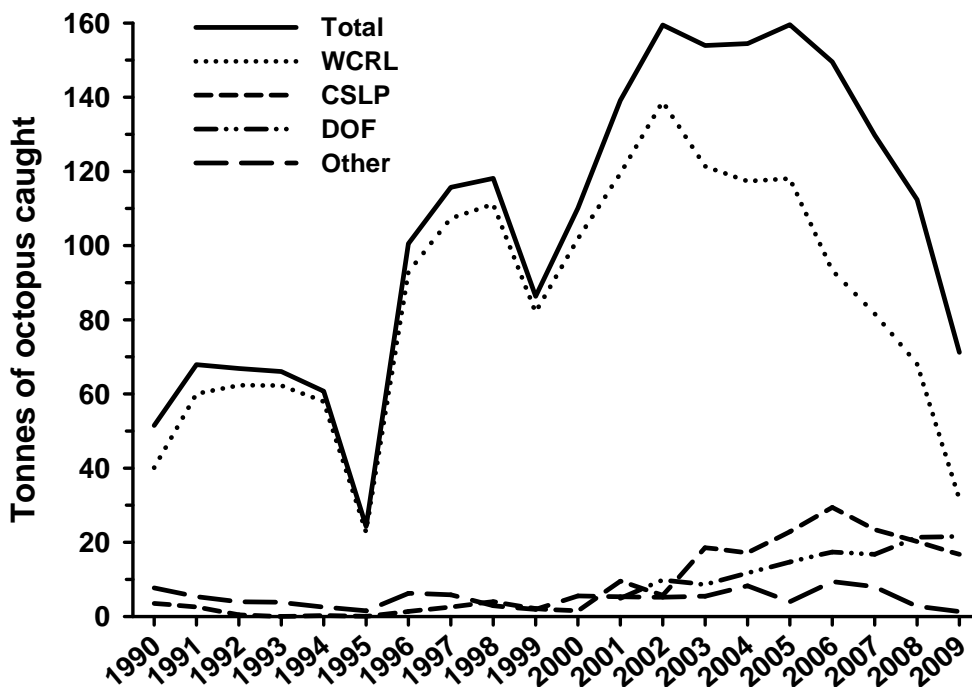
External Factors

Cephalopods in general, including octopus, are known to be subject to large environmentally-driven fluctuations in abundance. If the fishery expands to reach a catch level approaching maximum possible yields, this year-to-year variability in abundance may prove a significant issue for the fishery.

OCTOPUS TABLE 1

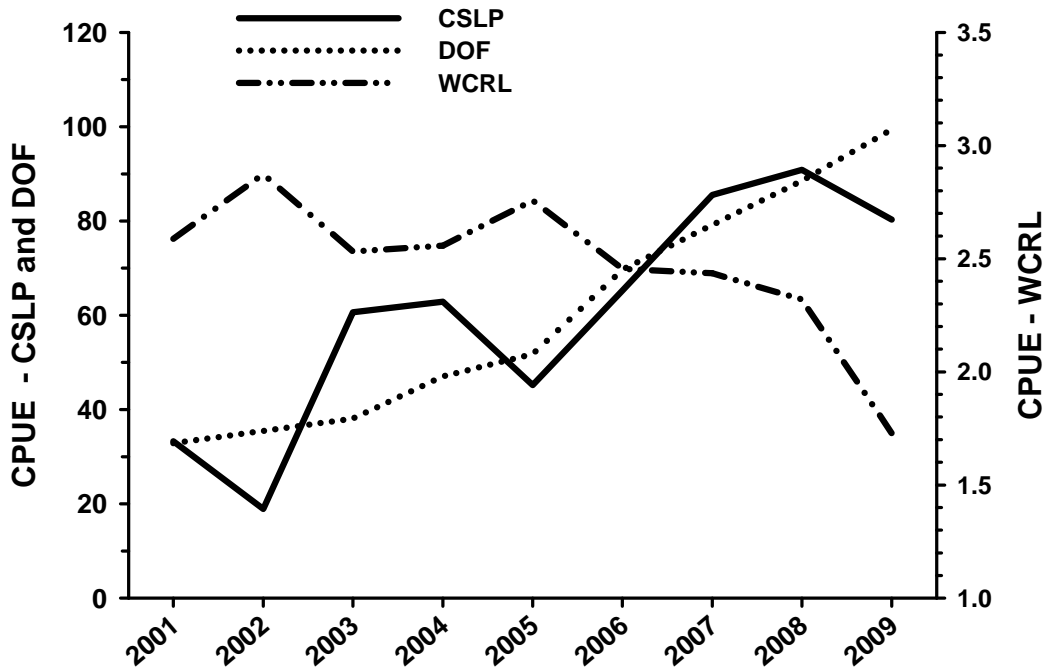
Percentage of octopus catch and total days fished from different sectors of the fishery. – WCRL (West Coast Rock Lobster Fishery), CSLP (Cockburn Sound Line and Pot), DOF (Developing Octopus Fishery) and Other, which is by-catch from trawl and miscellaneous pot fisheries

Year	Percentage of total catch				Effort (total days fished)		
	WCRL	CSLP	DOF	Other	WCRL	CSLP	DOF
2001	86	6.9	3.5	3.8	46,100	287	149
2002	87	3.6	6.2	3.2	48,300	300	278
2003	79	12.1	5.6	3.6	47,900	306	225
2004	76	11.1	7.6	5.3	45,900	273	249
2005	74	14.3	9.2	2.5	42,800	505	284
2006	62	19.7	11.6	6.3	38,000	451	250
2007	63	18.1	12.9	6.1	33,500	274	211
2008	61	18.0	19.0	2.4	29,400	222	241
2009	44	23.5	30.3	1.8	18,300	208	217



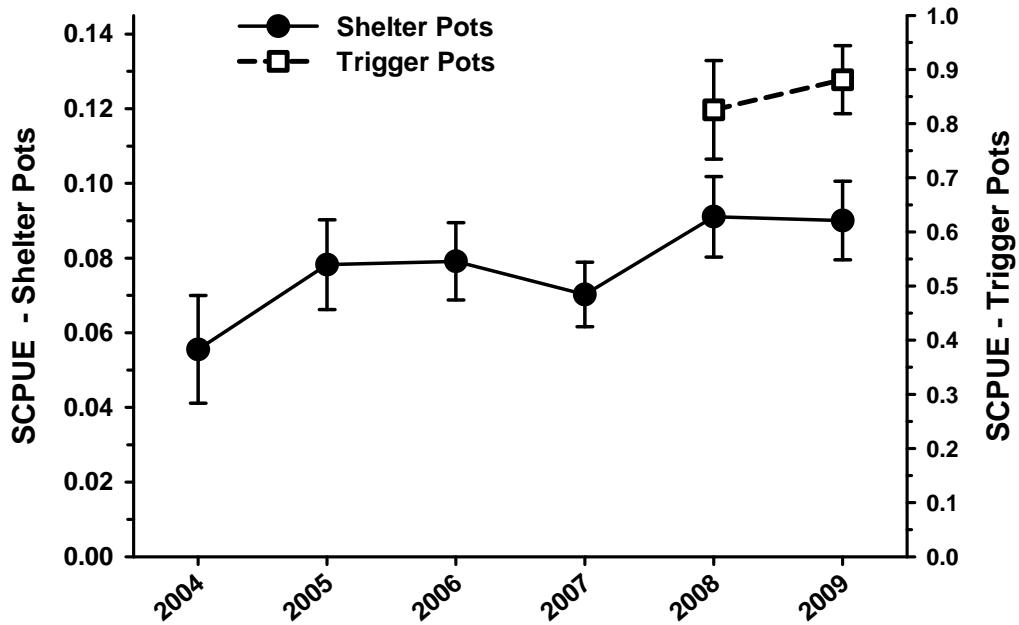
OCTOPUS FIGURE 1

Commercial catch (t) of octopus in Western Australia since 1990. Catch is divided between the main sectors – WCRL (West Coast Rock Lobster Fishery), CSLP (Cockburn Sound Line and Pot), DOF (Developing Octopus Fishery) and Other, which is by-catch from trawl and miscellaneous pot fisheries



OCTOPUS FIGURE 2

Catch per unit effort (CPUE) in kg/day of Octopus in the three main sectors – WCRL (West Coast Rock Lobster Fishery), CSLP (Cockburn Sound Line and Pot), DOF (Developing Octopus Fishery).



OCTOPUS FIGURE 3

Standardised catch per unit effort (SCPUE) ($\pm 95\%$ CL) in kg/pot of Octopus in the CSLP (left axis) and DOF (right axis) sectors. Trends are for two pot types – passive shelter pots, and active trigger pots.

AQUACULTURE

Regional Research and Development Overview

Aquaculture production statistics are compiled at the Western Australian Fisheries and Marine Research Laboratories (WAFMRL) at Hillarys.

In 2008/09, the value of aquaculture increased by around 11% and aquaculture tonnage increased by 4% compared to equivalent data for 2007/08 (excluding marine algae and all pearl oysters). However, aquaculture production is still less than the peak in 2003/04.

The framework to allow for the granting of leases for aquaculture has been finalised; however, its release has been delayed to allow for the amendments to the *Land Administration Act* by the Department of Regional Development and Lands. The Minister has granted two leases: one for the aquaculture of octopus in Cockburn Sound and another for abalone in Flinders Bay in the south west of the state.

The Department's review of aquaculture licence conditions is continuing. The outcome of the review will deliver higher levels of consistency, transparency and certainty in licensing and compliance arrangements across all aquaculture industry sectors.

Significant progress has been made on the development of a new framework for the environmental arrangement for aquaculture applications, both large- and small-scale. The Ecologically Sustainable Development (ESD) reports for marine finfish, land-based finfish and prawns have been completed and Environmental Codes of Practice drafted in conjunction with industry and the Department of Environment and Conservation (DEC). This sector will be the first to be run through a process to deregulate it from Part V of the *Environmental Protection Act 1986*.

A Memorandum of Understanding to formalise these new arrangements has been finalised with DEC and the Environment Protection Authority. The process will include

agreed Management and Environmental Monitoring Plans and a Guidance Statement for baseline data collection. These will be required for all new applications.

Some of the proposed legislative amendments to the *Fish Resources Management Act 1994*, designed to improve the regulatory environment and streamline the approvals processes, have received Royal assent and their proclamation is anticipated before June. The remaining amendments are expected to be drafted this financial year.

The Department's marine finfish aquaculture research team continued its collaboration with Cognis Australia to develop commercial production of *Artemia* (brine shrimp) at Hutt Lagoon, Port Gregory. During April 2010, the Minister for Fisheries Mr Norman Moore officially opened the commercial production site. The project was supported by the FRDC and is taking advantage of the red algae (*Dunaliella salina*) that the company also farms. DoFWA staff developed and built sophisticated state-of-the art filtration, aeration and harvesting systems to suit the high volume of water passing through the facility. The production system is a world-first at commercial tank production of *Artemia*.

A new application was submitted to FRDC to continue the productive collaboration and further optimize the system as well as develop new products.

As well, a new FRDC project in collaboration with a commercial octopus fishing and processing company was initiated. Initial growth trials, achieving a doubling of octopus weight every fortnight, emphasised the potential of octopus to become a major aquaculture species in WA. Following these results the project will research ranching wild-caught juvenile octopus and seek to close the life cycle through larvae rearing.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education in commercial and recreational fisheries in the West Coast Bioregion is undertaken by Fisheries and Marine Officers (FMOs) based at the Busselton, Bunbury, Mandurah, Rockingham, Fremantle, Hillarys, Lancelin, Jurien, Dongara and Geraldton offices, as well as aboard the large ocean-going patrol vessels *Hamelin*, *McLaughlan*, and *Walcott*. The Department's MarineDiscoveryWest education team delivers targeted education programs throughout the West Coast region. These programs are delivered by Community Education Officers based in Busselton and Fremantle, with the assistance of Fisheries Volunteers (formerly known as Volunteer Fisheries Liaison Officers) based in Busselton, Bunbury, Mandurah, Fremantle, Hillary's, Dongara, Geraldton and Kalbarri. Staff

from the MarineDiscoveryWest team and the Naturaliste Marine Discovery Centre also provide education services and activities at Hillary's and in the Regions.

Services provided by land-based officers include processing inspections, landing and gear inspections, licensing checks, wholesale/retail checks and inshore sea-based patrols utilizing vessels ranging in size from 5 m to 12 m. They also provide support to seagoing personnel and provide a wide variety of educational and extension services through formal and informal media to commercial fishers, fishing related operations (wholesale/retail/processors), other resource management agencies and community members.

WEST COAST BIOREGION

The Department also delivers at-sea marine safety compliance services on behalf of the Department for Planning and Infrastructure in the Metropolitan region extending from Mandurah to Lancelin (excluding the Swan/Canning Rivers). Outside of this area marine safety is unfunded and inspections are carried out in combination with fisheries compliance inspections.

Activities during 2008/09

During 2008/09, Fisheries and Marine Officers delivered a total of 14807 hours of compliance and community education services in the field (West Coast Bioregion Compliance Table 1). A major component of this time was focused on the West Coast Rock Lobster Managed Fishery. A continuing emphasis was placed on employing risk- and intelligence-based approaches to compliance planning and prioritization.

The 12-metre patrol vessel "PV Waterman" was a welcome addition in undertaking compliance operations and research projects in the Metropolitan Region. The "PV Waterman" is used throughout the year and provides a valuable resource for at sea compliance activity including gear and entitlement checks in the West Coast Rock Lobster fishery, West Coast Demersal Scalefish fishery, marine safety compliance, Marmion Marine Park compliance and education and shark response as part of the whole of government approach to the shark hazard program.

Compliance planning for the West Coast Rock Lobster Managed Fishery focused on the outcomes of the Compliance Risk Assessment process. Routine compliance operations targeted a number of significant risks including over potting, fishers interfering with other fishing gear and black market operations, which resulted in a number of apprehensions.

Targeted operations were also conducted to address illegal fish sales, failing to release totally protected rock lobsters, and pulling rock lobster pots prior to the prescribed starting time each day.

Within the West Coast Rock Lobster Managed Fishery, each vessel had its catch inspected by FMOs on at least one occasion, with an average of 6.5 checks per vessel throughout the fishery (West Coast Compliance Table 2). On average 18.5 baskets were inspected per vessel, an increase on the number of 17 baskets per vessel in 2007/08. The percentage of total catch inspected was slightly greater than the previous season with approximately 2.6 – 3.3% of the catch inspected (compared to 2.0 – 2.5% in 2007/08). The observed per-animal non-compliance rate for the catch was lower than the previous season with an estimated range of 0.0007-0.0010. This range has been used to estimate that between 5.1 and 7.9 tonnes of illegal rock lobster were consigned during 2008/09.

In addition to the rock lobster fishery, FMO's focused activity on ensuring high levels of compliance in other commercial fisheries such as the abalone, demersal scalefish (Wetline), crab, shark, scallop, pilchard and estuarine fisheries.

Overall, compliance in the west coast bioregion commercial fisheries was similar to previous years, although there was a concerning increase in the number of prosecutions from 35 to 73. The number of infringements increased slightly from the previous year, with a total of 90 infringement notices being

issued. Infringement warnings decreased from 244 to 193.

Considerable compliance activity was directed towards recreational fisheries within the bioregion, with FMOs achieving 29,201 field contacts with recreational fishers. The majority of the compliance effort focused on rock lobster, abalone, marine finfish and crabs.

Of concern was a substantial rise in the amount of illegal crabbing occurring in the Peel-Harvey Estuary. A strong compliance presence in response was responsible for a substantial increase in the number of prosecutions for illegal crabbing, which served to increase the number of prosecutions in the recreational sector from 93 in 2007/08 to 222 in 2008/09. A total of 662 infringement warnings and 442 infringement notices were instigated for less serious recreational offences during 2008/09.

The Department continues to work collaboratively with the Department of Environment and Conservation in delivering compliance services to marine parks throughout the bioregion. This collaborative approach has worked very effectively, particularly during the metropolitan abalone season, which occurs predominately within the Marmion Marine Park, and in the Jurien Marine Park, where DEC officers undertake joint patrols with FMOs thereby increasing the effectiveness of compliance service delivery. The level of non-compliance encountered in these parks is low.

As part of the collaborative approach towards marine park compliance service delivery, the Department continued its commitment to training officers from DEC, Water Corporation and the Rottne Island Authority.

Throughout the year FMOs undertook joint patrols with other agencies including Department for Planning and Infrastructure, Australian Customs Service and WA Police Service.

The Fisheries Volunteer (FVs) program continued to play a vital role in educating fishers about fishing rules, catch care and fishing techniques, as well as in other education and research activities. Volunteers in the bioregion conducted beach patrols, school talks, fishing workshops, and attended various boat shows and festivals.

FVs together with FMOs attended the Mandurah Crab Fest and Boat Show respectively, to provide advice regarding fishing regulations to the large number of boating enthusiasts and recreational fishers attending these very popular events.

Initiatives in 2009/10

Drawing on an improved intelligence capacity, a number of targeted rock lobster compliance operations are planned for the 2009/10 rock lobster season, with a focus on over potting and gear related offences. Additional Fisheries and Marine officers will be used on board Patrol Vessels to increase their efficiency.

The Department will continue to improve its at sea patrol capability with the construction of a new 22m Patrol Vessel based in Geraldton and planned to replace the PV McLaughlan. The new vessel should be launched during 2010.

Sea based compliance capability will be improved in the Metropolitan Region with two new 8.5 metres vessels: PV 5 based from Rockingham and PV26 based from Lancelin.

Following the planned implementation of new recreational fishing rules and the introduction of a statewide recreational boat fishing license, planning will take place for eight additional recreational mobile patrol units to be deployed around the state. These patrols will be dedicated to recreational fishing compliance and education activities.

Ensuring that only licensed wetline fishers are taking fish for a commercial purpose in the West Coast Demersal Scalefish Interim Managed Fishery will be a compliance priority throughout the bioregion.

Compliance and management personnel will continue to refine compliance planning to deliver greater efficiencies and outcomes through the use of risk assessments and intelligence processes. Greater capacity to target specific offence types

utilising risk analysis can result in deploying resources more efficiently.

The Volunteer program will focus on a Marine Education Program for the South Coast that will incorporate the management initiatives for the Walpole – Nornalup inlets Marine Park.

In the Metropolitan area, MarineDiscoveryWest staff continue their focus on school-based incursions working on sustainability and education themes developed as part of the state-wide education strategic plan. They have delivered information and education activities at major events such as the Mandurah Boat Show and Crab Fest. The Naturaliste Marine Discovery Centre continues to play its role as the hub for education programs in the Metropolitan area, catering to students from kindergarten through to tertiary levels, school and environmental educators and the broader community.

WEST COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the west coast bioregion during the 2008/09 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	14,807 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	305
District Office contacts	1406
Infringement warnings	193
Infringement notices	90
Prosecutions	73
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	29,201
District Office contacts	13,767
Infringement warnings	662
Infringement notices	442
Prosecutions	222
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field Contacts by Fisheries & Marine Officers	4,898
District Office contacts	7,956
Fishwatch reports**	607

*Commercial West Coast Rock Lobster contacts are excluded from these totals and detailed in West Coast Compliance Table 2.

**Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "Other" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of these contacts are recreational in nature (e.g. personal contacts in Marine Parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises etc. are also included in this category. This table includes contacts made by PV's Hamelin and McLaughlan. Contacts made by PV Walcott are included in North Coast Compliance Table 1.

***This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors. It also includes any calls relating to the southern inland bioregion that were referred to Busselton, Bunbury, Mandurah, Rockingham, Fremantle, Hillary's, Lancelin, Jurien, Dongara and Geraldton District staff.

WEST COAST BIOREGION

WEST COAST COMPLIANCE TABLE 2

Summary statistics for Commercial West Coast Rock Lobster compliance in all bioregions in the 2008/09 fishing season.

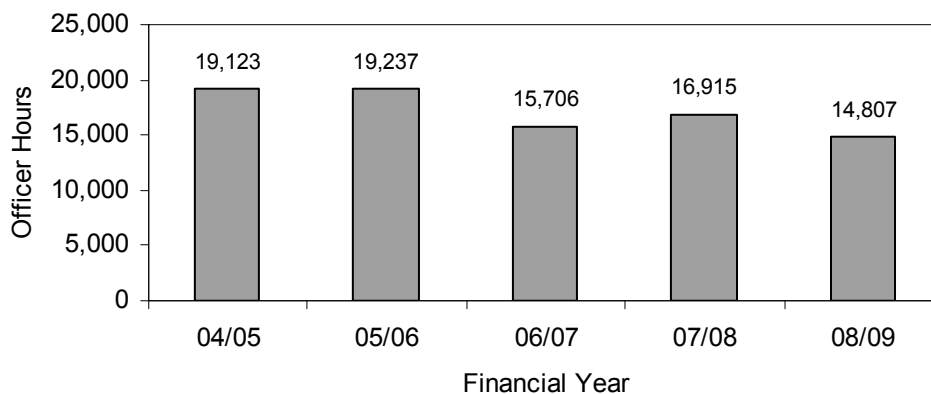
TOTAL COMPLIANCE HOURS*	25,104 Officer Hours
Field Contacts by Fisheries & Marine Officers	2346
District Office contacts	1467
FACTORY INSPECTIONS OF CONSIGNMENTS	
Number of unique vessels checked	Entire fleet at least once
Average number of inspections per vessel	6.5
Average number of baskets checked per vessel **	18.5
Proportion of total commercial catch inspected	2.6 - 3.3%
Non-compliance rate (per-animal basis) ***	0.0007 - 0.0010
Total consigned commercial catch ('000 kg)	7,595
Estimated total illegal catch consigned ('000 kg)	5.1 - 7.9

*Includes all time spent on compliance related tasks e.g. investigations, prosecutions etc.

** Calculated as the total baskets checked per vessel divided by total inspections per vessel.

*** A rate of 0.001 indicates 1 illegal animal detected in every 1,000 animals checked.

West Coast Bioregion Compliance Patrol Hours



WEST COAST COMPLIANCE FIGURE 1*

“On Patrol” Officer Hours showing the level of compliance patrol activity delivered to the west coast bioregion over the previous 5 years. The 08/09 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1 and Table 2. (The totals exclude time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.)

*These figures do not include 3,040 “on-patrol” hours delivered in 2008/09 by *PV Hamelin* and *PV McLaughlan*.

The total on-patrol hours for each of the Department’s 3 large patrol vessels is reported in the compliance summary of the most relevant bioregion: *PV Walcott* in North Coast, *PV McLaughlan* and *PV Hamelin* in West Coast.

GASCOYNE COAST BIOREGION

ABOUT THE BIOREGION	100
SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES	100
ECOSYSTEM MANAGEMENT	101
ECOSYSTEM BASED FISHERIES MANAGEMENT	103
FISHERIES	107
AQUACULTURE	142
COMPLIANCE AND COMMUNITY EDUCATION	143

GASCOYNE COAST BIOREGION

ABOUT THE BIOREGION

The marine environment of the Gascoyne Coast bioregion represents a transition between the fully tropical waters of the North West Shelf and the temperate waters of the west coast. Offshore ocean temperatures range from about 22°C to 28°C, while the inner areas of Shark Bay regularly fall to 15°C in winter. The major fish stocks are generally tropical in nature, with the exceptions of the temperate species, pink snapper, whiting and tailor, which are at the northern end of their range off Shark Bay.

The coastline is characterised by high cliffs in the southern half changing to fringing coral reefs in the north. Coastal waters are generally high-energy in terms of wave action due to the strong trade wind system. The Exmouth Gulf section of the Gascoyne Coast bioregion is seasonally influenced by extreme tropical summer cyclones, while the Shark Bay end of the bioregion receives very infrequent cyclones, but is affected at times by river outflows from inland cyclone-based summer rainfall. The limited local rainfall comes mostly from the northern edge of winter storm fronts.

The waters off the Gascoyne coast are also strongly influenced by the unusual southward-flowing Leeuwin Current, generated by flow from the Pacific through the Indonesian archipelago. This tropical current becomes evident in the North West Cape area and flows along the edge of the narrow continental shelf where, coupled with low rainfall and run-off plus the north flowing Ningaloo current creates the highly diverse Ningaloo Reef system and fish fauna associated with the latter.

The outer area of the large marine embayment of Shark Bay is also influenced by the warm winter current. The inner waters of the embayment are hypersaline, owing to the high evaporation and low rainfall of the adjacent desert areas. The World Heritage-listed Shark Bay is unusual for its extreme hypersalinity at the bay heads, the extensive Wooramel seagrass bank, and associated banks and channels. The sea floor of both Shark Bay and the continental shelf is typically sandy compared to Exmouth Gulf, which has more mud areas and greater turbidity.

The Gascoyne region has been identified as one of the 18 world 'hotspots' in terms of tropical reef endemism and the threats facing them. The article ranks this region of Western Australia as the second most diverse marine environment in the world in terms of tropical reef species, and also indicates that it is subject to the second lowest level of environmental threat of the 18 areas that were investigated.

The Ningaloo reef in the north of the region is the largest continuous reef in WA and is one of the most significant fringing reefs in Australia. The bioregion also has extensive areas of mangroves, mostly in Exmouth Gulf while extensive seagrass beds are located in a number of areas.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

Commercial fishing is a very significant industry in the region, with 3 of the State's more valuable fisheries – the Shark Bay Prawn, Exmouth Gulf Prawn and Shark Bay Scallop Fisheries – landing combined catches valued in the range of \$40 – \$50 million annually. These fisheries have operated sustainably in the region since the mid-1960s and are internationally recognised as 'best practice' in terms of both management and research.

The Gascoyne Coast bioregion has also supported since the 1960s an offshore snapper fishery and the Denham-based beach seine fishery, which respectively provide most of the pink snapper and whiting catch for the state. The fishery for blue swimmer crabs, based primarily in Carnarvon but operating throughout the waters of Shark Bay, is currently the largest Western Australian fishery for this important species. The snapper fishery has been evolving into a broader fishing sector taking demersal species including emperors, cods and deeper water species such as goldband snapper (jobfish). Formal management arrangements for the mackerel fishery were introduced in 2004.

The special features of the Gascoyne coast, coupled with the warm, dry winter climate and accessible fish stocks, have made it a focal point for winter recreation by the Western Australian community. Fishing is a key component of many tourist visits. A full range of angling activities is available, including beach and cliff fishing (e.g. Steep Point and Quobba), embayment and shallow-water boat angling (e.g. Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g. off Ningaloo).

Recreational fishing is predominantly for tropical species such as emperors, lutjanid snappers, groupers, mackerels, trevallies and other game fish. Some temperate species at the northern end of their ranges, such as pink snapper, tailor and whiting, provide significant catches, particularly in Shark Bay.

In addition, the Gascoyne Coast bioregion supports extensive scuba diving and snorkelling activities, particularly inside the coral lagoons of the Ningaloo reef system. Specialised 'eco-tourism' activities include whale shark and manta ray observation at Ningaloo and dolphin and dugong viewing in Shark Bay.

Aquaculture development in the Gascoyne is largely restricted to the production of pearls and pearl oysters in the major embayments. Hatchery production of oysters is of critical importance in this region, driven by the irregular and therefore unreliable recruitment of both large species of pearl oysters in the wild. Hatcheries in Carnarvon and Exmouth supply significant quantities of *Pinctada maxima* spat to pearl farms in Exmouth Gulf and the Montebello Islands, while several hatcheries supply juveniles of the blacklip pearl

oyster *Pinctada margaritifera* to the bioregion's developing black pearl farms.

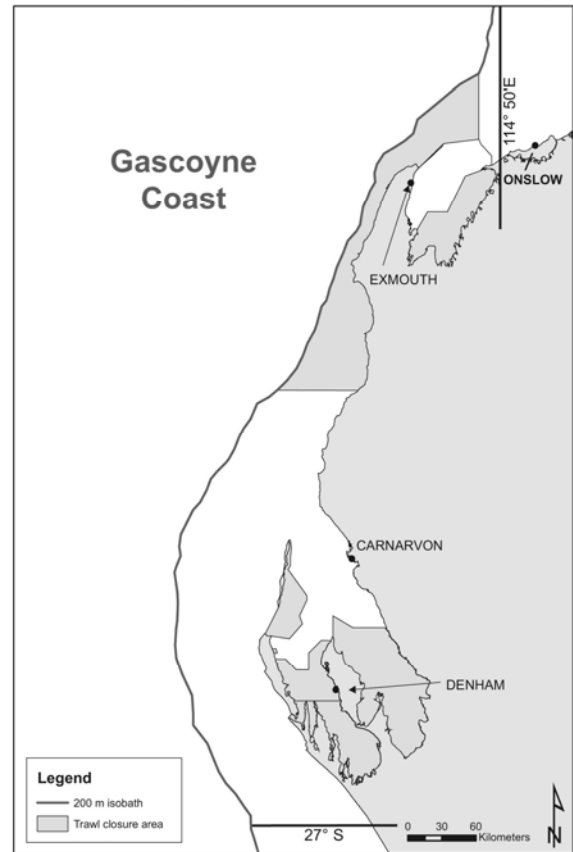
ECOSYSTEM MANAGEMENT

Extensive trawl closures inside the 200m depth zone in the Shark Bay and Exmouth region provide protection to sensitive benthic habitat, including coral reef, sand flats and seagrass beds of the continental shelf. These areas provide significant fish nursery, breeding and feeding habitat (Gascoyne Coast Habitat Protection Figure 1). The extent of these areas means that 35% of the entire shelf region (< 200 m) of the Gascoyne Bioregion could be classified as a marine protected area with an IUCN category of IV (as per Dudley, 2008¹; Gascoyne Ecosystem Management Table 1). The effective area that is not trawled is, however, much greater such that over 90% of the waters less than 200 m depth are not trawled (Gascoyne Ecosystem Management Table 1).

In addition to the trawl based, benthic habitat management protection, specific commercial fishing regulations implemented in the 1970s and 1980s preclude the use of large-mesh gillnets and long-lines throughout the region, to prevent the incidental entanglement of dugongs and turtles which inhabit the region. These controls have also provided protection for the large shark species which are a feature of this region. More recently, bycatch reduction devices ('grids') installed in trawl nets have increased the protection for sharks, rays and the occasional turtle encountered on the trawl grounds.

There are also a number of other 'formal' marine protected areas in this bioregion that have been established under both the Conservation and Land Management Act 1984 and the Fish Resources Management Act 1994 (see Gascoyne Ecosystem Management Figure 2). These include the Ningaloo and Shark Bay marine parks, the Muiron Islands Marine Management Area, and the Quobba and Miaboolya Beach Fish Habitat Protection Areas.

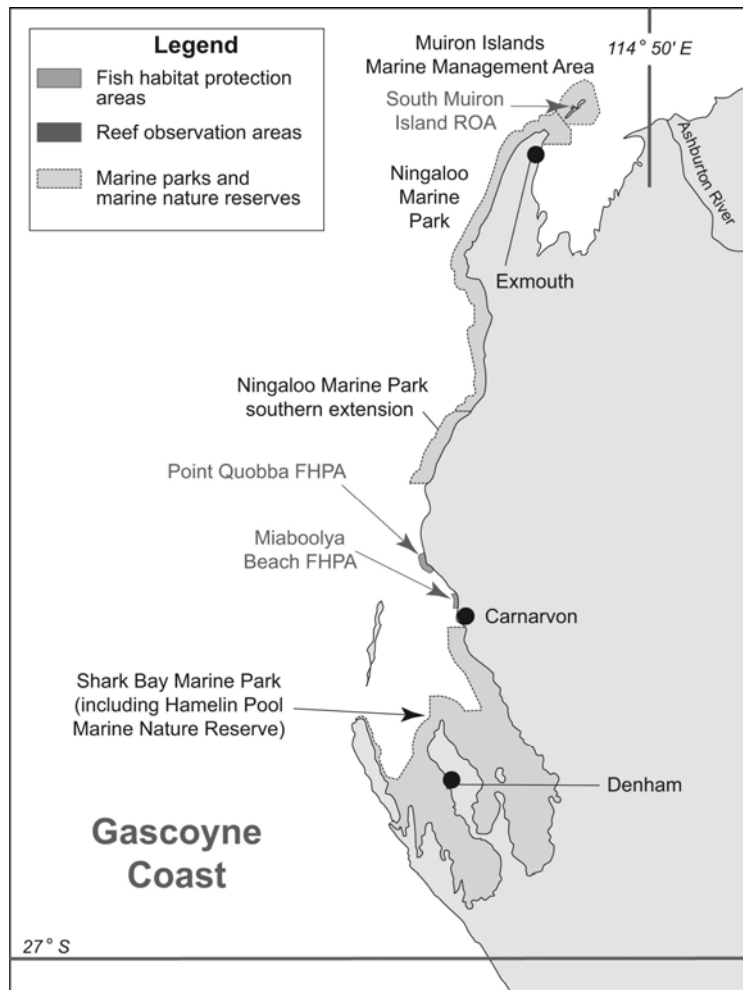
The Australian Government Department of Environment, Water Heritage and the Arts (DEWHA) is also undertaking a process of identifying additional protected areas for Commonwealth waters between Shark Bay and the Northern Territory border. The DEWHA plan was originally to complete a draft North West Marine Bioregional Plan (MBP) in late 2009, but it is currently unclear when this will now be released. The Draft Plan is expected to include proposed marine protected areas, and will be released for a 3 month public consultation period.



GASCOYNE ECOSYSTEM MANAGEMENT FIGURE 1
Map showing areas permanently closed to trawling in the Gascoyne Coast bioregion. The areas permanently closed are consistent with IUCN marine protected area category IV.

¹ Dudley, N. (editor) (2008) Guidelines for applying protected area management categories. IUCN, Gland, Switzerland.

GASCOYNE COAST BIOREGION



GASCOYNE ECOSYSTEM MANAGEMENT FIGURE 2

Map showing current and proposed marine parks and FHPAs in the Gascoyne Coast

GASCOYNE ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the Gascoyne Bioregion making up continental shelf waters (< 200 m depth) where habitats are protected from the physical disturbance of trawl fishing. The areas which are formally closed to trawling would be equivalent to meet the IUCN criteria for classification as marine protected areas as category IV. The area of habitat effectively protected refers to the total area of the shelf (< 200 m) where trawling doesn't occur.

Total Area of Shelf	Area of shelf equivalent to IUCN marine protected area <= category IV (%)	Maximum area of actual trawling activity	Total area of habitat effectively protected from direct damage (%)
15800 sq nm	5600 sq nm (35%)	1100 sq nm	14700 sq nm (93%)

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets/Resources using the EBFM framework

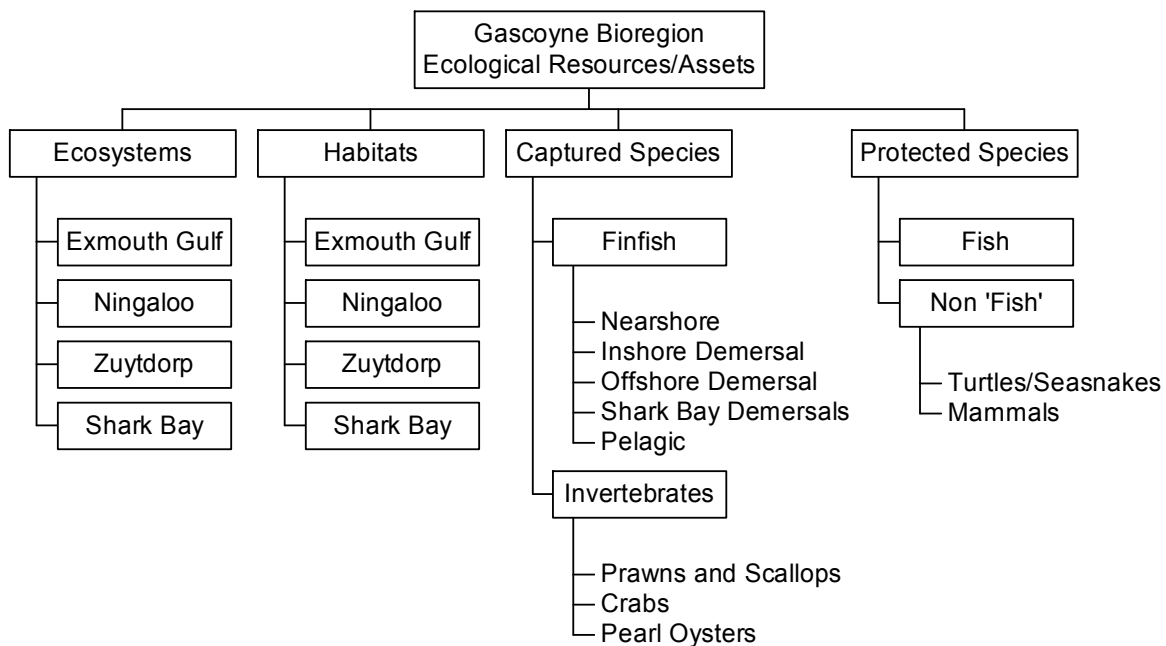
Under the Integrated Marine and Coastal Regionalisation for Australia scheme, the bioregion has been divided into 4 meso-scale regions: Zuytdorp, Shark Bay, Ningaloo, and Exmouth Gulf (IMCRA, V 4.0, 2006). This sub-regional scale of management has now been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, *et al.*, 2010) see How to Use section for more details.

In terms of ecological assets (= resources), the Department utilises the following categories for the IMCRA regions within the Gascoyne Bioregion:

- Ecosystem structure and biodiversity (on a meso-scale basis);
- Captured fish species
- Protected species (direct impact – capture or interaction);
- Benthic habitats; and
- External impacts.

For some assets a finer level of division of the IMCRA ecosystems is used by the Department. This incorporates the recent management initiatives to recognise that there are different suites of exploited fish and invertebrates across the continental shelf.

These sub-components are defined by depth contours (Nearshore 0-20m; Inshore 20-250m; Offshore >250m). The full set of ecological assets identified for ongoing monitoring are presented in Gascoyne Ecosystem Management Figure 3.



GASCOYNE ECOSYSTEM MANAGEMENT FIGURE 3

Component tree showing the ecological assets identified and separately assessed for the Gascoyne Bioregion.

Risk Assessment of Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Gascoyne Ecosystem Management Figure 3 are often made up of individual components at the species or In some cases at the stock level. The risks to each of the individual 'stocks' or lower level components are mostly detailed in the individual fishery reports presented in the remainder of this section of the document. The following table (Gascoyne Ecosystem

Management Table 2) provides an overview and cumulative assessment of the current risks to the ecological assets of the Gascoyne Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied.

These bioregional level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion

GASCOYNE COAST BIOREGION

GASCOYNE ECOSYSTEM MANAGEMENT TABLE 2 - RISK LEVELS FOR EACH ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Moderate values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where a high risk value is in brackets, this indicates the stock/asset is now recovering due to previously applied management. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, is not being generated by fishing activities.

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Zuytdorp	Marine	LOW	An assessment of the community structure and trophic level of all commercially caught fish species in the Gascoyne Bioregion over the past 30 years through an FRDC project found no evidence of systematic changes that could be evidence of an unacceptable impact on this ecosystem (Hall and Wise, 2010).
Ningaloo	Marine	LOW	See above. In addition, a significant level of research and monitoring is being undertaken in the Ningaloo marine park region by DEC, CSIRO, AIMS and universities.
Exmouth Gulf	Marine	LOW MODERATE (non fishing)	A major project surveying biodiversity on and off the trawl grounds in Exmouth indicated that trawled areas have similar diversity to the larger adjacent untrawled areas. The ecosystem in this region could be at risk if a number of proposed developments are implemented.
Shark Bay Gulfs	Marine	LOW	A major project surveying biodiversity on and off the trawl grounds in Shark Bay indicated that trawled areas have similar diversity to the larger adjacent untrawled areas.

Captured fish species

Captured Species	Aquatic zone	Ecological Risk	Status and Current Activities
Finfish	Nearshore (0-20m depth)	MODERATE	This indicator species for this suite are all considered to have adequate breeding stocks, fishing is occurring at acceptable levels and there are no additional risks that have been identified. Annual catch and effort monitoring is continuing.
	Inshore demersal (20-250m depth)	(HIGH) MODERATE	The key indicator species for this suite is pink snapper which is currently in a rebuilding phase and spangled emperor, in northern part of the bioregion, is considered to be suffering overfishing. Pink snapper are sampled to provide representative catch-at-age data for used in an integrated stock assessment model which is updated every 3 years (most recently in 2009). Comprehensive research on spangled emperor and goldband snapper has generated 'weight of evidence' based assessments. Monitoring of commercial catches and age structure is continuing and further research is planned to refine estimates of the key biological parameters
	Offshore demersal (>250m depth)	MODERATE	Some concern around deeper-water species (e.g. ruby snapper, various cods) is largely due to uncertainty in the stock status of these species and their long-lived, slow growing life histories. The other risk to these stocks comes from fishing by Commonwealth licensed trawlers who operate outside of 200 m depth.
	Pelagic	MODERATE	The stock status and fishing levels on these species (e.g. Spanish mackerel) are both at acceptable levels

GASCOYNE COAST BIOREGION

Captured Species	Aquatic zone	Ecological Risk	Status and Current Activities
	Shark Bay Gulf Demersals	(HIGH) - MODERATE	The spawning biomass of pink snapper has returned above the target level (40%) in both the Eastern Gulf and Denham Sound but remained below the threshold level (30%) in Freycinet. Research on pink snapper in the inner gulfs is now largely restricted to monitoring (daily egg production method [DEPM] surveys to estimate spawning biomass approximately every 3-5 years) and intermittent surveys of recreational catch. It is possible that grass emperor will be added to the set of indicators for this suite.
Invertebrates	Nearshore (Crabs)	MODERATE	There are a number of issues related to resource sharing and gear conflicts between the Shark Bay crab trap and Shark Bay prawn and scallop trawl fisheries. A more precautionary management approach for the Shark Bay crab stock is currently being considered due to uncertainty of the sustainable catch level. Data for the assessment of blue swimmer crab stocks in the Gascoyne is currently obtained from fishers' compulsory catch and effort returns and voluntary daily log books. Department of Fisheries' research staff also conduct quarterly catch monitoring surveys aboard commercial crab trap vessels in Shark Bay.
	Prawns and Scallops	MODERATE	Management of the prawn and scallop fisheries is based on input controls which include limited entry, seasonal and area openings and closures, gear controls. Permanently closed nursery areas within the fishery prevent the fishing of small prawns while spatio-temporal closures serve to maintain tiger prawn breeding stocks above the threshold abundance level. To ensure that sufficient stock remained for spawning, the fishing arrangements provide a threshold catch rate limit for the scallop fleet to cease fishing.
	Pearl Oysters	(HIGH) - MODERATE	The recent stock levels of pearl oysters in this region have been low. Recovery management arrangements have already been implemented.

Protected species

Protected species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Turtles/ Sea Snakes	LOW	While protected species including dugongs, turtles and sea snakes occur in the general area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both species are typically returned to the sea alive. Grids are now compulsory, which has largely eliminated the capture of any turtle or other large animal. The number of turtles captured now is very low and most of these are returned alive. Turtle captures and their status at release are monitored and reported.
	Mammals	NEGLIGIBLE	There are no recorded captures of mammals by the trawl fisheries in this bioregion.
Protected 'Fish' Species	Fish	LOW	There are no protected fish species (including syngnathids) specifically at risk in this region.

Benthic habitat

Benthic Habitat	Category	Risk	Status and Current Activities
Exmouth Gulf	Sand Mud Sponge	MODERATE	There is a large permanent closure to trawling on the eastern and southern sides of the Gulf which protect nursery areas. In the area open, trawling effort is focused in the deeper central and north-western sectors of Exmouth Gulf. Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. The total area trawled each year has to remain below 40%. The area trawled each year is monitored.
Shark Bay Gulfs	Sand Sponge	MODERATE	The majority of sponge/coral habitats are now contained within specific trawl closures and there are limits to the trawled area to less than 40% of the sand habitats. The area trawled each year is monitored.

GASCOYNE COAST BIOREGION

Benthic Habitat	Category	Risk	Status and Current Activities
	Seagrass	NEGLECTIBLE	There are extensive, permanent closures in the Shark Bay fishery covering all inshore seagrass areas.
Ningaloo	Sand Coral	LOW	There are no trawl activities in these areas. The main risk is to coral habitat from tourism and other boating related activities.
Zuytdorp	Sand Reef	NEGLECTIBLE	There are few direct impacts to these habitats.

External Drivers

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	LOW	This issue is not as high a risk as in some other WA bioregions due to lower level of international and interstate shipping.
Climate	MODERATE in short term	Being a transitional region, the biota in this bioregion are at enhanced risk of being affected by climate change. Projects to examine potential impacts on this bioregion are now underway or planned
	HIGH in medium term	

Summary of Monitoring and Assessment of Ecosystem Assets

The Department is a contributor and supporter of the extensive ecological research and monitoring that is underway in the Ningaloo Marine Park, much of this was funded by WAMSI Node 3 (see www.WAMSI.org.au for full details).

Each of the fisheries is undertaking monitoring that feeds into the assessment of the various assets outlined above. It is expected that the community structure analyses completed as part of the FRDC project by Hall and Wise will become a

regular part of the monitoring of this bioregion. It is also expected that the biodiversity trawl surveys will be repeated at regular intervals.

The Ranked Risk Assessment of Multiple Fisheries (RRAMF) was tested for the Gascoyne Coast Bioregion of Western Australia using fishery-independent data for general teleost and elasmobranch bycatch; and fishery-dependent data for threatened, endangered and protected species (TEPs). This method allows ranking of bycatch species within each fishery and the accumulation of the ranks across multiple fisheries by incorporating the relative impact of each fishery. The analyses are in the final stages of completion and will be written up as a Fisheries Research Report.

FISHERIES

Shark Bay Prawn and Scallop Managed Fisheries Status Report

E. Sporer, M. Kangas and S. Brown

Management input from R. Gould

Main Features

Status		Current Landings	
Stock level		King Prawns	927 t
Prawn	Acceptable	Tiger Prawns	300 t
Scallop	Acceptable	Endeavour Prawns	<1t
Fishing level –		Scallops	3391 t
Prawn	Acceptable		
Scallop	Acceptable		

Fishery Description

The Shark Bay Prawn Managed Fishery is the highest producing Western Australian fishery for prawns. It targets the western king prawn (*Penaeus latisulcatus*) and brown tiger prawn (*Penaeus esculentus*) and takes a variety of smaller prawn species including endeavour prawns (*Metapenaeus* spp.) and coral prawns (various species).

The Shark Bay Scallop Managed Fishery catches the saucer scallop (*Amusium balloti*), and is usually WA's most productive scallop fishery. These two managed fisheries are limited entry and both use low opening, otter trawls as the fishing method.

Both A class boats and B class boats are permitted to fish for scallops, but only B class boats can fish for prawns.

Governing legislation/fishing authority

Shark Bay Prawn Management Plan 1993

Shark Bay Prawn Managed Fishery Licence

Shark Bay Scallop Management Plan 1994

Shark Bay Scallop Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Regular formal and in-season meetings between the Department of Fisheries and industry.

Boundaries

The boundaries of the Shark Bay Prawn Managed Fishery and the Shark Bay Scallop 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, together with those waters of Shark Bay south of 26°30' south latitude (Shark Bay Prawn and Scallop Figures 1 & 2).

Management arrangements

Management of the prawn and scallop fisheries is based on input controls which include limited entry, seasonal and area openings and closures, gear controls and limits on crew numbers. The prawn fishery also has moon closures. These management arrangements are designed to keep effort at levels that will maintain sufficient spawning stock levels of all target species and achieve optimal yields. Management is also aimed at catching prawns and scallops at the best size and condition for the market, thereby maximising the economic return while maintaining breeding stock levels. Fishing is undertaken by both fleets using otter trawls, with 'bison' otter boards (under exemption) and standard flat wooden otter boards.

Both fleets (prawn and scallop boats) have standardised net headrope allocation whereby each boat has an equal allocation of net headrope for each fishery. For the prawn fishery, boats are authorised to operate with two eight fathom nets (29.27 metres) and boat units no greater than 375. The prawn fleet is operating under an exemption from both the net size and the 375 hull unit rule to provide for trawl gear amalgamation and improved economics. The total net headrope capacity for the prawn fleet is 432 fathoms (790 metres). The total headrope net capacity for the scallop fishery A class fleet is 196 fathoms (358.4 metres). The A class boats are permitted to take scallops by a maximum of two seven fathom nets (25.6 metres).

Bycatch reduction devices ('grids') are fitted to all prawn and scallop trawl nets. In addition, secondary bycatch reduction devices (fish escape devices) are fitted to nets of prawn boats. Scallop boats have larger 100mm mesh resulting in only a

GASCOYNE COAST BIOREGION

small amount of bycatch being taken during trawl operations and therefore do not require the secondary devices.

The Australian Government Department of Environment, Water, Heritage and the Arts has assessed the fisheries under the provisions of the Environment Protection and Biodiversity Conservation Act 1999 and has accredited the fisheries for a period of five years (re-assessment in 2013), allowing product from the fisheries to be exported from Australia. The comprehensive Ecological Sustainable Development assessment of these fisheries has also identified potential sustainability risks requiring direct management actions. The issues requiring direct management identified through this process were the breeding stock levels of the targeted prawn and scallop species, bycatch species impacts, protected species interactions (including loggerhead turtles), habitat effects and provisioning effects. Boxed text in this status report provides the annual assessment of performance measures/indicators for each of these issues.

The Department of Fisheries' Research Division carries out daily monitoring of the scallop fleet catch to provide advice on when to close areas based on the threshold catch rates. This is a major element of the management strategy to control spatial and temporal fishing effort. The vessel monitoring system continues to monitor the activity of all licensed Fishing Boats in this fishery.

The most equitable and economically efficient means to manage sharing of the available scallop catch between A class and B class licensees in the Scallop Managed Fishery and managing the associated competition for the scallop catch has been an ongoing unresolved and contentious management issue and the subject of extensive and ongoing consultation with licensees. This matter was covered in the recently published *Fisheries Management Paper 235 Shark Bay Prawn and Scallop Fisheries Review* and publication of this paper is likely to renew focus on matters in 2010- 2011.

Prawns

The yearly cycle of operation for the prawn fishery is dynamic as it depends on the strength and timing of recruitment therefore the opening and closing dates for the fishing seasons vary each year depending on environmental conditions, moon phase and the results of fishery independent surveys to estimate recruitment strength. The timing and spatial pattern of the fishing season allows the harvesting of the current season's recruits and the large residual prawns not caught in the previous fishing season. Permanently closed nursery areas within the fishery prevent the fishing of small prawns and provide habitat preservation, while spatio-temporal closures serve to maintain tiger prawn breeding stocks above the threshold abundance level.

Within the main fishing period, there are various subsidiary openings and closures designed to fish large size, quality and optimise market value of prawns while protecting the stocks from recruitment over-fishing. Non-fishing periods occur around the full moon, commonly known as moon closures. These moon closure periods are variable and can range from five to ten days and are set out in the season arrangements. King prawns are photosensitive, which makes them less active around the full moon and hence less catchable. Industry has voluntarily extended these closures to increase economic efficiency by shifting fishing effort away from these times of reduced catch rate.

For 2009, the prawn season opened on 16 March and closed on 13 October providing a total of 176 nights fishing with 173 nights actually fished. Fishing from the 16 to 18 March inclusive was for prawns only in the more northern part of Shark Bay. Fishing during the season involved flexible fishing arrangements and voluntary rolling area openings, based on assessment of both king and tiger prawn size through fishery-independent surveys.

Scallops

The scallop catch is taken by boats licensed to take only scallops (14 A class licences) and boats that also fish for prawns in the Shark Bay Prawn Managed Fishery (27 B class licences).

The opening date of the scallop fishing season is a compromise between maintaining breeding stock levels (measured by a pre-season survey of stock abundance and commercial catch rates during the fishing season) and the seasonal decline in meat condition associated with spawning.

An early opening has the aim of increasing the total weight of scallops caught by taking them at a time when the meat size is large prior to spawning. However, to ensure that sufficient stock remained for spawning, the fishing arrangements provided a threshold catch rate limit for the scallop fleet to cease fishing.

The 2009 scallop season officially opened on 15 March with fishing beginning in the Leads area in southern Denham Sound of Shark Bay. On 19 March the A class scallop boats moved into the northern part of Shark Bay to continue fishing scallops together with the B class boats. The A class scallop boats moved to Denham Sound on 2 April and remained there until 20 April, then returning to northern Shark Bay to continue fishing scallops. A and B class scallop boats ceased fishing on 7 May, which was the commencement of the moon closure for the B class boats and when the threshold catch rate was reached. The B class scallop boats continued to retain scallops from August after the key spawning period until the close of the fishing season.

Research summary

Research activities continue to focus on stock assessment and annual monitoring of the target stocks, particularly tiger prawns and scallop stocks. All boats complete detailed daily log books, and these, together with pre-season recruitment surveys and in-season surveys of size composition and spawning stock, provide the information sources for monitoring the status of the stocks.

In-season prawn surveys have proved to be valuable in ensuring that the prawns are targeted at an optimal market size.

Research for monitoring the status of the scallop stock in Shark Bay also requires real-time monitoring of catch levels to monitor the threshold levels and catch shares. In addition, an annual research survey is carried out in November, which, together with existing detailed biological knowledge, enables an annual catch forecast to be provided. These survey data are also used as the basis for the management arrangements in the following year.

A two-year FRDC project on research into prawn/scallop gear interactions, scallop and prawn larval movement

patterns in Shark Bay and potential effects of area closures in scallop/prawn management commenced in March 2008 and is due for completion in 2010.

Retained Species

Commercial production (season 2009)

Prawns	1,228 tonnes
Scallops	3,391 tonnes (whole weight)

Landings

Prawns

The total (whole weight) landings of major prawn species for this fishery was 1228 tonnes, comprising 927 tonnes of king prawns, 300 tonnes of tiger prawns, less than 1 tonne of endeavour prawns (Shark Bay Prawn and Scallop Figure 3). These total landings were similar to the last two years' of 1250 and 1232 t but below the target catch range (1501 to 2330 tonnes). In addition, 197 t of coral prawns (various species but mainly *Metapenaeopsis crassissima*) were landed.

King prawn landings (927t) were below the target catch range (1100 to 1600 tonnes). The focus by industry on capturing prawns of a larger size combined with the reduction of effort through fishing with a less number of boats, has resulted in lower landings, of around the 950 to 1450 tonnes, under normal environmental conditions compared to historical catch ranges. In 2009, there was an effort increase and an associated increase in total catch compared to the 2008 fishing season. However, the total landings for 2009 were slightly below the proposed target level mainly because of the lower effective effort on king prawns. The target catch level is still being reviewed and it is anticipated that it will take a further two years to be adjusted to reflect current fishing/targeting strategies.

Tiger prawn landings (300 t) were below the target catch range (400-700 tonnes) with the average catch over the last 15 years being 556 tonnes. For two consecutive years the tiger prawns have been below the target catch range. As with king prawns, effort was not focused as much on the tiger prawns as in past years. This due to increased scallop abundance and because scallops provide more value and cash flow in the first part of the year. However, the price for tiger prawns has declined and they no longer attract a premium price over king prawns. The expectation is that, with the reduced scallop catch prediction for 2010 and the focus of effort in the early part of the season on prawn, catch rates should improve for 2010 season.

Scallops

The total scallop landings for this fishery, which includes the catch from both A and B class scallop boats, was 3391 t (whole weight) (Shark Bay Prawn and Scallop Figure 4). A class boats landed 2315 t (68%) and the B class boats landed 1076 t. The 2008 scallop survey provided a catch prediction of 3150 t of scallop (whole weight) for the entire Shark Bay scallop fishery. The scallop caught from Red Cliff and North West Peron areas from the scallop and prawn boats were 2381 t. This area provided the majority of scallop catch in Shark Bay for the 2009 season. The scallop landing from Denham Sound was 899 t. Denham Sound has provided

consistent catches since 2002. The A class boats caught 111 t from "the Leads" area.

By-product

By-product landings from the prawn fishery included 251 t of blue swimmer crab (*Portunus pelagicus*), 1 t of coral crabs (*Charybdis feriata*), 21 t of squid, 22 t of cuttlefish, 15 t of tuna (wetlining), 2 t of bugs (*Thenus orientalis*) < 1 t each of octopus, mantis shrimp (Squillidae) mullet (*Argyrosomus hololepidotus*), snapper (*Pagrus auratus*) and other finfish species.

Byproduct landings for the A class boats in the scallop fishery included 2t of blue swimmer crabs (*Portunus pelagicus*), and < 1 tonne of bugs (*Thenus orientalis*).

Fishing effort/access level

There are 27 licences in the Shark Bay Prawn Managed Fishery, but as a result of changes in gear configuration resulting in amalgamation of net headrope onto lesser number of boats, 18 boats operated in 2009, towing quad gear (4 x 5.5-fathom nets). This was accompanied by a reduction of total headrope length used of 8% from 432 fathoms to 396 fathoms.

The total nominal effort recorded by the prawn fleet in 2009 was 28,368 hours and is 37% lower than that historically recorded by 27 boats between 1990 and 2004 (mean 44,864 hours). The impact of gear amalgamation means that effective effort has not reduced as much as nominal effort. An adjustment was made to the nominal effort for the increased headrope (37.5% per boat) towed by the quad boats with the 2009 adjusted effort being 39,977 hours (twin-gear equivalent effort). This adjusted effort is 17% higher than last year but well below the adjusted effort of the mid 1990s of close to 60,000 hours.

The total effort recorded by the A class scallop boats in 2009 was 9,871 hours. The effort for both 2008 and 2009 is similar.

Recreational component: Nil

Stock Assessment

Assessment complete: Yes

Assessment method: Direct survey/catch rate

Breeding stock levels:

Prawns

King Adequate

Tigers Adequate

Scallops: Adequate

Prawns

The catch per unit of effort for the fishery can be used as an indicator to monitor changes in stock levels from year-to-year. Spawning stock and recruitment indices are derived from survey data and tiger prawn spawning stock catch rate levels verified using logbook data. Conservative tiger prawn threshold catch rate levels are in place to maintain spawning

GASCOYNE COAST BIOREGION

stock above acceptable levels. Logbooks provide information on the daily catch (kg) of target species and effort (hours trawled) expended in specific fishing areas. Catch per unit effort can then be derived for each fishing area by each boat by species. Fishery-independent surveys are undertaken for king and tiger prawn stock levels, which are monitored and assessed using size, catch and effort information from recruit surveys (March and April), surveys in Denham Sound (king prawns) and breeding stock surveys in July and August (tiger prawns). Recruitment surveys are undertaken mainly to provide information regarding abundance and size structure of prawns. This is used to determine the extent of areas opened to fishing to meet prevailing market requirements. These data will also be used in the future to forecast a predicted catch range for tiger and king prawns. One additional survey was carried out during May 2009 to obtain size grade information of king and tiger prawns within the Carnarvon/Peron line to assist with harvesting strategies and optimise returns to fishers.

Catch assessment

The overall catch rate of 23.8 kg/hr (for adjusted effort equivalent to twin gear units) for king prawns observed in 2009 was slightly higher than last year's rate of 22.6 kg/hr. It should be noted that some effort was directed towards scallops and indicates that, if more effort was directed towards king prawns, it may have increased total landings and improved catch rates. The 2009 tiger prawn catch rate of 7.7 kg/hr was below the mean catch rate (10-11 kg/hr) observed in the 1990's to 2000.

To maintain adequate breeding stock levels for tiger prawns, the tiger prawn spawning area (TPSA) is closed when the mean catch rate reaches the threshold level. The threshold catch rate was conservatively adjusted for quad gear (four 5.5-fathom nets) to 27.5 kg/hr, with a range of 25 to 30 kg/hr. Some of the king prawn breeding stock is also protected by this closure and their catch rates are also recorded during the surveys. In 2009, the mean fleet tiger prawn catch rate was within the threshold range at 26 kg/hr when the TPSA opened to fishing but this declined to 12 kg/hr by the second fishing period and subsequently the TPSA was closed at the end of this fishing period.

Survey assessment

The multi-species nature of this fishery requires the levels of harvest for both king and tiger prawn stocks to be carefully monitored to achieve optimum sustainable catches.

In 2009, the TPSA was closed to fishing on 6 July, therefore the assessment surveys were undertaken in July and August. The mean catch rate of tiger prawns from these two surveys was 16.8 kg/hr, which was low compared to the threshold range, and the mean king prawn catch rate was only 15.3 kg/hr. No increase in catch rates were observed between the July and August surveys indicating little movement of tiger prawns into this area during this period. A review of tiger prawn spatial catch and effort data is being undertaken to assess if there has been a shift of tiger prawn abundance (i.e. change in migration patterns) to areas adjacent to the TPSA (hence the lower catch rates observed within the TPSA) and if more tiger prawn stock was carried over from the previous season into the northern part of the bay.

From early August onwards, the Extended Nursery Area (ENA) is closed to protect smaller prawns (primarily king prawns) moving onto the trawl grounds from the nursery area. In addition, the Denham Sound opening is now later (July/August) in the year, which gives protection to these smaller prawns early in the season allowing a higher spawning biomass in this region.

Fishery-independent survey data allows fishing to target appropriate prawn sizes for market value each season with the longer-term aim of providing catch predictions with standardised recruitment indices. The recruitment index for tiger and king prawns in 2010 was higher than observed in 2009. The increased recruitment of tiger prawns in 2010, even though the tiger prawn catch rate was below target highlights the conservative nature of the current threshold. This threshold range will be reviewed in the future.

Current stock and recruitment assessment indicates that, at current exploitation levels, the king prawn stock remains above the level where recruitment is affected by spawning stock levels. Thus, at the current level of exploitation, fluctuations in the annual king prawn harvest are most likely to have resulted from varying effort levels and environmental effects on recruitment, not from the spawning stock abundance.

Variable quantities of minor penaeids (predominantly coral prawns) are retained, depending on the catch of the target species. Owing to the small size of these species, it is likely that the majority of the stock is able to pass through the trawl mesh, suggesting that the overall exploitation is low and that breeding stock levels will therefore be adequate. Due to the current low market prices for these minor species their retention is minimal.

The main performance measures for the prawn fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2009, the breeding stock indicator for tiger prawns was below the level set therefore, not met. The surveys in July and August indicated a mean catch rate in the TPSA that was lower than the target range. Only in May was the catch rate within the range. Fishing for tiger prawns was then monitored in the TPSA but catch rates remained low without any build up of stock levels. Because of the low catch rates very little fishing effort occurred in the TPSA and there was insufficient information to close the area during a fishing period prior to July. Analysis of daily logbook data for the fleet indicated that catch rates declined from 26 kg/hr on average to 12 kg/hr on average within two fishing periods (May and June). In future years, if early surveys indicate low catch rates, a more conservative approach may be warranted for fishing and subsequent closure of this area. The catch rate at which fishing ceased for the last four years was between 20 to 25 kg/hr range and a review needs to be undertaken to determine if this threshold level is adequate as recruitment in 2010 was higher than observed in 2009. The king prawns annual landings catch were below the indicator range but there is little concern for the king prawn stock as spawning is more widespread and over a more protracted period of time. It should be noted that for both species, targeting larger size prawns and some shift of effort from prawns to scallop reduces total landings.

The 2008 November survey showed that a moderate proportion of the scallops were left at the end of the 2008 season (but less than that observed in 2007) which provided some carry over of residual stock into the 2009 season adding to the season's catch and breeding stock.

The performance measure is to ensure adequate breeding stock levels. Since 2004, a catch rate threshold level is used to cease fishing to maintain breeding stock during the key spawning period. In 2009 the fishing season was opened prior to the start of the spawning season, however a cut-off threshold catch rate was applied for the fishery based on daily fleet average catch of 400 kg/boat day in both northern Shark Bay and in Denham Sound (day fishing only) to ensure adequate breeding stock levels remain for the spawning period. This catch rate has continued to be adjusted upwards since being implemented and the 400 kg/boat day for both areas (Shark Bay north and Denham Sound) may be adequate to provide recruitment in the acceptable range given 'normal' environmental conditions. It is considered the cut-off catch rate of 400 kg/boat day should be trialled for a further three years to determine if this level ensures an adequate breeding stock. Also the fishing strategy has involved leaving part of the stock to be carried over to the following year providing a buffer in case of low recruitment and this should remain part of the sustainable fishing strategy.

Scallops

The catch rate of 46.9 kg/hr (based on A class boats) for scallops indicates maintenance of previous fishing efficiency. For the last three years the fishing regime has focussed on fishing pre-spawning scallops and fishing to a cut off catch rate. This was done in consultation with industry to ensure it provided the best opportunities to enhance fishing efficiency and associated profitability.

The status of the scallop stock is determined from the annual pre-season survey of recruitment and residual stock carried out in November–December. This survey enables the management arrangements of the fishery to be determined in a way that take into account fishing scallops at an optimum size and allows an adequate spawning stock.

Recruitment of juveniles to the stock and residuals are estimated using the data from the scallop survey for the main fishing grounds and in Denham Sound. The survey design and analysis of the data provides catch forecasts for the Shark Bay separated into two sectors, northern Shark Bay (Red Cliff and North West Peron) and Denham Sound, allowing separate opening dates for each area to optimise scallop meat size and condition each season. Scallops mature at about one year of age and spawning typically occurs from April to November. Fishing is therefore controlled to ensure that sufficient scallops remain through the key spawning season (April to July), which is the critical period for generating future recruits.

Projected scallop catch next season (2010):

1735 tonnes (whole weight)

The catch projection for the 2010 season is based on the 2009 survey results. On the main fishing grounds (North West Peron and Red Cliff) in Shark Bay, recruitment was lower than the previous three years with a moderate abundance of residuals. This resulted in a catch forecast for this area of approximately 1155 t whole weight, a reduction compared to last year's forecast of 2250 t. Recruitment levels were higher than residuals in Denham Sound, giving a predicted catch of 580 t whole weight. The catch projection for the fishery as a whole is therefore 1735 t with a range of 1350 - 2100 t whole weight. These predictions provide a relative indicator of catch trends based on historic fishing practices. These estimates are being revised to take into account management changes since 2005 that have been significantly altered by the timing that fishing occurs and allowing carryover of scallops. It is intended to complete this revision during 2010/11 which provides a total of five years of data with the new fishing strategies, the minimum needed for such an analysis.

Non-Retained Species

Bycatch species impact:

Low

Prawn trawlers

Bycatch composition for the prawn fishery is dominated by dead wire weed, which breaks off from the extensive shallow Wooramel seagrass bank annually over summer. The bycatch also contains a number of small size fish species mostly not taken by other sectors. Small blue swimmer crabs and other

GASCOYNE COAST BIOREGION

crustacean species are also taken in significant quantities but are generally released alive. Overall bycatch taken in trawl nets are moderate relative to other subtropical trawl fisheries at about 4–8 times the prawn catch. Field sampling for a study on the bycatch of trawled and untrawled areas of Shark Bay is now available (Kangas et al. 2008). Grid and secondary bycatch reduction devices (square mesh panels in cod-ends) are fully implemented and should further reduce the quantity of small fish retained in trawls.

Scallop trawlers

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

The two performance measures for the fishery relate to:

(i) its impact on biodiversity through the take of non-target (bycatch) species, and (ii) its impact on associated species, e.g. dolphins, through the discarding of bycatch (provisioning). In the case of biodiversity, a major project surveying bycatch species on and off the trawl grounds has been completed. Data analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas, indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort and implementation of BRDs in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.

Protected species interaction: **Low**

Although protected species including whales, dolphins, dugongs, turtles and sea snakes are particularly abundant in Shark Bay generally, only sea snakes are seen regularly in the trawl catches in certain areas, and these are mostly returned to the sea alive. The full implementation of bycatch reduction devices (grids) in the fishery since 2002 has generally eliminated the occasional capture of turtles in trawl nets.

One performance measure for the fishery is for 90% of turtles from non-BRD nets to be returned alive. These fisheries have BRDs (grids) in all net so this performance measure is no longer valid. For the 2009 season, 5 turtles were recorded as caught in nets in the prawn fishery and were recorded as being returned to the sea alive. For the scallop fishery, 13 turtles were reported as being taken in scallop nets and all were returned back to the sea alive.

Ecosystem Effects

Food chain effects: **Low**

Although the harvest rates of the retained target species are high, such species have very high natural mortality rates and make up a relatively small proportion of the 'fish' biomass on the trawl grounds. Thus, most prawn and scallop predators are opportunistic due to these natural variations in prawn and

scallop populations. Consequently, it is considered unlikely that the commercial take of prawns and scallops impacts significantly on the upper trophic levels within the Shark Bay ecosystem. The reduced levels of effort now used by the fishery, combined with the modifications to gear to reduce unwanted catch, will have further reduced the potential for indirect food chain impacts to occur.

Habitat effects:

Prawn fishery **Moderate** Scallop fishery **Low**

There are extensive permanent and temporary closures in the Shark Bay fishery. Inside Shark Bay, is 4652 nm² and represents 38% of the fishery area (including closed areas). (Shark Bay Prawn and Scallop Figure 1).

Prawn trawlers

The prawn fleet operates in approximately 7% of the overall fishery. The permitted trawl area inside Shark Bay is 1768 nm² and represents 38% of inner Shark Bay (excluding the closed areas). Trawl fishing is focused in the deeper areas (predominantly sand/shell habitats) of the central bay, north and northeast of Cape Peron and in the northern area of Denham Sound. The majority of sponge/coral habitats are contained within specific trawl closures to protect these areas.

Scallop trawlers

The scallop fleet operates in approximately 3% of the overall fishery. The permitted trawl area inside Shark Bay is 1483 nm² and represents 32% of inner Shark Bay (excluding the closed areas). Trawl fishing is focused in predominantly sand/shell habitats of the central bay, north west of Cape Peron and in the northern area of Denham Sound. The majority of sponge/coral habitats are contained within specific trawl closures to protect these areas.

Performance measures for habitat impact relate to the spatial extent of prawn trawling within Shark Bay's sand/shell and coral/sponge habitats. Both the prawn and scallop fleet permitted trawl areas are below the 40% level of the inner Shark Bay area. Most sponge/coral habitats in Shark Bay are now protected by fishery permanent closures which will limit the actual trawl area below 40% at any time. In 2009 the performance measure was met as the total area trawled within inner Shark Bay by the prawn fleet was approximately 801 square nautical miles or 17% of inner Shark Bay and the scallop area trawled was approximately 407 square nautical miles or 9% of the inner Shark Bay.

Social Effects

During 2009, approximately 250 skippers and crew were employed in the prawn and scallop fisheries. There are also processing and support staff employed at Carnarvon, Geraldton and Fremantle. These industries are a major contributor to regional employment.

Economic Effects

Estimated annual value (to fishers) for year 2009:

Prawns \$13.8 million

Scallops \$13.2 million

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time, and average ex-boat prices were as follows:

King prawns	\$10.50/kg
Tiger prawns	\$12.00/kg
Coral prawns	\$2.50/kg
Scallops	\$3.90/kg

Fishery Governance

Target catch range:

Prawns (Historical range) 1501 - 2330 tonnes

Prawns (New interim range) 950 - 1450 tonnes

Scallop 1250 – 3000 tonnes whole weight

Under previous effort levels, normal environmental conditions and based on catches in the 1990s following the restructuring of the fishery to 27 licences, the target catch range had been set for major penaeids at 1501 – 2330 t. Similarly, the target catch ranges for individual species were king prawns 1100 – 1600 t, tiger prawns 400 – 700 t and endeavour prawns 1 – 30 t.

Now that the focus by industry is to target larger size prawns, the resulting effort shift has reduced expected total landings to around the 950 to 1450 tonnes under normal environmental conditions compared to historical catch ranges. This reduction in total landings will be reviewed after a few more years and a new target catch range developed. As effort has been directed to avoid areas of smaller prawns, which is where endeavour prawns were mainly taken, the catch of this species will no longer be included as a performance indicator for the fishery.

The target catch range for scallops remains at approximately 1250 – 3000 t whole weight, based on catches over the five-

year period 1995 – 1999. This period excludes the high catches of the early 1990s (Shark Bay Scallop Figure 1), apparently created by an unprecedented four years of El Niño conditions.

The projected catch for next season (1735 t) whole weight, based on a pre-season survey, is within the target catch range.

New management initiatives (2010)

Discussions with Industry continued on the implementation of a scallop catch share between the A and B class scallop boats.

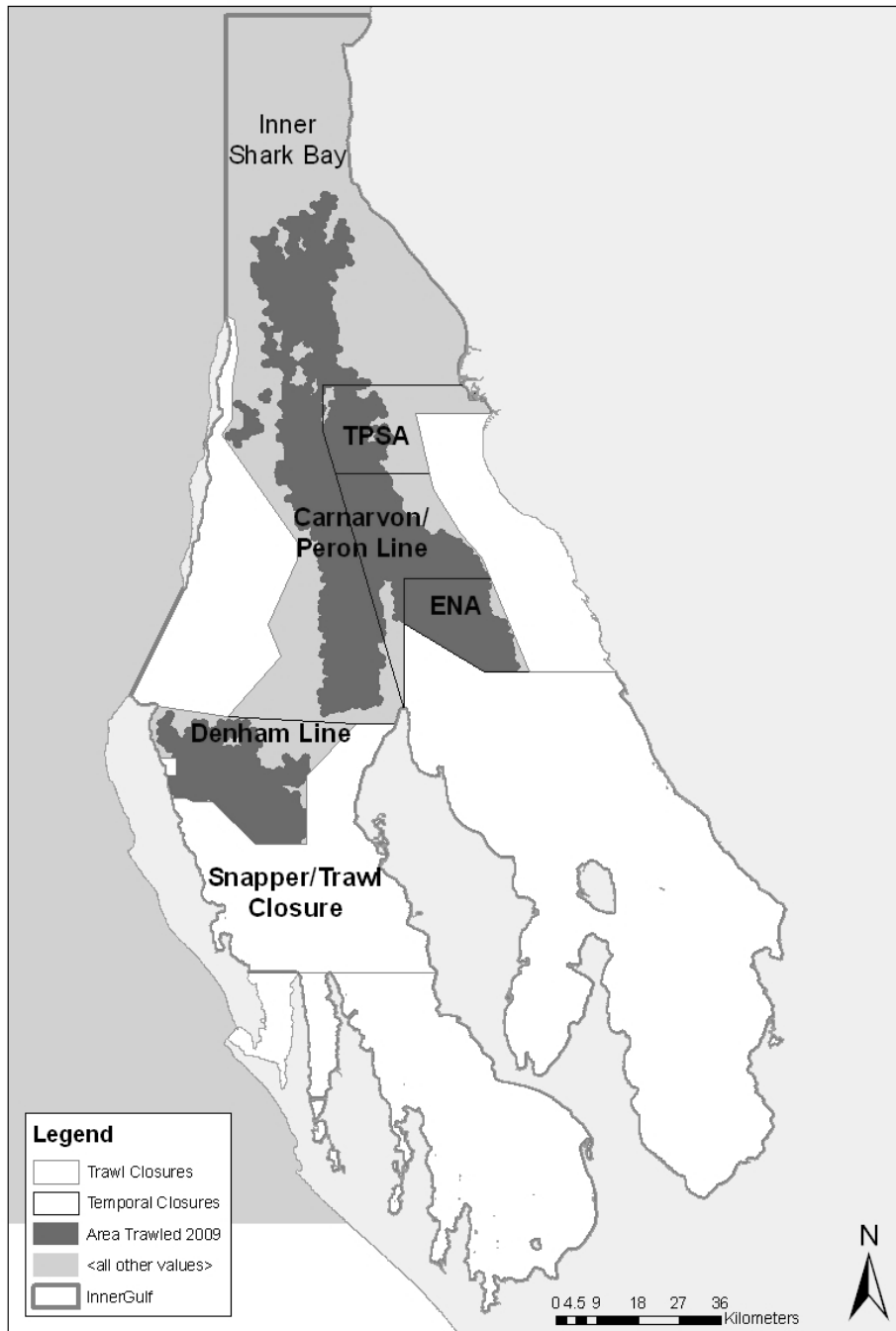
External Factors

High costs of fishing and lower returns due to the current economic climate and competition from aquaculture on small prawns has required focussing management and harvesting practices to reduce fishing costs (i.e. only fish efficient catch periods) and to target larger prawns and to shift the emphasis on domestic markets rather than the export market.

The catches of prawns in Shark Bay are relatively stable compared with other Penaeid fisheries. The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment. A relationship between current strength (as measured by Fremantle sea level) and king prawn catches has been identified and may be used to indicate broad catch trends. The mechanism proposed is that higher current flows increase water temperatures which may increase the growth and catchability of the prawns.

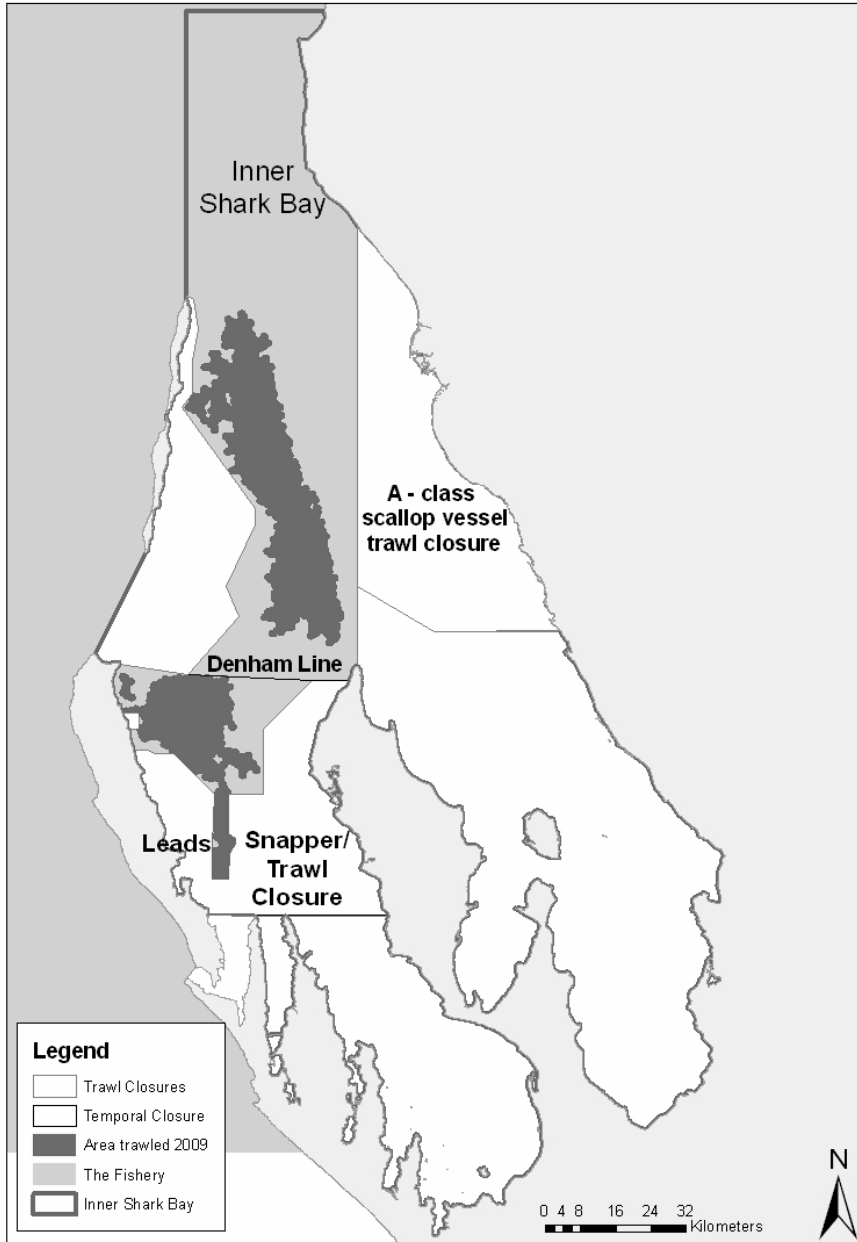
A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay, particularly in the Red Cliff area. Generally, high sea levels corresponding to strong Leeuwin Current correlate with poor recruitment. Due to this variability a redirection in effort away from prawn areas can artificially lower prawn catches when scallops are very abundant, due to a shift in effort/targeting.

The Department of Fisheries is currently examining the mechanisms that control recruitment success in greater detail, in order to explain more of the inter-annual variation that occurs.



SHARK BAY PRAWN AND SCALLOP FIGURE 1

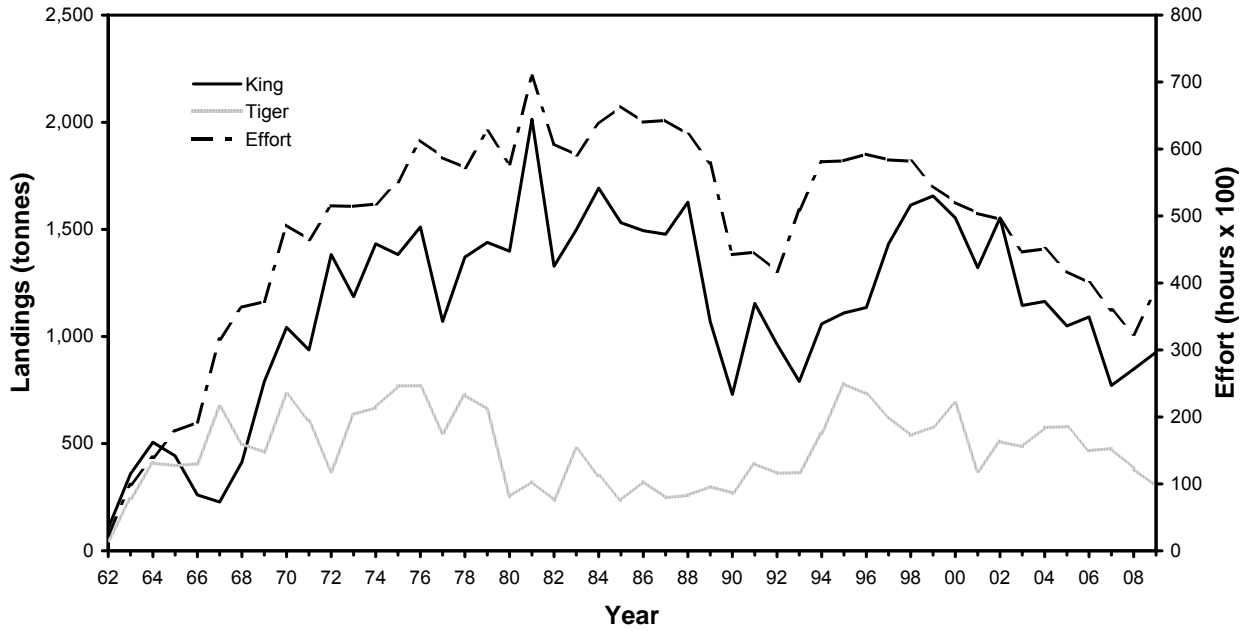
The main boundaries of the Shark Bay Prawn Fishery, Inner Shark Bay, TPSA, ENA, trawl closures, permitted trawl (extends out to the 200m isobath) area and area trawled in 2009.



SHARK BAY PRAWN AND SCALLOP FIGURE 2

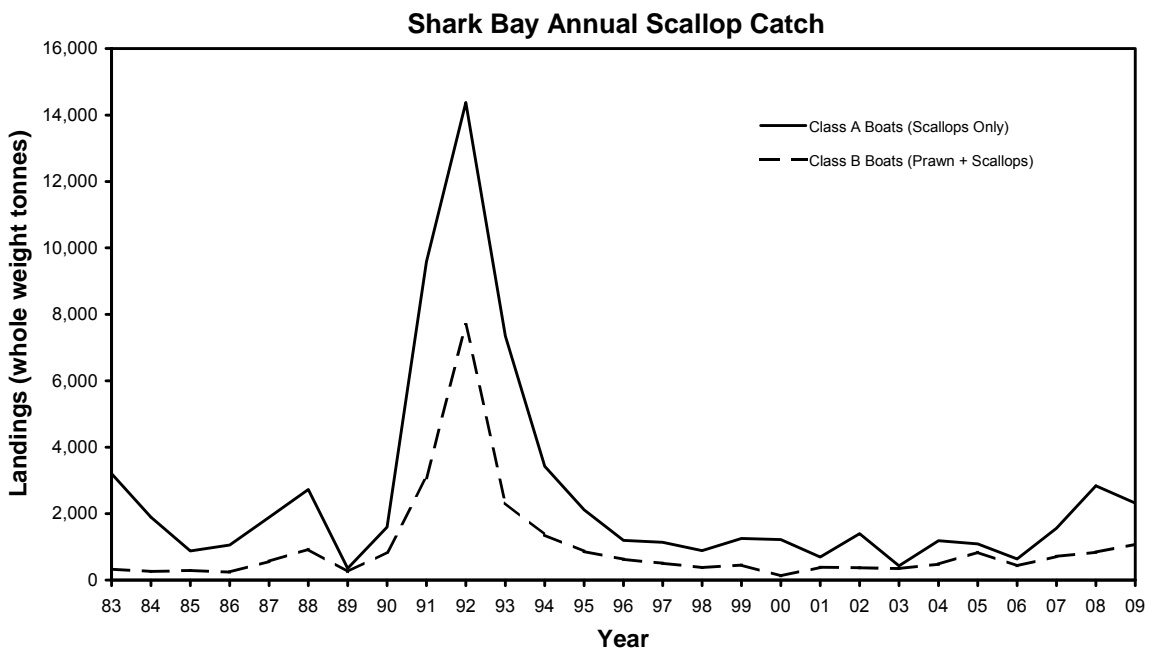
The main boundaries of the Shark Bay Scallop Fishery, permitted trawl (extends out to the 200m isobath) area and area trawled in 2009.

GASCOYNE COAST BIOREGION



SHARK BAY PRAWN AND SCALLOP FIGURE 3

Shark Bay Prawn Managed Fishery annual landings and effort (adjusted to twin gear units) 1962 – 2009.



SHARK BAY PRAWN AND SCALLOP FIGURE 4

Shark Bay Scallop Managed Fishery annual landings 1983 – 2009.

Exmouth Gulf Prawn Managed Fishery Status Report

E. Sporer, M. Kangas and S. Brown

Management input from R. Gould

Main Features			
Status		Current Landings	
Stock level	Acceptable	Tiger	412t
		Kings	283t
Fishing level	Acceptable	Endeavours	132t

Fishery Description

The Exmouth Gulf Prawn Managed Fishery targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguensis*). This limited entry fishery operates in the sheltered waters of Exmouth Gulf using low opening, otter prawn trawl systems.

Governing legislation/fishing authority

Exmouth Gulf Prawn Management Plan 1989

Exmouth Gulf Prawn Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Meetings between the Department of Fisheries and industry.

Boundaries

The main boundaries for the Exmouth Gulf Prawn Managed Fishery, which includes the areas where trawling is generally permitted, the Tiger Prawn Spawning Area (TPSA) and closed areas are shown in Exmouth Gulf Figure 1.

Management arrangements

Management of this fishery is based on input controls which include limited entry, seasonal and area openings and closures, moon closures and gear controls. These sophisticated set of management arrangements are designed to keep fishing effort at levels that will maintain sufficient spawning biomass of prawns (particularly tiger prawns). The yearly cycle of operation for the fishery is dynamic and involves real-time management with the opening and closing dates varying each year, depending on environmental conditions, moon phase and the results of fishery-independent surveys that estimate tiger prawn recruitment (abundance and size) and spawning stock and provides a prediction of catch. The Department's vessel monitoring system (VMS) monitors the activities of all boats during the season.

In recent seasons, management arrangements have provided

for a fishing period of about 200 nights with a minimum of 28 non-fishing nights for moon closures (i.e. four nights each full moon) during the period. For the 2009 season, official opening and closing dates were formally set at 1 April and 28 November respectively, providing a maximum of 203 nights for fishing. The season commenced on 1 April, based on results from pre-season surveys and it closed at 0800 hrs on 18 November resulting in a total of 183 nights fished. There were spatio-temporal closures during the early part of the season (April – July) to avoid fishing on small prawns.

Stringent measures are in place to ensure that spawning stock levels are maintained at adequate levels and that the prospect of both recruitment and growth over-fishing is avoided. These measures will continue to be applied, while incorporating a flexible fishing regime to optimise size and value of prawns.

There is a consultative process in operation whereby the Department of Fisheries (the Department) and industry jointly decide on the timing and extent of areas to be fished or closed, according to size and abundance of prawns. Research staff are onboard the commercial boats to undertake fishery independent recruitment and breeding stock surveys and, at times, industry undertake within season surveys to determine changes in prawn distribution, abundance and size composition. This enables a rapid response to resource fluctuations to maximise tiger and king prawn size (and hence market value) while still providing a sustainable approach to stock management.

The Research Division monitors the catch and effort of the fleet and provides real time advice about when to open and close areas which is a key part of the fishery's management strategy for spatial and temporal closures.

Management guidelines prescribe a mandatory closure of the TPSA when the tiger prawn catch rate falls to 25 kg/hr (based upon 'quad gear' catch rate, 4 x 6-fathom nets) or on 1 August, whichever is the sooner. From 1 November, after the main spawning period, the catch rate threshold level is reduced from 25 kg/hr to 19 kg/hr. Also, fishing ceases at the end of the season according to the size of king prawns and or an agreed to catch rate threshold.

The fishery is subject to a maximum total headrope allocation. However, the gear configuration package (net and board sizes) permitted within this total allocation is under review, with vessels currently operating under an exemption

GASCOYNE COAST BIOREGION

allowing the use of 'quad gear' (four smaller nets) rather than the standard twin 7.5-fathom nets. This has resulted in a reduction in the number of boats operating with the headrope allocation redistributed among the remaining boats. The reduction of boat numbers and overall net allocation is ongoing with the aim of maximizing economic efficiency but still maintaining overall catch in this fishery as well as ensuring sustainability.

Bycatch reduction devices (BRDs) are utilised in this fishery, with all vessels required, by way of a condition on the managed fishery licence, to fish with a 'grid' and a secondary BRD (fish escape device) in each net. Industry, in association with the Department, successfully gained certification from the US Department of State in 2008 that the fishery is BRD-compliant, in terms of potential turtle captures. This allows licensees to export product to the US market. Industry also uses 'hopper' in-water sorting systems since 2002, which provide an improved quality of prawns and reduced mortality for some bycatch species.

The Australian Government's Department of Environment, Water, Heritage and the Arts has assessed the fishery in 2008 under the provisions of the Environment Protection and Biodiversity Conservation Act 1999 and has accredited the fishery for a period of five years, allowing product from the fishery to be exported from Australia. The comprehensive Ecologically Sustainable Development assessment of this fishery identified risks to breeding stock levels of target prawn species, bycatch species impacts, habitat and provisioning effects that required specific management actions. Boxed text in this status report provides the annual assessment of performance measures/indicators related to these issues.

Research summary

Research activities continue to focus on stock assessment and surveys to monitor annual recruitment of tiger prawns and breeding stock surveys to monitor spawning stock levels, and a pre-season survey of king prawns to assist with harvesting strategies (these are detailed above in the management arrangements). Monitoring of fishing activity is undertaken in real time to determine the specific timing of the closure of the tiger prawn spawning area based on threshold catch rates. All boats complete detailed daily logbooks, which, together with survey data and factory catch unload records, provide the information sources for managing the fishery. The joint evaluation and implementation of gear modifications to reduce bycatch and improve product quality is ongoing.

Retained Species

Commercial production (season 2009):

828 tonnes

Landings

The total landings of major penaeids for the 2009 season were 828 t, comprising 283 t of king prawns, 412 t of tiger prawns and 132 t of endeavour prawns and less than 1 t of banana prawns. This was lower than last year's catch of 1170 t, mainly due to reductions in tiger and endeavour prawn catches. The tiger prawn and endeavour prawn

landings were within the target catch range of 250–550 t and 120–300 t respectively (Exmouth Gulf Prawn Figure 2). King prawn landings were still under the target catch range of 350–500 t.

Recorded landings of by-product included 25 t of coral prawns, 16 t of squid, 10 t of octopus, 10 t of blue swimmer crab (*Portunus pelagicus*) and 2 t of bugs (*Thenus orientalis*).

Fishing effort/access level

There are 16 Managed Fishery Licenses in this fishery. Since 1990 the total allocation of net headrope capacity for this fishery was set at 240 fathoms, based on 16 boats each towing 15 fathoms of net headrope. To improve the economic efficiency while maintaining sustainable catch levels, there has been an amalgamation of gear onto a reduced number of boats. As a result of these changes, only 9 boats operated in 2009 towing a total of 206 fathoms of net headrope. There were two differing net headrope sizes 5.5, and 6 fathoms because 5 boats cannot tow the maximum size of 6-fathom headrope nets allocated for each boat.

Total nominal effort for the 2009 season was 17,934 hours. The adjusted effort was 27,851 hours, which was similar to that in 2008. Of the 200 nights allocated to fishing, the fleet fished 183 nights during the 2009 season. This is the highest number of nights fished since 2002. This may reflect the lower number of boats fishing. Although the annual landings were below the historical catch range, effort was focused on king prawns to ensure that this species was exploited to its potential this season. Therefore, the overall effort for the 2009 season was slightly higher than expected for the total catch taken.

Stock Assessment

Assessment complete: Yes

Assessment method: Direct survey/catch rate

Breeding stock levels: Adequate

Projected catch next season (2010):

342 (270 - 410) tonnes tiger prawns

The standardised catch per unit effort data from the fishery is an indicator of abundance, which can be used to monitor changes in stock levels from year to year. The average catch and catch rate is compared to a ten-year reference point (1989 to 1998) for each species. The tiger and king prawns stocks are also assessed each year using standardised surveys (recruitment and breeding stock).

Catch assessment

The adjusted catch rate 10.2 per kg/hr, for king prawns is slightly below the reference catch rate level of 11.7 kg/hr. Even though the landings of king prawns were below the target catch range, overfishing does not appear to be the cause of the decline in annual landings. The season commenced early, however, areas of small prawns were closed to fishing in the early part of the season to ensure that size and quality was maintained. Also, the season ceased according to the catch rate threshold and size of king prawn protocol. The fishery is closed when the king prawns size

composition reaches approximately, on average 23 to 25 per pound, or if 50% or greater of the daily catches are 21-30 and 31 + count per pound (particularly if the catch rate of king prawns is low at 20 to 25 kg/hr).

The catch rate of 14.8 kg/hr for tiger prawn is high compared to the reference point catch rate of 10 kg/hr. The high catch rates of tiger prawns reflect their high abundance because of favourable environmental conditions. Although both tiger and endeavour prawns occupy similar inshore structured habitats, fishing effort was focused on tiger prawns rather than endeavour prawns. This was reflected in an endeavour prawn catch rate of 4.8 kg/hr which was below the reference point catch rate of 5.6 kg/hr. This catch rate may not represent the actual abundance of endeavour prawns because not all endeavour prawns caught were landed due to the daily vessel catch cap (industry practice) and skippers tended to high grade towards retention of tiger prawns.

Survey assessment

For tiger prawns, this process involves analysis of survey-based indices of recruitment and spawning stock, which are used for catch prediction and assessed against the spawning stock-recruitment relationship. For the 2009 season the total landings were below the catch prediction, based on recruitment survey indices (549 tonnes with a range of 439–659 tonnes). Tiger prawn breeding stock levels are maintained at adequate levels by real-time monitoring the tiger prawn catches to determine when fishing should cease in the main tiger prawn fish grounds. This strategy maintains the spawning biomass of tiger prawns above the historically determined biological reference point. The present cut-off threshold catch rate is 25 kg/hr based on 6-fathom nets in quad gear configuration.

During 2009, tiger prawn catch rates were monitored from May to August and the tiger prawn grounds closed on 1 August. Three standardised tiger prawn breeding stock surveys carried out from August to October with an average CPUE of 29.7 kg/hr in the main spawning area (Q1). Therefore the stock level was maintained above the threshold level. The August, September and October surveys showed a CPUE of 25.5 kg/hr, 34.0 kg/hr and 26.4 kg/hr respectively. The tiger prawn spawning area (Area B) was re-opened for fishing on 26 October and closed 16 November when the catch rate level declined to the threshold cut off level (19 kg/hr).

The spawning survey regime extends to the central Gulf (Q2 area) and the mean spawning indices for the three surveys were higher (45.2 kg/hr) in this region.

King prawn breeding stock levels in the fishery are maintained at adequate levels through controls on fishing effort and the extended breeding period and due to the lower catchability of the species compared to tiger prawns. The variability in the abundance of the king prawn stock has been assessed since 2002 by a pre-season recruitment survey.

There is no formal assessment for endeavour prawns, a secondary target species whose distribution overlaps that of tiger prawns, and they are fished to varying levels depending on the abundance of (and hence the fishing effort applied to) the more valuable tiger prawns. The breeding stock of endeavour prawns is considered to be adequate because their distribution overlaps that of the tiger prawns and the tiger

prawn closures also protect a significant portion of the endeavour prawn breeding stock. In addition, endeavour prawns are also considered to be more resilient to fishing pressure due to their smaller size and lower catchability, which is similar to king prawns.

Environmental conditions were generally favorable for all species during the 2009 season, i.e. no cyclonic impacts or heavy rainfall during the summer months (December to March).

The catch prediction for tiger prawns is based on the relationship between recruitment survey indices (early and late March and early April) and the season’s landings (April–November of the same year). The projected tiger prawn catch range for 2010 is 270-410 tonnes.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2009 the breeding stock indicators (catches within specified ranges) for tiger and endeavour prawns were met. The king prawns were below the target range, however there is a conservative harvesting strategy in place for this species. The low banana prawn landings recorded corresponded to a low rainfall year.

Non-Retained Species

Bycatch species impact:

Low

Bycatch levels for Exmouth Gulf are relatively low by tropical trawl fisheries standards, with few species of significance to other fishing sectors being taken. Trialing of secondary bycatch reduction devices continues (including square mesh cod-end nets) in order to reduce the volume of overall bycatch species retained in the trawls whilst improving the quality of the prawn catch. In addition, all boats used hoppers (in-water catch sorting systems), which add another level of improvement for bycatch survival and product quality. Fishing effort (in hours) in 2009 was slightly higher than expected for the total landings but still low compared to historical levels, however, there was a slight decrease in the area trawled (27% of the whole fishery) compared to the 2008 season and much lower compared to seasons prior to the 1990's.

The two performance measures for the fishery relate to (i) its impact on biodiversity through the take of non-target (bycatch) species, and (ii) its impact on associated species, e.g. dolphins, through the discarding of bycatch (provisioning). Analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas (even though abundances may vary), indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort and implementation of BRDS in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.

GASCOYNE COAST BIOREGION

Protected species interaction: **Low**

While protected species including dugongs, turtles and sea snakes occur in the general area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both species are typically returned to the sea alive. Grids are now compulsory, which has largely eliminated the capture of any turtle or other large animal. In addition, secondary bycatch reduction devices (square mesh panels) were implemented all nets in 2005. Three turtles (unidentified) were reported as being caught in nets and returned alive during 2009.

Ecosystem Effects

Food chain effects: **Low**

Although the prawn species are managed such that the relatively high levels of annual harvest, the impact of the catch on local food chains is unlikely to be significant in view of the high natural mortality, extent of non-trawled nursery areas and variable biomass levels of prawns resulting from variable environmental conditions, such as cyclone events.

Habitat effects: **Low**

Historically, the fishery has impacted on some shallow water areas (less than 12 m in depth) containing sponge habitats, but the refocusing of the fishery into deeper waters to take larger prawns since the early 1980s has reduced this interaction. The trawling effort is now focused in the deeper central and north-western sectors of Exmouth Gulf. Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. Overall, the nature of this particular trawl fishery and the very tight controls on effort indicate that its environmental effect is now likely to be low.

Performance measures for habitat impact relate to the spatial extent of trawling within the licensed area of the Exmouth Gulf fishery. In 2009 the performance measure was met as the total area trawled, at approximately 311 square nautical miles (27%) per cent of Exmouth Gulf, was below the 40% level.

Social Effects

The estimated employment in the fishery for the year 2009 was 27 skippers and crew. Additional processing and support staff are also based in Exmouth Gulf and Fremantle. Within the Exmouth area, the fishery is one of the major regional employers and contributes to the economic viability of the Exmouth township.

Economic Effects

Estimated annual value (to fishers) for year 2009:
\$8.9 million

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time. In this fishery there is a high degree of vertical integration, with the fishing companies which own the boats undertaking direct marketing of the product into overseas markets. For this reason, the product prices quoted can only be estimates, however prices are similar to the Shark Bay fishery.

Estimated prices were as follows:

King prawns	\$11.00/kg
Tiger prawns	\$11.50/kg
Endeavour prawns	\$6.00/kg
Coral prawns	\$3.00/kg

Fishery Governance

Target catch range: 771 – 1,276 tonnes

Current fishing level: Acceptable

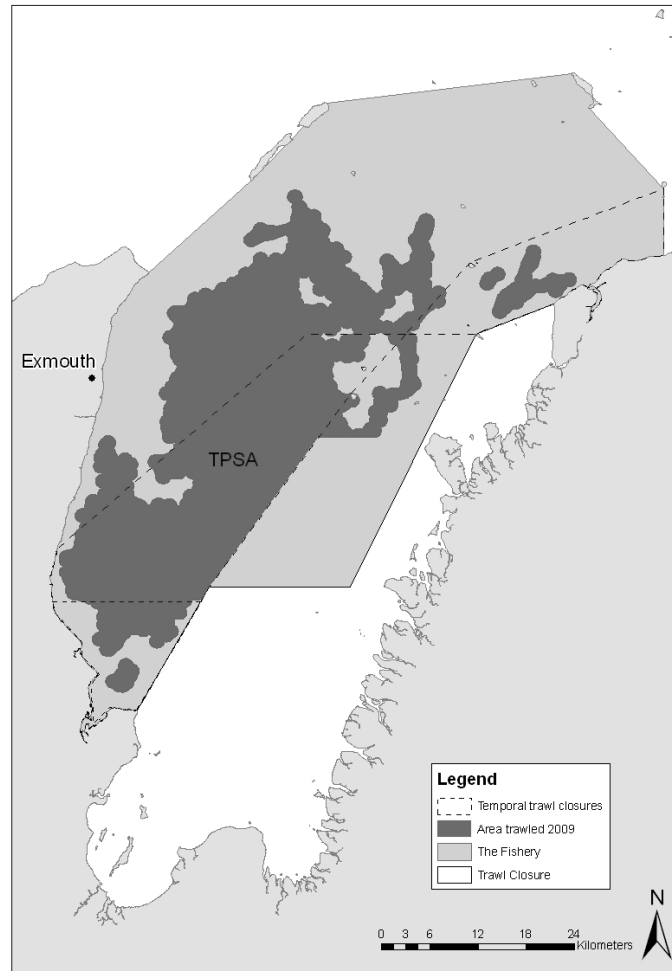
Under current fishing effort levels, the target catch range for major penaeids is 771–1,276 t. The long-term target catch ranges for individual species are king prawns 350–500 t, tiger prawns 250–550 t and endeavour prawns 120–300 t (noting that maximum or minimum catches do not occur for all species simultaneously). These overall and individual figures are generally based on a 10-year average (1989–1998). The target catch ranges for the total of all three species combined were within the target catch range. Tiger and endeavour prawns were within each species range but king prawns were lower for the 2009 season.

New management initiatives (2010): Nil

External Factors

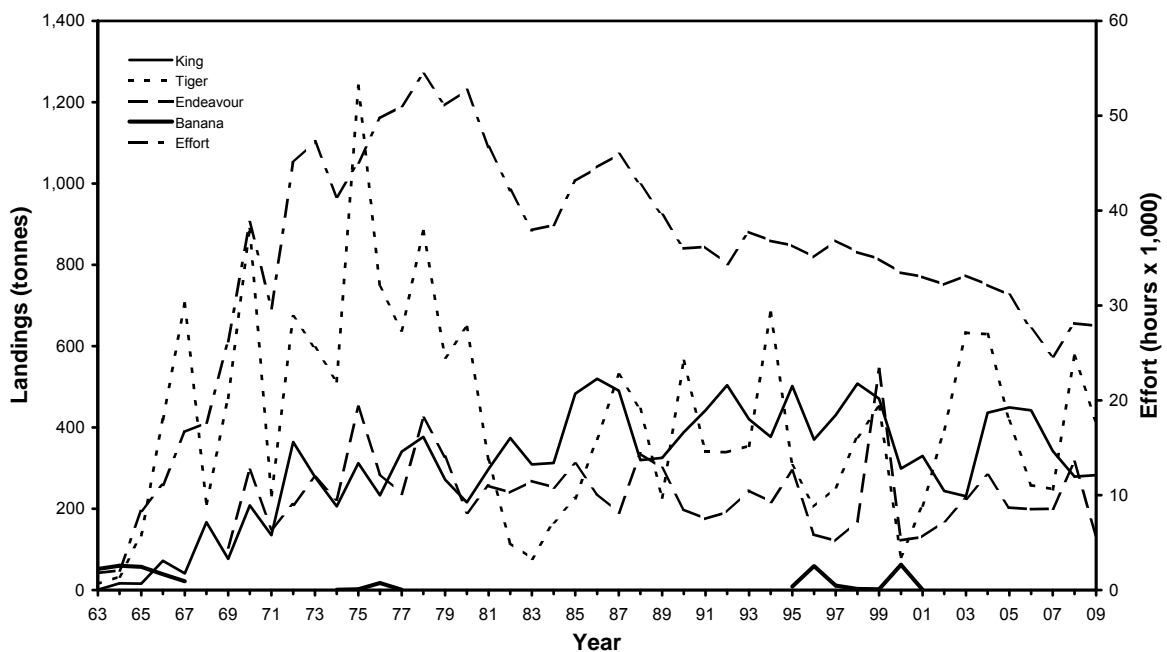
High costs of fishing and lower returns due to the current economic climate and competition from aquaculture on small prawns has required focussing management and harvesting practices to reduce fishing costs (i.e. only fish efficient catch periods) and to target larger prawns and to shift the emphasis on domestic markets rather than the export market.

Cyclones appear to have a significant effect on the productivity of Exmouth Gulf. Cyclone impacts can be either positive or negative. Early (December to February) cyclones can have a negative impact (high mortality) on small size prawns in the shallow nursery areas. There are other environmental factors that have not been fully investigated that can affect the spawning stock – recruitment relationship.



EXMOUTH GULF PRAWN FIGURE 1

The main boundaries of the Exmouth Gulf Prawn Fishery, TPSA and Q1 and Q2, potential trawl area and area trawled in 2009.



EXMOUTH GULF PRAWN FIGURE 2

Exmouth Gulf Prawn Managed Fishery annual landings and adjusted effort (twin-gear), 1963 – 2009.

Gascoyne Demersal Scalefish Fishery Status Report

G Jackson, R Marriott and E Lai

Management input from M Stadler

Main Features			
Status		Current Landings (2009)	
Stock level		Pink snapper:	
Pink snapper	Recovering	Commercial	231 t
Goldband snapper	Adequate	Recreational	ca. 50 t
Spangled emperor	Adequate	Charter	15 t
Fishing Level		Goldband snapper:	
Pink snapper	Acceptable	Commercial	144 t
Goldband snapper	Acceptable	Recreational	ca. 15 t
Spangled emperor		Charter	8 t
North Gascoyne	Unacceptable		
South Gascoyne	Acceptable	Spangled emperor:	
		Commercial	3 t
		Recreational	ca. 50 t
		Charter	5 t

Fishery Description

The Gascoyne Demersal Scalefish Fishery encompasses all commercial and recreational fishing for demersal scalefish in the continental shelf waters of the Gascoyne Coast Bioregion (Gascoyne Demersal Scalefish Fishery Figure 1). This includes the activities of the Shark Bay Snapper Managed Fishery (SBSF), commercial 'open-access' wetline fishing and recreational fishing from both licensed charter and private vessels.

Commercial fishing is now almost entirely undertaken by SBSF licensed vessels that have historically targeted the oceanic stock of pink snapper (*Pagrus auratus*) in the waters off Shark Bay. SBSF licensed vessels use mechanised handlines and, in addition to pink snapper, catch a range of other species including goldband snapper (*Pristipomoides* spp., mainly *P. multidens*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, includes spangled emperor, *Lethrinus nebulosus*, and redthroat or sweetlip, *L. miniatus*), cods (Serranidae), ruby snapper (*Etelis carbunculus*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicus*) and trevallies (Carangidae).

Commercial 'open-access' wetline vessels (those without SBSF-quota) operate in waters outside of the SBSF management zone (see Boundaries) and catch a similar variety of species. A limited number of licensed charter vessels and a large number of recreational vessels fishing out of Denham, Carnarvon and around the Ningaloo area (Coral Bay, Tantabiddi, Exmouth) also catch this suite of demersal species.

This report focuses on the three Gascoyne demersal indicator species, i.e. pink snapper, goldband snapper and spangled emperor.

Governing legislation/fishing authority

Commercial

Shark Bay Snapper Management Plan 1994

Shark Bay Snapper Managed Fishery Licence

Prohibition on line fishing from trawlers (Shark Bay) Order 2000

Prohibition on commercial line fishing in waters of Shark Bay Snapper Managed Fishery Order 2004

Prohibition on Fishing by Line From Fishing Boats (Pilbara Waters) Order 2006

Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC - Export Exemption)

Recreational

Fish Resources Management Act 1994, *Fish Resources Management Regulations 1995* and subsidiary legislation

Consultation process

Commercial

Department–industry meetings

Recreational

Recreational Fishing Advisory Committee

Regional Recreational Fishing Advisory Committees
(Denham, Carnarvon, Exmouth)

Boundaries

Commercial

The SBSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°34'S and 26°30'S (Gascoyne Demersal Scalefish Fishery Figure 1). SBSF vessels are not permitted to fish in inner Shark Bay. A limited number of commercial vessels without SBSF-quota are permitted to fish (i) north of 21°56'S, and (ii) between 23°07' and 23°34'S. No state-licensed commercial vessels are permitted to fish between 21°56' and 23°07'S ('Point Maud-Tantabiddi Well' closure). Management arrangements for the West Coast Demersal Scalefish Fishery (WCDSF) permit a limited number of commercial vessels licensed in that fishery to operate in waters up to the southern boundary of the SBSF (26°30'S).

Recreational

The recreational fishery (which includes activities by licensed charter vessels) operates in all Gascoyne waters with the exception of Sanctuary Zones, Marine Nature Reserves and Conservation Areas within the Ningaloo and Shark Bay Marine Parks.

Management arrangements

Commercial

Commercial fishing for pink snapper (oceanic stock) came under formal management for the first time in May 1987. Between then and 2000, pink snapper catches taken during the peak season (May–August) were subject to individual quotas while gear controls applied in the off-peak season (September–April). From 2001, the SBSF has been quota-managed on a year-round basis. A minimum holding of 100 quota units applies and all units are transferable. These quota units operate from 1 September to 31 August ('quota-year'), with a total of 5,125 units in the fishery (value of one quota unit = total allowable commercial catch [TACC] ÷ 5,125).

In response to scientific advice on stock status there have been a number of significant reductions in TACC in recent years. The TACC was reduced from 563,750 kg to 338,250 kg in 2004, it was further reduced to 297,250 kg in April 2007, and most recently to 276,750kg, in September 2007. An EPBC assessment for the SBSF fishery was completed in 2003 and was re-assessed in early 2009.

'Open-access' commercial wetline fishing in waters between 23°34'S and 23°07'S (Gascoyne Demersal Scalefish Fishery Figure 1) will be incorporated within the Gascoyne Demersal Scalefish Fishery Management Plan (see Fisheries Management Paper No. 224 for further details). As previously noted, commercial fishing below 26°30'S has been managed as part of the WCDSF since January 2008.

Minimum legal sizes apply to many of the commercial target species (emperors, pink snapper, red emperor, cods).

Recreational

The recreational fishery (including charter vessels) is managed using daily bag, possession, trip and size limits coupled with limitations on the use of certain fishing gears.

Research summary

Catch and effort monitoring for this fishery includes analyses of commercial (daily/trip returns for SBSF licensed vessels; monthly returns for 'open access' vessels) and charter catch and effort (monthly) returns and catch-disposal records (SBSF, pink snapper only, to monitor individual quotas) and recreational survey data.

Commercial catch and effort data reported here covers all commercial line fishing within Gascoyne waters between 114°50'E and 26°30'S. Commercial catches are reported for the period of the SBSF quota-year, i.e. September 1 2008 - August 31 2009 (referred to hereon as the 'season 2009'). Charter catches are reported for the period January – December 2009. The most recent survey of boat-based recreational fishing within the Gascoyne Coast Bioregion was for April 2007 and March 2008 (equates to commercial 'season 2007').

Pink snapper: Detailed research on the oceanic pink snapper stock and the associated SBSF was undertaken throughout the 1980s and early 1990s. Commercial catches are sampled throughout the year to provide representative catch-at-age data. An integrated stock assessment model has been used to determine stock status since 2003 and is updated every 3 years (most recently in 2009). A Western Australian Marine Science Institute (WAMSI) project has been investigating the relationships between pink snapper stocks from Shark Bay to the South Australian border based on genetics and otolith chemistry; results from this project will be available in late 2010.

Goldband snapper: Comprehensive research on goldband snapper commenced in 2007 as part of a Gascoyne Integrated Fisheries Management (IFM) project. A 'weight of evidence' based assessment has been completed and is pending external review. Monitoring of commercial catches and age structure is continuing and further research is planned to refine estimates of the key biological parameters.

Spangled emperor: Comprehensive research on spangled emperor commenced in 2007 also as part of the Gascoyne IFM project. A 'weight of evidence' based assessment has been completed and is pending external review. Limited monitoring of recreational catches landed at fishing tournaments in the Bioregion is continuing.

GASCOYNE COAST BIOREGION

Retained Species

Commercial landings (season 2009):

	Total 478 tonnes
Pink snapper	231 tonnes
Goldband snapper	144 tonnes
Spangled emperor	3 tonnes
Other species	100 tonnes

The total commercial catch of 478 t taken in the Gascoyne in 2009 included 231 t of pink snapper (oceanic stock), 144 t of goldband snapper, 3 t of spangled emperor and 100 t of other scalefish species.

Of the total commercial catch, SBSF licensed vessels fishing within the waters of the SBSF caught 224 t of pink snapper (TACC = 277 t) plus 158 t of other species including 87 t of goldband snapper, 2 t of spangled emperor and 68 t of other scalefish species.

Recreational catch estimate (2007/08):

Pink snapper	71 tonnes
Goldband snapper	23 tonnes
Spangled emperor	56 tonnes

In 2007/08, an estimated 49 t of pink snapper (oceanic stock) was taken by recreational vessels fishing in Gascoyne waters (excluding inner gulfs of Shark Bay). The recreational catch of pink snapper (oceanic stock) reported by licensed charter boats in 2009 was 15 t, a reduction on the 22 t reported in 2008.

An estimated 51 t of spangled emperor was taken by recreational vessels fishing in Gascoyne waters in 2007/08. The recreational catch of spangled emperor reported by charter boats in 2009 was 5 t (same in 2008).

An estimated 14 t of goldband snapper was taken by recreational vessels fishing in Gascoyne waters in 2007/08. The recreational catch of goldband snapper reported by charter boats in 2009 was 8 t (9 t in 2008).

Fishing effort/access level

Commercial

Commercial line fishing between 23°34'S and 26°30'S is now entirely conducted by SBSF licensed vessels. The SBSF landed 80% of the total commercial catch of demersal scalefish target species in the Gascoyne Coast Bioregion (includes pink snapper) in the 2009 season. At the start of the season there were 55 licences in the SBSF with a total of 14 vessels actively participating in fishing (21 vessels in 2008). These vessels fished for a total of 802 days in waters between 23°34'S and 26°30'S in the period September 2008-August 2009.

The level of effort targeted at pink snapper by SBSF vessels varies on a seasonal basis, historically peaking in June–July, when pink snapper aggregate to spawn. Pink snapper catch rates are assessed using 'standard boat days', i.e. days fished by SBSF vessels that caught more than 4 t each of pink

snapper by line during the period June–July. SBSF vessels fished for 257 boat days during June–July 2009 while targeting pink snapper.

Recreational

Total recreational boat fishing effort (fisher days) across the entire Gascoyne in 2009 was likely to be similar to that estimated from the last recreational fishing survey (April 2007 - March 2008), i.e. ca. 240,000 fisher days.

Stock Assessment

Assessment complete:

Pink snapper	Yes
Goldband snapper	Yes
Spangled emperor	Yes

Assessment method:

Pink snapper	Composite Assessment
	Catch Rates
Goldband snapper	Fishing Mortality
Spangled emperor	Fishing Mortality

Breeding stock levels:

Pink snapper	Recovering
Goldband snapper	Adequate
Spangled emperor	Adequate

(overall, but declining in North Gascoyne)

Pink snapper: A stock assessment based on an integrated age-structured model indicated that the spawning biomass of the oceanic pink snapper stock was at a depleted level in 2002-2003. The most recent assessment, that incorporated data from the 2008 season, indicated that the spawning biomass in 2008 was close to the threshold level (30% of the unexploited spawning biomass). The model estimated that at 2008 harvest levels (total annual catch ca. 300 t), the target level (40% of the unexploited spawning biomass) would be reached by 2014. The next assessment is scheduled for 2012.

Prior to the development of the integrated assessment model, the breeding stock was assessed using a pink snapper catch rate based on catch and effort information from the peak of the spawning season (June–July) only. It is recognised that the use of catch rate as an index of pink snapper abundance must be treated with caution, due to the aggregating behaviour of the species during the winter spawning period.

This indicator was used in the original EPBC Act assessment with a trigger level set at a minimum of 500 kg pink snapper/standard boat day. The pink snapper catch rate in 2009 (SBSF licensed vessels fishing in June–July only) fell to 507 kg pink snapper/standard boat day (see box below).

The current performance measure for the Shark Bay Managed Snapper Fishery is that the pink snapper catch rate for the peak months (June–July) should not fall below a minimum trigger level of 500 kg pink snapper/standard boat day.

Catch rates steadily declined through the 1990s and early 2000s reaching a low of 450 kg pink snapper/standard boat day in 2004. Since that time (TACC was reduced significantly in 2004), despite marked fluctuations, catch rates have increased overall. While the catch rate has most recently fallen again, to 507 kg pink snapper/standard boat day in 2009, it remains above the trigger level of 500 kg pink snapper/standard boat day.

Goldband snapper: Historical catch rate data from the SBSF were found to be uninformative for using as an index of relative abundance. Catch rate data were not considered useful for this purpose because changing catch rates have likely reflected an increased market demand and concomitant changes in targeted fishing effort for this species. These historical data were also considered too coarse for a reliable analysis. Several more years of data collection from the daily trip logbooks (implemented in January 2008), will provide scope for analyses of an improved time series of catch rates for predicting trends in relative stock biomass.

A ‘weight of evidence’ approach, based on an assessment of fishing mortality (F) was used. Sufficient data from sampling the commercial fishing catches in both the 2006 and 2008 quota years were available for this analysis. Preliminary estimates of F for both years were within the target range, indicating that fishing is not currently having an unacceptable impact on the age structure of the population. However, while the breeding stock levels and fishing level are currently assessed as adequate, due to the limited data available, there is high uncertainty in the estimates.

The completed ‘weight of evidence’ assessment is pending external review and will be released as a Fisheries Research Report in late 2010.

Spangled emperor: Commercial catch rate data for spangled emperor were found to be uninformative as an index of abundance. A ‘weight of evidence’ approach, based on an assessment of fishing mortality, has been used in each of two study regions in the Gascoyne Coast Bioregion (North Gascoyne, South Gascoyne) using data collected primarily in 2007. Biological assessments have shown spangled emperor to be moderately long-lived (maximum age ca. 30 years). Individuals commence life as females, then either change sex to male or remain as female prior to reaching sexual maturity. The average length at sex change and length at female maturity were both shown to be below the current minimum legal size limit.

Estimates of fishing mortality (F) indicated that in the South Gascoyne, F was close to the target level, with many older fish collected, up to the maximum observed age of 30 years old. In the North Gascoyne, F was above the limit level, indicating that localised over-fishing is occurring north of Point Maud. Relatively few individual spangled emperor

older than 10 years old were sampled from the North Gascoyne in 2007, indicating that older fish had been removed by fishing, at least from areas outside of sanctuary zones of the Ningaloo Marine Park. That F exceeded the limit level indicates, given available evidence, that the current level of fishing on the spangled emperor population is too high in the North Gascoyne (i.e. unacceptable). The spangled emperor population is a single genetic stock throughout the Bioregion. The breeding stock is estimated to be at an acceptable level for the Bioregion overall but noting significant reductions in the relative numbers of older (breeding age) spangled emperor in the North Gascoyne due to localised depletions (i.e. declining in north). The completed ‘weight of evidence’ assessment is pending external review and will be released as a Fisheries Research Report in late 2010.

Non-Retained Species

Bycatch species impact

Negligible

The commercial catch consists of a large number of demersal species of medium to high market value; therefore there are few species captured by the fishery that are not retained.

Commercial operators must return any sharks caught and are not permitted to use wire trace, in order to minimise interactions with sharks.

Protected species interaction

Negligible

The line fishing methods used do not catch protected species.

Ecosystem Effects

Food chain effects

Low

Pink snapper are generalist feeders and just one of a number of such species inhabiting the continental shelf waters in this Bioregion. Food chain effects due to fishing for pink snapper are considered to be low because the quota system restricts SBSF catches to a relatively small percentage of the total biomass. The juvenile and sub-adult components of the stock are likely subject to large, mostly-environmentally driven fluctuations in abundance even in the absence of fishing, due to significant variability in annual recruitment strength.

Habitat effects

Negligible

The nature of the fishery, targeting aggregations of adult pink snapper and other demersal scalefish using hooks and lines, means that the commercial fishery has virtually no direct impact on habitat.

Social Effects

The pattern of fishing by SBSF vessels in 2009 was similar to previous years and reflects the combination of focus on fishing for pink snapper during the peak season and fishing for deeper water species (goldband snapper, ruby snapper) throughout the rest of the year.

In 2009, 11 vessels fished for more than 10 days during the

GASCOYNE COAST BIOREGION

peak season with average crew of 2-3.

Fishing and associated fish processing are important sources of local employment in Denham and Carnarvon.

Recreational fishing in Shark Bay and Ningaloo are very popular activities in this region, including being major tourist attractions especially during the winter months and school holidays.

Economic Effects

Estimated annual value (commercial sector)

(season 2009) \$ 3.8 million

The overall value of the commercial component of the Gascoyne Demersal Scalefish Fishery (catch taken by SBSF and 'open-access' wetline vessels combined) was around \$ 3.8 million in 2009 with \$1.7 million from pink snapper and \$2.0 million from all other scalefish species. Note: the estimated value of the commercial catch reported here includes all species landed and is based on entitlement (quota) year not financial year.

While a dollar value is difficult to assign to recreational and charter catches at this stage, the availability of demersal target species underpins the local tourism industry and generates significant income for the regional economy.

Fishery Governance

Commercial:

Current effort level (season 2009): Acceptable

Target catch (and effort) range:

Pink snapper 277 tonnes/380-540 days

In 2009, SBSF vessels required 442 boat days to catch 224 t of pink snapper (oceanic stock, TACC = 277 t). The available TACC was not entirely taken due to quota being left in the water by prawn/scallop vessels and a number of SBSF vessels not actively fishing for a range of reasons.

The average catch rate at 507 kg pink snapper/boat day for the 2009 season was above the EPBC Act performance measure (500 kg/standard boat day). This catch rate-based EPBC Act performance measure will be re-assessed when sufficient higher resolution (daily/trip catch and effort returns) data are available, possibly as part of the next EPBC Act review (due in 2014).

Recreational:

Current effort level (2007/08):

Pink snapper Acceptable

Goldband snapper Acceptable

Spangled emperor

Unacceptable (North Gascoyne)

Acceptable (South Gascoyne)

Estimates of fishing mortality indicate localised over-fishing of spangled emperor is occurring north of Point Maud.

New management initiatives (2009/10)

The most recent stock assessment indicated that the spawning biomass of the oceanic pink snapper stock in 2008 had recovered to the threshold level (30% of unexploited level of spawning biomass). At a level of annual catch of ~300 t (all sectors combined), the model projected that the target level (40% of unexploited level of spawning biomass) will be reached by 2014, which is within the agreed 10-year recovery timeframe. Based on this assessment, the Department indicated that the current TACC (277 t) would be retained for the 2009/10, 2010/11 and 2011/12 seasons; the assessment will be updated and consideration of management arrangements in early 2012 ahead of commencement of the 2012/13 season.

Concerns around the sustainability of fishing for deeper-water species (e.g. goldband snapper, ruby snapper, various cods) remain, largely due to uncertainty in the stock status of these species and their long-lived, slow growing life histories. As an interim measure, SBSF fishers initiated an effort day cap to control fishing effort in the SBSF until management arrangements for the Gascoyne Demersal Scalefish Fishery are implemented. The interim effort day cap was implemented through a licence condition on 1 January 2009 and restricts operators to a maximum of 30 fishing days in the fishery per 100 units of pink snapper quota held.

A Vessel Monitoring System (VMS) became operational in the SBSF in May 2008. A management plan introduced for the West Coast Demersal Scalefish Fishery (adjacent to the southern boundary of the SBSF) and compulsory VMS introduced for these operators in May 2008 has significantly improved the integrity of management arrangements for both Bioregions.

A state-wide recreational boat fishing license was introduced in March 2010. The new licensing system will provide a database of boat fishers across Western Australia, which will assist in determining who is fishing, where they are fishing and what they are catching.

Reports on the stock status of the three demersal indicator species (pink snapper, goldband snapper and spangled emperor) will be made available in late 2010 following external review. The information contained in these reports will be used as the basis for management recommendations, to be developed in conjunction with stakeholders in 2010/11, as part of the IFM process in the Gascoyne.

External Factors

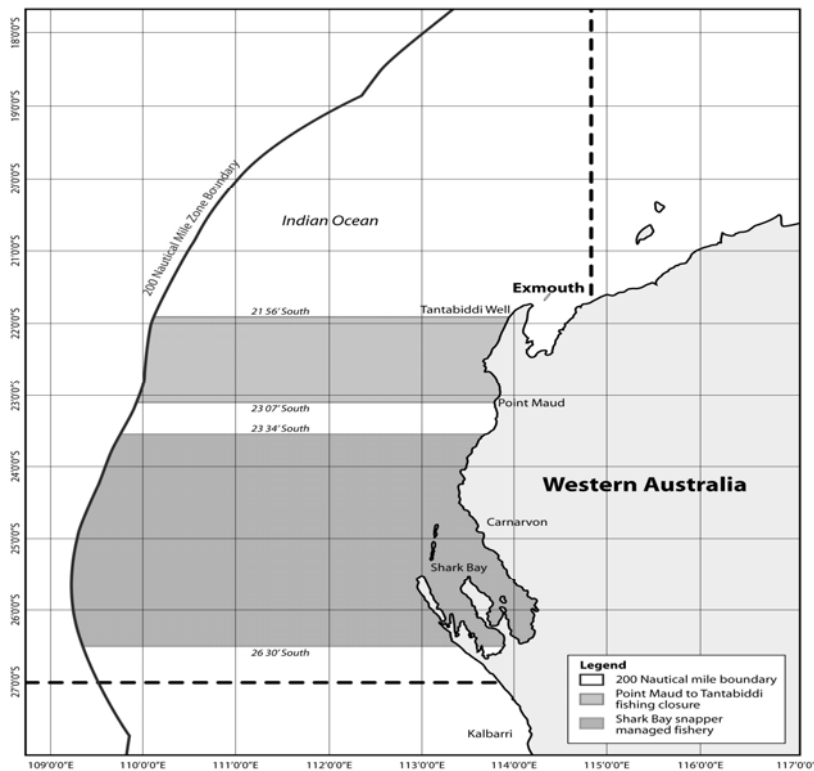
Under the Offshore Constitutional Settlement, commercial trawlers licensed by the Commonwealth may operate in waters outside the 200 m isobath as part of the Western Deepwater Trawl Fishery (WDWTF). Information on catches of pink snapper or other key species taken or returned by WDWT vessels in 2009 is not available (last reported catch of pink snapper was <0.5 t in 2006).

Climate change has the potential to impact fish stocks in range of ways including influencing their geographic distribution (latitude shift) with temperate species such as pink snapper likely to shift southwards. A review of the impacts and responses to marine climate change in Australia has recently been undertaken by CSIRO, and is available at www.oceanclimatechange.org.au.

GASCOYNE DEMERSAL SCALEFISH FISHERY TABLE 1

Total commercial catches of demersal scalefish species other than pink snapper taken in Gascoyne waters between 2000/01 and 2008/09 (excludes mackerels, sharks and tunas). Units are tonnes.

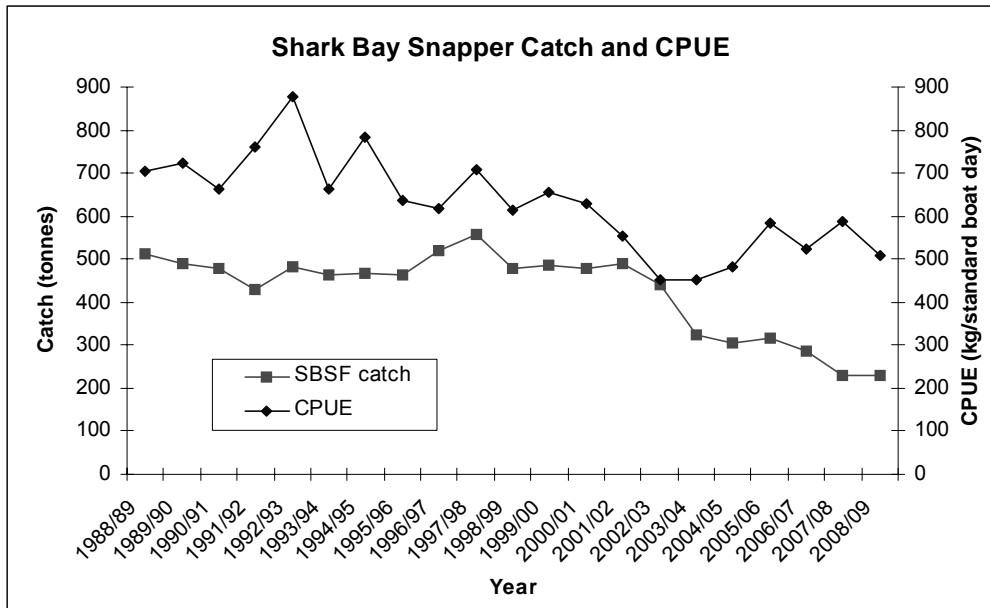
Species	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
Goldband snapper	41.6	110.0	310.7	250.4	239.8	105.8	107.2	121.1	143.8
Red emperor	24.4	21.3	18.6	21.3	18.5	19.4	17.0	12.8	11.7
Spangled emperor	40.3	23.1	20.4	15.2	13.5	18.1	7.0	7.0	3.3
other emperors	35.6	25.7	25.8	37.4	31.8	29.2	34.3	26.8	13.8
Cods	27.2	29.7	38.0	39.2	27.9	21.9	21.5	15.0	9.5
Other	89.9	85.9	90.5	95.4	82.0	78.1	77.1	65.8	64.8
Total	259.0	295.7	504.0	458.9	413.5	272.5	264.1	248.5	246.9



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 1

Waters of Gascoyne Coast Bioregion including Shark Bay Snapper Managed Fishery management zone and 'Point Maud to Tantabiddi Well' fishing closure. Hatched lines indicate boundaries of Gascoyne Coast Bioregion. Commercial line fishing in waters between 26 deg 30 S and 27 deg S has been managed as part of West Coast Demersal Scalefish Fishery since January 2008.

GASCOYNE COAST BIOREGION



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 2

Catch and catch per unit effort by season from 1988/89 to 2008/09 for the SBSF. Units are kg whole weight of pink snapper per standard boat day. The CPUE for line fishing by dedicated snapper vessels in June-July (peak season) is incorporated in the stock assessment model used for the oceanic pink snapper stock.

Inner Shark Bay Scalefish Fishery Status Report

G Jackson and J Norriss

Management input from M Stadler

Main Features

Status

Stock level:

Whiting	Adequate
Mullet	Adequate
Tailor	Adequate
Yellowfin bream	Adequate
Pink snapper	Eastern Gulf – Adequate Denham Sound – Adequate Freycinet Estuary – Recovering

Fishing Level:

Whiting	Acceptable
Mullet	Acceptable
Tailor	Acceptable
Yellowfin bream	Acceptable
Pink snapper	Eastern Gulf – Acceptable Denham Sound – Acceptable Freycinet Estuary – Acceptable

Current Landings

Commercial (2009)

Whiting	112 t
Mullet	104 t
Tailor	17 t
Yellowfin bream	8 t
Pink Snapper	1 t

Recreational (Pink Snapper only)

Eastern Gulf	4 t (2007)
Charter	1 t (2009)
Denham Sound	4 t (2007)
Charter	0.5 t (2009)
Freycinet	2 t (2007)

Fishery Description

The Inner Shark Bay Scalefish Fishery encompasses commercial and recreational fishing for scalefish species within the waters of the Eastern Gulf, Denham Sound and Freycinet Estuary in inner Shark Bay (Inner Shark Bay Fishery Figure 1). This includes the activities of the Shark Bay Beach Seine and Mesh Net Managed Fishery (SBBSMNF) and the Inner Shark Bay Recreational Fishery.

The SBBSMNF operates from Denham and uses a combination of beach seine and haul net gears to mainly take four species/groups: whiting (*Sillago schomburgkii* and *S. analis*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and yellowfin bream (*Acanthopagrus latus*).

Most recreational fishing is boat-based using rod & line or handline. The key recreational species are black snapper (grass or blue-lined emperor, *Lethrinus laticaudis*), western butterflyfish (*Pentapodus vitta*), whiting (*Sillago* spp.), pink snapper (*Pagrus auratus*), Queensland school mackerel (*Scomberomorus queenslandicus*), tailor, and blackspot tuskfish (bluebone, *Choerodon schoenleinii*). Recreational fishers also take significant numbers of blue swimmer crabs, mostly in the Eastern Gulf.

A limited number of licensed charter vessels operate out of Denham (mostly fishing in the oceanic waters off Cape Inscription) and Monkey Mia.

Governing legislation/fishing authority

Commercial

Shark Bay Beach Seine and Mesh Net Management Plan 1992

Shark Bay Beach Seine and Mesh Net Managed Fishery Licence

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Commercial

Department–industry meetings

Recreational

Prior to 2010 - Recreational Fishing Advisory Committee and Regional Recreational Fishing Advisory Committees (Denham, Carnarvon). Future consultation process to be facilitated by RecFishWest.

Direct consultation with local community on specific issues (e.g. Shark Bay Inner Gulf Pink Snapper Working Group, convenes every 3 years)

GASCOYNE COAST BIOREGION

Boundaries

The areas covered by this report are shown in Inner Shark Bay Fishery Figure 1. Fishing is not permitted in the Hamelin Pool Marine Nature Reserve.

Management arrangements

Commercial

The SBBSMNF is managed through input controls in the form of limited entry and gear restrictions (e.g. vessel size, net length and mesh size). A unit in the fishery comprises one primary vessel, a maximum of three netting dinghies and a maximum fishing team of three individual fishers.

Commercial line-fishing for pink snapper and other species has not been permitted in these waters since 1996 (see 'Gascoyne Demersal Scalefish Fishery').

Recreational

For most species, the recreational fishery is managed using the normal combination of daily bag, possession, size and gear limits. For pink snapper more complex arrangements are used within the Eastern Gulf, Denham Sound and Freycinet Estuary (Inner Shark Bay Fishery Figure 1). These stocks are managed separately with explicit total allowable catches (TACs). In 2008, the TACs for pink snapper were as follows:

Eastern Gulf – 15 tonnes (approx. 12 tonnes recreational, 3 tonnes commercial)

Denham Sound – 15 tonnes (approx. 12 tonnes recreational, 3 tonnes commercial)

Freycinet Estuary – 5 tonnes (approx. 1,400 fish, i.e. 1,050 recreational and 350 commercial)

Research summary

Pink snapper in the inner gulfs have been the focus of comprehensive research since 1996/97. Integrated age-structured stock assessment models have been used to separately assess the status of the Eastern Gulf, Denham Sound and Freycinet Estuary stocks, and to determine appropriate levels of TAC since 2002. These assessments are updated every 3 years, most recently in 2008 (next assessment is scheduled for 2011).

Estimates of recreational catch and effort were derived from annual surveys (except 1999/00) involving interviews with boat crews returning to the Monkey Mia, Denham, and Nanga boat ramps between 1998/99 and 2007/08.

The catch by species for licensed commercial and charter fishing vessels is derived from compulsory monthly catch returns. The status of the four SBBSMNF target species (whiting, sea mullet, tailor and yellowfin bream) is monitored each year using data from commercial catch returns coupled with the extensive scientific knowledge gained from research dating back to the 1960s. Performance indicators for the SBBSMNF were determined as part of an ESD risk-based assessment that was undertaken in 2002-03 for Departmental purposes.

Research on pink snapper in the inner gulfs is now largely restricted to monitoring (daily egg production method [DEPM] surveys to estimate spawning biomass approximately every 3-5 years). At the last meeting of the

Shark Bay Inner Gulf Pink Snapper Working Group (June 2008), the Department committed to completing a DEPM survey in each of the three areas to enable the stock assessments to be updated prior to their next scheduled meeting in 2011. A survey of boat-based recreational fishing in inner Shark Bay involving interviews at the three main boat ramps commenced in January 2010 and will be completed in December 2010.

Retained Species

Commercial landings (season 2009):

Whiting	112 tonnes
Mullet	104 tonnes
Tailor	17 tonnes
Yellowfin bream	8 tonnes
Pink snapper	1 tonne

The total commercial catch taken by SBBSMNF licensed vessels in 2009 was 251 t, a decline on the 269 t taken in 2008. This comprised 112 t of whiting, 104 t of sea mullet, 17 t of tailor, 8 t of yellowfin bream and 10 t of other mixed scalefish species including 1 t of pink snapper (taken as bycatch by net fishing gears).

Last available recreational catch estimates (including charter, season 2007)

Pink snapper	Eastern Gulf 4.5 tonnes
	Denham Sound 4 tonnes
	Freycinet Estuary 2 tonnes
Black snapper	14 tonnes

As a direct result of management intervention, including the introduction of TAC-based management in 2003, recreational catches of pink snapper decreased significantly after 1998. While no recreational fishing survey was conducted in 2009, recreational catches of pink snapper in the Eastern Gulf, Denham Sound and Freycinet Estuary are assumed to be similar to recent years.

In 2009, approximately 1 t of pink snapper was taken in the Eastern Gulf and 0.5 t in Denham Sound by licensed charter vessels; no catches from the Freycinet Estuary were reported. No catches of black snapper were reported by charter vessels in 2009.

Fishing effort/access level

Commercial

In 2009, of the 12 SBBSMNF licenses, seven vessels were actively involved in fishing.

Fishing effort in the SBBSMNF declined slightly (7%) in 2009 (1,118 boat days) compared with 2008 (1,200 boat days).

Recreational

In 2007, boat-based recreational fishing effort in the inner gulfs was estimated at approximately 33,000 fisher days.

Stock Assessment

Assessment complete

Whiting	Yes
Mullet	Yes
Tailor	Yes
Yellowfin bream	Yes
Pink snapper	Yes (2007)
Black snapper	Yes (2005)

Assessment method:

Whiting/Mullet/Tailor/YF Bream

Catch, Catch Rate

Pink snapper Composite Assessment

Black snapper Fishing Mortality

Breeding stock levels

Whiting	Adequate
Mullet	Adequate
Tailor	Adequate
Yellowfin bream	Adequate
Pink snapper	Eastern Gulf – Adequate Denham Sound - Adequate Freycinet - Recovering
Black snapper	Adequate

Whiting, Mullet, Tailor, Yellowfin bream: Assessment of the four main SBBSMNF target species is based on annual analysis of the commercial catch and effort data. A target range of annual catch and a CPUE trigger level have been determined for the fishery overall and for each species separately.

The total catch (all species) was 251 tonnes in 2009 and was within the target range (235–335 tonnes). The overall CPUE of 224 kg/boat day (all species) was slightly below the long-term average since 1990 (230 kg/boat day). The catch and CPUE for whiting (112 tonnes, 100 kg/boat day), mullet (104 tonnes, 93 kg/boat day) and yellowfin bream ((8 tonnes, 7 kg/boat day) were all within the respective target (catch) ranges and above the minimum (CPUE) trigger levels in 2009 (Inner Shark Bay Fishery Table 1). However, the tailor catch (17 tonnes) was again below the target range and the CPUE (15 kg/boat day) still below the minimum trigger level. While some reduction in natural abundance cannot be discounted, low tailor catches can mostly be attributed to local processing restrictions.

Pink snapper: DEPM surveys that directly estimate pink snapper spawning biomass were conducted annually in the Eastern Gulf, Denham Sound and Freycinet Estuary during the period 1997-2004 and periodically since. Research trawl surveys, to monitor variation in juvenile recruitment, have been conducted each year since 1996. Integrated age-

structured assessment models have been used to assess the status of the three stocks in relation to the management target (40% of the unexploited spawning biomass) since 2002.

These assessments are now updated every 3 years (in 2005 and 2008).

The most recent assessments (2008) estimated the spawning biomass of pink snapper was above the target level (40%) in both the Eastern Gulf and Denham Sound but remained below the threshold level (30%) in Freycinet; however the spawning stock is rebuilding and is projected to reach the target (40%) level by 2012 with a probability of 80%.

Black snapper: Based on age-structure data collected in 2005, fishing mortality (F) was estimated to be around the threshold level (F=M, natural mortality). More recent information on F for this species is not available.

Non-Retained Species

Bycatch species impact **Low**

Bycatch is minimal in the SBBSMNF because netting operations selectively target specific schools of fish. Based on experience, fishers can determine the species and size of the school, and the size of individual fish within the school, before deploying the net. Fish are readily observed in the very shallow near-shore waters of Shark Bay. Non-target species and under-sized fishes are avoided in most cases.

Protected species interaction **Negligible**

As nets are actively set and hauled, if any protected species such as dugongs, dolphins or marine turtles are caught (a rare event) they are immediately released.

Ecosystem Effects

Food chain effects **Low**

The overall catch levels in the fishery have been relatively stable over several decades, despite a long-term reduction in effort, suggesting that recruitment of the main target species has not been significantly affected by fishing mortality. The total biomass of the key target species appears sufficient to maintain trophic function in these waters.

Habitat effects **Negligible**

Seine nets are set and hauled over shallow sand banks, including intertidal areas. Sand habitats are naturally dynamic environments with resident infauna adapted to cope with regular physical disturbances. Combined with the low frequency of fishing in any one location, this indicates that the fishery would have no lasting effect on the habitat.

Social Effects

Commercial

Currently around 20 fishers are employed in the SBBSMNF based on 7 managed fishery licenses actually operating. Fishing and associated fish processing is an important source of local employment - the fishery, although relatively small-

GASCOYNE COAST BIOREGION

scale, makes a significant contribution to the Denham economy and community.

Recreational

Shark Bay is a very popular tourist destination, especially during the winter months and school holidays: data indicate that approximately 30% of all visitors participate in recreational fishing during their stay.

Economic Effects

Estimated annual value (commercial sector)

(2009) \$1.50 million

Commercial

The overall value of the SBBSMNMF in 2009 was estimated at \$1.50 million and includes catch values of \$870,000 for whiting, \$468,000 for sea mullet, \$40,000 for yellowfin bream and \$83,000 for tailor. Note: the estimated value of the commercial catch reported here includes all species landed and is based on calendar year not financial year.

Recreational

While a dollar value is difficult to assign to recreational and charter catches, the availability of quality fishing underpins the tourism industry and generates significant income for the regional economy.

Fishery Governance

Commercial

Current effort level (2009): Acceptable

Target catch range (2009):

All species (ex Pink snapper) 235–335 tonnes

**Pink snapper Eastern Gulf 3 tonnes
Denham Sound 3 tonnes
Freycinet 1.2 tonnes**

Total fishing effort in SBBSMNMF declined by 7% (to 1,118 boat days) in 2009 compared with 2008.

The total commercial catch in 2009 was 251 t, i.e. within the acceptable target range (235–335 t). Acceptable catch ranges for the four main target species (Inner Shark Bay Fishery Table 1) were developed, based on catch data from 1990–2003, to incorporate natural variations in stock abundance in the acceptable catch levels. At this time, this fishery is considered to have a low risk in terms of sustainability, and a low research/management priority.

Commercial catches of pink snapper taken as bycatch by SBBSMNMF vessels in 2009 were less than 1 tonne overall, i.e. well within their allocation within the respective pink

snapper TACs, with 0.5 tonne from the Eastern Gulf and 0.5 tonne from Denham Sound. No catch of pink snapper was recorded from the Freycinet Estuary.

Recreational

Target catch range (2009):

**Pink snapper Eastern Gulf 12 tonnes
Denham Sound 12 tonnes
Freycinet Estuary 3.8 tonnes**

Catches of pink snapper taken by recreational vessels in 2009 are not known but assumed to be similar to those in recent years. A total of 950 Freycinet Estuary management quota tags were allocated to recreational fishers in 2009 via the lottery.

New management initiatives (2009/10)

As an outcome of the 'Wetline Review' (see Fisheries Management Paper No. 224 for details), a management plan will be developed for the proposed Gascoyne Inshore Net Fishery. The Plan may incorporate the existing SBBSMNMF, the Exmouth Gulf Beach Seine Fishery and commercial net fishing in the Carnarvon area as separate zones under a single management plan.

Exemptions (administered through the Denham Fisheries Office), that previously had allowed recreational fishers to land more pink snapper than the Shark Bay inner gulf bag limit when the fish were caught in oceanic waters and landed at Denham no longer apply.

A state-wide recreational boat fishing license was introduced in March 2010 which includes the majority of recreational fishing activities in Shark Bay. The new licensing system will provide a database of boat fishers across Western Australia, which will assist in determining who is fishing, where they are fishing and what they are catching.

Integrated Fisheries Management (IFM) in the Gascoyne is scheduled to begin in 2011 and will include consideration of the inner Shark Bay Fishery and other scalefish fisheries in the Gascoyne Coast Bioregion.

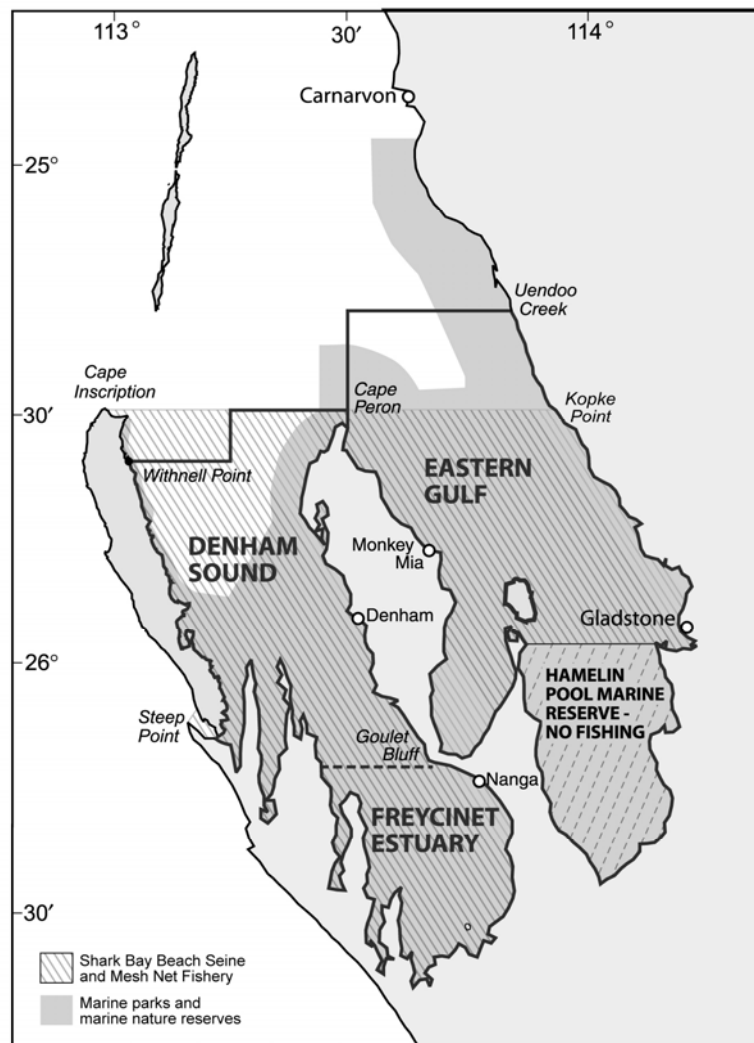
External Factors

The inner Shark Bay environment is particularly stable as a result of its low-rainfall, arid environment. The abundances of some target species tend to be relatively stable with fishery production mostly determined by levels of fishing effort. However, species including pink snapper, yellowfin bream and possibly tailor appear to be influenced by environmentally driven variations in recruitment.

INNER SHARK BAY SCALEFISH FISHERY TABLE 1

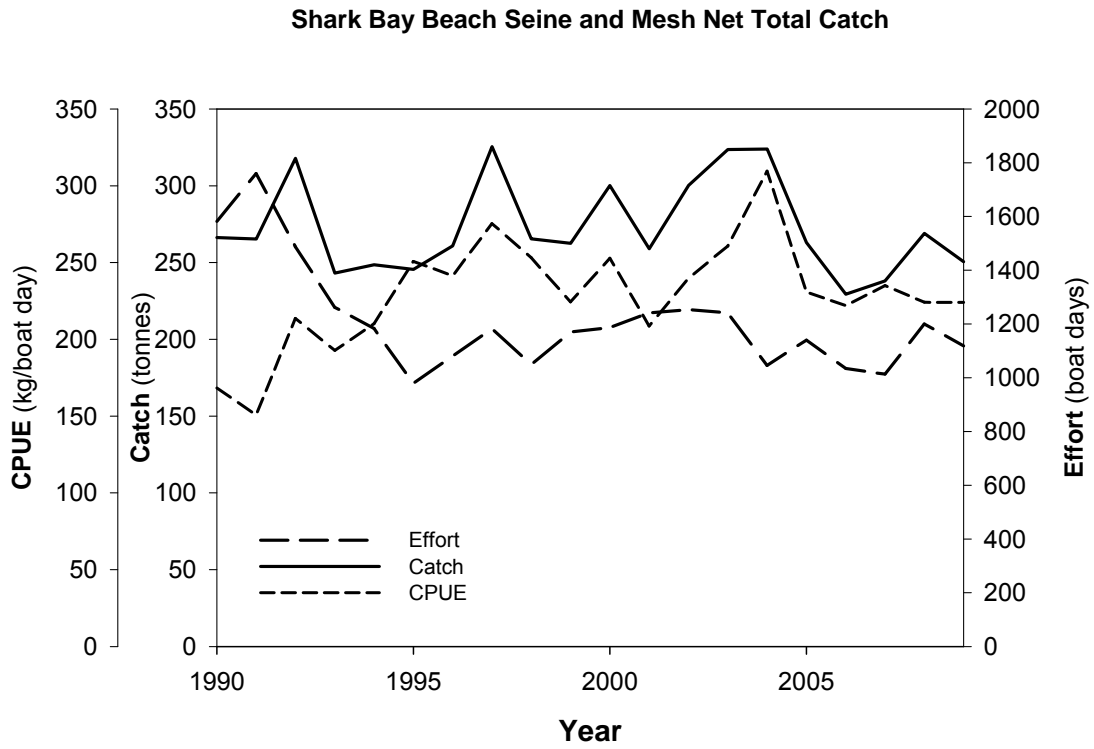
Annual catch per unit effort (kg/boat day) and minimum CPUE trigger levels for key species taken by Shark Bay Beach Seine and Mesh Net Managed Fishery vessels for the period 2001-2009.

Species	Trigger Level	2001	2002	2003	2004	2005	2006	2007	2008	2009
Whiting	75	92	79	86	114	102	110	100	98	100
Mullet	62	93	80	120	137	74	60	90	89	93
Tailor	20	21	21	22	23	17	20	22	19	15
Bream	5	6.2	13	19	26	23	22	14	6	7



INNER SHARK BAY SCALEFISH FISHERY FIGURE 1

The commercial (scalefish) and recreational fishing areas of inner Shark Bay.



INNER SHARK BAY SCALEFISH FISHERY FIGURE 2

The total scalefish annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2009.

Gascoyne and North Coast Blue Swimmer Crab Fishery Status Report

D. Johnston and D. Harris

Management input from M. Stadler and N. Moore

Main Features

Status		Current Landings	
Stock level		Commercial catch	774 t
Shark Bay	Acceptable	Shark Bay trap fleet	493 t
Exmouth	Acceptable	Shark Bay trawl fleet	227 t
Pilbara	Acceptable	Exmouth Gulf	17 t
		Pilbara	37 t
Fishing Level			
Shark Bay	Under review	Recreational catch	Minimal
Pilbara	Under Review		

Fishery Description

The blue swimmer crab (*Portunus pelagicus*) is found along the entire Western Australian coast, in a wide range of inshore and continental shelf areas, from the inter-tidal zone to at least 50 m in depth. However, the majority of the commercially and recreationally-fished stock, is concentrated in the coastal embayments and estuaries between Geographe Bay in the south west and Port Hedland in the north.

Crabbing activity in the Gascoyne Coast bioregion is centered in the embayments of Shark Bay and Exmouth Gulf. Since its inception in 1998, the Shark Bay Crab (Interim) Managed Fishery has developed into the largest crab fishery in WA, with an annual catch of about 650 t. It is a limited-entry fishery with a total of 5 permits authorising fishing in the waters of Shark Bay.

The Exmouth Gulf Developing Crab Fishery was established in October 2003 via the Developing New Fisheries process, following the granting of an exemption from existing trap prohibition legislation, pursuant to section 7(3)(c) of the *Fish Resources Management Act*. A further exemption was issued under the process in June 2004. The exemptions were issued to allow for the sustainable exploration of the commercial viability of fishing blue swimmer crab stocks in the waters of Exmouth Gulf. As at 30 June 2008, two fishers held valid exemptions to operate in the fishery, one permitting the use of 200 traps, the other permitting the use of 300 traps.

The Pilbara Developing Crab Fishery was established in 2001 via the Developing New Fisheries process, following the granting of an exemption from existing trap prohibition legislation, pursuant to section 7(3)(c) of the *Fish Resources Management Act*. The exemptions were issued to allow for the sustainable exploration of the commercial viability of fishing crab stocks along the Pilbara coastline. Two operators currently hold exemptions to fish in the fishery, one using up to a maximum of 200 traps, the other using up to a maximum of 400 traps.

Blue swimmer crabs are targeted using a variety of fishing gear but most commercial crab fishers in WA now use purpose-designed crab traps. Operators in the Shark Bay Crab (Interim) Managed, Exmouth Gulf Developing Crab and Pilbara Developing Crab Fisheries are only permitted to use 'hourglass' traps. The State's prawn and scallop trawl fisheries that operate in this region also retain crabs as a by-product.

Governing legislation/fishing authority

Shark Bay Crab Fishery (Interim) Management Plan 2005

Exceptions to the Fish Traps Prohibition Notice 1990 and Fish Traps Restrictions Notice 1994

Exemptions under Section 7 of the Fish Resources Management Act 1994

Shark Bay Prawn Management Plan 1993

Shark Bay Scallop Management Plan 1994

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order – Shark Bay fishery only)

Note The Pilbara fishery has a three year WTO as well expiring November 2008

GASCOYNE COAST BIOREGION

Consultation process

Meetings between the Department of Fisheries and industry

Meetings with Regional Recreational Fishing Advisory Committees (future consultations to be facilitated by RecFishWest).

Boundaries

The Shark Bay Crab Interim Managed Fishery covers the waters of Shark Bay north of Cape Inscription, to Bernier and Dorre Islands and Quobba Point (Gascoyne Coast Blue Swimmer Crab Figure 1). In addition, two Shark Bay Crab Permit holders with long-standing histories of targeting crabs in Shark Bay are permitted to fish in the waters of Shark Bay south of Cape Inscription.

The Exmouth Gulf Developing Crab Fishery operates south of a line drawn between the northern most point of North West Cape and Locker Point, and within waters east of a line drawn due north from Point Murat (21° 48.90' south latitude and 114° 11.46' east longitude) and west of 115° 06.5' east longitude (Onslow).

Crabbing activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around the embayment of Nickol Bay.

The boundaries of the Shark Bay Prawn, Shark Bay Scallop, Exmouth Gulf Prawn, Onslow Prawn and Nickol Bay Prawn Managed Fisheries which also capture crabs as by-product are described in the relevant status report elsewhere within this document.

Management arrangements

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the Fish Resources Management Act 1994. Individual fisheries are managed under an input control system, primarily through the regulation of vessel and trap numbers. Supplementary controls cover retainable species and associated minimum size limits, gear specifications, and area, seasonal and daily time restrictions.

The principal management tool employed to ensure adequate breeding stock in the commercial crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. Male blue swimmer crabs in Shark Bay become sexually mature at 115 mm carapace width, while females become sexually mature below 100 mm carapace width. The commercial minimum size of 135 mm carapace width should ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

Five crab trap peerimits operate in Shark Bay under the Shark Bay Crab Fishery (Interim) Management Plan 2005 which sets the number of traps that can be fished, fishery specific spatial closures, gear specifications and other controls. Two permit holders also have a Fishing Boat Licence (FBL) condition that allows them to fish no more than 200 traps south of Cape Peron (south of the existing waters of the

SBCIMF). The FBL condition reflects a long-standing history of these two operators fishing in this area. However, at no time may more than 300 traps in total be used by each of these operators across all of the waters of Shark Bay.

The management arrangements for the Exmouth Gulf and Pilbara Developing Crab Fisheries are set by conditions on the exemptions and are aimed at ensuring the stock and environment are protected. The management measures include gear restrictions, a minimum size limit, spatial closures and reporting requirements. While a maximum of 600 pots are permitted in the fishery, only 400 traps may be used in Nickol Bay.

Management controls for the various prawn trawl fisheries that capture crabs are located elsewhere.

A second comprehensive Ecologically Sustainable Development assessment of the Shark Bay fishery was completed in 2007. The Commonwealth Department of the Environment, Water, Heritage and the Arts approved the fishery to export product for a further three years, subject to several conditions and recommendations - for details refer to <http://www.environment.gov.au/coasts/fisheries/wa/shark-bay/index.html>.

Recreational fishing for blue swimmer crabs in WA is managed through a series of input and output controls. As with commercial fishing, the principal management tool employed to sustain an adequate breeding stock involves maintaining minimum size limits well above the size at sexual maturity. A minimum legal size limit of 127 mm carapace width applies in the waters of the Gascoyne Coast bioregion, along with a bag limit of 20 crabs per person or 40 crabs per boat. Restrictions also govern gear types that can be used to take blue swimmer crabs, along with localised spatial and temporal closures.

Research summary

Data for the assessment of blue swimmer crab stocks in the Gascoyne and North Coast bioregions are obtained from fishers' compulsory catch and effort returns and voluntary daily log books. Department of Fisheries' research staff also conduct quarterly catch monitoring surveys aboard commercial crab trap vessels in Shark Bay.

Some base-line information on the biology and ecology of blue swimmer crabs has been generated by a number of Fisheries Research and Development Corporation (FRDC)-funded projects conducted by the Department of Fisheries and Murdoch University over the past decade. An FRDC project completed in early 2005 produced a preliminary stock assessment of the Shark Bay blue swimmer crab fishery.

A review of the available blue swimmer crab research data for Shark Bay conducted in 2009 suggests that the size structure of the blue swimmer crab population still appears healthy but an accurate assessment of sustainable catch levels could not be provided due to insufficient scientific data. As a result of this uncertainty, management options for the commercial trap and trawl sectors are being considered until a more robust stock assessment can be completed.

Retained Species

Commercial landings (season 2008/09):

	774 tonnes (total)
Shark Bay trap fleet	493 tonnes
Shark Bay trawl fleet	227 tonnes
Exmouth Gulf	17 tonnes
Pilbara	37 tonnes

The total combined catch for the Gascoyne and North Coast bioregions during 2008/09 was 774t, which accounted for 91% of the state catch of blue swimmer crabs. This was similar to last year’s catch of 770 t.

The annual blue swimmer crab catch from the Shark Bay crab trap fishery for 2008/09 was 493 t, marginally lower than the 2007/08 catch of 514 t (Gascoyne Coast Blue Swimmer Crab Figure 2, 3). Landings of crabs by the Shark Bay prawn trawl fleet were 227 t in 2008/09, similar to the 223 t for 2007/08.

A total of 17 t of blue swimmer crabs was landed in the Exmouth Gulf region during 2008/09, similar to the previous year’s catch of 18 t (Gascoyne Coast Blue Swimmer Crab Figure 2). All of this crab catch for Exmouth was landed as by-product from prawn trawlers, with no commercial trap fishing undertaken in Exmouth Gulf during 2008/09. The trap fishery was formally closed in June 2009.

The combined commercial catch of blue swimmer crabs from dedicated crab fishers and prawn trawlers operating along the Pilbara coast during 2008/09 was 37 t, compared to the very low catch of 14 t caught in 2007/08 (Gascoyne Blue Swimmer Crab Figure 4).

Recreational catch:

Gascoyne Bioregion	< 1 % of total
Pilbara coast	approximately 35% of total

A recreational survey monitoring crabbing in the Gascoyne Coast bioregion was carried out during 1998/99. The survey provided a recreational blue swimmer catch estimate of 968 kg, representing less than 1% of the total catch. Most of the recreational catch was taken in inner Shark Bay. A subsequent recreational fishing creel survey was conducted in the Gascoyne region between March 2007 and March 2008, and analysis of the collected data is expected to be published in 2010/11.

Information on recreational blue swimmer catches in the inner gulfs of Shark Bay has also been extracted from recreational surveys targeting pink snapper. Data collected also indicated that the recreational crab catch was minimal compared with the take by commercial fishers operating in the gulfs. The surveys provided estimates of 0.7 t, 1.7 t and 1.3 t of blue swimmer crabs taken by recreational fishers in the gulfs for the 2005, 2006 and 2007 calendar years, respectively.

A small amount of recreational crabbing also occurs in Exmouth Gulf.

A survey of recreational crabbing in Nickol Bay estimated a recreational catch of blue swimmer crabs of 20 t for the 2000

calendar year. This represented the majority of the catch from Nickol Bay in that year, as commercial operations targeting blue swimmer crabs in the area did not begin until the following year. No further surveys quantifying recreational catch have been undertaken since the 2000 survey. If this level of recreational effort has been maintained and the abundance has been consistent, it would provide for about 35% of the total catch based on current commercial catches.

Fishing effort/access level

Effort in the Shark Bay crab fishery remained stable during 2008/09, as operators continued to maximize profitability by capitalizing on peak catch periods. Shark Bay crab trap fishers reported 317,416 pot lifts (Gascoyne Coast Blue Swimmer Crab Figure 3) – similar to the 324,401 pot lifts reported for the previous year.

No effort was expended in the Exmouth Gulf crab trap fishery during 2008/09. The fishery was officially closed in June 2009.

The significant increase in catch along the Pilbara coast was mirrored by a similar increase in effort. Commercial crab fishers operated on 151 fishing days during 2008/09, compared to just 52 days during the previous year.

Stock Assessment

Assessment complete:

Shark Bay:	Yes (to be reviewed)
Exmouth:	Yes
Pilbara:	Yes

Assessment method:

Catch rate/Size Distributions

Breeding stock levels:

Shark Bay:	Acceptable
Exmouth:	Acceptable
Pilbara:	Acceptable

Length-frequency data gathered from ongoing monitoring programs in the Shark Bay crab fishery and the Pilbara crab fishery suggests that management controls currently in place appear to have provided adequate measures to maintain a sustainable level of breeding stock.

Monitoring of the commercial catch in Shark Bay has been conducted since 1998, with consistent size distributions being recorded between years within the fishery.

The development of appropriate mesh sizes for use on commercial crab traps has eliminated the catch of juvenile crabs (< 80 mm carapace width) and significantly reduced the catch of undersize crabs < 120 mm carapace width, without impacting on legal catches. Improved work practices have also reduced the mortality of returned undersize and berried crabs caught in commercial traps to negligible levels. Catch

GASCOYNE COAST BIOREGION

rates from each fishery provide an index of abundance that can be used to assess fishery performance from year-to-year.

Shark Bay: Following the establishment of the dedicated trap fishery in 1998, blue swimmer crab trap catches in Shark Bay increased almost five-fold over the next 5 years (Gascoyne Coast Blue Swimmer Crab Figure 2). This

The performance measure for the Shark Bay fishery requires that the breeding stocks be maintained. The breeding stock is reported as adult crab abundance (catch per unit effort - CPUE). The CPUE in the Shark Bay fishery for 2008/09 was 1.55 kg/trap lift – well above the Environment Protection and Biodiversity Conservation Act 1999 performance measure of 1.0 kg/trap lift. This level of breeding stock has proven adequate to support recruitment to the fishery to date.

increase was achieved with only a three-fold increase in effort. Consequently, there was a significant increase in catch per unit effort during this initial period of development, reflecting the more efficient fishing of blue swimmer stocks in Shark Bay as the commercial operators' knowledge of stock dynamics and distribution increased over time and improvements were made to fishing gear and vessels.

Catch and effort have since stabilised in the Shark Bay crab trap fishery, with the mean annual CPUE since 2000/01 ranging between 1.4 and 1.8 kg/trap lift. During 2008/09 the catch rate was 1.55 kg/traps lift (Gascoyne Coast Blue Swimmer Crab Figure 3), similar to the 2007/08 catch rate of 1.59 kg/trap lift. A review of the interim management plan is planned for 2010/11.

There has been a substantial increase in the quantity of blue swimmer crabs retained as by-product by the prawn trawl fleet, and to a lesser extent scallop trawl fleet, in Shark Bay over the past decade. Shark Bay trawlers tend to retain more crabs as a by-product of their fishing operations in years when their target prawn and scallop catches are lower. Market factors have also influenced the quantity of crabs retained by the trawl fleet, with more crabs retained as demand from processors and subsequent returns to vessels has increased. Furthermore, several of the smaller trawlers in the fleet have been replaced with larger vessels, able to carry more crew and with larger freezer capacity to facilitate greater crab retention.

Exmouth Gulf: Catch and effort levels on blue swimmer crabs in the Exmouth Gulf trawl fishery have been relatively stable and are considered acceptable.

Pilbara: Trap catch rates in the Pilbara Developing Crab Fishery have generally increased since the commencement of exploratory fishing along the Pilbara coast. This reflects a more efficient fishing of blue swimmer stocks in the Pilbara region, as the commercial operators' knowledge of the spatial distribution of resident stocks and localized environmental influences increased over time. The increase in catch rate can also be attributed to improvements to fishing gear and vessels.

The Pilbara Developing Crab Fishery recorded a mean catch rate for 2008/09 of 0.7 kg/trap lift – down from 0.9 kg/trap lift the previous year. This decrease was primarily due to some effort being used for exploratory fishing during the year.

The minimum legal size at first capture (127mm carapace width for recreational fishers; 135mm carapace width for commercial fishers based on industry agreement) for crab fisheries in the Gascoyne Coast Bioregion is set well above the size at first maturity (85 – 115 mm carapace width) of the resident stocks. Consequently, breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas under normal environmental conditions.

The breeding stocks in the Gascoyne Coast bioregion and along the Pilbara coast are also supported by the influence of the warmer waters that occur at these latitudes which extends the spawning period over the whole year, whereas spawning is restricted to the late spring and early summer months on the lower West Coast.

Non-Retained Species

Bycatch species impact

Negligible

The shift from using gillnets to traps in most blue swimmer crab fisheries has resulted in a substantial reduction in bycatch from dedicated crab fishing. Pots are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled.

Small numbers of fish are infrequently captured in crab pots, but the fishers are not permitted to retain them. The low number of fish caught and returned by crab fishers is considered to pose a negligible risk to these stocks.

Discarded bycatch from trawl fisheries that retain crabs as a by-product is dealt with in those sections of this report specific to the trawl fisheries.

Protected species interaction

Negligible

The crab trap longline system used in the targeted crab fisheries has little possibility of interacting with protected species. The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.

Ecosystem Effects

Food chain effects

Low

As the commercial take of crabs represents a relatively small portion of the biomass, which is effectively renewed annually, secondary food chain effects are likely to be minimal in these fisheries.

Habitat effects

Negligible

Fishing with traps results in limited habitat disturbance, with only minor dragging of traps on the sea bottom occurring during trap retrieval. Sand and associated biota does not get brought to the surface in commercial blue swimmer crab traps, as the mesh used on traps is sufficiently large to allow the escape of any sand-dwelling macro-benthos.

Although seagrasses are occasionally uprooted and brought to the surface with the trap, the infrequent nature of this occurrence, and the small amount of living seagrass removed, results in minimal habitat damage.

Social Effects

During 2008/09, approximately 15 people were employed as skippers and crew on vessels fishing for blue swimmer crabs in the Gascoyne Coast bioregion and a further 4 people along the Pilbara coast. Additional employment for some 25-30 workers has been created in Carnarvon and Point Samson through the development of post-harvest processing of the crab catch.

Economic Effects

Estimated annual value (to fishers)

for year 2008/09

\$3.5 million

Blue swimmer crab landings from the Gascoyne Coast bioregion during 2008/09 were worth \$3.5 million, down slightly on the \$3.9 million generated during 2007/08. This marginal decrease was largely due to a slight reduction in the catch of blue swimmer crabs by the Shark Bay trap fleet, and no catch from the Exmouth Gulf trap fleet. The catch from the Pilbara region for 2008/09 was valued at approximately \$170,000, a substantial increase on the \$69,000 from 2007/08.

Beach prices for blue swimmer crabs from the major trap fisheries throughout 2008/09 ranged from \$5/kg to \$15/kg live weight, with the average price in the Gascoyne fisheries for the year around \$5.50-\$6/kg. The frozen crabs landed by trawlers generally attract a slightly lower beach price than those landed from traps.

While the majority of the product was sold through local and inter-state markets, several Shark Bay fishers have been developing markets in south-east Asia and focusing on the value-adding of product for the domestic market. The crab catch from the Pilbara region was sold through local and interstate markets.

Fishery Governance

Target catch (or effort) range:

Shark Bay:

Under review

A review of these blue swimmer crab fisheries is being undertaken and target catch ranges will be set.

Current fishing (or effort) level: **Shark Bay: NA**

Following several years of rapid expansion as the fishery developed, current trap catch and effort in the Shark Bay Crab (Interim) Managed Fishery suggests that commercial trap fishing effort may have stabilized. The trap catch rate will be monitored closely, along with the trend in catch and effort from all sectors.

Improved markets and greater vessel and crew capacity has seen a significant increase in the retention of blue swimmer

crabs captured as by-product by the Shark Bay trawl fleet over the last decade.

With the closure of the Exmouth Gulf Developing Crab Fishery and only slight inter-annual variability in fishing pressure from the Exmouth Gulf trawl fleet, the current level of effort in Exmouth Gulf is considered acceptable.

While the Pilbara Developing Crab Trap Fishery has undergone a steady expansion since exploratory fishing for blue swimmer crab stocks between Onslow and Port Hedland began in 2001, effort levels in the fishery are acceptable. The large area covered by the fishery and the remote nature of much of this coastline provides significant logistical and financial challenges in returning the harvested catch to market in an acceptable time period. Improvements to fishing gear and vessels, along with a substantial increase in the understanding of localised environmental influences such as tide and wind, has allowed commercial fishers to maintain catch levels with reduced effort. Fishing effort in this region is further limited by very hot weather experienced during the summer months, which generally restricts fishing effort to between April and November.

Because of the logistical and financial difficulty in fishing this area, only one licensee has renewed their exemption for the 2008/09 fishing season, reducing the number of traps from 600 down to 400.

New management initiatives (2009/10)

The Shark Bay Crab Interim Management Plan has been extended until 31 August 2011 to provide more time to resolve a number of issues related to resource sharing and gear conflicts between the Shark Bay crab trap and Shark Bay prawn and scallop trawl fisheries. A more precautionary management approach for the Shark Bay crab stock is currently being considered due to uncertainty of the sustainable catch level. The issue of better integrating the activities of the two fishers in the southern part of Shark Bay (south of Cape Peron) with the interim managed fishery will also be considered.

Both the Exmouth Gulf and Pilbara Developing Crab Fisheries were formally reviewed in mid-2007 by the Developing Fisheries Assessment Committee (DFAC) as part of the 'Developing New Fisheries' process.

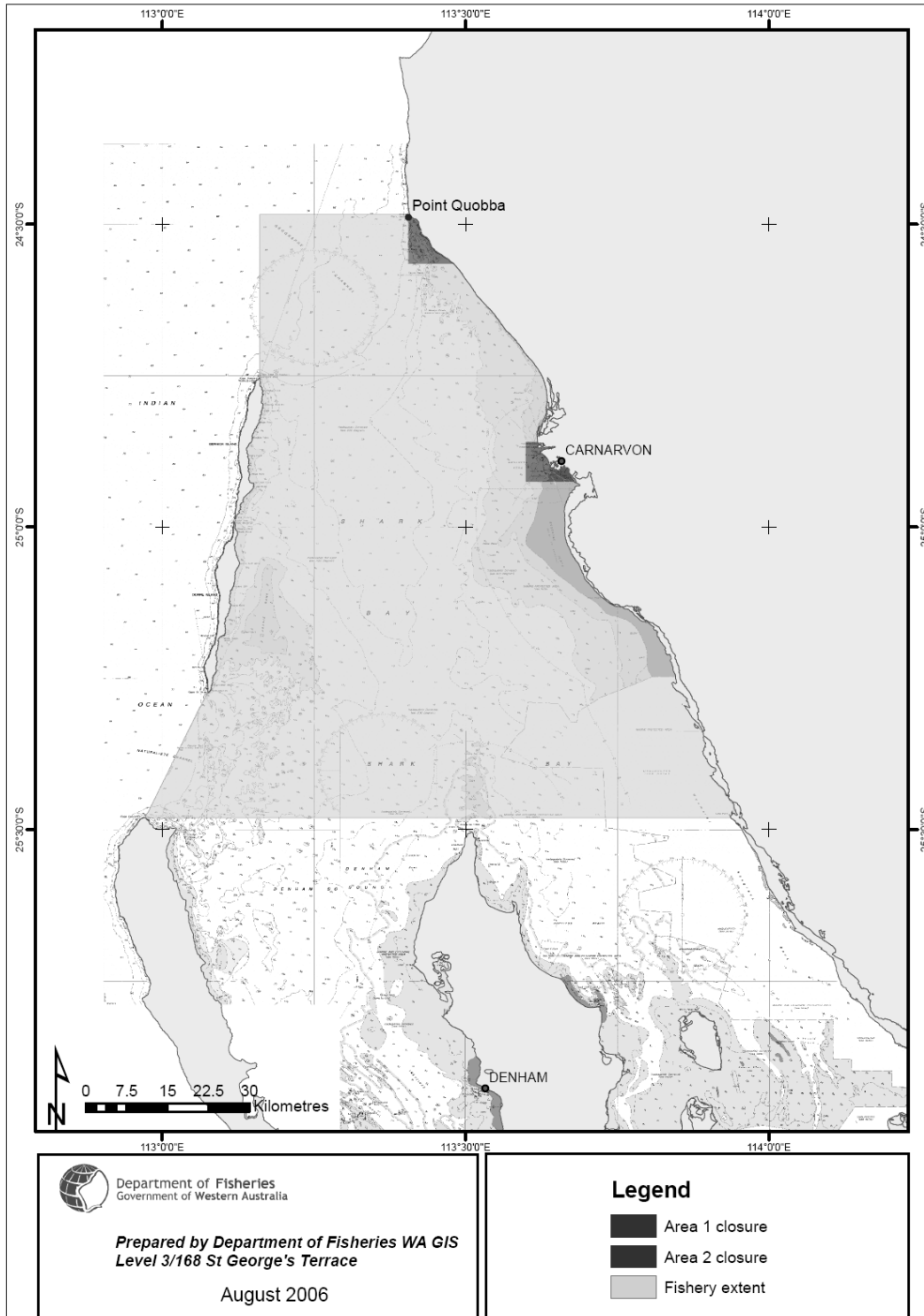
The Exmouth Gulf Developing Crab Fishery was not considered economically viable in the long-term by the Developing Fisheries Assessment Committee. On this basis, in June 2009, the CEO of the Department decided to close the Exmouth Gulf Developing Crab Fishery.

The Department proposes to bring the Pilbara Crab DNF under formal management arrangements during 2010/11.

External Factors

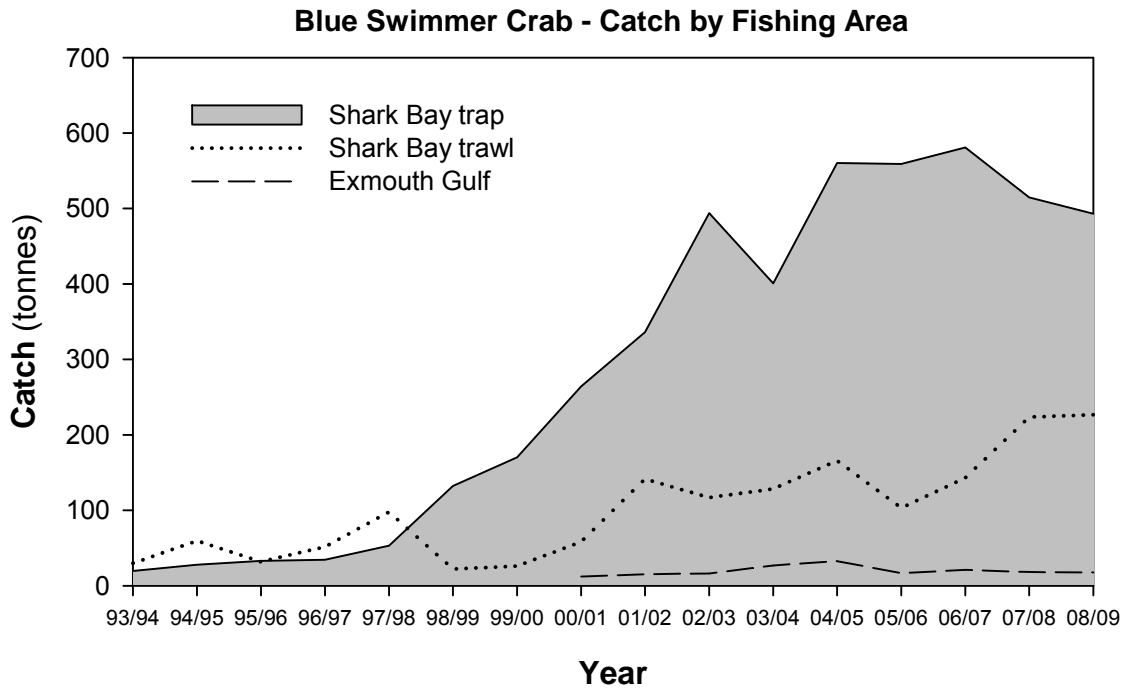
Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of these variations are not fully understood, it is considered most likely due to environmental influences on spawning success and larval survival through to recruitment. The relationship between environmental factors, recruitment and catch is being further evaluated as data becomes available.

GASCOYNE COAST BIOREGION



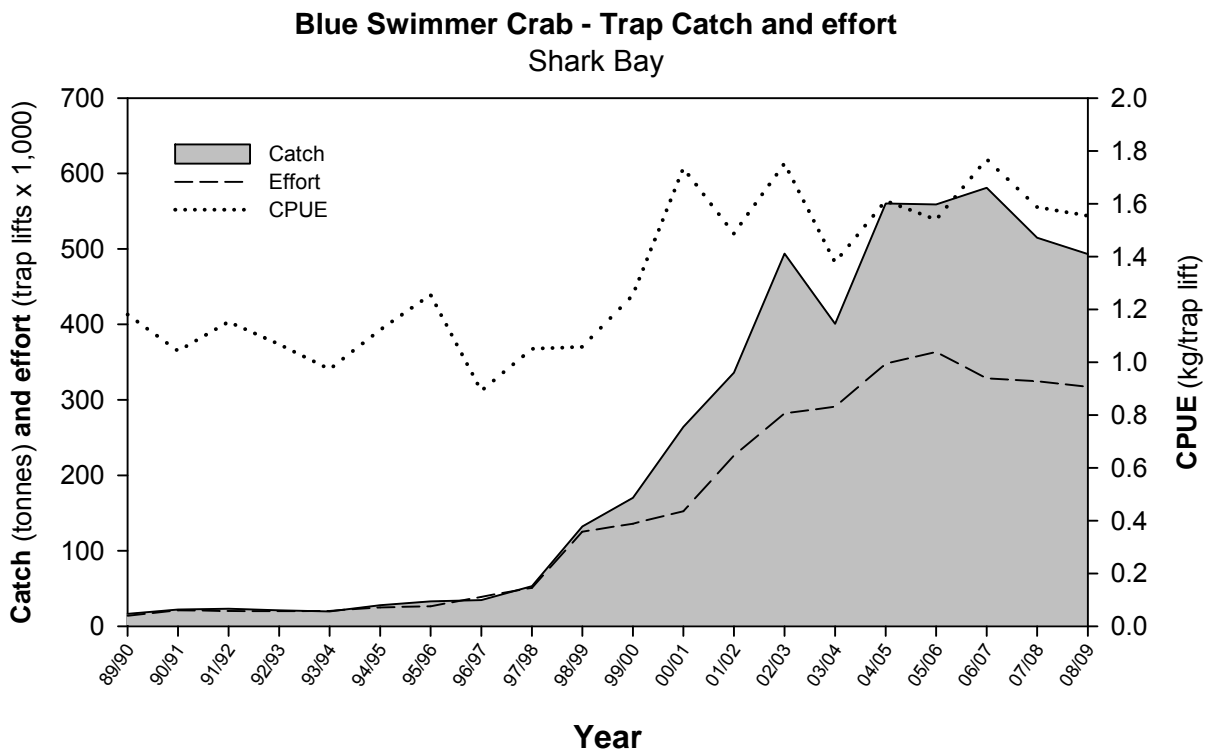
GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 1

Extent of the Shark Bay Crab (Interim) Managed Fishery. Two additional 200-trap exemptions allow for fishing in the western and eastern gulfs south of Cape Peron.



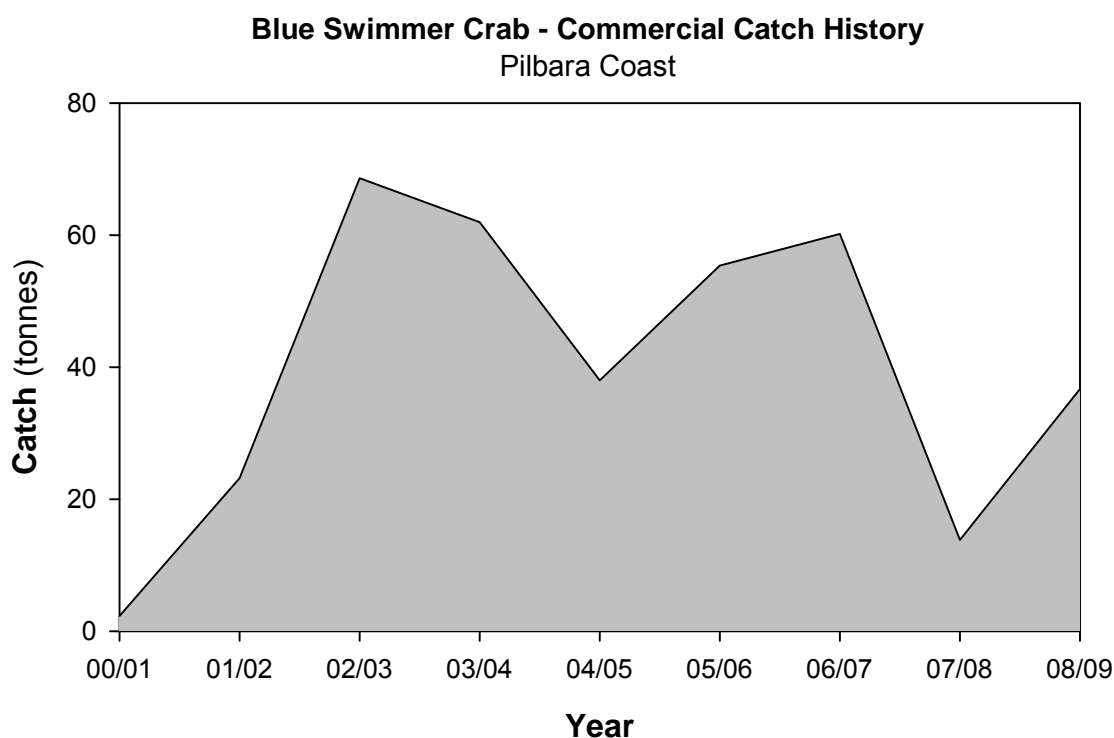
GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 2

Commercial catch history for the blue swimmer crab (*Portunus pelagicus*) fisheries in the Gascoyne Coast bioregion of Western Australia between 1989/90 and 2008/09.



GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in Shark Bay from 1989/90 using traps.



GASCOYNE BLUE SWIMMER CRAB FIGURE 4

COMMERCIAL CATCH HISTORY for the blue swimmer crab (*Portunus pelagicus*) in the North Coast bioregion between 2000/01 and 2008/09.

AQUACULTURE

REGIONAL RESEARCH AND DEVELOPMENT OVERVIEW

The main focus of the Department of Fisheries in the Gascoyne continues to be on the regulation of the regional pearling industry, based on species such as the blacklip oyster *Pinctada margaritifera*, which complements the major state industry built on silverlip pearls (*Pinctada maxima*).

Key development tasks continue to involve supporting the emergence of a local aquarium fish production sector. The Department released its relevant policy entitled The Aquaculture of Coral, Live Rocks and Associated Products in August 2009. The first licence application for coral and live

rock is being progressed for a site at the Abrolhos Islands.

Construction of a land-based prawn farm to the south of Exmouth has not progressed as a result of issues on land tenure.

An exemption issued to a proponent to undertake research and development on the aquaculture of tropical rock lobster species has enabled the proponent to successfully develop hatchery production methods that are in the process of being up scaled. This work is continuing.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services in the Gascoyne Coast Bioregion are delivered by Fisheries and Marine Officers (FMOs) and associated management and administrative support staff based at District Offices in Denham, Carnarvon and Exmouth. During 2008/09 the three district offices supported a total of nine FMO positions allocated to deliver services to several client groups including commercial and recreational fisheries, marine parks, pearling and aquaculture operations and fish habitat protection areas. The region covers approximately 2700 kilometers of the Western Australian (WA) coastline, some 13% of the WA coast. The various coastal landscapes represent some of the most remote, isolated, pristine and dangerous marine and terrestrial environments in the state.

FMOs carry out at-sea marine safety compliance as part of their normal patrol routine, inspecting recreational and commercial vessels for compliance with marine safety legislation as well as promoting safer boating practices. They continue to promote and support the Recreational Skippers Ticket, the new EPIRB units and safer boating practices generally.

A further significant aspect of their work is the provision of compliance services to the State's Marine Parks. The Gascoyne Coast Bioregion has two of WA's most iconic and significant Marine Parks, Ningaloo Marine Park and the associated Commonwealth Marine Park and Shark Bay Marine Park and the associated World Heritage Area. These two Marine Parks occupy just over 70% of the Gascoyne Coast Bioregion. In partnership with the Department of Environment and Conservation (DEC), FMO's monitor and deliver compliance and education programs covering some 30 Sanctuary Zones and Marine Managed Areas and other protected areas.

FMOs undertake regular land, air and sea patrols programmed using a compliance delivery model supported by a risk assessment process and associated operational planning framework. Throughout the bioregion they employ specially equipped four-wheel-drive vehicles, quad bikes and small towable vessels. They also make use of sophisticated surveillance, mapping and GPS equipment to assist in evidence gathering. This includes high-powered telescopes and photographic mapping technology.

FMOs at Denham make extensive use of the recently commissioned 13-metre patrol vessel (PV) the PV *Edwards* to conduct compliance activities throughout Shark Bay. FMOs in Exmouth use the 8-metre PV *Gnulli* and a 7.3-metre rigid inflatable boat to conduct at-sea inspections in Exmouth Gulf and within the Ningaloo Marine Park and Commonwealth Marine Park. In both Districts FMOs spend approximately 100 days a year at sea on patrol duties. Large patrol vessels (greater than 20 m in length) also assist FMOs at various times of the year for offshore patrols, especially in the Shark Bay Prawn and Scallop Fisheries; this accounted for 12 days of at-sea patrols in 2008/09. FMOs also conduct aerial surveillance, dive inspections, at-sea and on-land catch, licence, gear and marine safety inspections, and attended community events as well as school education programs.

The sustainability of the Shark Bay Snapper Managed Fishery continues to be a high priority and major management challenge. The monitoring of commercial catch quota via the "Catch and Disposal Record" (CDR) process remains a pivotal part of the management process, as does the inspection of catch landed ashore in accordance with the CDR's. Recreational snapper tags in the Freycinet Estuary area continues to be another positive method for managing the pink snapper recovery in this area. Ensuring fair, balanced and equal access to the fishery for both commercial and recreational fishers whilst ensuring the sustainability of the species remains a high priority for management and FMOs in the region.

The continuing recovery of the Shark Bay Inner Gulf pink snapper stocks has been, in large part, attributable to the efforts of the Department's staff in the Gascoyne Coast Bioregion and the officers of the Denham District in particular.

FMOs continue to support and maintain important and long-term relationships with the community through their participation in community events and coordination of educational and interpretive activities during peak periods throughout the bioregion. These peak periods commence in late March and finish in early October. During this peak season, fishing competitions like the *Carnarfin*, *Shark Bay Fishing Fiesta* and *Gamex*; and community events such as the *Whale Shark Festival* and *Gascoyne Expo* provide high exposure community education opportunities for FMOs. FMOs make a substantial contribution to the pre-season preparations of the Shark Bay and Exmouth trawl fleets by providing advice, pre-season briefings and inspections of vessels, fishing and safety equipment.

The Department's satellite-based vessel monitoring system (VMS) continues to be a central compliance and management tool enabling positional surveillance and monitoring of commercial vessels and provides an important safety tool for fishers in case of emergency. The VMS allows for fishery-specific management plan closures to be enforced remotely by triggering an alarm should a boundary be crossed or an unauthorized activity be detected. FMOs can program their inspection regimes and apply their investigation methods more efficiently by using the facilities provided by VMS. The expansion of the VMS into other fisheries such as the snapper and mackerel fisheries has ensured that a higher and more effective rate of compliance is achieved.

Activities during 2008/09

During 2008/09 FMOs delivered a total of 5889 hours of "in-field" compliance activity (Gascoyne Coast Bioregion Table 1 which excludes Gascoyne pearling compliance activities which are reported in the North Coast Bioregion), representing a significant increase on the previous financial year (Gascoyne Coast Compliance Patrol Hours Figure 1). The total budgeted hours for compliance were not delivered by FMOs in the region during 2008/09. This was due again to staff shortages for significant periods of time during the

GASCOYNE COAST BIOREGION

year. It has been demonstrated in previous years that the ongoing positive effects of a stable FMO work group have resulted in a better working relationship between fishers and FMOs, especially commercial fishers, however previous efforts might be at risk because of the ongoing issue of staff shortages. Commercial and recreational fishers alike continue to provide positive feedback that the routine attendance of familiar FMOs in their workplace and recreational fishing locations has led to a better understanding and knowledge of the regulations and a higher rate of compliance.

In delivering compliance services to the Gascoyne, FMOs under the management of the Compliance Manager make use of a risk assessment and intelligence analysis-driven model to compliance planning and prioritization. All the existing Operational Compliance Plans (OCP) were reviewed and updated during the 2008/09 year using this model. Several other OCP's were completed, including the Patrol Vessel Business Unit –Gascoyne Operations. This continues to be the model for delivering compliance across the agency and continues to provide the most effective and efficient method for a planned and measurable approach to compliance delivery. The OCP's deliver agreed outcomes and provide a more accountable and realistic process for budget creation and the actual services that are to be delivered.

OCP's have been operating for several years now, the Exmouth Gulf Prawn Fishery, Shark Bay Prawn Fishery, Shark Bay Scallop Fishery, Shark Bay Crab Interim Managed Fishery, Shark Bay Snapper Managed Fishery, Gascoyne Aquaculture and Pearling Fishery, and, for the management of the Ningaloo Marine Park, Shark Bay Marine Park and Commonwealth Ningaloo Marine Park. A more targeted, effective and relevant compliance service in terms of both cost and activities was delivered using this planning and delivery process.

FMOs delivered compliance activities directed at commercial fisheries mostly through pre-season inspections, catch inspections and quota monitoring, as well as at-sea inspections and investigations resulting from suspected breaches detected via the VMS and intelligence led operations. FMO effort was again directed at building stronger relationships with industry through higher levels of contact both at sea and in port. The number of suspected breaches of closed waters detected through the VMS and other monitoring methods has continued to remain at a high level in 2008/09. However, compliance overall is assessed as being at an acceptable level across all the fisheries except for the Shark Bay Prawn Fishery where issues regarding VMS compliance remain an ongoing concern. Compliance staff assess that the commercial fishing industry continues to demonstrate a positive approach to complying with regulations and playing their part to ensure the sustainability of their fisheries. A total of 9 infringement warnings and 8 infringement notices were issued and no prosecutions were instigated from a total of 385 field contacts with commercial fishers. Field contacts were lower than 2007/08 because of the previously highlighted staff shortages.

The monitoring of marine park activities with respect to recreational fisheries has divided the recreational fishing compliance program from a stand-alone program into two distinct programs, one with a marine park focus. FMOs

increased their compliance activities in relation to both Ningaloo Marine Park and Shark Bay Marine Park in line with the increased importance and focus of government on marine parks across the State. The number of infringement warnings (78) was significantly higher, as was infringement notices issued (99). Prosecutions instigated (8) have decreased considerably from the previous year. This was inline with a new direction in referring marine park matters to the court. This was achieved from a total of 10,920 recreational fishing field contacts, which reflects the increased importance placed on recreational fishing and marine parks in general across the Gascoyne. Recreational fisher contacts were approximately 13% higher in 2008/09, especially in the Ningaloo Marine Reserve. This reflects the direct effects of better management and planning processes, a stable workforce with more expert knowledge of their sanctuary zones and offender profiles and a greater emphasis on intelligence driven activities.

Two FMOs from "Mobile 1" were active in the Gascoyne in 2008/09. "Mobile 1" provides a dedicated mobile recreational fishing patrol using specialized remote-area-equipped vehicles and surveillance equipment. "Mobile 1" patrols operated mainly in the Denham and Carnarvon Districts, working in a coordinated approach with District Officers to provide greater coverage and improved compliance outcomes. The focus for this unit was again on education and enforcing management arrangements for Shark Bay Inner Gulf pink snapper and the Gnarraloo Bay area.

The bioregion's Volunteer Fisheries Liaison Officer (VFLO) program continued to find it difficult to attract volunteers during 2008/09. As in previous years, with a population base of less than 12,000 people in the Gascoyne Region, all organizations (including emergency services) find it hard to attract people to the large number of volunteer organisations existing within the region. Solutions to this problem remain elusive, however the regions management team has entered into a partnership arrangement with DEC in the Coral Bay area that has returned very positive outcomes. Utilizing DEC's Volunteer program, volunteers provide a joint DEC/DoF information service at Coral Bay. The information service focuses on fishing rules and sanctuary zone restrictions.

Initiatives in 2009/10

For the 2009/10-year a number of initiatives across the Gascoyne Bioregion have been planned. These include: -

- Delivery of the replacement vessel for the *PV Gnulli* in Exmouth;
- Delivery of the replacement vessel for the 7.8 Naiad destroyed in a motor vehicle accident;
- Providing driver training and trailer driver training to all staff in the region;
- Trialing an education program that will tour Denham, Carnarvon and Exmouth. The program will focus on delivering DoF education sessions to all regional schools and at recreational fishing events and competitions;
- Commencing a dedicated Recreational Fishing Mobile Patrol. This Patrol will be a high profile mobile unit that will attend high use areas and events across the

- Gascoyne delivering education and advice as well as compliance services;
- Delivering education and advice to commercial fishers regarding the introduction of the Gascoyne Demersal Scalefish Managed Fishery Management Plan;
 - Provide educational, interpretive and access infrastructure to the Point Quobba and Miaboolya Fish Habitat Protection Areas;
 - Develop a project plan for raising the profile of the DoF across the Gascoyne region, its objectives, activities and achievements;
 - Develop and analyze the various offender profiles relevant to the Shark Bay and Ningaloo Marine Parks and develop educational and compliance remedies to achieve higher rates of voluntary compliance amongst these groups;
 - Commence construction of a new DoF building in Denham;
 - Develop a business proposal for an Education Officer to service the Midwest and Gascoyne Regions in a shared arrangement.

GASCOYNE COAST COMPLIANCE TABLE 1

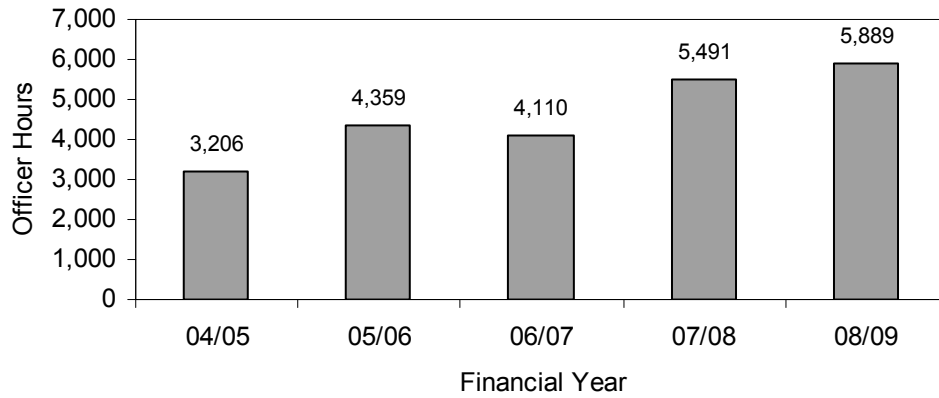
Summary of compliance and educative contacts and detected offences within the Gascoyne coast bioregion during the 2008/09 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	5,889 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	385
District Office contacts	1,515
Infringement warnings	9
Infringement notices	8
Prosecutions	0
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	10,920
District Office contacts	2,860
Infringement warnings	78
Infringement notices	99
Prosecutions	8
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	1,103
District Office contacts	4,166
Fishwatch reports**	

*Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "Other" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of these contacts are recreational in nature (e.g. personal contacts in Marine Parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises etc. are also included in this category.

**This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors. It also includes any calls relating to the northern inland bioregion that were referred to Exmouth, Carnarvon or Denham District staff.

Gascoyne Coast Bioregion Compliance Patrol Hours



GASCOYNE COAST COMPLIANCE FIGURE 1

“On Patrol” Officer Hours showing the level of compliance patrol activity delivered to the Gascoyne coast bioregion over the previous 5 years. The 08/09 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. (The totals exclude time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.).

NORTH COAST BIOREGION

ABOUT THE BIOREGION	148
SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES	148
ECOSYSTEM MANAGEMENT	149
ECOSYSTEM BASED FISHERIES MANAGEMENT	151
FISHERIES	155
AQUACULTURE	210
COMPLIANCE AND COMMUNITY EDUCATION	210

NORTH COAST BIOREGION

ABOUT THE BIOREGION

The oceanography of the North Coast bioregion has some of its origins in the flow of Pacific Ocean waters through the Indonesian archipelago and from the Indian Ocean current.

The Integrated Marine and Coastal Regionalisation for Australia (IMCRA V 4.0) scheme divides this bioregion into 8 meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley.

Ocean temperatures range between 22°C and 33°C, with localised higher temperatures in coastal waters due to the arid nature of the hinterland, particularly along the Pilbara coastline. Fish stocks in the North Coast bioregion are entirely tropical, with most having an Indo-Pacific distribution extending eastward through Indonesia to the Indian subcontinent and Arabian Gulf regions.

Coastal waters are generally low-energy in terms of wave action, but are seasonally influenced by infrequent but intense tropical cyclones, storm surges and associated rainfall run-off. These cyclone events generate the bulk of the rainfall, although the Kimberley section of the coastline does receive limited monsoonal thunderstorm rainfall over summer.

Significant river run-off and associated coastal productivity can be associated with cyclone events, with run-off ceasing during winter. The entire north coastal region is subject to very high evaporation rates (3 metres per year), although the Pilbara coastline is more arid than the Kimberley, due to its lower cyclone frequency.

The second significant influence on coastal waters is the extreme tidal regime, related to the wide continental shelf. Spring tides range from up to 11 metres along the Kimberley section of the coast down to around 2 metres at Onslow in the west Pilbara.

As a result of these factors, the generally tropical low-nutrient offshore waters can, in the few locations with rivers, be significantly influenced by rainfall run-off and tidal mixing to generate varying water quality in different sections of the North Coast Bioregion. Along the Kimberley coastline, waters are turbid and relatively productive, while the Pilbara coast with its lower run-off and lesser tidal influence has the clear waters more typical of the tropics.

The coastal geography of the various sections of the coastline also differs. The Kimberley coast is highly indented, with bays and estuaries backed by a hinterland of high relief. Broad tidal mudflats and soft sediments with fringing mangroves are typical of this area. The eastern Pilbara coast is more exposed than the Kimberley, with few islands and extensive inter-tidal sand flats. Softer sediments and mangroves occur around the river entrances. The western Pilbara coastline is characterised by a series of significant but low-relief islands including the Dampier Archipelago, Barrow Island and the Montebello Islands. Near-shore coastal waters include rocky and coral reef systems, creating significant areas of protected waters. West Pilbara shorelines also include areas of soft sediment and mangrove communities.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

One of the principal commercial fisheries in the North Coast bioregion focuses on tropical finfish, particularly the high-value emperors, snappers and cods that are taken by the Pilbara Fish Trawl Fishery and the Pilbara and Northern Demersal trap fisheries. The typical catch is in the order of 3,000 t annually, making these fisheries, at an estimated annual value of around \$12 million, the most valuable finfish sector in the state.

Another significant commercial fishery in this bioregion is based on the collection of pearl oysters (*Pinctada maxima*) for use in the aquaculture production of pearls (see below). These are collected from the fishing grounds primarily off the Eighty Mile Beach, with smaller catches being taken around the Lacepede Islands (north of Broome).

The North Coast Bioregion also has a number of small, limited-entry trawl fisheries for prawns, producing about 700 t annually, valued at around \$10 million.

A number of other finfish fisheries operated in the region including surface trolling for Spanish mackerel, demersal line fishing, near-shore beach seining and gillnetting for barramundi/threadfin salmon and shark. However, the bioregion is increasingly coming under threat from international poaching, particularly for sharks.

Recreational fishing is experiencing significant growth in the North Coast Bioregion, with a distinct seasonal peak in winter when the local population is swollen by significant numbers of metropolitan and inter-state tourists travelling through the area and visiting, in particular, the Onslow, Dampier Archipelago and Broome sections of the coastline. This has been added to by the increased recreational fishing by those involved in the construction or operation of major developments in this region. Owing to the high tidal range, much of the angling activity is boat-based, with beach fishing limited to periods of flood tides and high water.

The numerous creek systems, mangroves and rivers, and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including saddletail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish.

Aquaculture development in the north coast bioregion is dominated by the production of pearls from the species *P. maxima*. A large number of pearl oysters for seeding are obtained from wild stocks but are supplemented by hatchery-produced oysters, with major hatcheries operating at Broome and King Sound. Pearl farm sites are located mainly along the Kimberley coast, particularly in the Buccaneer Archipelago,

in Roebuck Bay and at the Montebello Islands.

Developing marine aquaculture initiatives in this region include growing trochus and barramundi. A focus of aquaculture development is provided by the Department of Fisheries' Broome Tropical Aquaculture Park, which houses a commercial pearl oyster hatchery, an indigenous-owned multi-species hatchery and the Kimberley College of TAFE aquaculture training facility.

ECOSYSTEM MANAGEMENT

Extensive fisheries closures in coastal and most offshore waters have been introduced to manage finfish trawling by Australian vessels (North Coast Ecosystem Management Figure 1). However, trawling is still permitted in a number of locations (see specific commercial trawl fishery reports elsewhere in this volume). This activity is carefully managed to ensure that impacts are acceptable. The trawling is subject to Ecologically Sustainable Development (ESD) requirements in accordance with Australian Government 'Guidelines for the Ecologically Sustainable Management of Fisheries' under the Environment Protection and Biodiversity Conservation Act 1999. The extent of these areas means that 41% of the entire shelf region of the North Coast Bioregion could be classified as a marine protected area with an IUCN category of IV (as per Dudley, 2008¹; North Coast Ecosystem Management Table 1).

In addition to these habitat related marine protected area closures, the bioregion has a number of other marine protected areas including the Montebello and Barrow Islands Rowley Shoals proclaimed under the Conservation and Land Management Act 1984, and closures to fishing under section 43 of the Fish Resources Management Act 1994 at Point Samson, Peron Peninsula and the wreck of the Kunmunya Samson II (Delambre Reef) (see North Coast Ecosystem Management Figure 2). The proposed Dampier Archipelago marine conservation reserves are still under consideration by Government.

The Department of Fisheries has also participated in marine conservation reserve planning process in this region. There is considerable interest in developing marine protected areas within the Kimberley area, including the Camden Sound region which has recently been proposed by the State Government. The Department continues to work closely with relevant agencies and stakeholders to develop strategies to minimize environmental effects in the marine environment including the Kimberley Science and Conservation Strategy with DEC.

The Australian Government's Department of Environment, Water, Heritage and the Arts (DEWHA) is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border, with a view to completing a draft North West Marine Bioregional Plan in 2010. The Draft Plan will be released

for a 3 month public review, and contain proposed marine protected areas.

Marine habitats within the North Coast Bioregion of Western Australia are experiencing increasing pressure through a range of activities but most notably as a result of increased resource development activity that is occurring in the area.

The Department continues to engage with the Environmental Protection Authority through the environmental impact assessment process by providing advice on individual development proposals, which if implemented, have the potential to have an adverse impact on the marine environment. These include new (and upgraded) port developments in the Pilbara region, as well as offshore and nearshore oil and gas extraction projects in the Kimberley and Pilbara region. Major developments recently assessed for which the Department has played a key role include the Gorgon Gas Development at Barrow Island, and the proposed Kimberley LNG processing site.

The increase in international shipping movement and dredging activity associated with resource development in the Northern region is considered to present a high risk to the marine environment because of the potential for the introduction of non-indigenous marine organisms (including animals, plants, pathogens and diseases) into WA's coastal environment.

The recent Montara oil spill that occurred in this region highlights the potential risks to this area from oil and gas production. The outcome of this incident on fishery resources and assets may not be known for some time.

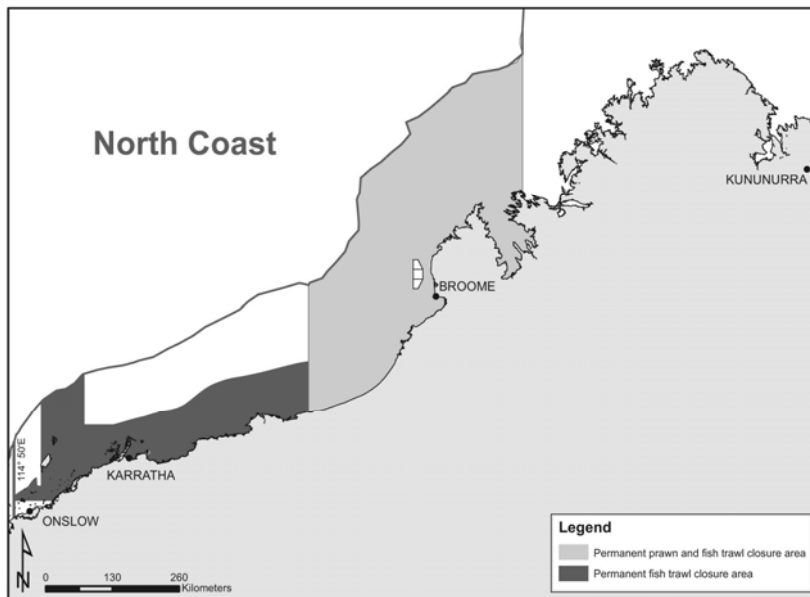
¹ Dudley, N. (editor) (2008) Guidelines for applying protected area management categories. IUCN, Gland, Switzerland.

NORTH COAST BIOREGION

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

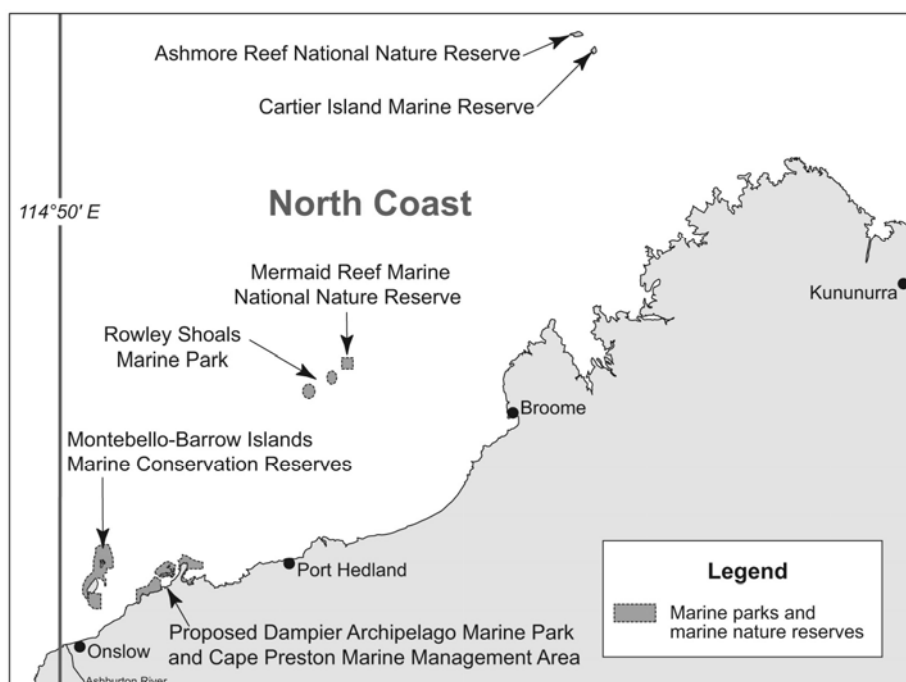
The areas and proportions of the North Coast Bioregion making up State Waters and continental shelf waters where habitats are protected from the physical disturbance of trawl fishing. The areas, 200 m depth which are formally closed to trawling would be equivalent to meet category IV of the IUCN criteria for classification as marine protected areas. The area effectively protected covers those areas of the shelf < 200 m depth where state managed trawling doesn't occur.

Total Area of Shelf	Area of shelf equivalent to IUCN marine protected area category IV (%)	Maximum area of actual trawling activity	Total area of habitat effectively protected (%)
98600 sq nm	40700 sq nm (41%)	10500 sq nm	88100 sq nm (89%)



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

Map showing areas permanently closed to trawling by WA state managed fisheries in the North Coast bioregion.



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 2

Map showing current and proposed areas of protected fish habitat in the North Coast bioregion.

ECOSYSTEM BASED FISHERIES MANAGEMENT

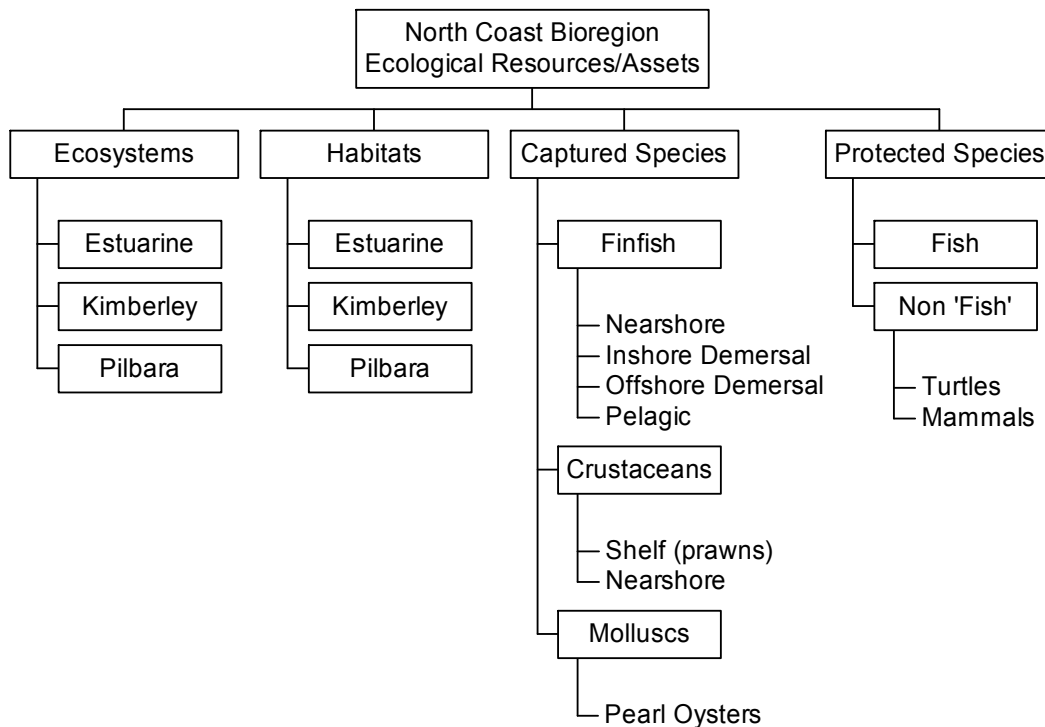
Identification of Ecological Assets using the EBFM framework

Under the Integrated Marine and Coastal Regionalisation for Australia scheme, the bioregion has been divided into the bioregion has been divided into 8 meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley Gulf (IMCRA, V 4.0, 2006). While this sub-regional scale of management has been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (see How to Use section for more details), in the North Coast these meso-scales have been combined into two marine based ecosystems Pilbara (Pilbara and NW Shelf, eighty Mile Beach), Kimberley (Canning, Kimberley) and a Nearshore/estuarine ecosystem.

In terms of ecological assets, the Department has recognised the following ecological values for the IMCRA regions within North Coast Bioregion:

- Ecosystem structure and biodiversity;
- Captured fish species
- Protected species (direct impact – capture or interaction);
- Benthic habitats; and
- External impacts.

For some issues a finer level of division of the IMCRA ecosystems is used by the Department. This relates to recent management initiatives necessary to recognise different suites of exploited fish and invertebrates across the continental shelf. These sub-components are defined by depth contours (Nearshore 0-20m; Inshore 20-250m; Offshore >250m; Pelagic). The full set of ecological assets identified for assessment and in some cases ongoing monitoring are presented in North Coast Ecosystem Management Figure 3.



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 3

Component tree showing the ecological assets identified and separately assessed for the North Coast Bioregion.

Risk Assessment of Bioregional Level Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined in North Coast Ecosystem Management Figure 3 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (North Coast Ecosystem

Management Table 2) provides an overview and cumulative assessment of the current risks to the ecological assets of the North Coast Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department’s Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 2: RISK LEVELS FOR EACH NORTH COAST ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level (bioregional) components. Negligible, Low and Moderate values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by ‘(non-fishing)’, this indicates that all, or the majority of the risk value, was not generated by fishing activities but by some external factor including those activities which are managed by other government agencies (State or Federal).

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Nearshore/ Estuarine	Marine	LOW (non fishing)	With the onshore developments that are proposed in this area, while some specific areas may be locally impacted, these still only pose a low risk to the overall nearshore/estuarine ecosystem of this bioregion.
Pilbara	Marine	LOW	Given the large areas closed to both trawling and to all commercial fishing, there is only a low risk that the level of fishing in this region is changing the community structure to an unacceptable level. A recent study by Hall and Wise (in press) found no change in community structure of commercially captured finfish over the past 30 years consistent with a significant trophic impact. A proposal to further examine recovery of this area from the impacts of Taiwanese fishing that occurred in the 1980s is currently under development.
Kimberley	Marine	LOW (non fishing)	While there are a number of specific oil and gas related offshore developments that are proposed in this region, at the overall ecosystem level there is only a negligible risk that the ecosystem will be altered measurably. A recent study by Hall and Wise (in press) found no change in community structure of commercially captured finfish over the past 30 years consistent with a significant trophic impact. A significant level of planning has been undertaken to study this region as part of WAMSI 2.

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Finfish	Nearshore/estuarine	MODERATE	The barramundi and threadfin salmon stocks are considered to be at acceptable levels.
	Shelf demersal	HIGH	The current status of demersal finfish stocks captured by the Pilbara trawl fishery is uncertain. A research survey is underway to assist determine if the recent low catch rates are due to changes to trawl gear or to localized depletion.
	Pelagic	MODERATE	There are no concerns about the Spanish mackerel stock in this region and there are few other pelagic fish that are impacted.

Fish species	Aquatic zone	Risk	Status and Current Activities
Crustaceans	Nearshore/Estuarine	LOW	There is a small amount of fishing for mud crabs and blue swimmer crabs in some estuarine and inshore areas.
	Shelf	MODERATE	There are a number of separate prawn stocks and fisheries within this bioregion that each have limited entry, seasonal and area closures. Annual recruitment to these stocks is variable, which combined with the higher costs of operating in this region, has resulted in fishing effort being much lower in recent years.
Molluscs	Pearls	LOW	The fishery only targets a very small section of the stock both spatially and the available size range. Recent catches have been well below the quota levels due to low market demand,

Protected species

Protected fish species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Non fish	NEGLECTIBLE	Crocodiles are occasionally captured in nets but are released alive.
	Mammals	MODERATE	Dolphins are captured by the Pilbara trawl fishery, but dolphin excluder devices have reduced this incidence to acceptable levels.
Protected 'Fish' Species	Fish	LOW	The sawfish (Pristidae), spartooth shark (<i>Glyphis glyphis</i>) or the northern river shark (<i>Glyphis garricki</i>), are captured in small numbers by net fishing in small regions of the Kimberly region.

Benthic habitat

Benthic Habitat	Category	Risk	Status and Current Activities
Estuaries/ Nearshore		LOW (non Fishing)	The main risks to nearshore habitats come from oil and gas developments.
Pilbara		MODERATE	This bioregion has fish trawling but this activity is tightly constrained. The large area permanently closed to trawling and the relatively small area where trawling actually occurs indicates that the habitat in this region is appropriately managed.
Kimberley		LOW (Non Fishing)	Except for some small areas where prawn trawlers operate for short periods each year, most of this region is closed to trawling. These activities will be examined as part of the proposed Camden Sound marine park. The most likely potential impacts to the habitat in this area are from oil and gas infrastructure and operations.

External Drivers (NON FISHING)

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	HIGH	The extremely high level of international shipping that operates in this region poses a high risk that an introduced pest may be imported. The department is working towards developing and implementing a suitable monitoring and inspection program.
Climate	LOW	This area is predicted to have relatively minor impacts from climate change, especially in the coming decade compared to more southerly locations. Projects to examine potential impacts are planned.

Summary of Monitoring and Assessment of Ecosystem Assets

The Department of Fisheries continues to provide advice to the Environmental Protection Authority on development proposals, which, if implemented, have the potential to impact on the aquatic environment. The Department is working closely with the Australian Government and other jurisdictions to develop and implement the National System for the Prevention and Management of Marine Pest Incursions that will minimise the biosecurity risks associated with increased shipping in the Pilbara and Kimberley regions. Within WA, this will be achieved through the Fish Resources Management Act 1994 and the Biosecurity and Agriculture Management Act 2007. Associated regulations and subsidiary legislation are currently being developed. Work has also been undertaken to develop monitoring designs for introduced marine species for the Port of Dampier. The design has been developed in conjunction with the Invasive Marine Pests Program within DAFF (Department of Agriculture Fisheries and Forestry). This work is expected to contribute to introduced aquatic organism incursion and fish kill incident response programs already in place.

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch has recently completed a

pilot project aimed at establishing resource condition monitoring protocols for the Pilbara and Kimberley. The project focussed on an extensive survey of the research literature relating to the coastal and marine environments in the Pilbara and Kimberley. The review of the literature has highlighted those areas of research that are lacking from the region. These knowledge gaps ranged in scope from fine scale life history trait studies of particular species; to large-scale oceanographic studies to identify major ocean current dynamics, and oceanic primary production from plankton.

The vast and remote coastline of the region dictates that remote sensing (satellite imagery and aerial photography) will be the primary tool for resource condition monitoring. The project concentrated on developing remote sensing as a monitoring tool, and developing a suite of resource condition indicators that accurately portray the health of the numerous marine and coastal environments, and set bench marks for which to assess environmental change, within the Pilbara and Kimberley.

The Department has been provided with funds to begin a monitoring program during 2011/12 for the marine protected area being developed in the Camden Sound region. Further initiatives are being developed as part of the broader Kimberly Science and Conservation strategy and in the submission for WAMSI 2.

FISHERIES

Northern Prawn Managed Fisheries Status Report

M. Kangas, E. Sporer and S. Brown

Management input from R. Gould

Main Features

Status		Current Landings	
Stock level	Acceptable	Onslow:	57 t
		Nickol Bay:	126 t
Fishing level	Acceptable	Broome:	< 2 t
		Kimberley:	238 t

Fishery Description

There are four small prawn fisheries that operate in the northern bioregion which are all undertaken using otter trawls.

The Onslow (OPMF) and Nickol Bay (NBPMF) Prawn Managed Fisheries operate along the western part of the North-West Shelf and OPMF targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) whereas NBPMF primarily targets banana prawns (*Penaeus merguensis*).

The Broome Prawn Managed Fishery (BPMF) operates in a designated trawl zone off Broome and targets western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species).

The Kimberley Prawn Managed Fishery (KPMF) operates off the north of the state between Koolan Island and Cape Londonderry. It predominantly targets banana prawns (*Penaeus merguensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*).

Governing legislation/fishing authority

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Broome Prawn Managed Fishery Management Plan 1999

Broome Prawn Managed Fishery Licence

Kimberley Prawn Fishery Management Plan 1993

Kimberley Prawn Managed Fishery Licence

Commonwealth *Government Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Annual meetings between the Department of Fisheries and industry.

Boundaries

The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114°39.9' on the landward side of the 200 m depth isobath and is divided into three parts with associated size management fish grounds (SMFGs) and nursery areas for prawns as follows: Area 1, incorporating the Ashburton SMFG; Area 2, incorporating the Mangrove Island and Weld Island SMFGs and Coolgra Point Nursery; and Area 3, incorporating the Fortescue SMFG (Northern Prawn Figure 1).

The boundaries of the NBPMF 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*' (Northern Prawn Figure 2).

The boundaries of the BPMF are '*all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200 m isobath*'. The actual trawl area is contained within a delineated small area north west of Broome as shown in Northern Prawn Figure 3.

The boundaries of the KPMF are '*all Western Australian waters of the Indian Ocean lying east of 123°45' east longitude and west of 126°58' east longitude*'. It abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF) (Northern Prawn Figure 4).

Management arrangements

Management controls for all the northern prawn fisheries are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices.

The Department's vessel monitoring system (VMS) monitors the activities of all boats.

NORTH COAST BIOREGION

Annual meetings are held with licence holders to consider the status of the stocks and recommend changes to the opening and closing dates that operate within the season. These are designed to protect smaller prawns and allow access to the various target species, primarily tiger and banana prawns, at appropriate times.

OPMF: The management arrangements in the OPMF involve using a standardised net headrope allocation whereby each Managed Fishery Licence (MFL) has an equal allocation of net headrope length in each area. However, there are different net sizes permitted between Areas. Area 1 boats are authorised to use two trawl nets each having a maximum headrope length of 6 fathoms (10.98 metres). In Area 2 and 3 a maximum headrope length of 16 fathoms (29.27 metres) is permitted in either twin or quad gear configuration. Trawl net headrope amalgamation between MFLs has been permitted in the OPMF consistent with other trawl fisheries. The fleet is composed of trawlers up to 23 metres in length, operating under an exemption from the net size and boat unit rule specifically for Area 1 and the 375 hull unit rule for Areas 2 and 3.

The official season arrangements for the various areas in the OPMF were as follows:

Area 1	1 April – 26 October
Area 2	1 April – 26 October
Area 3	1 April – 26 October
Fortescue SMFG	17 May – 12 September
Ashburton SMFG	17 June – 1 August
Weld Island SFMG	17 May – 12 September
Mangrove Island SFMG	1 April – 26 October

Moon closures were again implemented this season on a voluntary basis. The moon closure period was three days around each full moon during the fishing season across all areas.

Different licence classes apply to the OPMF, allowing boats to trawl in specific zones. These classes are listed below, with figures in brackets indicating number of licensed boats:

Class A	Areas 1, 2 and 3 (four MFLs)
Class B	Areas 2 and 3 (three MFLs)
Class C	Area 2 (12 Exmouth Gulf prawn MFLs)
Class D	Area 3 (12 Nickol Bay prawn MFLs)

NBPMF: The NBPMF management arrangements provide for authorised boats to use standard otter trawl nets not exceeding 16 fathoms (29.27 metres in either twin or quad gear configuration) whereby each boat has an equal allocation and the maximum total headrope length for the entire fleet is 224 fathoms (409.78 metres). The 2009 season opened on 14 March with a closure on 9 November. The major fishing areas opened during these periods:

Nickol Bay	17 May – 1 August (Day fishing only 17 May – 1 June)
Extended Nickol Bay SMFG	17 May – 9 November
Depuch SMFG	17 May – 1 August (Day fishing only 17 May – 1 June)
De Grey SMFG	17 May – 9 November

BPMF: The BPMF management arrangements provide for standard otter trawl nets not exceeding 40 fathoms (73.16 metres in either twin or quad gear configuration). Each boat has an equal allocation and the maximum total headrope length for the entire fleet is 200 fathoms (365.8 metres).

The 2009 season arrangements opened the Fishery on 17 June and it officially closed at 0800 hrs 26 September, providing 72 fishing nights. Only one boat entered the BPMF fishery at the commencement of the season and fished for seven days then left the fishery to fish in the Northern Prawn Fishery (NPF).

KPMF: The KPMF Management Plan permit the use of two otter trawl nets where the total headrope, length including bridles and sweeps does not exceed 32 fathoms (58.5metres) and mesh of trawl nets does not exceed 50 mm.

Seasonal dates for the KPMF are generally aligned with those of the adjacent NPF. A significant number of vessels hold authorisations to operate in both the KPMF and the NPF. Opening and closing dates are aligned to prevent large shifts of fishing effort into the KPMF. Consequently, the 2009 season opened on 7 April and closed mid-season closure on 16 June. The fishery re-opened on 1 September, with a promulgated final season closure on 1 December. The total allowable effort cap system was in place for both periods with a total of 1500 days allocated.

A comprehensive Ecologically Sustainable Development (ESD) assessment of these fisheries has been undertaken to identify any potential sustainability risks requiring direct management action. The only issue identified through this process related to the breeding stock levels of target species (e.g. banana, tiger and king prawns). Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Research programs are focused to underpin the sustainable management of these small fisheries involves stock monitoring and assessment utilising information from daily logbooks and processor unloads. For the NBPMF and KPMF rainfall records are also used to update the rainfall-catch relationship for banana prawns. In the OPMF a field-based consultative process is undertaken whereby industry and the Departments' Research Division decide on the extent of an area to be fished within the areas that are officially opened. For the BPMF a *De Lury* depletion analysis is usually undertaken when sufficient fishing activity occurs (insufficient effort in 2009) which assists in the assessment of the king prawn stocks within the permitted fishing area.

Retained Species

Commercial production (season 2009):

Onslow:	57 tonnes
Nickol Bay:	126 tonnes
Broome:	< 2 tonnes
Kimberley:	238 tonnes

Landings

OPMF: The total landings of major penaeids for the 2009 season were 57 t, comprising 9 t of king prawns, 42 t of tiger prawns, 3 t of endeavour prawns and 2 t of banana prawns. Tiger and banana prawns were within the target catch range whereas king and endeavour prawns were just below the target catch range. The landing of tiger prawns in 2009 was an increase on the catch recorded in 2008 (Northern Prawn Figure 5). The low landings overall are exacerbated by low effort caused by the current economic conditions and market prices.

Recorded landings of by-product species in the OPMF included 1 t of bugs (*Thenus orientalis*) with the landings of all other species being less than one tonne.

NBPMF: The total landings of major penaeids for the 2009 season were 126 t, comprising 123 t of banana prawns, 0.1 t of king prawns, 2 t of tiger prawns and no reported landings of endeavour prawns (Northern Prawn Figure 6). The recorded landings of banana prawns in 2009 were higher than 2008 but below the projected catch range (160 to 240 t) but within the target catch range. The king prawn landings were extremely low and below the target ranges for the species whilst the tiger prawn catch was within the target catch range. Recorded byproduct landings for 2009 were extremely low.

BPMF: Recorded landings in the BPMF were very low (< 2 t) for target species and negligible for byproduct species (Northern Prawn Figure 7).

KPMF: The total recorded landings in the KPMF were 238 t, comprising 221 t of banana prawns, 12 t of tiger prawns, 5 t of endeavour prawns (Northern Prawn Figure 8). Banana prawn landings were within their target catch range (200-450 t) but slightly below the projected catch range (230 to 350t) calculated using the relationship between summer rainfall and catches. Both tiger and endeavour prawns were slightly below their target catch ranges. Fishing occurred in both fishing periods for 2009 unlike the previous two years (2007 and 2008) where only the second part of the season was fished (with the aim to increase the size of prawn) however, effort was still low, possibly reducing total catch for these species. Negligible quantities of byproduct were reported as landed.

Recreational component: Nil

Fishing effort/access level

OPMF: Two boats fished in 2009 with a total of 265 boat days, an increase compared to 155 boat days in 2008. This is still low compared to the days fished between 2000 and 2005

inclusive. In Area 1, one boat was exempted to fish with larger nets using a total net headrope length of 18 fathoms (four 4.5-fathom nets) instead of the permitted 16 fathoms total net headrope length because of economic conditions and low abundance of prawns in recent years. This required the amalgamation of net allocations from two boats, licensed to fish all areas, onto one boat, resulting in a reduction of net headrope length from 32 fathoms to 20 fathoms in 2008 but the overall headrope has been voluntarily reduced by the licensee to 18 fathoms in 2009 for fuel efficiency.

NBPMF: Seven boats fished during the 2009 season for an aggregated total of 178 boat days, a low level of effort.

BPMF: Only seven days of fishing effort was expended by one boat in this fishery in 2009.

KPMF: Eleven boats operated in the fishery during 2009. The total number of days fished is 448 days well under the total days (1500) allocated to fish and the lowest since 1990 when effort estimates were first made.

Stock Assessment

Assessment complete: Yes

Assessment method: Catch
(Rainfall catch relationship for NBPMF and KPMF for banana prawns,

DeLury depletion analysis for BPMF (when appropriate))

Breeding stock levels: Adequate

Projected catch next season (2010):

NBPMF: 45t banana prawns

KPMF: 220t banana prawns

For the northern prawn fishery stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from reducing breeding biomass to critical levels. Historical catch levels from periods where it is known that recruitment was not affected by fishing effort have been used as the basis for calculating target catch ranges. These catch ranges are used as an indicator of breeding stock adequacy.

OPMF: The 2009 season king prawn catch (9 t) remains low compared to the mean catch of 33 t for 1985 to 2007. In the last few years the decline in effort may also be contributing to the low catches. Tiger prawn landings (43 t) show an increase compared to 2007 and 2008 fishing seasons and a return to average tiger prawn landings. The banana prawn landings were low at 2 t. Generally there is a positive correlation between early seasonal rainfall and the catch of banana prawns. However, this generally requires a few consecutive years of rainfall to provide a stock build-up. With relatively high rainfall levels in 2007/08 and 2008/9 the correlation between rainfall and anticipated higher banana catches did not occur for the 2009 season.

NBPMF: The recorded landings of banana prawns (123 t) in 2009 were higher than in 2008 and within the target catch range. The king and tiger prawn landings were extremely low and below the target ranges for these species.

NORTH COAST BIOREGION

The catch projection for banana prawns in Nickol Bay is based on the summer rainfall level between December and March (Northern Prawn Figure 9). The total rainfall between December 2009 and March 2010 (at Roebourne) was 42 mm and the predicted catch for 2010 is around 45 tonnes with a range of 30 –60 tonnes of banana prawns.

BPMF: Very low fishing effort (and resultant catch) occurred in this fishery during 2009 so no stock assessment was completed.

KPMF: Banana prawns were within the target catch range and tiger and endeavour prawns were below their target ranges. Effort levels were at historic low levels.

The relationship identified between the early season rainfall and catches of banana prawns (the dominant species taken in this area) provides a degree of forecasting. The projected catch based on the rainfall (241 mm) in Kalumburu and Derby in January and February 2010 is 220 tonnes with a range of 170-260 tonnes.

The main performance measures for the OPMF, NBPMF and KPMF relate to maintenance of breeding stocks for each of the major target prawn species. In 2009 the breeding stock indicators in the OPMF (catches within specified ranges, as set out in the 'Fishery Governance' section) for tiger and banana prawns were met whereas king and endeavour prawns were just below the target catch range. The overall low catches were in part due to low effort.

The breeding stock indicator for banana prawns in the NBPMF was met but was below the projected catch range. The king and tiger prawn landings were low and below the target ranges for these species. This is likely to be a result of the low effort and very limited targeting of these species this year.

An assessment of breeding stock could not be made for the BPMF due to very low fishing effort.

The breeding stock indicators in KPMF (catches within specified ranges) for banana prawns were met but tiger and endeavour prawns were below the target ranges. This may be due to low effort.

Non-Retained Species

Bycatch species impact: **Low**

Bycatch from the northern prawn fisheries is typical of tropical trawl fisheries (i.e. from 2:1 up to about 5:1 relative to the target species), but the effort levels and spatial coverage are too low to impact bycatch species' populations. The introduction of fish escapement devices (FEDs) within all the nets towed by each vessel should have reduced this risk even further. The NBPMF and KPMF fishery operates predominantly by specifically targeting schools of banana prawns. This results in relatively low effort and minimal bycatch compared with other trawl fisheries. The impact on bycatch in the BPMF was negligible due to very low effort.

Protected species interaction:

OPMF: **Low**

NBPMF, BPMF, KPMF: **Negligible**

The northern prawn fisheries have previously caught the occasional turtle and sea snake. These are generally returned to the sea alive, and the overall low effort level and targeted coverage suggest that such interactions would not have been significant. Bycatch reduction devices ('grids') and FEDs are now fully implemented minimising the capture of large animals including turtles. Two unidentified turtles and one green turtle was reported as caught but released alive in the ONPMF and NBPMF respectively.

Ecosystem Effects

Food chain effects: **Low**

For all the northern prawn fisheries and in particular the OPMF and BPMF the limited spatial coverage of the fisheries and low levels of catch, it is unlikely to have any significant ecological consequences. In addition for the NBPMF and the KPMF the highly variable nature of banana prawn recruitment, positively related to cyclonic rainfall, any food chain impacts from fishing are likely to be minimal, despite the relatively high annual exploitation rate.

Habitat effects:

BPMF: **Negligible**

OPMF, NBPMF, KPMF: **Low**

In 2009 the area fished in all four fisheries was less than 1-3% of the overall fishery. The fisheries are generally restricted to clean sand and mud bottoms, where trawling has minimal long-term physical impact.

Social Effects

Estimated employment in these fisheries for 2009 was 60 to 80 skippers and crew with additional people involved in local processing.

Economic Effects

Estimated annual value (to fishers) for year 2009:

OPMF: **\$0.6 million**

NBPMF: **\$1.0 million**

BPMF: **Negligible**

KPMF: **\$1.7 million**

Fishery Governance

OPMF Target catch range: 60 – 180 tonnes

Current fishing level: Acceptable

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

King prawns	10 – 55 t
Tiger prawns	10 – 120 t
Endeavour prawns	5 – 20 t
Banana prawns	2 – 90 t

NBPMF Target catch range: 90 – 300 tonnes

Current fishing level: Acceptable

Historical catch ranges from periods where it is known that recruitment was not affected by fishing effort have been used as the basis for target catch ranges for these species. These historical catch ranges are used as an indicator of breeding stock adequacy. Under current effort levels and previous environmental conditions, the target ranges of prawn catches, based on the catches of the 1990s, are as follows:

Banana prawns	40 – 220 t
King prawns	20 – 70 t
Tiger prawns	2 – 40 t

BPMF Target catch range: 55 – 260 tonnes

Current fishing level: Acceptable

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

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

For king prawns the target range is based on the catches of the 1990s, while for coral prawns it is based on the seven-year range (1996 – 2002) since catches were first recorded.

KPMF Target catch range: 240 – 500 tonnes

Current fishing level: Acceptable

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

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

The overall target range for all species combined is different from the aggregate of the individual species ranges shown above. This is because the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species.

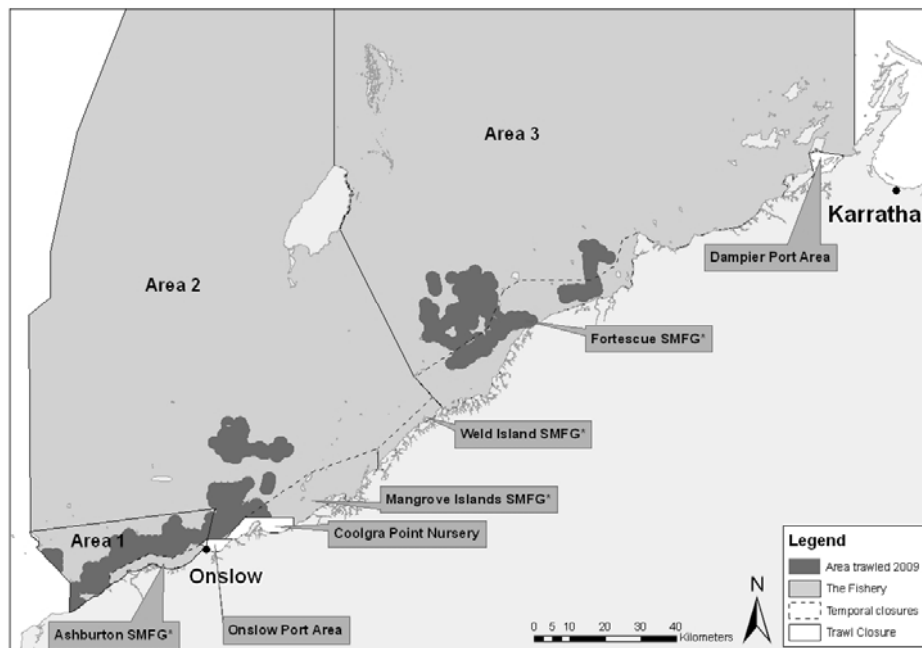
New management initiatives (2010): Nil

Alternative management arrangements (to the interim effort cap currently in place) will be pursued during 2010/11 for the KPMF to improve fishing efficiency and to optimise the value of stocks whilst ensuring sustainability.

External Factors

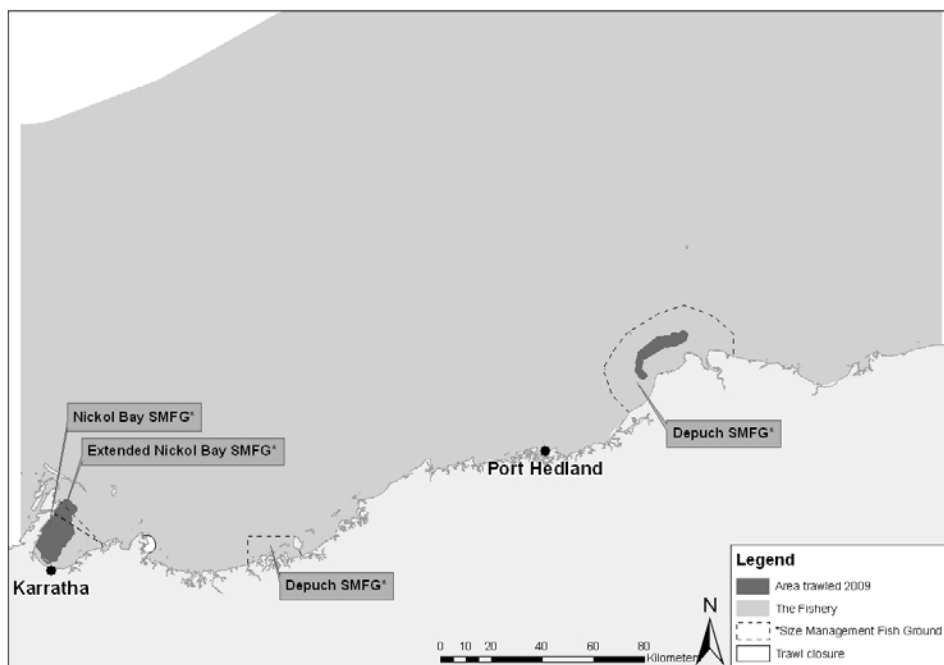
Banana prawns are rainfall dependent and can be highly variable annually in the KPMF, NBPMF and for the OPMF where banana prawns may be in some years be taken predominantly off the mouth of the Ashburton River. Due to high costs of fishing and low prawn prices, some boats in these fisheries are choosing not to fish in years of relatively low banana prawn catches. In the BPMF one factor influencing catches is the timing of the season which is set by the mid-season closure for the Northern Prawn Fishery, and, since the permitted fishing area is small, in some years the timing of prawn recruitment and the prawn migration patterns may not result in significant abundances in the permitted fishing area. The success of this fishery depends on how the limited fishing season coincides with the king prawn recruitment and catchability, which is strongly influenced by the lunar period. The KPMF fishing season also been set to mirror dates used in the NPF to prevent the KPMF from attracting too much fishing effort from the NPF.

NORTH COAST BIOREGION



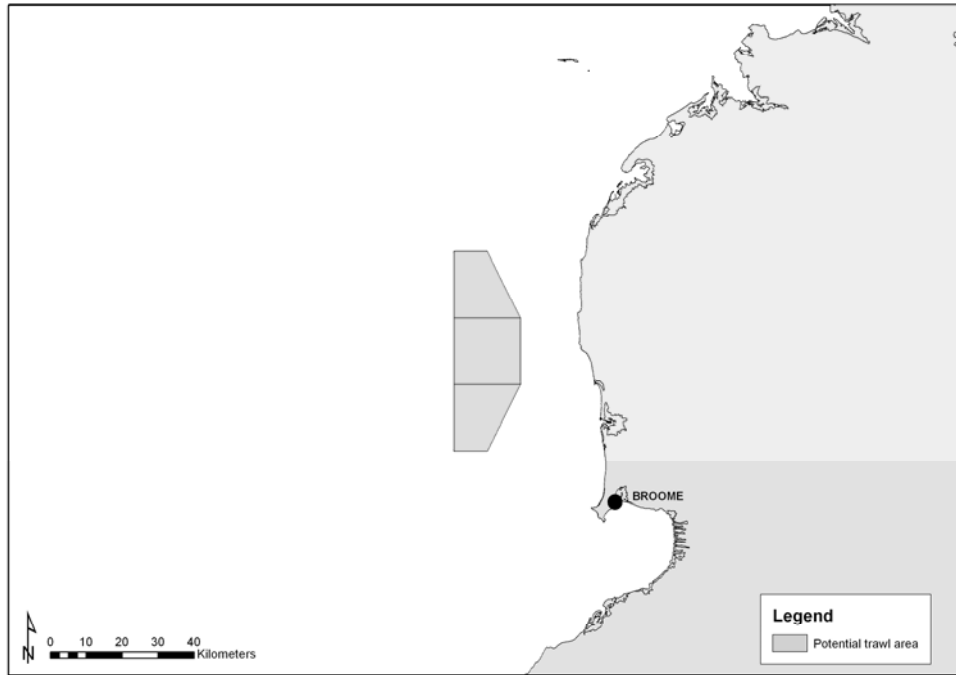
NORTHERN PRAWN FIGURE 1

Boundaries of the Onslow Prawn Managed Fishery indicating trawl closures and size management fish grounds and area trawled in 2009.



NORTHERN BAY PRAWN FIGURE 2

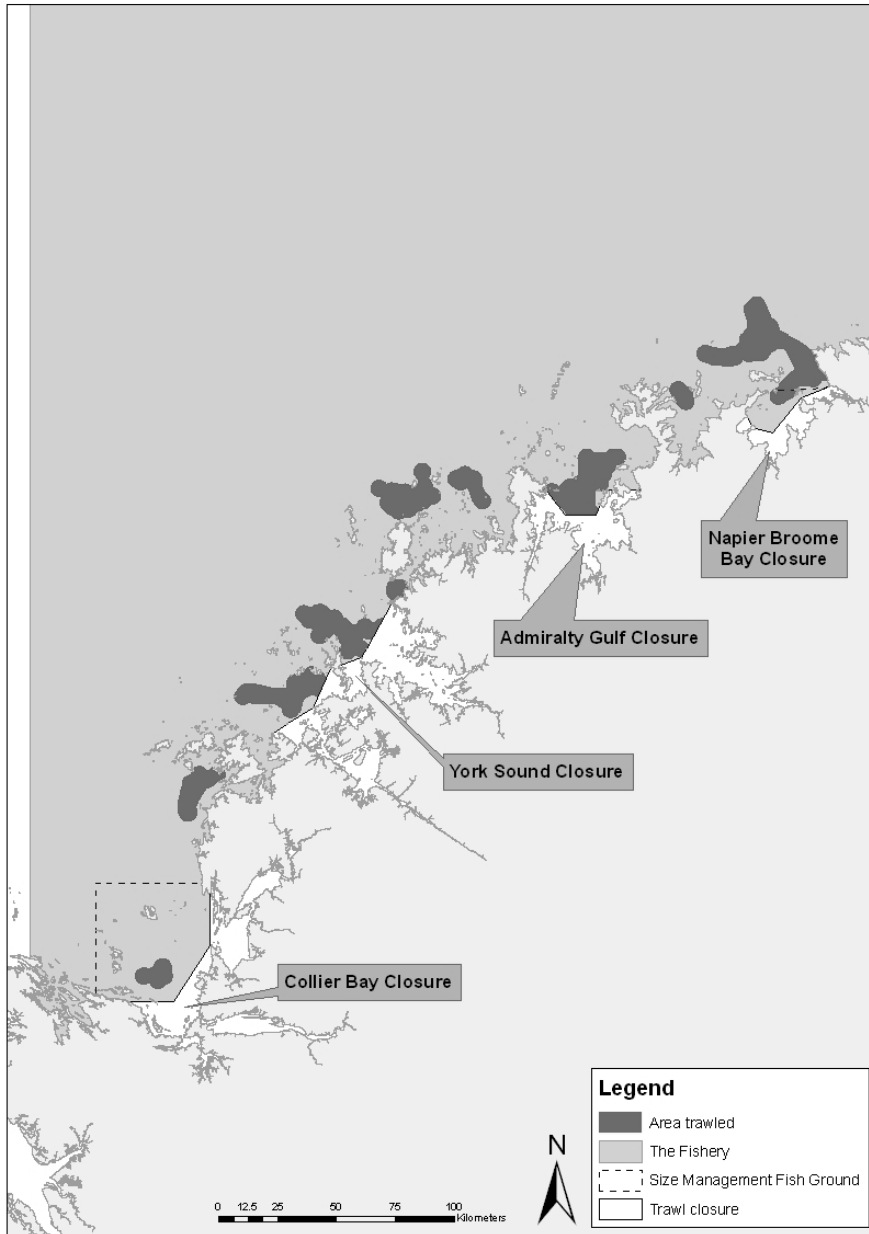
Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2009.



NORTHERN PRAWN FIGURE 3

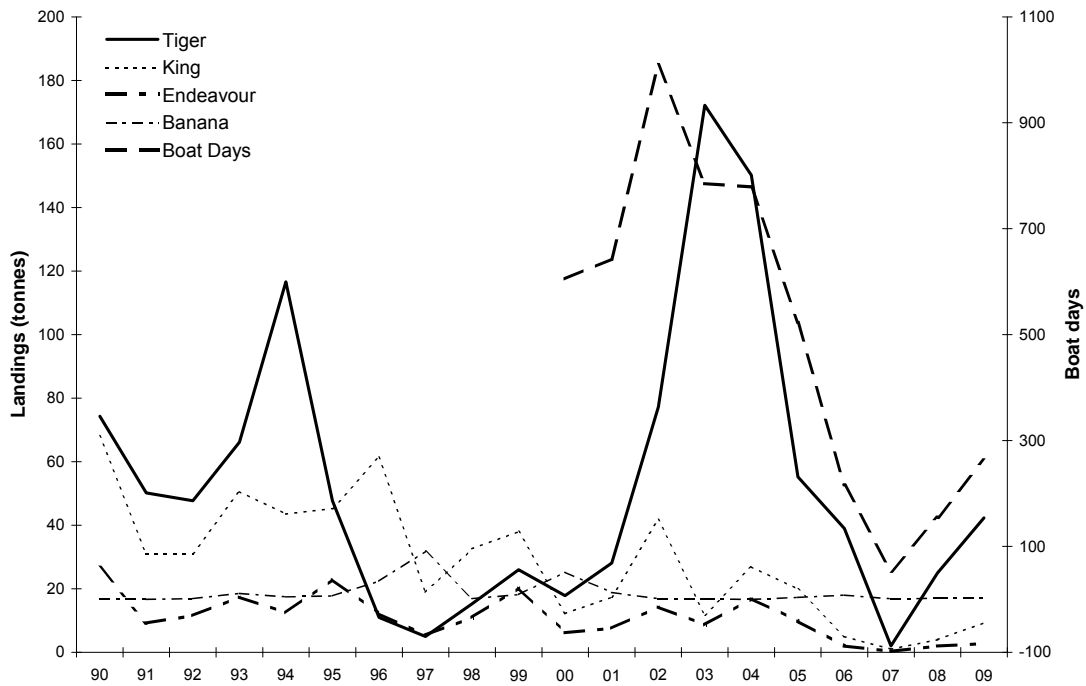
Boundaries of the Broome Prawn Managed Fishery. Negligible area was trawled in 2009.

NORTH COAST BIOREGION



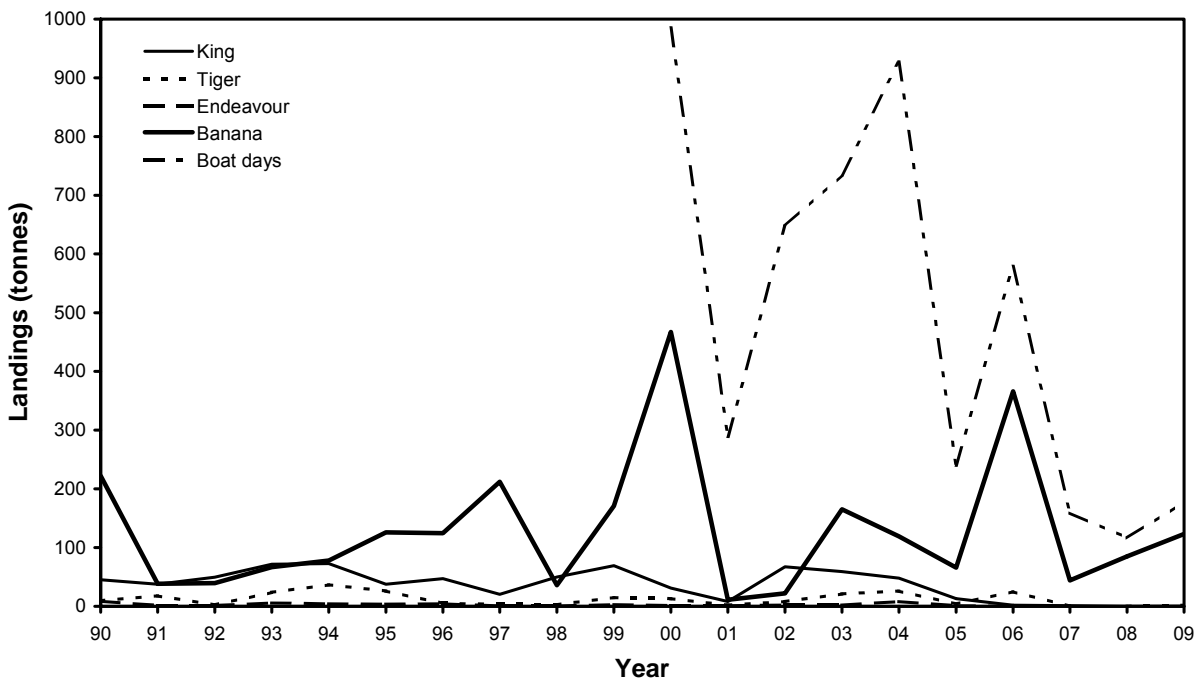
NORTHERN PRAWN FIGURE 4

Areas fished in the Kimberley Prawn Managed Fishery in 2009 and the inshore trawl closures implemented.



NORTHERN PRAWN FIGURE 5

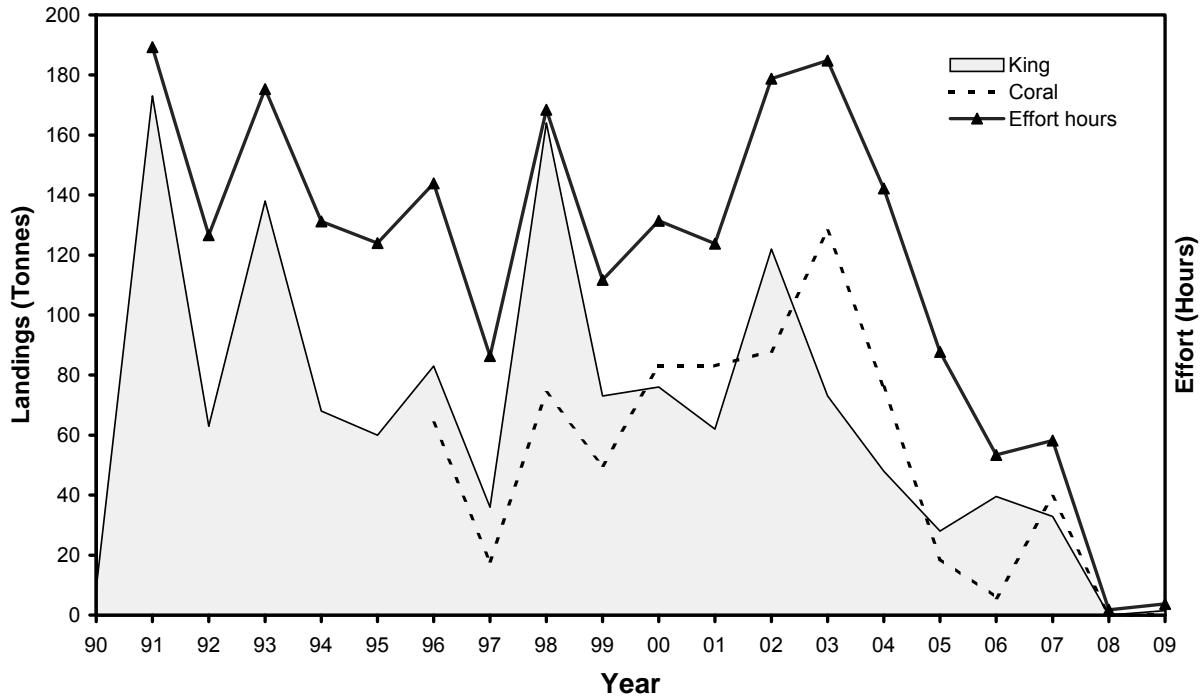
Annual landings and number of boat days (from 2000) for the Onslow Prawn Managed Fishery, 1990 – 2009.



NORTHERN PRAWN FIGURE 6

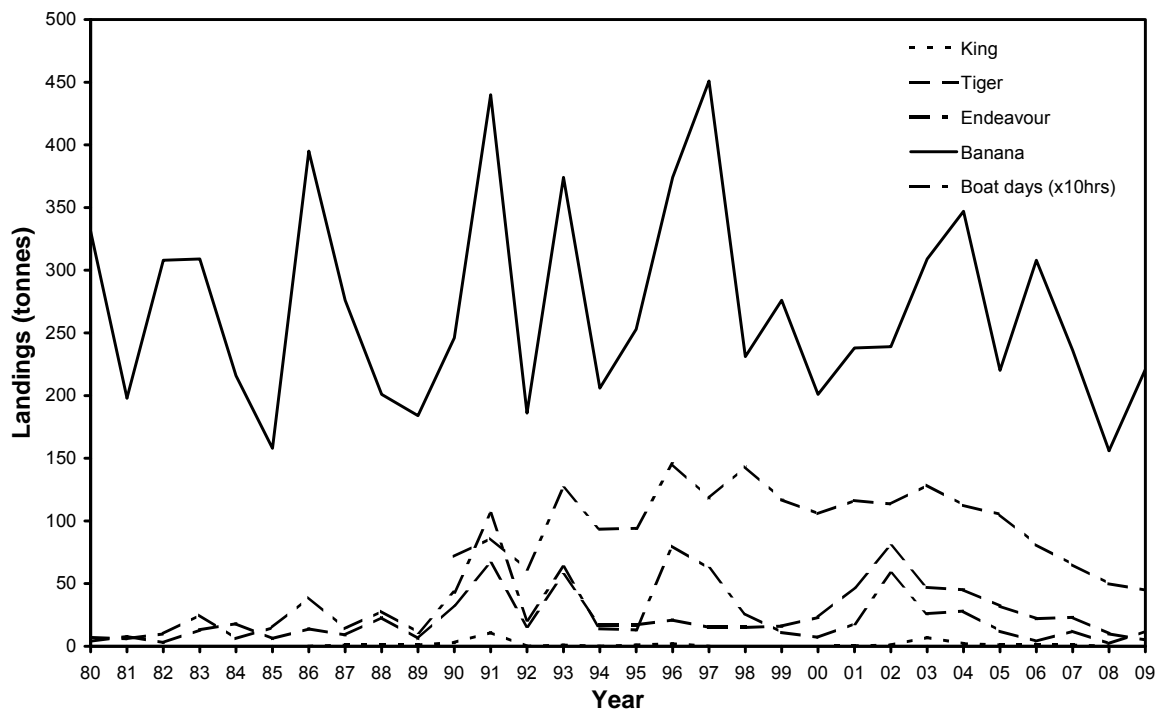
Annual landings and boat days (from 2000) for the Nickol Bay Prawn Managed Fishery, 1990 – 2009.

NORTH COAST BIOREGION



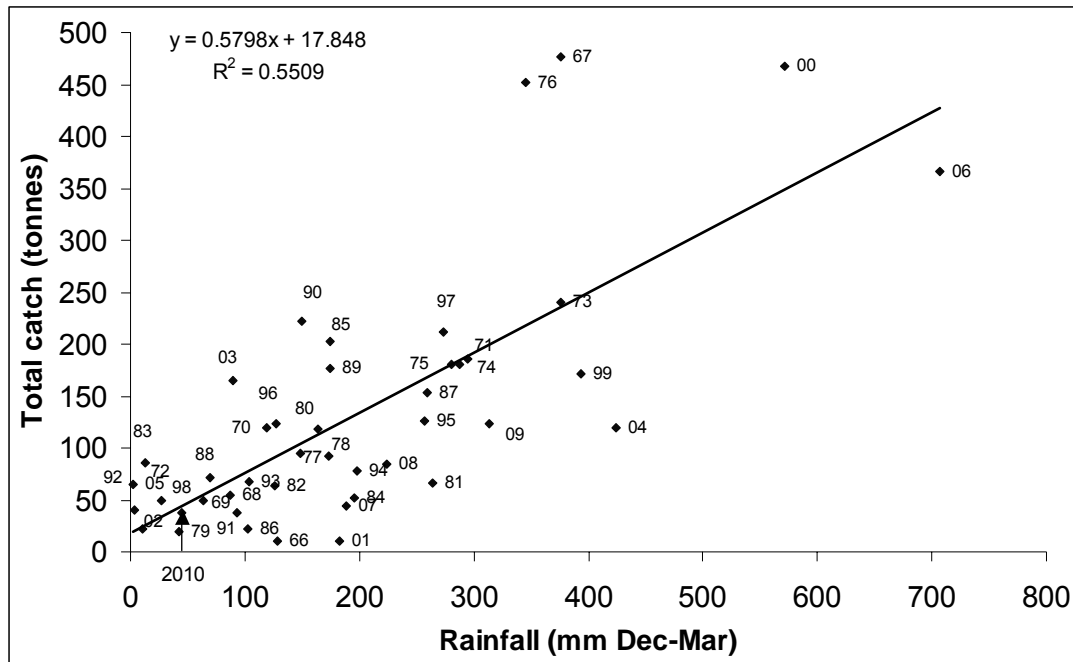
NORTHERN PRAWN FIGURE 7

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990 – 2009.



NORTHERN PRAWN FIGURE 8

Annual landings and number of boat days (from 1990) for the Kimberley Prawn Managed Fishery, 1980 – 2009.



NORTHERN PRAWN FIGURE 9

Relationship between banana prawn landings in Nickol Bay and rainfall between December and March for 1966 – 2009 with rainfall level for 2010 indicated.

North Coast Nearshore and Estuarine Fishery Status Report

S.J. Newman, C. Skepper, G. Mitsopoulos and R. McAuley
 Management input from R. Green

Main Features

Status		Current Landings	
Stock levels	Acceptable	Total	167.3 t
		Barramundi	59.6 t
Fishing Levels	Acceptable	Threadfin	89.9 t
		Recreational	2-10% of total (last estimate 2000)
		Charter	~10 t (barramundi and threadfin)

Fishery Description

Commercial

The only managed fishery currently operating in the North Coast nearshore and estuarine region is the Kimberley Gillnet and Barramundi Managed Fishery (KGBF) which extends from the WA/NT border (129°E) to the top of Eighty Mile Beach, south of Broome (19°S). It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi (*Lates calcarifer*) by any means.

The other species taken by the fishery are predominantly king threadfin (*Polydactylus macrochir*) and blue threadfin (*Eleutheronema tetradactylum*). The main areas of operation for the fishery are the river systems and tidal creek systems of the Cambridge Gulf, the Ria coast of the northern Kimberley, King Sound, Roebuck Bay and the northern end of Eighty Mile Beach to 19°S.

NORTH COAST BIOREGION

Recreational

Recreational fishing activities are concentrated around key population centres, with a seasonal peak in activity during the dry season (winter months).

Governing legislation/fishing authority

Commercial

Kimberley Gillnet and Barramundi Managed Fishery Management Plan 1989

Kimberley Gillnet and Barramundi Managed Fishery Licence.

Recreational

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995 and subsidiary legislation.

Consultation processes

Commercial

Department–industry meeting.

Recreational

Recreational Fishing Advisory Committee; West Kimberley Regional Recreational Fishing Advisory Committee (Broome)

East Kimberley Regional Recreational Fishing Advisory Committee (Kununurra).

Boundaries

Commercial

The waters of the KGBF are defined as ‘*all Western Australian waters lying north of 19° south latitude and west of 129° east longitude and within three nautical miles seaward of the low water mark of the mainland of Western Australia and the waters of King Sound of 16°21.47’ south latitude and Jacks Creek, Yardogarra Creek and in the Fitzroy River north of 17°27’ latitude*’. The principal fishing areas from the Broome coast to Cambridge Gulf in the KGBF are illustrated in Kimberley Gillnet Figure 1.

Recreational

The North Coast Bioregion, which encompasses the Pilbara and Kimberley regions, extends from the Ashburton River south of Onslow to the WA/NT border (all land and water north of 21°46’S latitude and east of 114°50’E longitude).

Management arrangements

Commercial

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures and gear restrictions.

Access to the KGBF is currently limited to seven licences.

There is a closed season in which fishing is prohibited in the KGBF. In the southern KGBF (west of Cunningham Point, 123°08.23’ E longitude) the closure extends from 1 December to 31 January the following year, while in the northern section of the KGBF (east of Cunningham Point) the

closure extends from 1 November to 31 January the following year. There are also limits on the length of net and mesh sizes to be used in the fishery.

Following the development of the *Accord for Future Management of the Barramundi Resource 2000-2005*, additional management arrangements were introduced for the commercial, charter and recreational sectors to facilitate improved management and conservation of barramundi resources in the Kimberley region. These arrangements include commercial fishing area closures around major town sites and recreationally important fishing locations, namely Broome Jetty to Crab Creek, Jacks Creek, Yardogarra Creek, Thangoo Creek, Cape Bossut to False Cape Bossut, Derby Jetty, the Fitzroy River north of 17°27’ S and the lower Ord River upstream of Adolphus Island.

In March 2007, representatives from the commercial, recreational and charter fishing sectors agreed to a revised agreement, the *Accord for the Future Management of Barramundi and Threadfin 2007-2012*. The new Accord includes a number of recommendations for improved management and conservation of barramundi and threadfin stocks in the Kimberley region. The Department of Fisheries is working in collaboration with Recfishwest and the Western Australian Fishing Industry Council to progress the outcomes from the 2007 Accord agreement.

Recreational

As a precautionary measure to ensure that breeding stock levels of barramundi are maintained, special fishing rules are in place for three key fishing areas: Fitzroy River area and King Sound (bag and possession limit of 2 fish); Broome area (bag limit of 1 fish, possession limit of 2 fish); and the Ord River area (bag and possession limit of 1 fish). Fish species in the North Coast bioregion are assigned to a number of risk categories for the purposes of recreational fisheries management. The bag and size limits are species-specific or species group specific. Recreational set and haul netting is prohibited in all waters of the North Coast bioregion with the exception of haul netting in the waters of the Dampier Archipelago (between Cape Preston and Cape Lambert) with the following restrictions: haul nets must not exceed 30 metres in length; mullet are the only species to be retained and all other species must be returned to the water.

Research summary

Monthly catch and effort data from the commercial fishery are used to assess the status of barramundi stocks targeted by this fishery. This status report is compiled annually and provided to industry and regional management.

The biological characteristics required for fisheries management for both the threadfin species have been completed (Pember et al. 2005). These data may be used to provide a stock assessment of threadfin in the KGBF and Pilbara in the future. The bycatch of elasmobranchs in the KGBF and the Pilbara Coast fishing area was examined during 2002 and 2003 (McAuley et al. 2005). The stock structure of both threadfin species is currently being assessed in FRDC Project 2007/032. This project will be completed in 2010.

Retained Species

Commercial landings (season 2009):

All species	167.3 tonnes
Barramundi	59.6 tonnes
Threadfin	89.9 tonnes

The principal species landed are two species of threadfin (the king threadfin and the blue threadfin), and barramundi. Small quantities of elasmobranchs (sharks and rays), black jewfish (*Protonibea diacanthus*) and tripletail (*Lobotes surinamensis*) are also landed. The composition of the elasmobranch catch varies considerably between fishing areas but it mainly consists of whaler shark species (Carcharhinidae), including pigeye sharks (*Carcharhinus amboinensis*), blacktip whalers (mainly *C. tilstoni*) and various species of rays. Sawfish (Pristidae) were totally protected in December 2005 and may no longer be retained by this fishery.

There are four principal fishing areas within the KGBF: Cambridge Gulf (including Ord River), Kimberley coast (six small river systems), King Sound (including Fitzroy River) and the Broome coast (Roebuck Bay). Each of these principal fishing areas is considered separately because of their differing histories of development, effort application, and recreational fishing interest and unit stock considerations.

The total reported catch of all species in the KGBF in 2009 was 167 t (Kimberley Gillnet Figure 2). Recent annual catches of the major target species by the KGBF are reported in Kimberley Gillnet Table 1. The composition of the KGBF catch in 2009 is summarised in Kimberley Gillnet Table 2.

The total landings of barramundi from all four prescribed fishing areas within the KGBF were 59.6 t for 2009 (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 3), a further increase on the reported catch of 54.8 t in 2008 and the highest recorded catch since 1987.

The 2009 landings of threadfin from all four prescribed fishing areas within the KGBF were 89.9 t (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 4). Although slightly lower than in 2008, this is still a relatively high catch.

Recreational catch estimate (last estimate 2000):

2-10% of total catch

The most recent non charter boat data available are from a 12-month creel survey of recreational boat-based and shore-based fishing in the Pilbara and West Kimberley region conducted from December 1999 to November 2000 (Williamson et al., 2006). In the entire survey area (Onslow to Broome), the total recreational fishing effort for the year was estimated to be 190,000 fisher days and the total recreational scalefish catch approximately 300 t. Recreational fishers in the survey area reported an estimated total catch of approximately 18 t of threadfin, whereas the estimated total catch of barramundi was less than 1 t. As this survey covered the Broome coast and Pilbara coast areas, the recreational catch can be estimated at around 10% of the combined (commercial and recreational) threadfin catch and around 2% of the combined barramundi catch in these areas in 2000.

The reported charter vessel catches for the north coast bioregion in 2009 was estimated to be approximately 6.7 t of barramundi and less than 1.0 t of threadfin.

Fishing effort/access level

Commercial

Procedures to validate and standardise reported fishing effort in the KGBF were developed by McAuley et al. (2005). These procedures are used to assess the fishery. The fishery's 'effective effort' is calculated from the validated data as the total length of net set per gillnet hour (km gn hr⁻¹). During 2009, the total effective effort across the four prescribed fishing areas was 1310.4 km gn.hr⁻¹ which is less than 2008 (1542.64 km gn hr⁻¹; Kimberley Gillnet Figure 2) but this is still high relatively to the period 2005-2007.

Recreational

Not assessed this season.

Stock Assessment

Assessment complete:

Barramundi **Yes**

Threadfin **Yes**

Assessment method: **Catch Rate**

Breeding stock levels:

Barramundi **Acceptable**

Threadfin **Acceptable**

The last detailed stock assessment (undertaken in 2002) indicated that the separate barramundi stocks in the Cambridge Gulf, Kimberley coast and King Sound sectors were being harvested at sustainable levels, while in the Broome coast sector the spawning biomass was declining.

The overall increased levels of catch of both barramundi and threadfin in the KGBF during the last 2 years is predominantly due to a marked increase in fishing effort in the Cambridge Gulf region and to a lesser degree over the other regions of the KGBF. This increased level of effort is mostly a result of the transfer of licenses and the subsequent presence of new operators in the fishery.

The catch rates for both barramundi and threadfin in the KGBF in 2009 remained relatively high despite the high catches. The catch rate for barramundi in 2009 was the highest recorded since 1984, continuing an upward trend that began in 2007 (Kimberley Gillnet Figure 3). The catch rate for threadfin in 2009 was marginally higher than in 2008 (Kimberley Gillnet Figure 4).

Continuing high levels of catch and effort will need to be monitored closely for both these species across all regions. There is a need to update the stock assessments for both barramundi and threadfin to assess any impact the increased catches may be having on stocks in each of the sectors across the commercial fishery. Factors such as species – specific targeting by fishers on catch rates need to be investigated and incorporated into any such assessment.

Non-Retained Species

Bycatch species impact: **Low**

The fishery operates at a relatively low intensity over a wide area of the Kimberley region, specifically targeting barramundi and threadfin. The fishing gear uses large mesh sizes, and hence does not generate a significant bycatch of species important to other sectors, but does take some sharks and rays. Where practicable, sharks and rays are released alive. However, there is some mortality of sharks and rays associated with gillnet capture. Because of the low spatial density of fishing effort relative to the widespread distribution of these species and the size-selectivity of the permitted mesh sizes, these impacts are unlikely to be significant to the stocks involved.

Protected species interaction: **Low**

The fishing gear used for this fishery (gillnets) is known to result in the bycatch of protected estuarine crocodiles (*Crocodylus porosus*) and sawfish (Family Pristidae). These species are generally released alive or avoided as far as is practicable. Because of the low effort levels and the low spatial intensity of fishing effort, these impacts are unlikely to pose a significant threat to the sustainability of the stocks of these species.

Catches of the spartooth shark (*Glyphis glyphis*) or the northern river shark (*Glyphis garricki*), which are listed under the *Environment Protection and Biodiversity Conservation Act 1999* as critically endangered and endangered, respectively are rare in the KGBF. However, as these species look similar to other whaler shark species, they may be captured but misidentified. Given the fishery's low effort levels, particularly inside the freshwater drainages in which these species are most likely to occur, the fishing operations of the KGBF are unlikely to pose a significant threat to the sustainability of the stocks of these species.

Ecosystem Effects

Food chain effects: **Low**

This fishery is unlikely to be having anything but a minimal effect on the nearshore and estuarine ecosystem of the Kimberley region.

Habitat effects: **Low**

The fishing gear has minimal impact on the habitat. The area and habitat fished is subject to extreme tidal currents and associated effects.

Social Effects

Commercial

During 2009, seven vessels fished in the KGBF with an average crew level of approximately 2.8 people, indicating that at least 20 people were directly employed in the fishery. There was additional employment through local processors and distribution networks. The fishery provides fresh fish for the local communities and the tourism industry throughout

the Kimberley region.

Recreational

A significant number of recreational and charter anglers also fished across the region.

Economic Effects

Estimated annual commercial value (to fishers)

for year 2009: **\$1 Million**

The KGBF landed a total of 167 t of fish in 2009, for a catch value of approximately \$1 million. This estimate is based on the landed weight of each species recorded in the CAES system and the 2009 average price per kilogram of whole weight of each species as supplied by fish processors.

Fishery Governance

Current Fishing (or Effort) Level **Acceptable**

The fishery is operating above the current target catch range for the key indicator species (barramundi). The catch rate for this species is slightly above the maximum of the past five years. The breeding stock levels of barramundi are considered adequate and therefore the current fishing and effort levels are acceptable but should be reviewed.

Target commercial catch range:

Barramundi 25-40 tonnes

The target catch range for barramundi (25–40 t) was derived from a double exponential smoothed forecasting model of the annual barramundi catches of the KGBF up to 1999. For the five years from 1999 to 2003, the level of barramundi catch was at the top end of the target catch range. The catch in 2004 exceeded the target range, although this was achieved at a CPUE reflecting higher abundance levels than during the 1980s and 1990s. The barramundi catch in 2009 was above the target range and while it was considered acceptable a review of the status of barramundi is required.

New management initiatives (2010/11)

In March 2007, representatives from the commercial, recreational and charter fishing sectors agreed to a revised agreement, the *Accord for the Future Management of Barramundi and Threadfin 2007-2012*. The new Accord includes a number of recommendations for improved management and conservation of barramundi and threadfin stocks in the Kimberley region. The Department of Fisheries plans to develop a community awareness and education package to facilitate the release of outcomes of the Accord process, in order to support the recommended legislative changes for the improved management of these stocks.

The Department plans to review the KGBF management plan in order to modernise the fishery management arrangements and address concerns in relation to transferability of licences and the potential for shifting of effort and localised depletion of stocks.

External Factors

The barramundi stocks utilising the large Kimberley river systems as nursery areas are expected to be reasonably resilient to fishing pressure. However, the impact of increasing exploitation from the charter and tourism sectors, as well as population growth associated with the gas and mining development sectors on barramundi stocks needs to be investigated.

Furthermore, the smaller, isolated stocks along the arid Pilbara coastline are likely to experience highly variable recruitment due to environmental fluctuations (e.g. amount of rainfall). These stocks are subject to increased exploitation pressure from recreational fishers (driven in the main by population growth resulting from gas and mining developments), and are likely to need specific management arrangements in the future.

KIMBERLEY GILLNET TABLE 1

Recent annual catches of the major target species by the KGBF.

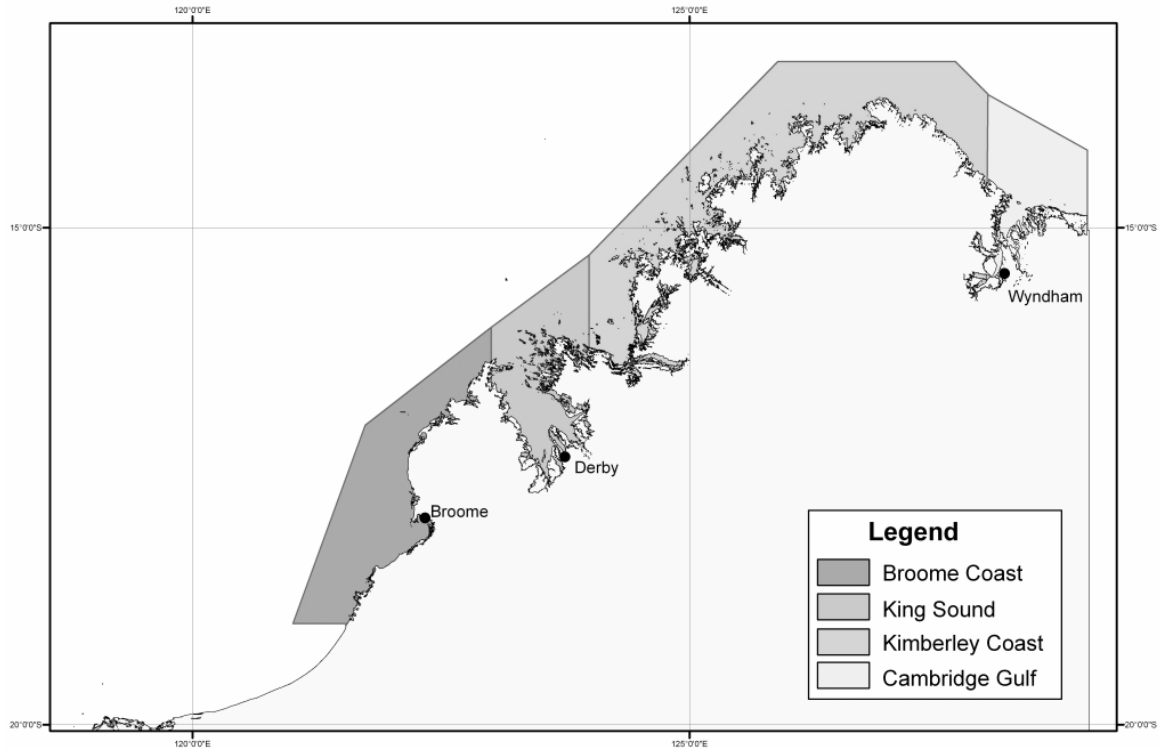
Species	Kimberley Gillnet Annual Catch (tonnes)										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Barramundi	41.2	42.9	38.8	39.5	45.0	53.5	35.6	36.3	27.2	54.8	59.6
Threadfin	109.8	66.7	50.9	76.4	94.1	75.8	70.6	67.7	78.5	101.2	89.9
Total	160.4	120.7	100.5	124.4	148.0	136.1	117.8	109.9	111.4	165.6	167.3

KIMBERLEY GILLNET TABLE 2

Summary of the reported catch (t) in the KGBF in 2009 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin	89.9	53.8
Barramundi	59.6	35.6
Tripletail	8.2	4.9
Black jewfish	2.8	1.7
Sharks and rays	3.8	2.3
Other fish	3.1	1.9
Total	167.3	100

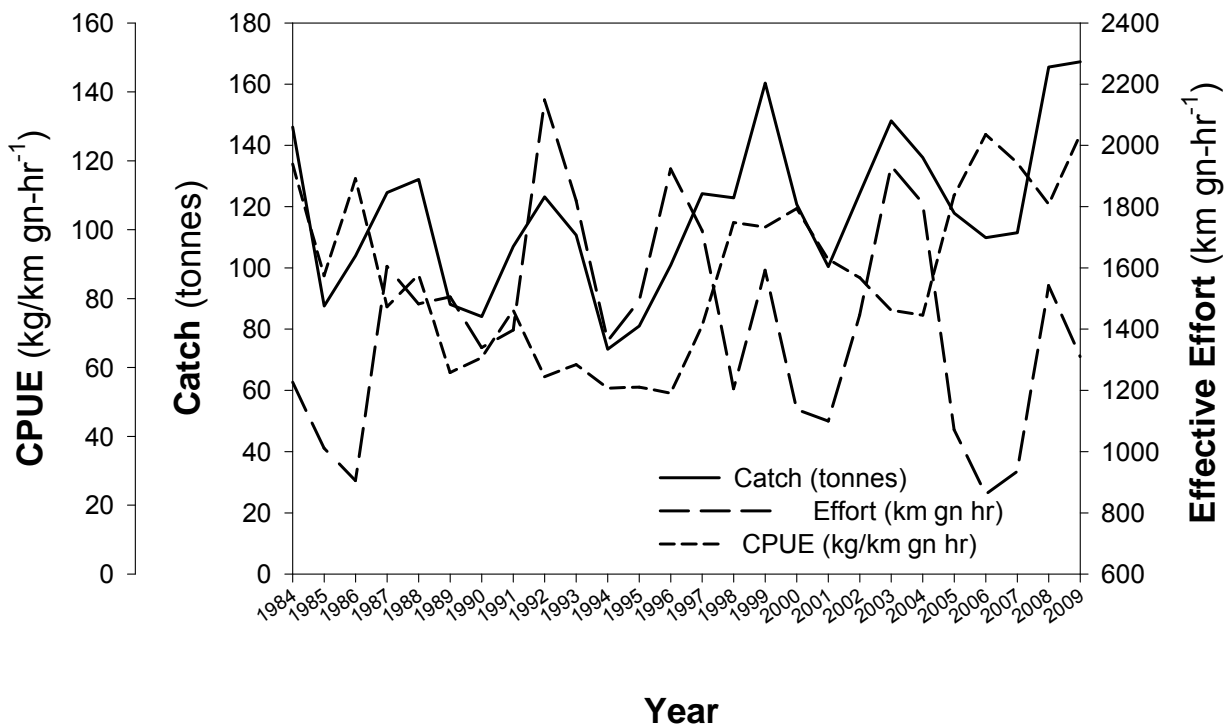
NORTH COAST BIOREGION



KIMBERLEY GILLNET FIGURE 1

Location of the principal fishing areas for barramundi and threadfin (Cambridge Gulf (including Ord River), Kimberley coast (six small river systems), King Sound (including Fitzroy River) and the Broome coast (Roebuck Bay)) within the KGBF. Note: this map is indicative only

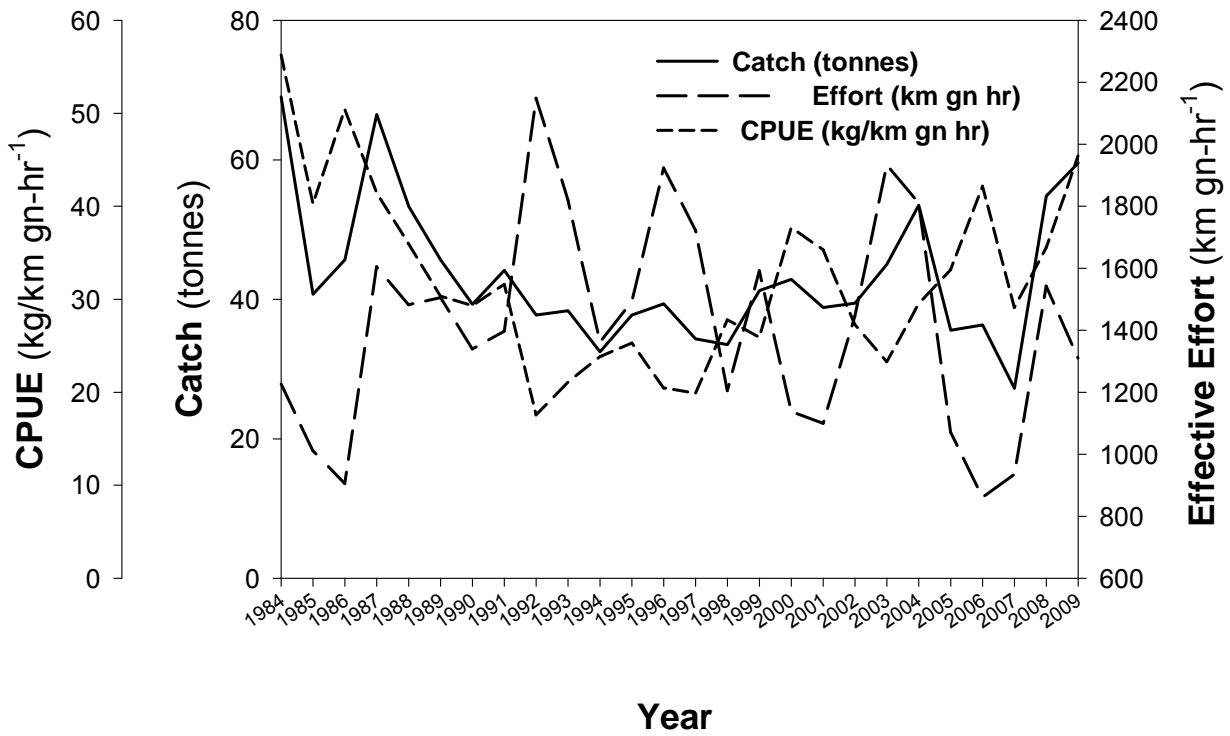
Kimberley Gillnet Annual Catch and Effort



KIMBERLEY GILLNET FIGURE 2

The annual total catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, km gn.hr⁻¹) from the KGBF over the period 1984 to 2009.

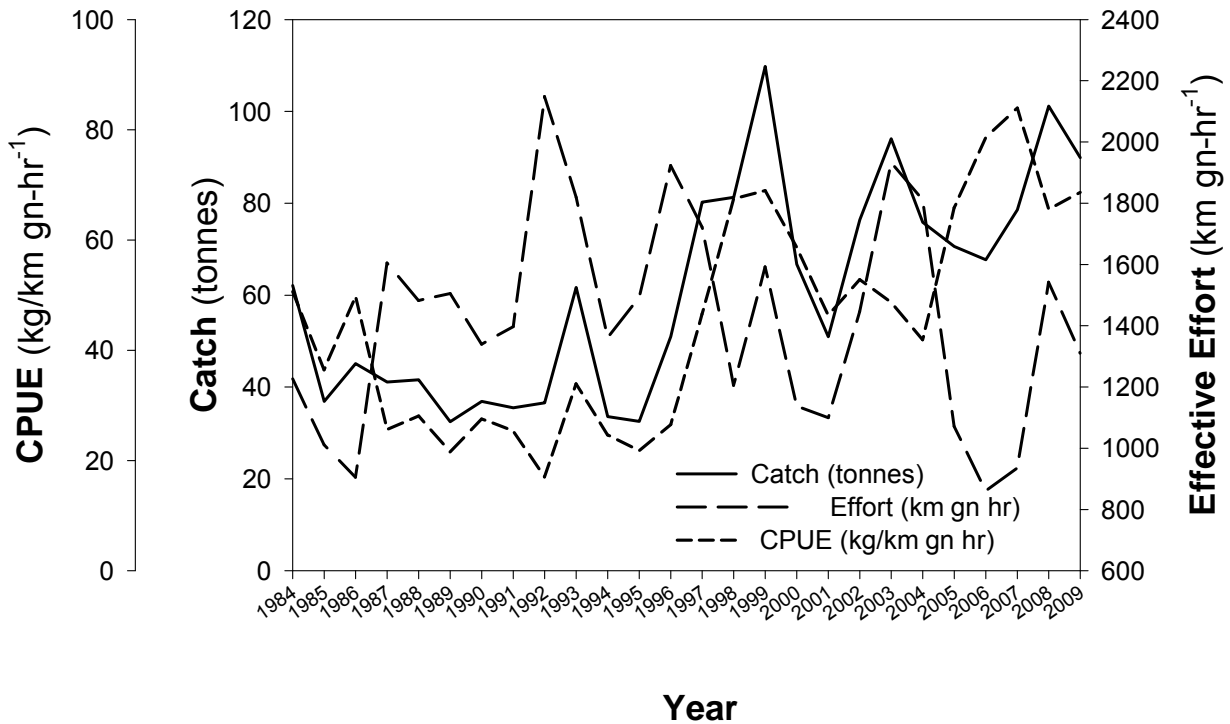
Barramundi



KIMBERLEY GILLNET FIGURE 3

The annual catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, km gn.hr⁻¹) for barramundi from the KGBF over the period 1984 to 2009.

Threadfin Salmon



KIMBERLEY GILLNET FIGURE 4

The annual catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, km gn.hr⁻¹) for threadfin from the KGBF over the period 1984 to 2009.

North Coast Demersal Fisheries Status Report

S.J. Newman, C. Wakefield, P. Stephenson, C. Skepper, D. Boddington, M. Cliff, G. Mitsopoulos and B. Rome

Management input from R. Green and S. Blazeski

Main Features

Status		Current Landings	
Pilbara:		Pilbara:	
Stock level	Acceptable	Total	1622 t
Fishing Level		Red emperor	159 t
Trap Fishery	Acceptable	Rankin cod	75 t
Trawl Fishery	Review required	Bluespotted emperor	173 t
		Pilbara Fish Trawl Fishery	1044 t
		Pilbara Fish Trap	455 t
		Pilbara Line	123 t
		Recreational	1.5% of total (2009)
		Charter	< 25 t
Kimberley:		Kimberley (NDSF):	
Stock level	Acceptable	Total	1046 t
Fishing Level	Acceptable	Red emperor	156 t
		Goldband snapper	485 t
		Recreational	<1% of total (2009)
		Charter	< 5 t

Fishery Description

The demersal fisheries in this region target, to varying levels, some or all of the following species, bluespotted emperor (*Lethrinus punctulatus*), rosy threadfin bream (*Nemipterus furcosus*), brownstripe snapper (*Lutjanus vitta*), crimson snapper (*Lutjanus erythropterus*), red emperor (*Lutjanus sebae*), saddletail snapper (*Lutjanus malabaricus*), goldband snapper (*Pristipomoides multidens*), spangled emperor (*Lethrinus nebulosus*), frypan snapper (*Argyrops spinifer*) and Rankin cod (*Epinephelus multinotatus*).

Commercial

Pilbara

The Pilbara demersal scalefish fisheries include the Pilbara Fish Trawl (Interim) Managed Fishery, the Pilbara Trap Managed Fishery and the Pilbara Line Fishery. The trawl fishery has until recently dominated the landed catch of demersal finfish in the Pilbara targeting all 10 species, with a subset of the main species taken by the trap and then the line fishery.

Kimberley

The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the north-west coast of Western Australia in the waters east of 120° E longitude. The permitted means of operation within the fishery include handline, dropline and fish traps. The main species landed are red emperor and goldband snapper.

Recreational

Recreational fishing activities are concentrated in inshore areas around key population centres, with a peak in activity during the dry season (winter months).

Governing legislation/fishing authority

Commercial

Pilbara

Pilbara Trap Managed Fishery Management Plan 1992

North Coast Shark Fishing (Professional) Notice 1993

Prohibition on Commercial Fishing for Demersal Scalefish (Pilbara Area) Order 1997

Pilbara Fish Trawl Fishery (Interim) Management Plan 1997

Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006

Australian Government Environment Protection and Biodiversity Conservation Act 1999 (Wildlife Trade Order).

Kimberley

Northern Demersal Scalefish Managed Fishery Management Plan 2000

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption).

Recreational

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995 and other subsidiary legislation.

Consultation processes

Commercial

Pilbara

Department - engagement with:

Industry meetings for the fish trawl, trap and line fisheries; and

Western Australian Fishing Industry Council (WAFIC).

Kimberley

Department – industry meeting for the NDSF and an annual Broome Consultative Forum.

Recreational

Department - in liaison with:

Recreational Fishing Advisory Committee;

Pilbara Regional Recreational Fishing Advisory Committee (Karratha);

West Kimberley Regional Recreational Fishing Advisory Committee (Broome);

Annual Broome Consultative forum; and

Recfishwest and stakeholder meetings

Boundaries

Commercial

Pilbara

The Pilbara Fish Trawl Fishery is situated in the Pilbara region in the north west of Australia. It occupies the waters north of latitude 21°35'S and between longitudes 114°9'36"E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath (North Coast Figure 1).

The Fishery consists of two zones, Zone 1 in the south west of the Fishery (which is closed to trawling) and Zone 2 in the North, which consists of six management areas. Areas 1 to 6 each cover 1,300, 1,800, 880, 1,500, 2,300 and 7,200 square nautical miles respectively. The total area available for trawling is 14,980 square nautical miles. The exact latitudes and longitudes delineating the areas are listed in the *Pilbara Fish Trawl Fishery (Interim) Management Plan 1997*.

The Pilbara Trap Managed Fishery (North Coast Figure 1) lies north of latitude 21°44'S and between longitudes 114°9'.6'E and 120°00'E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath. The exact latitudes and longitudes delineating the fishery are listed in the *Pilbara Trap Management Plan 1992*.

The Pilbara Line fishing boat licensees are permitted to operate anywhere within "Pilbara waters". This means all waters bounded by a line commencing at the intersection of 21°56'S latitude and the high water mark on the western side of the North West Cape on the mainland of Western Australia; thence west along the parallel to the intersection of

21°56'S latitude and the boundary of the Australian Fishing Zone and north to longitude 120°E. The exact latitudes and longitudes delineating the Fishery are listed in the *Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006*.

Kimberley

The waters of the Northern Demersal Scalefish 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 (North Coast Figure 2). The fishery is further divided into two fishing areas, an inshore sector (Area 1) and an offshore sector (Area 2) (see North Coast Figure 2). Under a voluntary industry agreement, the offshore sector (Area 2) has been further divided into 3 zones, A, B and C. Zone B comprises the area of historical fishing activity. Zone A is an inshore developmental area and Zone C is an offshore deep slope developmental area representing waters deeper than 200 m. The inshore waters in the vicinity of Broome are closed to commercial fishing. This closure was put in place to reduce the potential for conflict between commercial fishers and recreational, charter and customary fishers. This closure is represented in North Coast Figure 2 as the area that is closed to trap fishing.

Recreational

The north coast bioregion, which encompasses the Pilbara and Kimberley regions, extends from the Ashburton River south of Onslow to the WA/NT border (all land and water north of 21°46'S latitude and east of 114°50'E longitude), with the exception of some areas within Marine Parks.

Management arrangements

Commercial

Pilbara

The Pilbara Fish Trawl Interim Managed Fishery is managed through a combination of area closures, gear restrictions, and by the use of output controls in the form of individual transferable effort allocations monitored by a satellite-based vessel monitoring system (VMS). This Interim Management Plan was implemented for the fish trawl fishery in the Pilbara in 1998, with effort levels determined to achieve the best yield from the Fishery while keeping exploitation rates of the indicator species at sustainable levels.

A large amount of the area of the Trawl Fishery is closed to trawling, and has been since the implementation of the (Interim) Management Plan. Zone 1 of the Fishery and Area 3 of Zone 2 of the Trawl Fishery have been closed since 1998. In addition, Area 6 of Zone 2 has been closed since the commencement of the Plan except for two periods of research trawling in 1998 and 1999. The area inshore of the 50 m depth isobath is also closed to trawling. Areas 1, 2, 4 and 5 are open to fishing all year, with separate effort allocations (in hours) in each Area, as outlined in the (Interim) Management Plan. The open areas of the Trawl Fishery are trawled with varying intensity due to differing effort allocation, substrate composition and economic considerations (e.g. distance from port).

There are 11 permits for the Fishery, with the combined effort allocations being consolidated over time onto 3 full-

NORTH COAST BIOREGION

time vessels.

The Trap Fishery is also managed primarily by the use of input controls in the form of individual transferable effort allocations monitored with a satellite-based vessel monitoring system (VMS). There has also been a closure to trapping in Area 3 since 1998. A review of the Trap Fishery was undertaken in 1996 and based on performance criteria, the number of licences was halved.

The authority to fish in the Trap Fishery is limited by reference to a specified number of trap days expressed in terms of units of entitlement. The capacity is currently limited to 5456 trap days, however, the Management Plan allows the Chief Executive Officer to alter the value of these units.

The individual transferable effort management arrangements introduced into the Trap Fishery in January 2000 dealt with the issue of latent effort in the Fishery and proved effective at holding the Fishery within its acceptable 300 t limit at the time. The catch range has since been increased in response to the increased stock size in the areas used by the trap fishers. There are 6 licences in the Fishery, with the allocation consolidated onto 2 vessels in 2009.

The Line Fishery continues to be restricted by the Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006. 9 Fishing Boat Licences are exempted from this prohibition for any nominated 5-month block period within the year.

Comprehensive Ecologically Sustainable Development (ESD) assessments were submitted in 2004 for both the Pilbara Trap and Trawl Fisheries. These ESD assessments determined that performance should be assessed annually for breeding stock levels, protected species interactions and habitat effects. As a result, the Pilbara Trap Fishery was declared an approved Wildlife Trade Operation in November 2004 for a period of three years. This lapsed in December 2007. The Pilbara Fish Trawl Interim Managed Fishery was an approved Wildlife Trade Operation until June 2010. The Department of Environment, Water, Heritage and the Arts (DEWHA) is currently in the process of assessing a new application from the Department of Fisheries for another Pilbara Fish Trawl Fishery Wildlife Trade Operation.

Kimberley

The Northern Demersal Scalefish Fishery is managed primarily through input controls in the form of an annual fishing effort capacity, with supplementary gear controls and area closures. The annual fishing effort capacity limits the amount of effort available in the fishery to achieve the notional target total allowable catch (TAC). The annual effort capacity is based on the available research advice and in consultation with licensees. The effort capacity is set by the Chief Executive Officer and is then allocated among license holders through units of entitlement on Managed Fishery Licences, for use in Area 2 of the Fishery. An Exemption provides for additional effort in Zone A (56 standard fishing days per 160 unit licence) and Zone C (50 standard fishing days per 160 unit licence), in order to encourage fishers to explore the lesser-fished offshore waters of the NDSF.

The notional target TAC for Zone B is a recommended level of catch for the entire demersal species complex and is

derived from the estimated sustainable catch of the key target species (determined through stock assessments) and their historical proportions in the catch. In 2009, Zone B effort allocation was 1,144 standard fishing days.

The areas that encompass Zone A and Zone C are likely to be lower in productivity compared with Zone B, and thus the notional exploratory TAC set for Zone A and Zone C will need to be revised if substantial catches of either goldband snapper or red emperor are forthcoming. In 2009, the Zone A effort allocation was 616 standard fishing days.

Access to the offshore sector (Area 2) of the NDSF is limited to 11 licences under an individually transferable effort (ITE) system. This allows the effort quota to be operated by a lesser number of vessels. For example, during 2009, 7 vessels (trap fishing only) collectively held and operated the effort individually assigned to the 11 licences. Each trap must have an internal volume equal to or less than 2.25 m³. There is no restriction on the number of traps that can be fished per vessel. However, as each licensee is allocated an annual effort quota in 'standard fishing days' based on the use of 20 traps (or 5 lines) per day, if the number of traps (or lines) being fished increases, the number of allowable fishing days declines. The number of days fished, as recorded by the vessel monitoring system, is converted to standard fishing days. A comprehensive ESD assessment of this fishery has determined that performance should be reported annually against measures relating to breeding stocks of the two indicator species, red emperor and goldband snapper, and the cod/grouper complex (a suite of more than 10 species), as reflected by their catch levels.

Recreational

Demersal fish in the North Coast bioregion are assigned to a number of risk categories for the purposes of recreational fisheries management.

Demersal fish, particularly the icon species such as coral trout and red emperor, are considered prime recreational target species. As such, resource-sharing issues will be a consideration in future management arrangements across this bioregion.

Research summary

Pilbara

Monitoring and assessment of the Pilbara trawl, trap and line fisheries includes the collection of spatial data on effort and catch of 10 major target species from logbooks, VMS data, and weighed catches from unload data. Assessment of the status of the suite of retained demersal scalefish is based on the performance of indicator species using various assessment methods. These methods include trend analysis of catch rates using two measures of effort for five indicator species and the total catch in each of the trawl managed areas. In addition, otoliths are collected and ages determined for the indicator species, red emperor, rankin cod, bluespotted emperor, and goldband snapper in each of the trawl-managed areas and the trap fishery. Estimates of fishing mortality are derived from each of these age structures and compared to internationally recognised benchmarks or Exploitation Reference Points (ERPs, see Stock Assessment section). Every four years the spawning biomass of two indicator species, red emperor and rankin cod, is assessed using the

age-composition and catch rate data in an age-structured model.

Discussions are in progress on developing a collaborative project with CSIRO to assess ecosystem recovery since closure to trawling in Areas 3 and 6 on the North West Shelf.

Kimberley

Monitoring and assessment of the status of the demersal fish stocks in the NDSF is determined annually using catch and catch rates of the major species or species groups, and every three to four years using an age-based stock assessment model to assess the status of the two indicator species, red emperor and goldband snapper based on age-composition data collected in the previous years. Ongoing monitoring of this fishery is being undertaken using both catch and effort logbook and VMS data.

An FRDC-funded research project commenced in late 2006. This project aims to examine the relative catching efficiency of traps in the NDSF and to investigate resource availability and contribute to the stock assessment process in the NDSF.

The future catch from the NDSF may also include some species from the waters of Zone C in depths greater than 200 m. The resources of this zone are unlikely to be substantial, and given the lower production potential of these longer-lived, deeper-slope reef fish, the sustainable catch from this zone is likely to be low.

Retained Species

Commercial landings (season 2009):

Pilbara Fish Trawl	1,044 tonnes
Pilbara Fish Trap	455 tonnes
Pilbara Line	123 tonnes
Kimberley (NDSF)	1,046 tonnes

Pilbara

Catches of the major species for 2009 are shown in North Coast Table 1. The catches by different fishing methods for the years 1985 to 2009 are shown in North Coast Table 2.

The fish trawl catch decreased in 2009 and is below the target catch range. The decrease was due to a decrease in effort and catch rate of some species. The major target species landed by the trawl fishery in 2009 (2008 catch in brackets) were rosy threadfin bream 165 t (142 t), bluespotted emperor 108 t (152 t), crimson snapper 92 t (107 t), goldband snapper 69 t (78 t), red emperor 66 t (55 t), brownstripe snapper 62 t (47 t), saddletail snapper 51 t (57 t), Rankin cod 13 t (15 t) and spangled emperor 10 t (10 t). The total retained by-product was 73 t (37 t) including shark, bugs, cuttlefish, and squid.

The trap fishery catch decreased from 508 t in 2008 to 455 t in 2009, back within the 400-500 t target catch range. Major species taken by the trap fishery in 2009 (2008 figures in brackets) were red emperor 92 t (97 t), crimson snapper 78 t (34 t), bluespotted emperor 65 t (97 t), Rankin cod 60 t (54 t), goldband snapper 32 t (25 t) and spangled emperor 15 t (29 t).

Demersal scalefish catches taken by line fishing in 2009 were slightly higher than that reported in 2008. This was mainly due to an increase in catches of ruby snapper from 12 t in

2008 to 37 t in 2009. Catches of goldband snapper in 2009 were similar to 2008, 22 t and 24 t, respectively (North Coast Table 1).

Kimberley

The reported catch in the NDSF rose steadily after the initial development period from 1990 to 1992, reaching a peak in catch levels in 1996 (North Coast Figure 4). Following 1996, catch levels decreased and were relatively stable in the period from 1998 to 2003; total catch began to increase in 2004. The total catch of demersal scalefish in the NDSF in 2009 was higher than that reported in 2008 due mainly to an increased level of catch from Zone A of the fishery (North Coast Table 7 and 8).

The NDSF principally targets red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidens* and related *Pristipomoides* species), with a number of species of snappers (*Lutjanidae*), cods (*Serranidae*) and emperors (*Lethrinidae*) comprising the remainder of the catch. The catch of the major target and secondary target species over the last six years is provided in North Coast Table 7. The species composition of the landed catch in 2009 is similar to that reported in 2008. In 2009 the total catch of red emperor was 156 t, down from the reported catch of 173 t in 2008. However, there was an increase in the landed catch of goldband snapper up from 457 t in 2008 to 485 t in 2009, as well as a slight decrease in the cods/groupers catch, down from 148 t in 2008 to 142 t in 2009. The composition of the cod/grouper catch complex is dominated by Rankin cod (*Epinephelus multinotatus*). The catch of Rankin cod decreased from 2008 (57 t) to 2009 (45 t). The catch of the major species by zone in the NDSF is described in North Coast Table 8. The catch, effort and catch rates of red emperor, goldband snapper and the cod/grouper complex in Zone B are depicted in North coast Figures 5-7.

The 2009 catch of goldband snapper, red emperor and cods/groupers were all within acceptable levels as defined in the exemption for this fishery (see 'Fishery Governance' section), although the catch of goldband snapper was close to the trigger point (20% increase in average catch of the previous 4 years). The commercial catches of key species and species groups from across the North Coast Bioregion and their relative contribution to catches within the Pilbara and Kimberley sectors in 2009 are summarised in North Coast Table 10.

Recreational catch estimate (season 2009):

Pilbara	1.5%
Kimberley	<1%

Pilbara

While there is a major recreational fishery in the Pilbara and the charter sector is an increasing user of the resource, the inshore closures to the commercial sector provide a high degree of spatial separation between the user groups. The recreational and charter sectors do not catch significant quantities of most species targeted by the commercial Pilbara fish trawl, trap and line fisheries. The reported charter vessel catch of demersal scalefish in the offshore waters of the Pilbara (depth > 30 m) in 2009 is estimated to be 1% (~19 t) of the commercial catch. Due to the increasing population in the Pilbara from mining developments, catches are likely to

NORTH COAST BIOREGION

increase in the future.

Kimberley

Historically, there has been little recreational or charter boat fishing effort directed towards the deeper-water fish species in Area 2 of the NDSF that are the key species targeted by commercial fishers. However, this is now changing with charter vessels moving into the offshore waters of the NDSF. The reported charter vessel catch of demersal scalefish in the offshore waters of the NDSF (depth > 30 m) in 2009 is estimated to be less than 1% (<5 t) of the commercial catch. Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is thought to be concentrated in the Broome sector of Area 1, which is closed to commercial fishing. The magnitude of recreational fishing catch is small relative to the total commercial catch. However, the increasing number of vessels associated with oil and gas developments in the Kimberley region has the capacity to significantly increase the level of recreational catch taken from inshore and offshore waters of the NDSF.

Fishing effort/access level

Pilbara

The fishing effort in the trap and line sectors of the commercial fishery is based on the monthly catch and effort returns (North Coast Table 3). The trawl fishery effort is recorded as the net bottom time (hours) taken from skippers' logbook data, validated by VMS data.

The trawl fleet had the equivalent of four full-time vessels. The percentage of allocated hours used by the trawl fleet during the 2008/09 season were 87.5% in Area 1, 104.5% in Area 2, 104.2% in Area 4 and 97.4% in Area 5. Note, that trawling has not been permitted in either Area 3 or Area 6 since 1998 and trapping has not been permitted in Area 3 since 1998.

The number of trap days allocated, the number of days used and the percentage of the allocation used for the period 2000–2009 are shown in North Coast Table 4. In 2009, trap fishers were allocated 5,456 trap days (capacity is set in trap days with a value per unit of 1 unit = 1 trap day), with 97% of the units used as calculated from the VMS. This number of units equates to 469 days allocated and 456 days fished with an average of 10.3 traps per day.

In 2009, line fishers reported operating for 294 days, compared with 326 days in 2008.

Kimberley

The six fish trap vessels that fished in the NDSF in 2009 reported using between 20 and 38 fish traps per day. No line fishing was undertaken in Zone B of the NDSF in 2009. The history of effort allocation in the NDSF since the introduction of the ITE management system in 1998 is detailed in North Coast Table 9.

The effort allocated in Zone B in 2009 was 104 fishing boat days per licence, or a total of 1,144 standard fishing days (i.e. using 20 traps) (North Coast Table 9). The number of standard fishing days (SFDs) recorded in Zone B using VMS data was 938 SFDs (82%). That is, 18% of effort allocated to Zone B in 2009 was not used.

A total of 616 standard fishing days was allocated to Zone A in 2009. The number of standard fishing days (SFDs)

recorded using VMS data was 149, indicating that 76% remained unutilised in Zone A at the end of the season.

Stock Assessment

Assessment complete:

Pilbara	Yes
Kimberley	Yes

Assessment method:

Pilbara	Catch rates
	Fishing mortality and age-structured model
Kimberley	Age Structured Model

Breeding stock levels:

Pilbara	
Trap Fishery	Acceptable
Trawl Fishery	Acceptable
Kimberley	Acceptable

Pilbara

There are three forms of assessment used that combined, constitute a weight of evidence approach to determine stock status based on the performance of indicator species that represent the entire demersal suite of species. The different forms of assessment are applied to each indicator species. Catch rate analyses are used to assess five indicator species and the total catch for trawl managed Areas 1, 2, 4 and 5. Fishing mortality estimates (F) derived from age structure data are used to assess red emperor, rankin cod, goldband snapper and bluespotted emperor relative to internationally recognised exploitation reference points (ERP) based on ratios of natural mortality. The ERPs include (1) the Target level, where $F \leq 2/3$ the ratio of natural mortality (M), for which fishing mortality should not exceed; (2) Threshold level, where $F = M$, which indicates fishing has exceeded sustainable levels; and (3) Limit level, where $F = 1.5M$, which indicates that fishing has greatly exceeded sustainable levels. An age-structured model incorporating catch rates and mortality estimates is used to assess spawning biomass levels for red emperor and rankin cod.

The catch rates shown in North Coast Figures 3 are derived using logbook catch data and adjusted according to the unload data, so that the catch matches the reported unloads and the spatial component is obtained from the logbooks. There are two measures of effort used to derive catch rates including the duration of the trawl shots as reported in logbooks and the time spent in each management area on each trip from VMS data. VMS data has only been available since 2000. The catch and effort was pooled for each vessel and month and an ANOVA used to determine the annual catch rate and 95% confidence intervals with a natural log transformation. A moderate efficiency measure (1-2%) was included in the graphs but not the analyses.

The mean trawl catch rates of the indicator species and the total catch have been decreasing annually since about 2004

(North Coast Figures 3). In 2009, mean trawl catch rates of four of the five indicator species (excluding goldband snapper) and the total catch in Area 1 were higher in 2009 than in 2008. The mean trawl catch rates were also higher in Area 2 in 2009 compared to 2008 for red emperor, rankin cod, brownstripe snapper and the total catch. This is most likely due to a reduction in effort in Areas 1 and 2 since 2007. The trends in mean trawl catch rates for indicator species (except goldband snapper) and the total catch continued to decrease in Areas 4 and 5 in 2009.

The high rate of fishing mortality of red emperor (> ERP Limit level) in the western areas (Areas 1 and 2) of the trawl fishery (Table 5), and the declining catch rates of several species including the indicator species red emperor and rankin cod led to a reduction in effort of 16% in Areas 1 and 2 and 4% in Area 4 in 2009. This followed an industry agreed effort reduction in Area 1 in 2007 and 2008.

A comprehensive assessment was conducted for red emperor and rankin cod using an age-structured model to integrate catch and effort data, biological information and age composition data. The assessment indicated that the spawning biomass for these indicator species of the Pilbara Demersal Fishery as a whole were above their target levels indicating satisfactory breeding stock levels.

Pilbara: The major performance measures for the fish stocks in the Pilbara demersal fisheries relate to breeding stock levels of the long-lived and shorter-lived indicator species. The target level of spawning biomass is 40% of the initial level when the catch was first recorded. The limit level is 30% of the initial spawning biomass. The spawning biomass levels of the target species were assessed as adequate in 2007 by synthesizing the available data in an age structured model.

Kimberley

The determination of catch per unit of effort (CPUE) prior to 2009 was based on mean catch rates calculated from monthly returns. During 2009 a major transition from monthly returns to trip returns was undertaken to establish an improved level of spatial and temporal catch reporting. As a consequence there were two sources of catch returns for vessels operating in the NDSF during 2009; daily returns and monthly returns. Catch per unit of effort was determined for each source of return, and a weighting factor (based on SFD's used under each return type) applied to determine a composite single figure for CPUE. During 2009, Zone B catch rates for the indicator species were 141 kg/std day for red emperor, 582 kg/std day for goldband snapper and 145 kg/std day for cods/groupers. Catch rates of goldband snapper were much higher than those in 2008 (434 kg/std day), while catch rates for cods/groupers also increased (126 kg/std day in 2008). Catch rates for red emperor fell slightly (147 kg/std day in 2008).

While the 2009 level of catch for goldband snapper exceeded that in 2008, catches did not exceed the ESD trigger point of a 20% increase in catch above the average of the past four years. The 2009 catches of red emperor and cods/groupers

were below those taken in 2008. While the cods/grouper catch was above the average of the past 4 years it was below the trigger point. The catch of red emperor was well below the average of the previous 4 years.

The spawning biomass of the key target species in the NDSF has been estimated by an age-structured stock assessment model in 2002 and 2007, in relation to the accepted international reference point for these types of species of 40% of virgin biomass.

The most recent (2007) model outputs were reviewed by Prescott and Bentley in 2009. They concluded that the age-structured model used by the Department was appropriate although would benefit from modifications including the better determination of levels of model uncertainty. Improvements on the model have continued in 2009 and 2010.

NDSF: The performance measures for this fishery relate to the maintenance of adequate breeding stocks for the key indicator species as indicated by the catch levels. In 2009, the catches of goldband increased from 2008, but did not exceed the performance indicator of a 20% increase in catch above the average catch of the preceding four years. The 2009 level of catches of red emperor and cods/groupers were both below that taken in 2008, with the red emperor catch also below the average of the preceding four years. All three species/groups are likely to currently have adequate breeding stock levels. However, the current relatively high levels of catch of these species requires further investigation.

Non-Retained Species

Bycatch species impact:

Pilbara

Moderate

Kimberley

Low

Pilbara

The independent observer program designed to monitor bycatch and protected species interactions was completed in September 2009. The outcomes of the observer program are reported in the FRDC report for Project No. 2008/048. This project identified the need to trial a top-opening in the trawl nets to potentially further reduce the incidental capture of dolphins and turtles. A top-opening net configuration is currently being developed by industry and is scheduled for scientific trials in late 2010. The fish trap and line fisheries have minimal bycatch (see Kimberley below).

Kimberley

As a result of the catching capacity of the gear and the marketability of most species caught, there is a limited quantity of non-retained bycatch in this fishery. The most common bycatch species is the starry triggerfish, *Abalistes stellaris*, but the numbers taken are not considered to be significant, and most are released alive.

NORTH COAST BIOREGION

Protected species interaction:

Pilbara	Moderate
Kimberley	Negligible

Pilbara

The fish trawl fishery has an incidental capture of bottle nosed dolphins, turtles, sea snakes, pipefish and seahorses. Turtles and sea snakes are generally returned to the water alive but dolphins, pipefish and seahorses are generally dead when landed. The catch of these species is recorded in skippers' logbooks and reported annually to the Commonwealth Department of Environment, Water, Heritage and the Arts. The reported catch of protected species in 2009 is shown in North Coast Table 6. The bycatch of dolphins and turtles was similar in 2009 to 2008 and well below levels prior to the introduction of exclusion grids in trawl nets in 2005. Given the area of distribution and expected population size of these protected species, the impact of the fish trawl fishery on the stocks of these protected species is likely to be minimal. There is a small catch of green sawfish, a species that is protected in WA waters. The trap fishery has a negligible impact on protected species (see Kimberley below).

Pilbara: The performance measures for the impact of the trawl fishery on protected species: skippers are required to record incidents of capture and to minimise mortality. In 2009, the dolphin mortality rate was 4.8 per 1000 shots. The present catch rate is less than that in 2005 when grids were used and one-tenth that in 2005 when grids were not being used. The turtle catch rate was 1.5 per 1000 shots. Sygnathid, sawfish, and seasnake catches were all below their maximum levels and therefore their catch level is considered acceptable (North Coast Table 6).

Kimberley

Using trap gear in continental shelf regions is very unlikely to interact with protected species. Recent video observations indicate that the potato cod (*Epinephelus tukula*), a totally protected species, is present in high numbers at discrete locations within the fishery. The potato cod rarely enters traps due to its large size and girth that limits its capacity to pass through the entrance funnel into the traps.

Ecosystem Effects

Food chain effects:

Pilbara	Low
Kimberley	Negligible

Pilbara

The current fish trawl fishery operates with standard stern trawling gear (single net with extension sweeps) within an area previously trawled by a Taiwanese fleet. Historical research by CSIRO has suggested that the extensive Taiwanese pair trawl fishery caused a significant decrease in the biomass of finfish on the North West Shelf, and a change in species composition towards smaller species. The current

WA fish trawl fishery, which developed when the fish stocks had begun to recover, uses a much larger mesh size and much lighter ground gear, and operates at lower exploitation rates. At the present levels of fish trawl, fish trap, and line catch, the broader effect of the fishery on the food chain of the North West Shelf is considered to be at an acceptable level.

Kimberley

The need to maintain relatively high levels of biomass for the species caught in this fishery to meet stock recruitment requirements results in a negligible risk to the overall ecosystem from the fishery.

Habitat effects:

Pilbara	Moderate
Kimberley	Low

Pilbara

Impacts to the habitat are limited to those of the fish trawl fishery, which is restricted to around 7% of the North West Shelf (North Coast Figure 1). Area 3 and the waters inside 50 m are permanently closed to fish trawling, Zone 1 is closed to fish trawling, and Area 6 has had no fish trawl effort allocation since 1998.

Within the areas actually trawled, past research has indicated that approximately 10% of the sessile benthic fauna (e.g. sponges) is detached per year. It is not known whether the detachment rate exceeds the rate of re-growth.

Pilbara: The performance measure for the fish trawl impact on the North West Shelf ecosystem was set as a maximum area of operation by the trawlers. With the current closures within the licensed area of the fishery (50 m to 200 m depth), 46% of the area is accessible to the trawl vessels. Plots of trawl activity from VMS data indicate the actual area trawled being less than this as some of this area is too rough to be trawled.

Kimberley

As a result of the gear design, the fishery has little impact on the habitat overall, although there may be some rare interactions with coral habitats which are not common in areas where the fishery operates.

Social Effects

Pilbara

It is estimated that 18 fishers on 4 vessels were directly employed during 2008 in the Pilbara Fish Trawl Fishery, and 6 fishers on 2 vessels in the trap fishery. The level of employment in the line-fishing sector is not available. At least 30 people were directly employed in the Pilbara demersal scalefish fisheries.

Kimberley

Six vessels fished in the 2009 fishing season, with generally three crew per vessel, indicating that at least 18 people were directly employed in the NDSF.

Economic Effects

Estimated annual commercial value

(to fishers) for year 2009: **\$15.7 Million**

Pilbara **\$7.3 Million**

Kimberley **\$8.4 Million**

These current estimated commercial values for the north coast Fisheries are based on the most recent inputted price values for each species and are calculated for the 2009 calendar year, not necessarily the individual fishery entitlement year.

Pilbara

This estimate is based on the landed weight and price of each species as supplied by fish processors. There has been little overall increase in fish prices in the last few years. The fish trawl demersal finfish catch is dominated by lower-valued species such as bluespotted emperor and threadfin bream, and its value in 2009 was \$3.7 million. The fish trap and line catches are dominated by the valuable species such as red emperor and goldband snapper, and the demersal scalefish catch from these sectors was valued at approximately \$3.1 million (fish trap) and \$0.52 million (line). The fish trawl fishery also has a small amount of retained by-product valued at \$0.1 million.

The catches from the Pilbara fisheries dominate the Western Australian metropolitan markets and support the local fish-processing sector. The exports from this fishery have been minimal in the last few years due to the increased value of the Australian dollar.

Kimberley

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery landed a total of 1046 t of demersal scalefish in 2009, for a catch value of approximately \$8.4 million. This estimate is based on the landed weight of each species recorded in catch returns and the average price per kilogram of whole weight of each species as supplied by fish processors.

Fishery Governance

Target commercial catch range:

Pilbara Fish Trawl **2,000–2,800 tonnes**

Pilbara Fish Trap **400–500 tonnes**

Pilbara Line **50–115 tonnes**

Kimberley (NDSF) **600–1000 tonnes (All Zones)**

Current Fishing (or Effort) Level

Pilbara

Trap Fishery **Acceptable**

Trawl Fishery **Not Acceptable**

Kimberley **Acceptable**

Pilbara

In the fish trawl fishery, the total catch was well below the target catch range, it is unclear if this is due to changed net

designs to reduce protected species captures or from reduced abundances in the trawled areas. The target catch range for the trawl fishery will be revised in late 2010 in association with a review of the status of the indicator species.

In the fish trap fishery, the total catch was within the target catch range. The line catch was slightly higher than the target catch range due to the increased catch of deeper water species.

Kimberley

For the 2009 calendar year, the total allowable effort was set at 1,144 standard fishing days in Zone B, and 616 standard fishing days in Zone A, of the fishery respectively. The Zone A allocation aims to facilitate the exploration and development of this area of the fishery, while there is also further scope for fishers to develop Zone C (the deep slope area). At these levels of total effort and at recent catch rates, the total catch of the fishery is expected to be in the range of 600–1,000 t.

In addition to the overall catch target, ESD performance measures state that the annual catch of each of the key target species/groups (red emperor, goldband snapper and the cod/grouper complex) by the fishery should not increase by more than 20% above the average for the previous four years. None of the key target species/groups performance measures were exceeded in 2009, with the red emperor catch significantly below the trigger level.

New management initiatives (2010/11)

Pilbara

In 2009, the Pilbara Fish Trawl Interim Managed Fishery Management Plan cessation date was extended to expire on 30 June 2011. The extension was provided to allow for the conclusion of the Fisheries Research and Development Corporation (FRDC) Project 2008/048 *Reducing dolphin bycatch in the Pilbara finfish trawl fishery*, completed in late 2009 and assessment regarding the long-term future of the Pilbara Fish Trawl Interim Managed Fishery, including consideration of moving the fishery to “managed” fishery status.

Should the Minister approve moving the Pilbara Fish Trawl Interim Managed Fishery to a managed Fishery, the Department of Fisheries will then undertake statutory public consultation as required under the *Fish Resources Management Act 1994* and move to develop a new management plan for the Fishery.

Kimberley

There is a need to incorporate the industry agreed zoning and effort allocation arrangements of Area 2 of the NDSF into the management plan. The Department continues to consider projects related to the outcomes of the Prescott Review in consultation with licensees.

External Factors

Pilbara

The available fishing area has decreased over recent years as a result of exclusion zones for gas pipelines and associated facilities. Seismic surveys also restrict the operation of fishers. However, neither of these operations are expected to

NORTH COAST BIOREGION

significantly affect fish catches as these closures and operations occur over a limited area.

The Pilbara line fishery and North West Slope Trawl Fishery are likely to be targeting the same stock of ruby snapper.

Kimberley

The impacts of environmental variation on the fishery are not considered to be large as the target species are long-lived.

Fishers within the fishery are concerned about the increasing numbers of charter vessels operating in the offshore waters of

the NDSF, which could generate resource-sharing issues in the future. In addition, offshore developments in the energy/gas industry may involve exclusion zones thus potentially limiting fisher access to some areas of the fishery. In 2009, an additional exclusion zone was imposed due to an oil spill in the northern regions of Zone B. Increasing development of the Kimberley region is also likely to see a marked increase in the recreational effort and this may impact on stock sustainability.

NORTH COAST TABLE 1

Commercial catches (tonnes) and the percentages of each major species taken by trawl, trap and line in the Pilbara in 2009 (estimates rounded to the nearest tonne).

Species		Trawl catch		Trap catch		Line catch		Total catch tonnes
		tonnes	%	tonnes	%	tonnes	%	
Bluespotted emperor	<i>Lethrinus punctulatus</i>	108	62%	65	38%	–	–	173
Crimson snapper	<i>Lutjanus erythropterus</i>	92	52%	78	44%	6	3%	176
Rosy threadfin bream	<i>Nemipterus furcosus</i>	165	99%	2	1%	–	–	167
Brownstripe emperor	<i>Lutjanus vitta</i>	62	85%	11	15%	–	–	73
Goldband snapper	<i>Pristipomoides multidens</i>	69	56%	32	26%	22	18%	123
Red emperor	<i>Lutjanus sebae</i>	66	42%	92	58%	1	1%	159
Saddletail snapper	<i>Lutjanus malabaricus</i>	51	63%	23	28%	7	9%	81
Spangled emperor	<i>Lethrinus nebulosus</i>	10	36%	15	54%	3	11%	28
Frypan snapper	<i>Argyrops spinifer</i>	36	97%	1	3%	–	–	37
Rankin cod	<i>Epinephelus multinotatus</i>	13	17%	60	80%	2	3%	75
Other demersal scalefish		372	70%	76	14%	82	15%	530
All demersal scalefish		1,044	64%	455	28%	123	8%	1,622

NORTH COAST TABLE 2

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

Year	Demersal Scalefish			Total	By-product*
	Line	Trap	Trawl		Trawl*
1985	180	168		348	
1986	65	113		178	
1987	67	192	3	262	
1988	136	243	3	382	
1989	104	457	124	685	
1990	157	407	421	985	4
1991	107	119	754	980	14
1992	63	148	1,413	1,624	21
1993	67	178	1,724	1,969	42
1994	79	207	2,506	2,792	102
1995	95	222	2,821	3,138	77
1996	136	302	3,201	3,639	102
1997	109	234	2,630	2,973	133
1998	78	250	2,512	2,840	119
1999	50	371	2,136	2,419	69
2000	59	257	1,995	2,314	80
2001	99	266	2,221	2,592	150
2002	90	306	2,310	2,706	180
2003	81	363	2,860	3,304	154
2004	240	395	2,837	3,449	113
2005	260	408	2,371	3,005	80
2006	105	473	2,222	2,800	46
2007	102	460	1,704	2,266	36
2008	86	508	1,210	1,804	37
2009	123	455	1,044	1,622	73

* By-product in 2009 consists of shark, cuttlefish, squid, bugs, and tropical lobster.

NORTH COAST BIOREGION

NORTH COAST TABLE 3

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

Year	Line (days)	Trap (days)	Trawl (days)	Trawl (hours)
1985	809	709	-	-
1986	655	548	19	-
1987	614	507	17	-
1988	985	804	32	-
1989	863	1,198	310	-
1990	1,332	1,321	698	-
1991	740	472	1,132	8,660
1992	514	681	983	10,030
1993	876	696	832	10,725
1994	732	545	1,484	22,087
1995	852	608	1,571	21,529
1996	814	513	1,550	25,246
1997	809	483	1,389	19,810
1998	692	503	1,291	20,555
1999	453	842	1,139	15,963
2000	500	518	957	14,084
2001	401	446	1,162	15,330
2002	660	418	1,035	14,830
2003	715	412	1014	14,663
2004	769	418	953	15,372
2005	985	431	886	14,721
2006	397	464	914	15,792
2007	385	425	841	14,197
2008	326	461	831	11,966
2009	294	456	711	10,605

NORTH COAST TABLE 4

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

Year	Time used (days)	Time allocation (days)	Time used (%)
2000	507	524	97
2001	414	420	99
2002	382	385	99
2003	389	399	98
2004	419	425	99
2005	403	429	94
2006	464	464	100
2007	425	462	92
2008	461	476	97
2009	456	469	97

NORTH COAST TABLE 5

Estimates of fishing mortality (F) relative to Exploitation Reference Points (ERPs) calculated for each of the indicator species collected in different management areas of the commercial trawl and trap fisheries in the Pilbara region from 2006 to 2008. ns = not sampled.

Indicator species	Year	Trawl area (Zone 2)				Trap
		1	2	4	5	
Red emperor	2007	$F > F_{limit}$	$F > F_{limit}$	$F_{threshold} > F > F_{target}$	$F_{threshold} > F > F_{target}$	$F_{limit} > F > F_{threshold}$
Rankin cod	2006	$F = F_{target}$	$F < F_{target}$	$F_{threshold} > F > F_{target}$	$F = F_{threshold}$	$F < F_{target}$
Goldband snapper	2008	$F_{threshold} > F > F_{target}$	$F < F_{target}$	$F < F_{target}$	$F_{threshold} > F > F_{target}$	ns
Bluespotted emperor	2008	$F_{threshold} > F > F_{target}$	ns	ns	ns	ns

NORTH COAST TABLE 6

Reported by-catch of protected species by skippers in the Pilbara trawl fishery in 2009.

	Number Alive	Number Dead*	Total Reported
bottlenosed dolphins	5	14	19
pipefish	43	88	131
sawfish, green	15	1	16
sawfish, narrow	18	4	22
seahorses	3	1	4
sea-snakes	111	19	130
turtles	6	0	6

*Where the condition was not reported, the animal was considered deceased.

NORTH COAST BIOREGION

NORTH COAST TABLE 7

Recent total annual catches of major target and by-product species or species groups across all zones in the NDSF.

Species	NDSF annual catch (tonnes)					
	2004	2005	2006	2007	2008	2009
Goldband snapper (<i>Pristipomoides</i> spp.)	283	429	336	393	457	485
Red emperor (<i>Lutjanus sebae</i>)	144	192	166	176	173	156
Scarlet perch (<i>Lutjanus malabaricus</i>)	68	92	79	96	104	108
Spangled emperor (<i>Lethrinus nebulosus</i>)	33	21	28	14	18	23
Cod/grouper (Serranidae)	103	110	129	121	148	142
Other species	59	78	63	108	110	132
Total demersal scalefish catch	690	922	801	908	1010	1046

NORTH COAST TABLE 8

Catches of major target and by-product species or species groups by zone in the NDSF in 2008 and 2009.

Species	NDSF annual catch (tonnes)			
	2008		2009	
	Zone A & C	Zone B	Zone A & C	Zone B
Goldband snapper (<i>Pristipomoides</i> spp.)	13.7	443.0	22.2	462.3
Red emperor (<i>Lutjanus sebae</i>)	20.0	152.6	34.0	121.9
Scarlet perch (<i>Lutjanus malabaricus</i>)	5.3	99.0	14.4	93.7
Spangled emperor (<i>Lethrinus nebulosus</i>)	1.4	17.0	2.8	20.5
Rankin cod (<i>Epinephelus multinotatus</i>)	9.4	47.6	10.0	34.9
Other Cods/groupers (Serranidae)	9.8	81.7	14.9	82.6
Other species	20.4	88.9	38.7	93.0
Total demersal scalefish catch	80	930	137	909

NORTH COAST TABLE 9

Total catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF since the introduction of full management arrangements in 1998.

Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
1998	1,684	45	78	497	916	542
1999	1,716	91	228	486	992	577
2000	1,562	67	155	409	890	476
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	0	0	690	1,300	690
2005	1,760	0	0	922	1,318	922
2006	1,144	0	0	801	1,193	801
2007	1,144	0	0	908	1,235	908
2008	1,144	7	0	1,003	1,150	1,010
2009	1,144	0	0	1,046	1,090	1,046

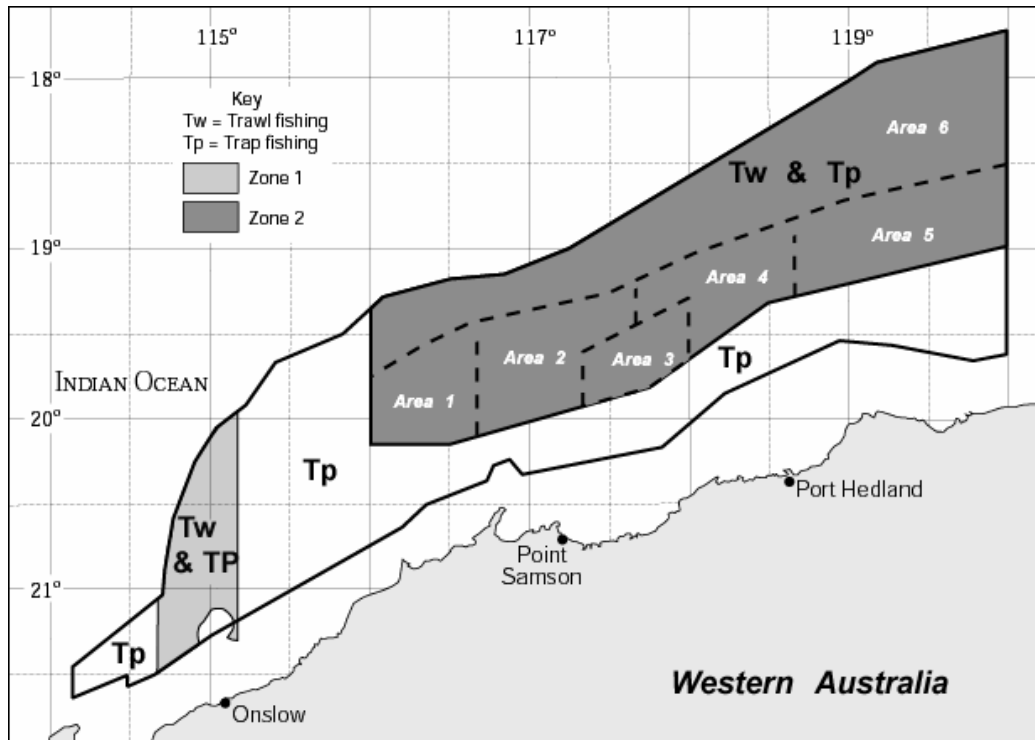
(2009 Estimated Catch: Zone A = 132 t, Zone B = 909 t; 2009 Estimated Effort: Zone A = 149 SFDs, Zone B = 938 SFDs)

NORTH COAST TABLE 10

Summary of the commercial catches and the relative contribution (% composition) of each of the major species taken within the Pilbara and Kimberley sectors of the North Coast bioregion in 2009.

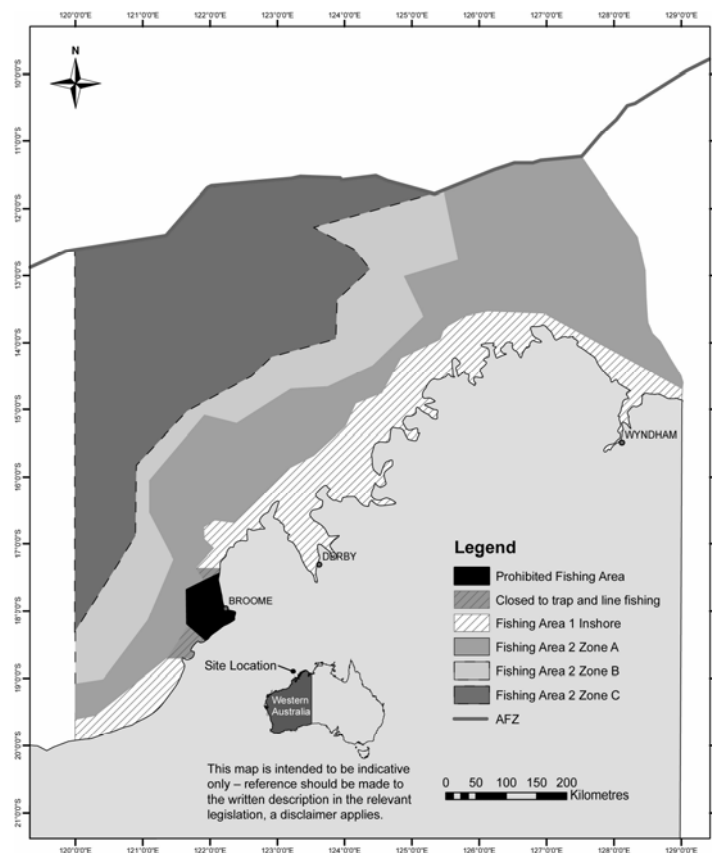
Species	Pilbara catch		Kimberley (NDSF) catch		Total catch tonnes
	tonnes	%	tonnes	%	
Red emperor	159	51%	156	49%	315
Saddletail snapper	81	43%	108	57%	189
Crimson snapper	176	83%	35	17%	211
Brownstripe snapper	73	94%	5	6%	78
Goldband snapper	123	20%	485	80%	608
Spangled emperor	28	55%	23	45%	51
Bluespotted emperor	173	92%	15	8%	188
Rankin cod	75	62%	45	38%	120
Frypan snapper	37	100%	0	0%	37
Rosy threadfin bream	167	100%	0	0%	167
Other demersal scalefish	530	75%	174	25%	704
Total all demersal scalefish	1,622	61%	1,046	39%	2,668

NORTH COAST BIOREGION



NORTH COAST FIGURE 1

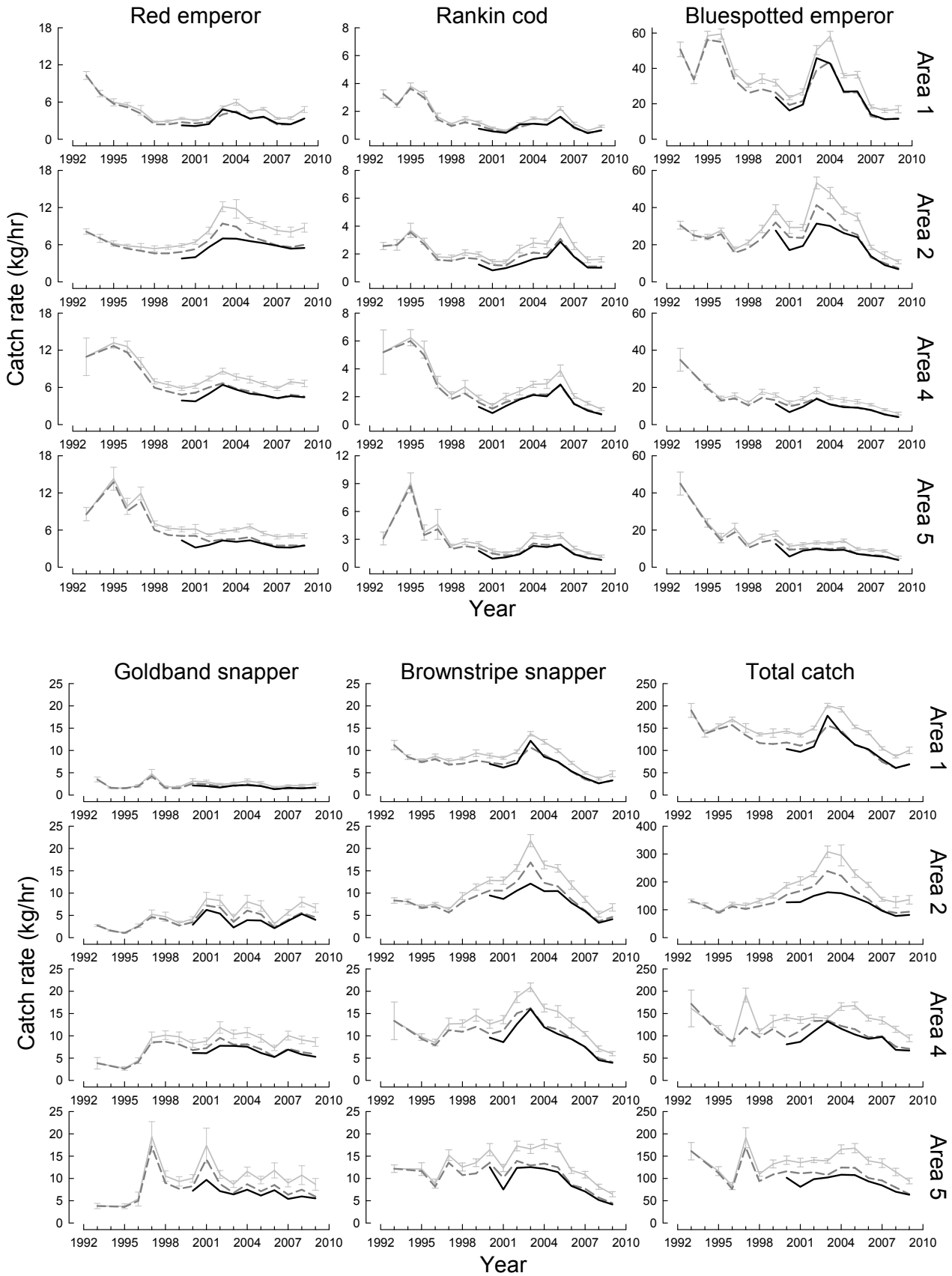
Demersal scalefish fisheries of the Pilbara region of Western Australia. Areas 1 to 6 refer to the management regions in Zone 2 of the trawl fishery. Zone 1 has been closed to trawling since 1998.



NORTH COAST FIGURE 2

Location of the Northern Demersal Scalefish Managed Fishery in the Kimberley region of Western Australia. Access areas and boundaries within the fishery are shown.

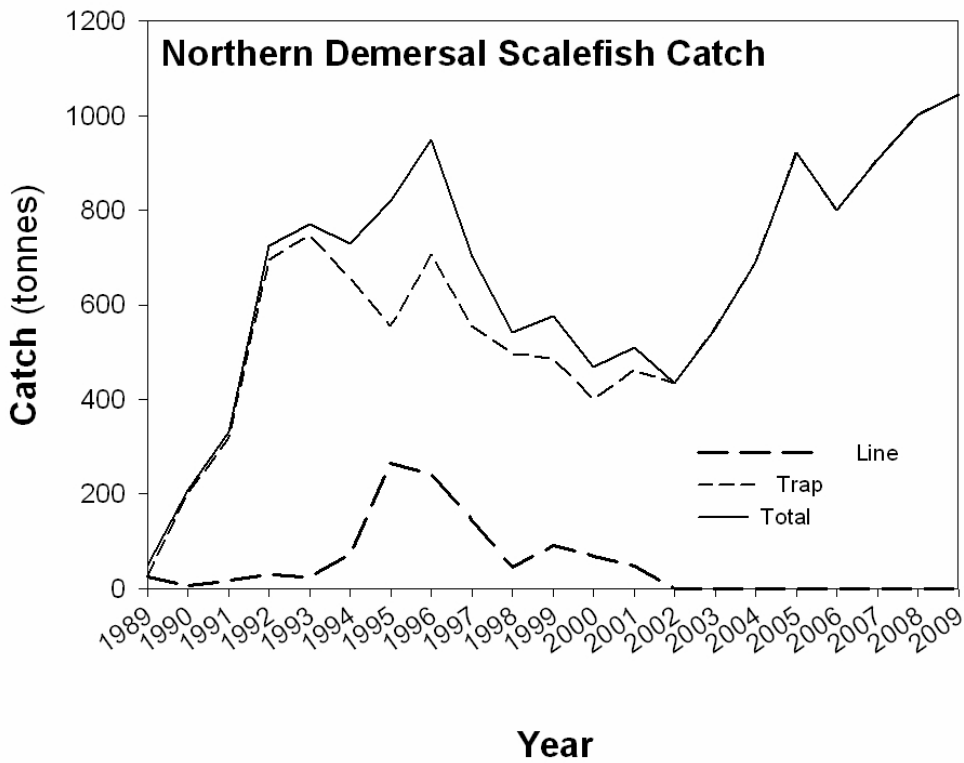
NORTH COAST BIOREGION



NORTH COAST FIGURE 3

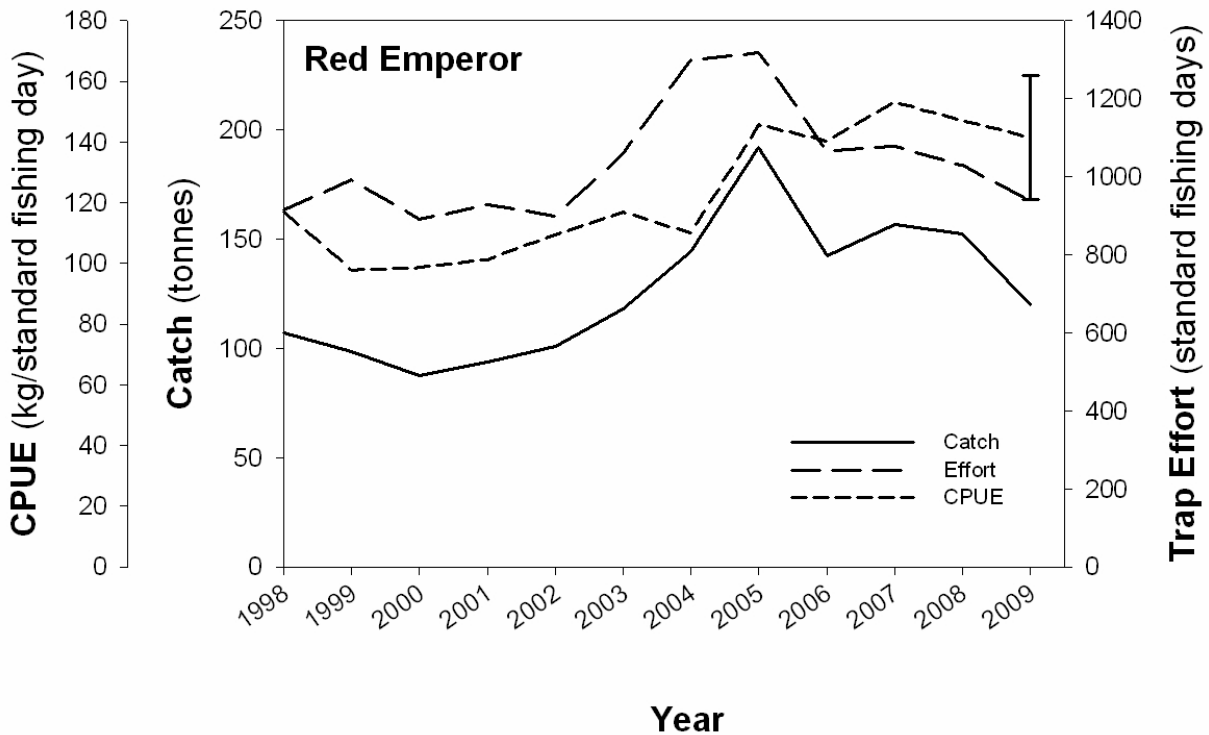
Annual mean Catch Per Unit Effort (CPUE, kg/hour) for five indicator species and the total catch in Area 1, 2, 4 and 5 of the Pilbara Trawl Fishery from 1993–2009. The solid grey line is catch rate (± 1 se) with trawl time as the effort measure, the dashed grey line is catch rate incorporating efficiency increase (trawl time as the effort measure) and the solid black line is catch rate using the time spent in each area as the effort measure (derived from VMS, data available since 2000).

NORTH COAST BIOREGION



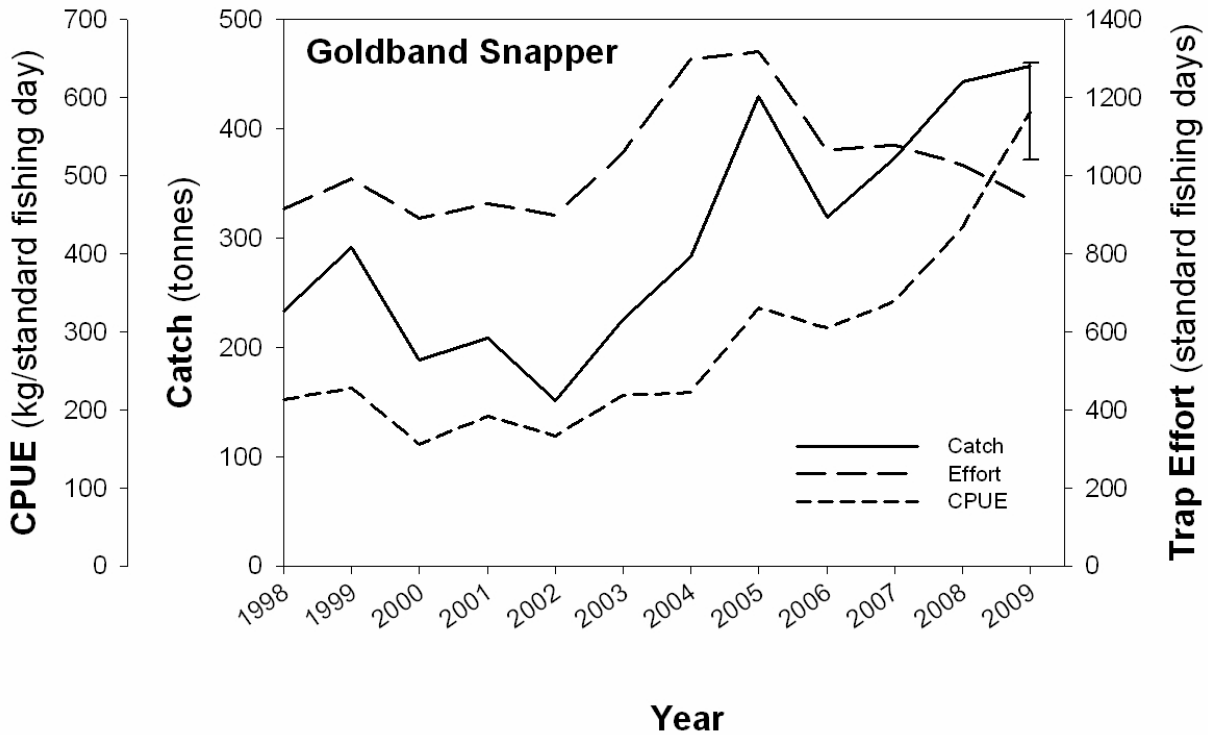
NORTH COAST FIGURE 4

Catch levels of demersal finfish in the NDSF by line and trap, 1989–2009 (All Zones).



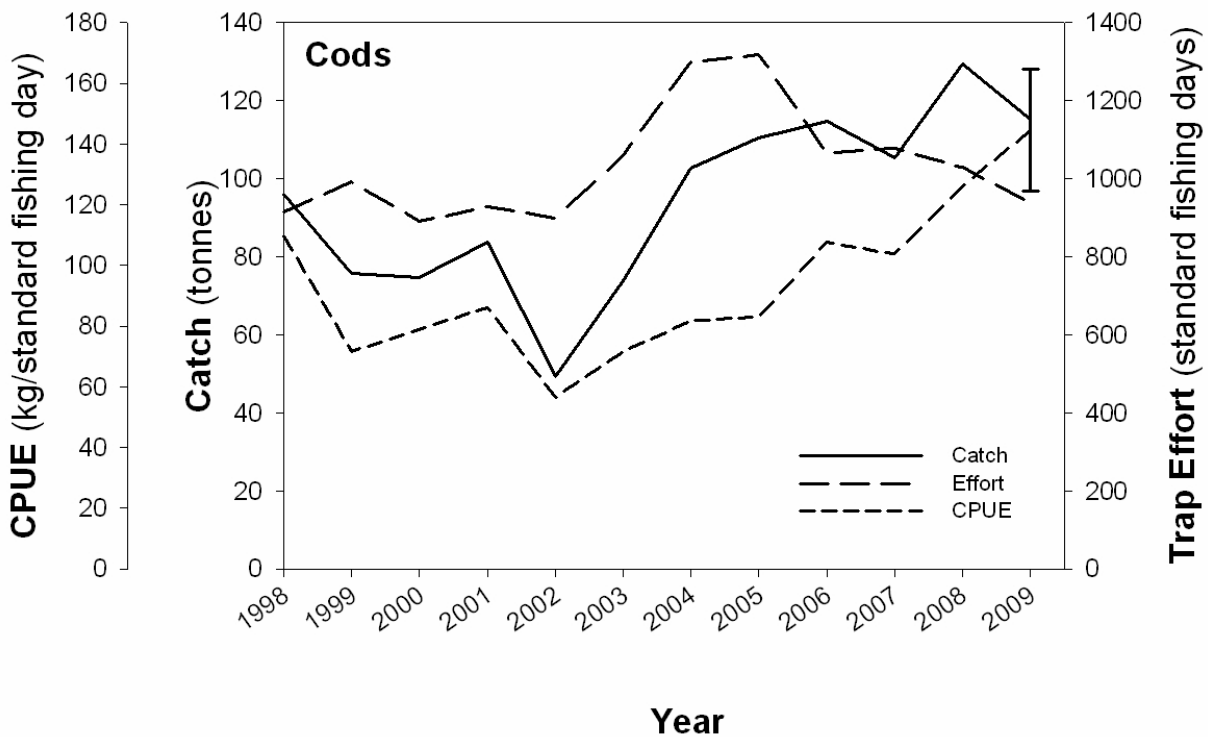
NORTH COAST FIGURE 5

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2009 (2006–2009 for Zone B only). Standard error bars for 2009 illustrate variability in CPUE from two sources of catch returns (daily and monthly).



NORTH COAST FIGURE 6

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998–2009 (2006–2009 for Zone B only). Standard error bars for 2009 illustrate variability in CPUE from two sources of catch returns (daily and monthly).



NORTH COAST FIGURE 7

Catch, effort and catch per unit of effort of cods in the NDSF by trap, 1998–2009 (2006–2009 for Zone B only). Standard error bars for 2009 illustrate variability in CPUE from two sources of catch returns (daily and monthly).

Mackerel Managed Fishery Report: Statistics Only

B. Molony and E. Lai

Management input from S. Blazeski

Fishery Description

Commercial

The Mackerel Fishery uses near-surface trolling gear from small vessels in coastal areas around reefs, shoals and headlands to target Spanish mackerel (*Scomberomorus commerson*). Jig fishing is also used to capture grey mackerel (*S. semifasciatus*), with other species from the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium* also contributing to commercial catches.

Recreational

Recreational fishers target similar species using a range of gears including trolls, shore-based drift fishing with balloons and spearguns.

Boundaries

Commercial

The Fishery extends from the West Coast Bioregion to the WA/NT border, with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts of the Northern Bioregion. Catches are reported for three areas: Area 1 - Kimberley (121° E to WA/NT border); Area 2 - Pilbara (114° E to 121° E); Area 3 - Gascoyne (27° S to 114° E) and West Coast (Cape Leeuwin to 27° S).

Recreational

The fishery operates between the West Coast Bioregion and the WA/NT border, with most activity occurring between Perth and Dampier.

Management arrangements

Commercial

An Interim Management Plan was implemented for the Mackerel Fishery in August 2004, with fishing commencing under the plan in 2005. On 1 January 2006, an Individual Transferable Quota system was introduced including setting Total Allowable Commercial Catches (TACCs) for each Area of the Fishery, allocation of the entitlement to take quota in the form of units, and establishment of minimum unit holding requirements to operate in the Fishery.

The maximum quantity of mackerel that may be taken from each Area of the Fishery during any permit period is limited to the quantity of mackerel that the Chief Executive Officer determines. The Total Allowable Commercial Catch (TACC) for each area of the fishery is currently:

	Spanish and other mackerel	Grey mackerel
Area 1:	205 t	60 t
Area 2:	126 t	60 t
Area 3:	79 t	60 t

The plan includes limitations on the number of permits to fish in the Fishery and the type of gear that can be used. Boats operating in the Fishery are monitored by VMS and the master of an authorised boat is required to submit logbook returns and catch and disposal records. Seasonal closures were removed in May 2008, as they were no longer a necessary tool to maintain sustainable and efficient management of the Fishery after quotas were put in place in 2006. A management plan amendment in May 2008 now permits the heading of broad-banded Spanish mackerel as compliance experience over the last two seasons indicates this will not be detrimental to the integrity of the quota management system. The amendment also modified the minimum operating holding from a percentage of units to a real number.

Permit holders may only fish for mackerel by trolling or handline. There are currently 78 permits in the Fishery with 35, 22 and 21 in Zones 1, 2 and 3 (respectively). Of these, 38 permits are active on 4, 7 and 6 boats operating within Zones 1, 2 and 3 (respectively).

A comprehensive Ecological Sustainable Development (ESD) assessment of this Fishery determined that levels of Spanish mackerel breeding stock should be used as an annual performance measure for the fishery. The annual assessment of performance is provided within the boxed text.

Landings and Effort (Season 2009)

Spanish mackerel	284.2 tonnes
Grey mackerel	11.1 tonnes
Other mackerel	0.4 tonnes

Commercial

The majority of the catch is taken in the Kimberly region, reflecting the tropical distribution of mackerel species (Spanish mackerel Figure 1). Estimates of catches are monitored through mandatory logbook systems with the total catch of Spanish mackerel in the 2009 season estimated at 284.2 t which is lower than the total Spanish mackerel catch taken in 2008 (331.1 t). This reflects reductions in fishing effort across all zones (approximately 15% reduction cf. 2008 levels) with most effort reductions reported in the Gascoyne.

The 11.5 tonnes of other mackerel (which is dominated by grey mackerel) landed in 2009 is also lower than in 2008. These estimates do not include fish caught and released or lost to sharks.

Recreational

Catch estimates and resource share by this sector are only available through creel surveys which occur periodically (Table 1). Reported annual catches of Spanish mackerel by recreational charter boats are relatively minor.

Fishery Governance

Target commercial catch range: 246 – 410 tonnes

The total catch in 2009 of 284.2 t was within the acceptable catch range. The reported catch from the Kimberley Area of 177.4 t was within this areas acceptable catch range (110 – 205 t) but catches for the Gascoyne/West Coast Area of 45.2 t (56 – 79 t) and the Pilbara Area of 61.6 t (80 – 126 t) were slightly below their acceptable ranges. Effort within these two areas during 2009 was 30% and 20% lower, respectively, compared to effort levels in 2008. The lower total effort (approximately 15% lower effort in 2009 compared to 2008) is likely to account for the lower catches in all areas.

The performance measure set for the fishery is the status of the Spanish mackerel spawning stock. As the minimum legal size of 900 mm total length is similar to the size at maturity for this species, the spawning stock is essentially the same as the exploited stock. In this context, catch rates across the major areas of the fishery are a general indicator of breeding stock levels, as reflected by catches being within target ranges. The total catch for 2009 was within the target catch

range and overall catch rates have been increasing since 2000.

Current Fishing (or Effort) Level: **Acceptable**

Fishing effort throughout the fishery appears has stabilised since 2006 following declines due to management changes. This is reflected by an increasing catch rate in the fishery.

New management initiatives (2010/11)

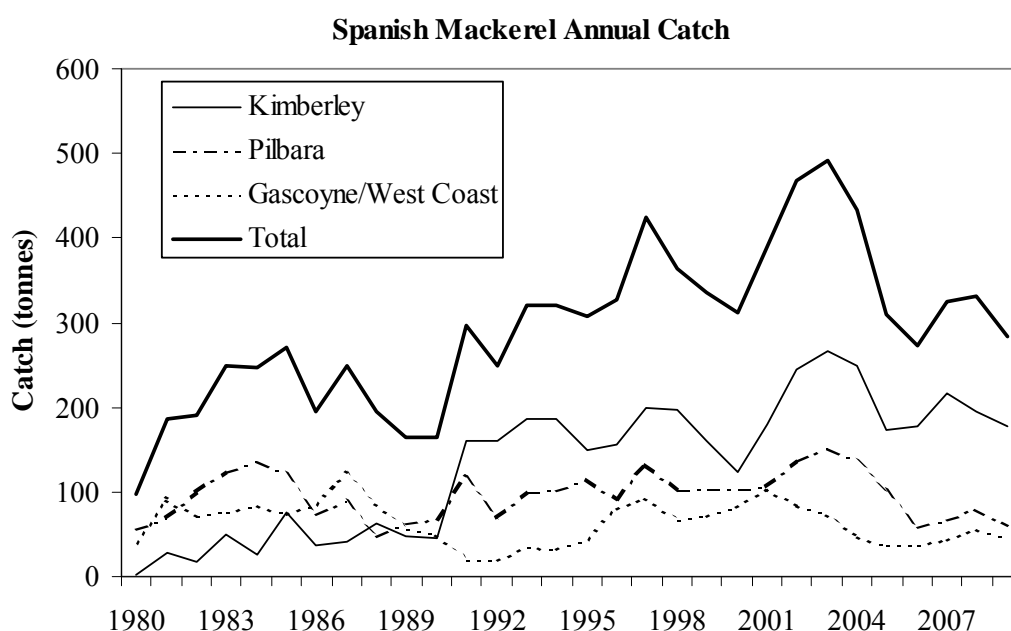
In December 2009, the Mackerel Fishery (Interim) Management Plan cessation date was extended to expire on 31 December 2011. The Minister for Fisheries has approved moving this Fishery to a managed Fishery and therefore the extension will allow for the development of a draft Mackerel Management Plan and statutory public consultation as required under the *Fish Resources Management Act 1994*.

In November 2009, the Fishery was exempt from the export controls of the *Environment Protection and Biodiversity Conservation Act 1999* for a period of five years.

SPANISH MACKEREL TABLE 1

Recreational catch estimates of Spanish mackerel in Western Australia

Bioregion	Year	Retained catch	Share	Source
Pilbara (including Broome)	1999/2000	Spanish: 28 t	21 %	Williamson et al. (2006)
		Other: 11 t	15 %	
Gascoyne	1998/1999	Spanish: 48 t	42 %	Sumner et al. (2002)
		Other: 8 t	10 %	
West Coast	2005/2006	Spanish: 7 t	45 %	Sumner et al. (2008)
		Other: <1 t	< 3 %	



SPANISH MACKEREL FIGURE 1

Annual catch of Spanish mackerel in Western Australia, 1979–2009

Northern Shark Fisheries Status Report

R. McAuley

Management input by Lindsay Joll

Main Features			
Status		Current Landings	
Stock level		Total sharks (2006/07- 2008/09 combined)	834 t
Sandbar shark	Depleted	Total scalefish (2006/07- 2008/09 combined)	9 t
Blacktip sharks	Uncertain	Shark catches by other commercial Fisheries (2006/07- 2008/09 combined)	11 t
Fishing Level	Unacceptable	Recreational	Not assessed
		Charter	Not assessed

Fishery Description

The 'northern shark fisheries' comprise the state-managed WA North Coast Shark Fishery (WANCSF) in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery (JANSF) in the eastern Kimberley. The primary fishing method employed in these fisheries is demersal longline with a relatively small amount of pelagic gillnetting occurring in the JANSF. The northern shark fisheries have targeted a variety of species including sandbar (*Carcharhinus plumbeus*), blacktip (various *Carcharhinus* spp.), tiger (*Galeocerdo cuvier*), hammerhead (Sphyrnidae) and lemon sharks (*Negaprion acutidens*). Due to the commonality of fishing methods and target species in the WANCSF and JANSF, data from the two fisheries are combined and considered as a single fishery for reporting purposes. As the number of active vessels in these fisheries has significantly reduced since new management arrangements were introduced in 2005, fishing returns data from the last three years have been combined to ensure individuals' fishing activities cannot be identified.

Governing legislation/fishing authority

Fisheries Notice no. 476 (Section 43 Order)

Fisheries Notice no. 602 (Section 43 Order)

Fisheries Notice no. 601 (Section 43 Order)

Offshore Constitutional Settlement 1995

Condition 127 and 129 on a Fishing Boat Licence

Other written authorities

Ministerial Exemption (WANCSF)

Consultation processes

Department–Northern Shark Industry Association meetings

WA Fishing Industry Council

Boundaries

The WANCSF extends from longitude 114°06' E (North West Cape) to 123°45' E (Koolan Island), and the JANSF from longitude 123°45' E to the WA/NT border (Northern Shark Figure 1).

Management arrangements

The commercial take of shark in Western Australian waters east of 123°45' E longitude is jointly managed by the Commonwealth Government and the State of Western Australia under an arrangement agreed through the Offshore Constitutional Settlement in February 1995. Under this arrangement, the State was given management responsibility for the JANSF on behalf of the WA Fisheries Joint Authority, whose members include the State and Commonwealth Ministers for Fisheries. Permitted fishing methods are longlines and gillnets.

The solely Western Australian-managed sector of the northern shark fishery was closed by a Section 43 order of the *Fish Resources Management Act 1994* in 2005. Those subsequently permitted to fish in the WANCSF were restricted to approximately 40% of the fishery's previous area under a Ministerial Exemption. This exemption entitled the use of longlines with metal snoods and pelagic gillnets. Longlines are restricted to a maximum of 1,000 hooks and gillnets are limited to 2 kilometres maximum length, 160 – 185 mm stretched mesh size and a maximum drop of 100 meshes. Additionally, gillnets must be attached to vessels at all times and may not come into contact with the seabed.

The WANCSF is now effectively zoned into three areas with separate levels of access. The area between North West Cape and a line of longitude at 120° E and all waters south of latitude 18° S has been closed indefinitely, primarily to protect the breeding stock of sandbar sharks. Operators are only allowed to fish in the area between 16° 23' S and 18° S latitude between 1 October and 31 January. Operators are allowed to fish in the remaining area (north of 16° 23' S latitude and between 120° and 123° 45' E longitude) throughout the year. A total of 200 gillnet fishing days and

100 longline fishing days are permitted in the WANCSF, with no more than 100 of those days allowed in the southern area (i.e. between 16° 23' and 18° S latitude). All vessels operating in the WANCSF are now required to report fishing activities via Vessel Monitoring System (VMS) and daily logbooks.

Formal management arrangements have not been implemented in the JANSF and management arrangements for this fishery (and the associated WANCSF) have been a matter of ongoing dialogue between the State and Commonwealth. In April 2008 the JANSF's export approval under the EPBC Act was revoked due to the lack of implementation of formal management arrangements and concerns about the fishery's ecological sustainability. In February 2009 the Wildlife Trade Operation Exemption that allowed the export of products from the WANCSF also expired and therefore, product from either fishery cannot now be legally exported.

Given that the majority of income from these fisheries has historically been generated by the export of shark fins, the ongoing economic viability of the northern shark fisheries is uncertain. The Department of Fisheries has reviewed future options for managing the WANCSF and is working with the Commonwealth Government to finalise a review of the JANSF.

Research summary

Research to assess the status of northern shark stocks was initiated as an extension of research into the targeted shark fisheries operating in the South and West Coast Bioregions. A three-year FRDC-funded project provided an age-structured demographic assessment of the status of the northern shark fisheries' principal target species, the sandbar shark (*Carcharhinus plumbeus*) and an improved understanding of the fisheries and of northern shark stocks more generally. Additional information on these fisheries and others that take sharks as bycatch in the North Coast Bioregion was collected during a series of Department of Environment and Heritage and FRDC-funded research projects to assess sustainability risks to Australia's tropical sharks and rays. Results from those projects have provided risk assessments for 75 elasmobranch species caught by 29 fisheries operating across the northern half of Australia.

Demonstrating the ecological sustainability of the northern shark fisheries is dependent on establishing robust estimates of sustainable harvest levels for target, byproduct and bycatch species. In particular, issues associated with blacktip shark, sandbar shark and mackerel sustainability, as well as Threatened, Endangered and Protected (TEP) species interactions require evaluation. Further research to estimate key biological parameters and fishing mortality rates for these and other species are therefore required.

To improve understanding of the northern shark fisheries' operations, a new daily/trip catch and effort reporting system was introduced in 2006/07. However, as some discrepancies were identified in the initially submitted logbook data, catches and fishing effort could not previously be reported with sufficient confidence for 2006/07 and 2007/08.

As those data have now been assessed and, where necessary, adjusted, they are reported below for the three years between 2006/07 and 2008/09.

Retained Species

Commercial landings (season 2006/07- 2008/09 combined):

Northern Shark Fisheries:

Total sharks	834 tonnes
Sandbar shark	188 tonnes
Blacktip sharks	202 tonnes
Scalefish	9 tonnes
Other Commercial Fisheries	11 tonnes

The total shark catch by the northern shark fisheries has decreased substantially from its peak of 1,294 t in 2004/05 as a result of the new management arrangements that were introduced in 2005. Between 2006/07 and 2008/09, the mean annual shark catch was 278 tonnes, slightly lower than its long-term (1994/95-2005/06) mean level of 339 t. However, the mean sandbar shark catch of 63 t over the last 3 years was more than 3 times the level estimated by demographic analysis to be sustainable (see Stock Assessment section of Demersal Gillnet and Longline Fisheries Status Report). Although the mean blacktip shark catch of 67 t during the last 3 years was similar to previous years and considerably less than its peak of 178 t in 2002/03, the sustainability of these catches cannot be determined (see Stock Assessment below).

Sharks are also incidentally caught by other commercial fisheries operating in the Northern Bioregion although since 2006 only three non-target shark fisheries are now authorised to retain shark catches (Pilbara Fish Trawl, Northern Demersal Scalefish¹ and Marine Aquarium Fish) when sharks and rays were commercially protected throughout the State. In the three years between 2006/07 and 2008/09, vessels licensed in those authorised fisheries reported total landings of 11 t of sharks and rays from the area between North West Cape and the WA/NT border. By comparison 31 t of sharks were reported from non-target commercial fisheries in 2005/06. It is expected that landings will remain at these low levels in the future.

The northern shark fisheries have a small scalefish catch that is generally retained for sale. Most of the fisheries' scalefish catch reported between 2006/07 and 2008/09 was caught by gillnets and included 6.2 t of grey mackerel, 1.3 t of estuary cod, 0.6 t of Spanish mackerel and 0.3 t of other mackerel. While such small catches are considered an insignificant risk to stock sustainability, the potential for a thirty-fold increase in pelagic gillnet effort and targeting of mackerel schools represent major sustainability risks and additional measures to manage this byproduct will need to be developed if these risks are realised.

Recreational catch estimate: Not assessed

¹ Within a 2 shark trip limit.

NORTH COAST BIOREGION

Commercial Fishing effort/access level

There were two active licenses in the northern shark fisheries during 2008/09 (one less than 2007/08 and the same as 2006/07). During the 3 years between 2006/07 and 2008/09, approximately 48% of permitted longline fishing effort and 3% of permitted gillnet fishing effort was utilised (based on one shot per vessel per day).

Stock Assessment

Assessment complete: Yes

Assessment method:

Sandbar shark:

Catch (relative to previous direct survey)

Blacktip sharks: Catch

Breeding stock levels:

Sandbar shark Depleted

Blacktip sharks Uncertain

For details of sandbar shark assessment, see Demersal Gillnet and Longline Fisheries Status Report.

The status of the multi-species northern Australian blacktip shark stock complex was previously assessed using an age-structured model and time-series of CPUE data from the various Australian and Taiwanese-operated fisheries that have exploited them. However, that assessment did not provide specific advice on the status of blacktip stock components in Western Australian waters and the reliability of catch, effort and biological data upon which the model relies is questionable. Assessing the status of these stocks is further complicated by the cryptic impacts of illegal foreign fishing, unreported catches in domestic fisheries and uncertainty in the species composition of catches. Given these issues, previous estimates of maximum sustainable yield (at least 2,000 tonnes per year) are considered unsuitable for assessment of Western Australian stock components.

Assessing the status of other Northern Bioregional shark stocks is even more complicated as most species were poorly identified in catch returns prior to 2000 and the biological information needed for developing assessment models is generally lacking. Thus, monitoring the status of other stocks taken by the northern shark fisheries will necessarily rely on analyses of reported catches and fishing effort for the foreseeable future. Although nominal catch rates of tiger and hammerhead sharks were at historically high levels between 2006/07 and 2008/09, the reported 94% and 96% declines in their respective CPUE between 1998/99 and 2005/06, suggests that these stocks were also depleted by the escalation of fishing effort as the northern shark fisheries developed. The causes of the high catch rates reported in daily logbooks since 2006/07 are uncertain.

Non-Retained Species

Bycatch species impact: Not fully assessed

There has previously been some observed discarded bycatch of unsaleable sharks, rays and scalefish in these fisheries although the magnitude of this bycatch cannot be reliably assessed. Although risks to other scalefish species were previously rated as a low to negligible during the ESD risk assessment process, these assessments will require reevaluation if the level of pelagic gillnet fishing effort escalates.

Protected species interactions (Longline only)

The northern shark fisheries were rated as having a generally low risk of interacting with Threatened, Endangered and Protected (TEP) species through the ESD risk assessment process. However, as this assessment was based on the majority of fishing effort being applied by longlines, these interactions will need to be reassessed if the gillnet fishing effort increases. Previous ESD risk assessments for individual TEP species groups in the northern shark fisheries are discussed with reference to contemporary data below.

Sharks and rays: Because the northern shark fisheries generally operate some distance offshore, they pose a negligible risk to spartooth sharks (*Glyphis garricki* and *G. glyphis*) and sawfish (Pristidae), which have primarily inshore, estuarine and riverine distributions. The closure of the south western portion of the WANCSF is expected to reduce the risk of interactions with white sharks (*Carcharodon carcharias*) and grey nurse sharks (*Carcharias taurus*) as these species have primarily temperate and subtropical distributions. Whale sharks (*Rhincodon typus*) are extremely unlikely to be caught by demersal longlines. However, the risk of entanglement in pelagic gillnet gear is uncertain.

Turtles: No turtle captures have either been observed or reliably reported in the northern shark fisheries. Although turtles are possibly more susceptible to capture by pelagic gillnets than demersal longlines, the amount of active gillnet effort over the last three years is small relative to the fisheries' operational area and historical levels of gillnet effort in the fisheries.

Billfish: The small observed bycatch of billfish by demersal longlines in the northern shark fisheries was previously assessed as being insufficient to impact breeding stocks. This level of bycatch is unlikely to increase given the restrictions on fishing effort.

Cetaceans: As almost all northern shark fishery effort prior to 2005/06 was applied by demersal longlines, the risk of interaction with cetaceans was previously assessed as negligible. Although the potential increase in the use of gillnets may result in higher levels of interaction with cetaceans, there are no empirical data from domestic pelagic gillnet fisheries to estimate cetacean capture rates. However, as the bycatch of dolphins is cited as the primary reason for restricting the Taiwanese-operated pelagic gillnet fishery that operated in the same area during the 1970s and 1980s, the risk of cetacean interactions would need to be re-assessed should gillnet effort increase.

Ecosystem Effects

Food chain effects: **Negligible**

Given the smaller shark catches intended under current effort restrictions, the associated risk of any detrimental food chain effects is likely to be negligible. However, given the long recovery times expected for overexploited stocks of long-lived sharks, such as sandbar (and possibly tiger and hammerhead) sharks, unassessed residual food chain effects may persist for decades. It may also be necessary to reassess this risk if higher levels of fishing effort resume.

Habitat effects: **Negligible**

The principal types of fishing gear that may be used to target sharks in the region are set so that they either do not or only unintentionally come into contact with the seabed, and their physical impact on the seabed is therefore considered to be minimal. Despite fishing being constrained to a smaller area in 2005, the contemporaneous reduction in overall effort capacity is likely to have reduced the risk of habitat effects further.

Social Effects

Direct: Northern shark fishing vessels reported crews of between 3 and 5 (mean of 5 in 2006/07 and 2007/08 and 4.2 in 2008/09). However, as only two or three fishing vessels have operated for a few months each year, the fisheries therefore represent a part time source of employment.

Indirect: Sharks are viewed as a menace by some members of the community due to their perceived danger to bathers and their predation of prized recreationally caught fish. However, others consider them to be important components of marine ecosystems that need to be conserved.

Economic Effects

Estimated annual value (to fishers)

For year 2006/07	\$224,000
Shark and scalefish	\$101,000
Shark fin*	\$123,000
For year 2007/08	\$1,031,000
Shark and scalefish	\$525,000
Shark fins*	\$506,000
For year 2008/09	\$985,000
Shark and scalefish	\$488,000
Shark fins*	\$497,000

*As fishers do not separately identify the weight of shark fins in catch returns, fin weight was calculated at an average of 3% of sharks' whole weight and value was estimated using an average price of \$45/kg. Categories of shark which do not have saleable fins were excluded from fin valuation.

Fishery Governance

Target effort range: **600 gillnet days**
(1,200 kilometre gillnet days) maximum
300 longline days
(300,000 hook days) maximum

Target catch range:

Sandbar sharks **< 20 tonnes**

Vessels operating in the northern shark fisheries reported using 516 (57%) of the 900 permitted longline fishing days and 59 (3%) of the permitted 1800 gillnet fishing days between 2006/07 and 2008/09. As operators generally reported using less than the maximum permitted amount of fishing gear (i.e. 1,000 longline hooks or 2,000 m of gillnet), 47% of the 900,000 permitted hook days and 3% of the 3,600 permitted km gillnet days were used during these three years.

Although total shark catches have declined significantly from their 2004/05 peak of 1,294 tonnes, the mean 2006/07-2008/09 annual sandbar shark catch of 63 tonnes far exceeded the upper target limit of 20 tonnes between 2006/07 and 2008/09 (Northern Shark Figure 2 and 3).

Current fishing (or effort) level:

Effort **unacceptable (although below target)**
Sandbar shark catch **unacceptable**

As longlining has been by far the dominant method employed in the fisheries, total effort is expressed in standardised units of number of hooks (or 'hook days') by converting the historically small amount of gillnet effort into the equivalent longline effort by comparing gillnet catches with longline Catch Per Unit Effort (CPUE) of all sharks. Total fishing effort was significantly lower in the northern shark fisheries between 2006/07 and 2008/09 than pre-2005/06 levels (Northern Shark Figure 2).

As breeding biomass of the sandbar stock is likely to be at the minimal acceptable limit reference point (40% of unfished biomass) and possibly continuing to decline (see Demersal Gillnet and Longline Fisheries Status Report), the excessive catches of this species in the northern shark fisheries over the last three years were unacceptable.

New management initiatives (2009/10)

Future management arrangements for the JANSF and the WANCSF are the subject of continuing discussion between the State and Commonwealth.

External Factors

The primary external factor affecting the northern shark fisheries is the withdrawal and expiry of their export approvals under the Commonwealth Government's EPBC Act. Development of demonstrably ecologically sustainable management arrangements required for the fisheries' re-approval is hampered by a lack of contemporary pelagic

NORTH COAST BIOREGION

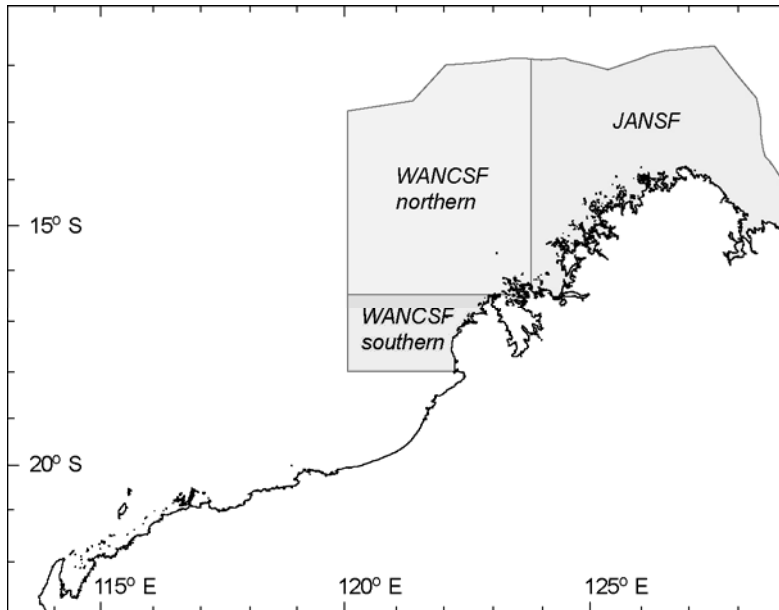
gillnet data in the Northern Bioregion and other factors beyond the WA fisheries' control including: Illegal, Under-reported and Unreported (IUU) shark catches, cross-jurisdictional catches of target and byproduct stocks and

long-term impacts on the breeding stock of sandbar sharks, which is critical to the sustainability of West Coast Demersal Gillnet and Demersal Longline Fishery catches (see Demersal Gillnet and Longline Fisheries Status Report).

NORTHERN SHARK TABLE 1

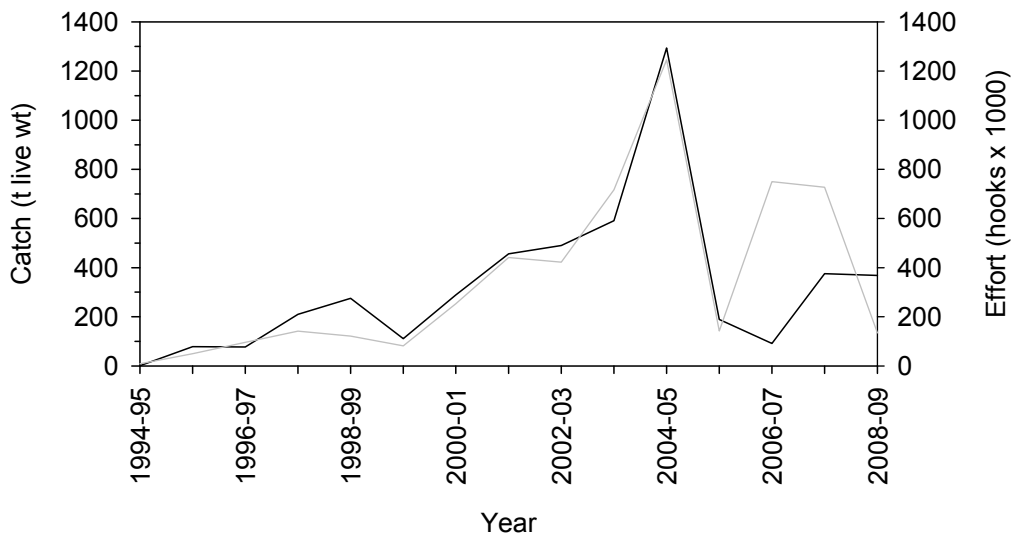
Northern shark fisheries' (WANCSF and JANSF) elasmobranch catch from 2001/02 to 2005/06. Data for 2006/07 are not reported due to confidentiality of records from fewer than five vessels.

Name	Species or taxon	2006/07 - 2008/09 catch (tonnes)	
		Total	Mean annual
Blacktip shark	<i>Carcharhinus</i> spp.	202.0	67.3
Sandbar shark	<i>Carcharhinus plumbeus</i>	188.5	62.8
Pigeye shark	<i>Carcharhinus amboinensis</i>	138.4	46.1
Tiger shark	<i>Galeocerdo cuvier</i>	103.1	34.4
Hammerhead sharks	Sphyrnidae	82.9	27.6
Lemon shark	<i>Negaprion acutidens</i>	45.4	15.1
Spot-tail shark	<i>Carcharhinus sorrah</i>	36.2	12.1
Dusky shark	<i>Carcharhinus obscurus</i>	10.4	3.5
Shovelnose rays	Rhinobatidae, Rhynchobatidae	8.5	2.8
Other elasmobranchs		18.9	6.3
Total elasmobranchs		834.4	278.1
Grey mackerel	<i>Scomberomorus</i>	6.2	2.1
Cod	Serranidae	1.3	0.4
Spanish mackerel	<i>Scomberomorus commerson</i>	0.6	0.2
Mackerel, other	Scombridae	0.3	0.1
Other scalefish	Teleostii	0.7	0.2
Total scalefish		9.1	3.0



NORTHERN SHARK FIGURE 1

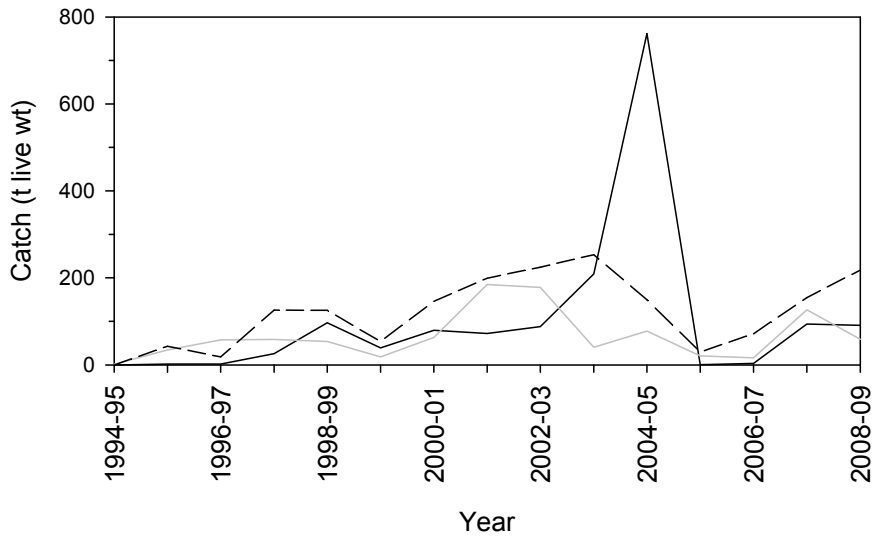
Management boundaries of the WA northern shark fisheries



NORTHERN SHARK FIGURE 2

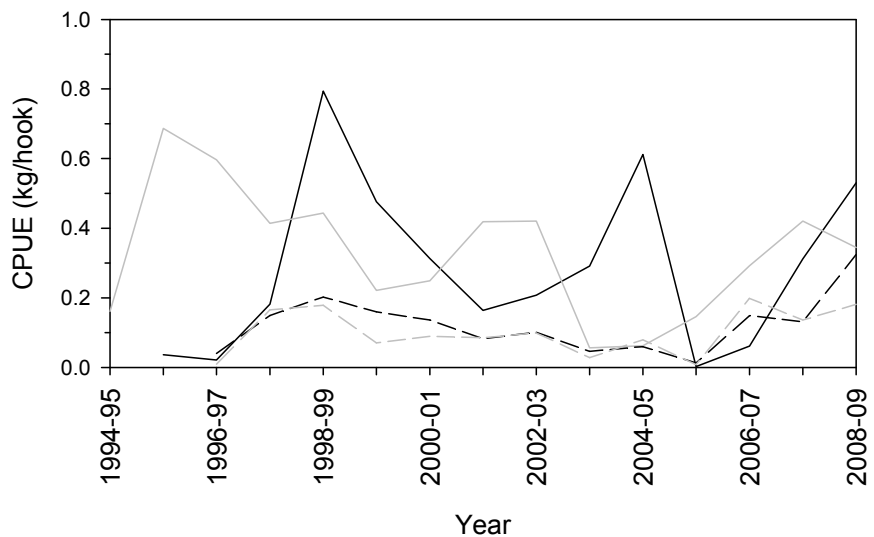
Total annual elasmobranch landings and standardised fishing effort (WANCFS and JANSF) for the period 1994/95 to 2008/09. Black line is catch (tonnes estimated live weight) and grey line is standardised total fishing effort (thousand hooks).

NORTH COAST BIOREGION



NORTHERN SHARK FIGURE 3

Annual catches (tonnes estimated live weight) of indicator and other shark species by the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2008/09. Solid black line is for sandbar shark, grey line is blacktip sharks and dashed black line is other sharks.



NORTHERN SHARK FIGURE 4

Nominal Catch Per Unit Effort (CPUE) of indicator and secondary target shark species in the northern shark fisheries. Solid black line is sandbar shark, solid grey line is blacktip sharks, dashed black line is tiger shark and dashed grey line is hammerhead sharks.

Pearl Oyster Managed Fishery Status Report

A. Hart and D. Murphy

Management input by J. Froud

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial Pearl Oyster Catch	
Fishing level	Acceptable	Shell numbers (All Zones) -	260,002 culture shells

Fishery Description

The Western Australian pearl oyster fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. It is a quota-based, dive fishery, operating in shallow coastal waters along the North-West Shelf.

The harvest method is drift diving, in which six to eight divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legal-sized oysters by hand as they are seen. The species targeted is the Indo-Pacific, silver-lipped pearl oyster (*Pinctada maxima*).

Governing legislation/fishing authority

Pearling Act 1990

Pearling (General) Regulations 1991

Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The fishery is separated into 4 zones (Pearl Figure 1), as follows:

Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30' E. There are 5 licensees in this zone.

Pearl Oyster Zone 2: East of Cape Thouin (118°20' E) and south of latitude 18°14' S. The 9 licensees in this zone also have full access to Zone 3.

Pearl Oyster Zone 3: West of longitude 125°20' E and north of latitude 18°14' S. The 2 licensees in this zone also have partial access to Zone 2.

Pearl Oyster Zone 4: East of longitude 125°20' E to the Western Australia/Northern Territory border. Although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not economically viable. However, pearl farming does occur.

There is also a 'buffer zone', which may be accessed by licensees from Zones 1 and 2; in practice, it is generally only utilised by Zone 1 licensees.

Management arrangements

The Western Australian pearling industry comprises three main components: the collection of pearl oysters from the wild; production of hatchery-reared pearl oysters; and grow-out of pearls on pearl farm leases. Quota limits are set for the take of pearl oysters from the wild to ensure the long-term sustainability of the resource.

In 1996 the WA Government granted hatchery options to licensees as part of an incentive program to encourage them to adopt new technology that enabled the production of pearls from oysters reared in hatcheries, thus reducing the reliance on the wild stocks of pearl oysters. The number of pearls produced from hatchery-reared pearl oysters is now also governed by quota limitations.

The pearl oyster fishery is managed primarily through output controls in the form of a total allowable catch (TAC) divided up into individually transferable quotas (ITQs). There are 572 wild-stock ITQ units allocated across three management zones (Zone 1 – 115; Zone 2 – 425; Zone 3 – 32) and 350 hatchery ITQ units allocated amongst 17 pearling licensees.

The value of a hatchery quota unit is 1,000 shell. The value of wild-stock quota units varies, depending on status of wild stocks, but historically has been about 1,000 shell per unit when pearl stocks are at normal levels. However, wild stock quota units for Zone 2/3 for the 2010 season were set at 3,200 shell (TAC: 1,500,000), as result of high stock levels (Pearl Table 1).

Wild stocks are reviewed each year by the Department of Fisheries to enable the TAC to be set for each zone of the fishery. There is a minimum legal size of 120 mm shell length, and maximum legal sizes and area-specific TACs have been set where appropriate, for example in Exmouth Gulf in Zone 1.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of pearl oysters. Boxed text in this status report provides the annual assessment of performance for this issue.

NORTH COAST BIOREGION

Research summary

Current stock assessment research is focused on:

- Stock assessment using catch and effort statistics (taking into account discard rates) and settlement and length-frequency sampling to estimate the total allowable catch.
- Monitoring an index of settlement for predicting future years catch levels using the relative number of piggy back spat.
- Research on decision rules for determining the TAC
- Understanding environmental drivers of pearl oyster abundance

The Department of Fisheries' Research Division's Fish Health Unit also provides a comprehensive disease-testing program to the industry.

There are several other significant research projects being carried out by the pearling industry focusing on environmental management, pearl oyster health, and improved health and safety for pearl divers. The main aims of this research are to:

- Investigate aspects of oyster oodema disease (OOD) in *Pinctada maxima*, to assist in mitigating the impacts and understand pathways to disease and disease response in pearl oysters;
- demonstrate that the pearling industry operates in a manner acceptable to public standards for access to the marine environment; and
- develop a culture of best practice and continuous self-improvement with regard to environmental management and health and safety

Retained Species

Commercial landings (season 2009):

260,002 oysters

In 2009, the number of wild-caught pearl oysters was 260,002, in comparison to 810,115 oysters caught in 2008 (Pearl Tables 1 and 2). The TAC for the pearl oyster fishery for 2009 was 1,060,400, therefore only 25% of the TAC was caught. The reduced take was due to an economic decision by industry, given the number of oysters they required, and not due to low abundance of the stock.

Zone 2 was the only area fished (Pearl table 1) with no fishing in Zone 1 or Zone 3 since 2008 (Pearl Table 2).

Fishing effort/access level

Total effort was 3,284 dive hours (Pearl Tables 1 and 2), a reduction of 80% from the 2008 of 15,785 hours.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Acceptable

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2009 fishing season based on catch and

effort statistics, settlement analysis (44,571 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (8,700 shells measured), shell discard rates by size and location, population surveys, and an evaluation of the predictive capacity of 0+ and 1+ spat settlement data.

These were used to generate trends in stock indicators, from which the determination of the TAC for 2010 was undertaken. Results for each zone, and issues relevant to stock sustainability, were as follows:

Zone 2/3: The catch rate achieved by the fishery is an indicator of the abundance of the 3/4 to 6/7-year-old oysters specifically targeted for pearl production. Year-to-year variations reflect changes in recruit abundance, while the long-term trend in catch per unit effort (CPUE) involves an element of effort efficiency change. In 2009, CPUE was 79 shells per dive hour which was the highest since this times series began in 1979 and a 50% increase from the 2008 catch rate (53 shells/hour – Pearl Table 1) but this occurred with a substantial reduction in catch and effort and an increase was therefore to be expected.

Catch Prediction: Recruitment to the fishery is predicted by the piggyback spat abundance index at 3 to 5 years prior to the current fishing year. A very high 0+ recruitment detected in the Zone 2 fishery in 2005 was confirmed in the 1+ year class in 2006, and again in the 2+ age class from population surveys in 2007. This cohort entered the commercially fished population in 2008 and 2009, resulting in the highest CPUE for over 30 years.

The 2010 stock abundance in Zone 2 is predicted to be higher than 2009. Consequently, the 2010 TAC in Zone 2/3 has been increased to 1,500,000 (3,200 shell per unit). This is 220 % above the baseline level of 1,000 shell per unit. (Pearl Table 1).

Zone 1: The Zone 1 fishery has not been fished for two years.

Breeding stock: Under average growth and mortality, recruitment into the pearl oyster breeding stock exceeds natural mortality, and hence breeding stocks are likely to be increasing in most years. This results from the 'gauntlet' fishing strategy employed by the industry, in which the young, fast-growing shell (principally males) of 120 – 165 mm shell length are targeted for their fast pearl-producing qualities.

Animals that survive this 'gauntlet' are effectively protected from 6 to 7 years of age onward, and may live for another 15 to 20 years. With very low natural mortalities, this results in a large residual broodstock being built-up over time. In Zone 1, breeding stock should also be increasing due to the low effort since 2002, including no fishing in 2004 and 2009 (Pearl Table 2).

The performance measures for this fishery, which relate to breeding stock biomass, include the area of fishing compared to the distribution of the stock and the catch rates of young oysters within each of the fishing zones.

All performance measures were met for 2009. The area of fishing remains substantially less than 60% of the distribution of oysters within this region. The catch rates in Zones 2 and 3 were both still above their respective performance levels, with a combined catch rate of 79 oysters/hour.

Non-Retained Species

Bycatch species impact: **Negligible**

Divers have the ability to target pearl oysters of choice (species, sizes and quality of *P. maxima*). Pearl oysters brought to the vessel after hand collection are young and have relatively little epiphytic growth (fouling organisms). A small number of over-sized or under-sized oysters are returned to the substrate.

Protected species interaction: **Negligible**

There is no interaction between the pearl oyster fishing operation and protected species.

Ecosystem Effects

Food chain effects: **Negligible**

The fishery removes only a small proportion of the biomass of pearl oysters on the fishing grounds and is considered to have negligible impact on the food chain in the fishing area.

Habitat effects: **Negligible**

Pearl divers have minimal contact with the habitat during fishing operations. The main habitat contact is by pearl oysters held in mesh panels on holding sites following capture. However, these sites cover a very small proportion of the habitat and the activity concerned is unlikely to cause any lasting effect.

Similarly, the pearl farming operation, which uses longline systems in areas of high tidal flow to culture pearls, has limited impact on the environment. Physical effects are limited to static anchoring systems in typically sand/mud habitats. Environmental management research (see 'Research summary') has found categorically that pearl farming has negligible impacts on habitat and environment.

Social Effects

Direct

Pearl oyster fishing vessels operate from the Lacepede Islands north of Broome to Exmouth Gulf in the south. The number of vessels in the fishing fleet has been slowly reducing from 16 in 1997 (overall), mostly due to increased fleet efficiency and increased reliance on hatchery-produced shells. In 2009, with the negative impact of the Global

Financial Crisis (GFC) on the industry, only two vessels fished.

Most vessels presently operate 10 – 14 crew for the fishing of pearl oysters between March and June each year. These vessels also support a number of other pearl farm functions throughout the year.

Indirect

Prior to the GFC, the pearling industry provided employment for approximately 500 people in the northern coastal regions, including in the operation of the pearl farms. However the impact of the GFC resulted in a substantial reduction in personnel employed in the pearling industry.

Economic Effects

Estimated annual value (to fishers)

2009 (Total Industry value): **\$85.5 million**

A precise estimate of the total industry value is difficult to achieve, owing to the variable time lags that occur between harvesting and sale to offshore buyers, and the costs incurred in marketing before sales take place. Based on information provided by the industry, the value of cultured pearls and by-products in 2009 was considered to be approximately \$85.5 million.

Fishery Governance

Target effort range: **14,071 - 20,551 hours**

The target effort range relates to the time required to achieve the TAC in the pearl oyster fishery of 1,060,400 oysters in 2009 (1,005,400 oysters in Zone 2/3, and 55,000 oysters in Zone 1).

Acceptable effort ranges for individual management zones are 11,456 – 15,819 dive hours for Zone 2/3 and 2,615 – 4,732 dive hours for Zone 1. These ranges are based on the 5-year period (1994 – 1998) following the introduction of global positioning systems (GPS) into the fishery, and reflect the typical variation in abundance of the stock under natural environmental conditions.

Zone 2/3 of the pearl oyster fishery achieved its catch with 3,284 dive hours (Pearl Table 1), which was well below the target range. The low effort was the result of only 26% of the TAC being caught, which was a consequence of cost-restraint within the industry deriving from GFC.

Zone 1 of the pearl oyster fishery was not fished in 2009 (Pearl Table 2).

The CPUE is at an all time high in Zone 2, indicating that stocks are at higher than average levels in Zone 2.

Current effort level: **Acceptable**

Overall fishery effort level is acceptable, but current levels do not reflect stock abundance.

NORTH COAST BIOREGION

New management initiatives (2010)

The Minister has approved a new departmental funding model for the industry through the establishment of access fees based on the gross value of the wild stock taken and lease fees rather than a recovery of management costs model. The Minister has also disbanded the Pearling Industry Advisory Committee. The Department is also continuing discussions with the pearling industry with a view to introducing a more delegated model of co-management in the pearling industry. Under such a model, the responsibility for completing certain tasks currently performed by the Department could instead be delegated to the pearling industry. Furthermore, the Department is intending to rationalise the legislation that is currently used to regulate the pearling industry by incorporating it into the broader fisheries legislation framework.

External Factors

The pearl oyster stocks underpinning the fishery in Zone 2/3 continue to provide a sufficient level of production to support this major Western Australian industry, however preliminary research points to environmental factors being an external driver of the current high abundance. The industry will continue to experience difficulty from the Global Financial Crisis, which had a major impact on the market for luxury goods, including pearls. The low catch and effort in 2009 are a direct result of companies opting not to fish because of this. Future signs for 2010 suggest a modest recovery and overall catches are expected to be higher, although the TAC will still not be taken. Finally, the on-going issue of the OOD (oyster oedema disease) continues to hamper hatchery-production capacity in some sectors of the Industry, however to date there is no evidence the disease has affected wild stocks.

PEARL TABLE 1

Pearl shell catch and effort – Broome area (Zone 2/3).

Year	Wild stock quota	No. of culture shells	No. of MOP ¹ shells	Total shells	Dive hours	Culture shells/hr	Average depth	Total shells/hr
1979		371,806	355,599	727,405	16,068	23.1		45.3
1980		364,502	260,714	625,216	18,568	19.6		33.7
1981		481,193	210,649	691,842	23,320	20.6		29.7
1982	460,000	439,092	132,931	572,023	15,710	27.9		36.4
1983	520,000	365,381	87,049	452,430	19,019	19.2		23.8
1984	375,000	242,828	47,230	290,058	11,615	20.9		25
1985	342,000	272,869	53,831	326,700	12,423	21.0		26.3
1986	360,000	337,566	10,929	348,495	16,478	20.5		21.2
1987	380,000	365,397	0	365,397	17,476	20.9		20.9
1988	445,000	379,657	0	379,657	14,600	26.0		26.0
1989	445,000	445,364	0	445,364	18,625	23.9		23.9
1990	457,000	453,705	0	453,705	23,263	19.5	15.3	19.5
1991	457,000	460,608	0	460,608	21,657	21.3	16.1	21.3
1992	457,000	461,599	0	461,599	19,455	23.7	13.9	23.7
1993	457,000	457,186	0	457,186	14,733	31.0	15.7	31.0
1994	457,000	456,832	0	456,832	12,384	36.9	11.4	36.9
1995	512,000	511,633	0	511,633	12,217	41.9	12.4	41.9
1996	512,000	511,756	0	511,756	12,774	40.1	16.8	40.1
1997	512,000	512,314	0	512,314	16,893	30.3	12.9	30.3
1998	457,000	457,266	0	457,266	14,499	31.5	12.6	31.5
1999	457,000	457,842	0	457,842	10,300	44.4	11.6	44.4
2000	502,500	501,419	0	501,419	9,258	54.2	11.2	54.2
2001	502,500	502,484	0	502,484	12,054	41.7	12.1	41.7
2002	479,750	479,562	0	479,562	15,661	30.6	13.4	30.6
2003	457,000	456,988	0	456,988	14,242	32.1	13.6	32.1
2004	457,000	404,984	0	404,984	11,994	33.8	12.3	33.8
2005	502,500	488,303	0	488,303	14,807	32.9	12.1	32.9
2006	502,500	467,436	0	467,436	11,992	39.0	13.7	39.0
2007	548,400	550,972	0	550,972	12,514	44.0	12.9	44.0
2008	822,600	810,115	0	810,115	15,387	52.6	14.7	52.6
2009	1,005,400	260,002	0	260,002	3,284	79.2	11.4	79.2
2010	1,500,000							

Notes: Total catches exceeding quota are a result of fisher shell tally error and the collection of broodstock shell being included as part of culture shell tallies. ¹ 'MOP' is an abbreviation for mother-of-pearl; ² wild stock quota in 2008 initially set at 639,800 (see SOF 2007 report), however a mid-season review increased it to 822,600 because of enhanced stock abundance

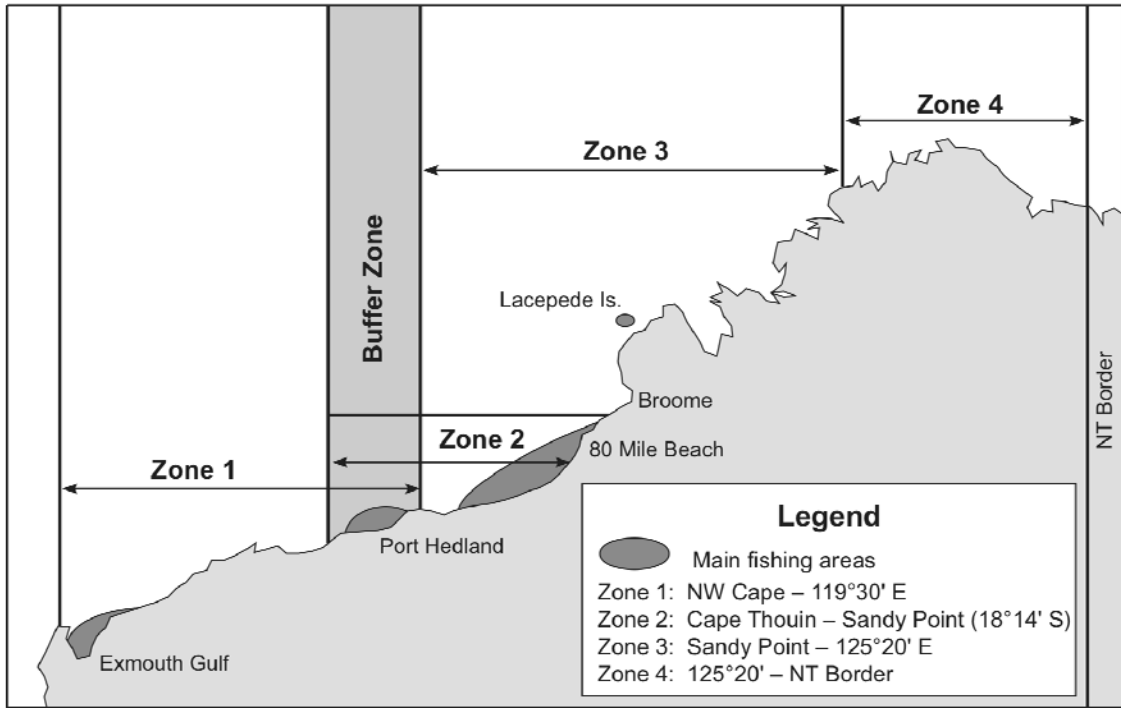
NORTH COAST BIOREGION

PEARL TABLE 2

Pearl shell catch and effort in Zone 1 since 1983.

Year	Wild stock quota	No. of culture shells	Dive hours	Culture shells/hr
1983		27,895	542	51.5
1984		45,690	827	55.3
1985	55,000	46,009	897	51.3
1986	55,000	39,663	1,104	35.9
1987	55,000	46,269	1,194	38.7
1988	55,000	43,046	1,243	34.6
1989	55,000	52,937	1,010	52.4
1990	55,000	43,711	1,146	38.1
1991	55,000	63,774	1,681	37.9
1992	55,000	53,386	1,266	42.2
1993	115,000	79,465	2,395	33.2
1994	115,000 ¹	132,316 ²	6,291	21.0
1995	115,000 ¹	121,312 ²	6,247	19.4
1996	115,000 ¹	80,163	5,013	16.0
1997	115,000 ¹	110,348	9,494	11.6
1998	115,000	108,056	6,094	17.7
1999	115,000	90,414 ³	4,789	18.9
2000	115,000	66,772	5,893	11.3
2001	115,000	68,931	9,480	7.3
2002	55,000	29,126	2,729	10.7
2003	45,000 ⁴	22,131	1,647	13.4
2004	45,000 ⁴	0 ⁵	0 ⁵	
2005	55,000 ⁶	25,572	1,084	23.6
2006a	55,000 ⁷	36,546	1,343	27.2
2006b	35,000 ⁷	34,900	349	100
2007	55,000	49,686	2,138	23.0
2008	55,000	10,092	398	25.3
2009	55,000	0	0	
2010	55,000			

1. A developmental period was introduced into the fishery from 1993 to 1997 to encourage hatchery production technology. The main undertakings were the introduction of 3 new Zone 1 pearl industry licences, and an increase in TAC of pearl shell in Zone 1 (from 55,000 to 115,000 shell).
2. Management arrangements in 1994 and 1995 allowed fishing of quota a year ahead.
3. Hatchery stock used since 1999 has reduced the need for wild-stock shell between 1999 and 2005.
4. In 2003 and 2004, the 115,000 Zone 1 quota was still maintained, however only 45,000 could be caught from wild stock due to hatchery shell substitution.
5. In 2004, no wild-stock quota was taken as only hatchery oysters were used.
6. Post 2005, the wild-stock quota for management and compliance purposes was returned to its long-term sustainable level of 55,000.
7. A higher TAC in 2006 was the result of an additional 35,000 experimental quota (2006b) allocated for a lightly-exploited stock within a pearl farm lease, and 34,900 of this quota was caught in 349 dive hours at a CPUE of 100 shells per hour. The remainder was caught at 27.2 shells per hour.



PEARL FIGURE 1
Distribution of pearl oyster stocks and fishing zones in Western Australia.

Beche-de-mer Fishery Status Report

A. Hart and D. Murphy

Management input from R. Green

Main Features			
Status		Current Landings	
Stock level	Acceptable	Total Catch	129 t
Fishing level	Acceptable	<i>Actinopyga echinites</i> – Redfish	98 t
		<i>Holothuria scabra</i> – Sandfish	31 t

Fishery Description

Beche-de-mer, also known as ‘sea cucumbers’ or trepang, are in the Phylum Echinodermata, Class Holothuroidea. They are soft-bodied, elongated animals that usually live with their ventral surface in contact with the benthic substrate or buried in the substrate.

To date the Western Australian beche-de-mer fishery operations has primarily been based in the northern half of the State, from Exmouth Gulf to the Northern Territory border, however fishers do have access to all Western Australian waters. It is a hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading. There are six commercial target species in Western Australia; prior to 2007 over 99% of the catch was sandfish

(*Holothuria scabra*) but an additional species (deepwater redfish - *Actinopyga echinites*) is also now targeted. There is no recreational fishery for beche-de-mer.

Governing legislation/fishing authority

Fisheries Notice no. 366 – Prohibition for commercial fishers unless otherwise endorsed for shellfish, coral, starfish, urchins and beche-de-mer

Instrument of Exemption (Section 7(3)(c) of the *Fish Resources Management Act 1994*)

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

NORTH COAST BIOREGION

Consultation process

Department-industry meetings and an annual Broome Consultative Forum.

Boundaries

The beche-de-mer fishery is permitted to operate throughout Western Australian waters with the exception of a number of specific closures around the Dampier Archipelago, Cape Keraudren, Cape Preston and Cape Lambert, the Rowley Shoals and the Abrolhos Islands.

Management arrangements

The developing fishery for beche-de-mer is managed through input controls including limited entry, maximum number of divers, species-dependent minimum legal size limits, and gear restrictions. Access to the fishery is limited to the 6 Fishing Boat Licence holders listed in the Instrument of Exemption enabling the take of beche-de-mer.

Beche-de-mer may only be harvested by hand or diving by licensed commercial fishers operating under the authority of a Fishing Boat Licence that is listed on the Instrument of Exemption.

The maximum number of divers (per endorsed fishing boat licence) allowed to dive for beche-de-mer at any one time is four, with a maximum number of six crew allowed on the vessel.

There are six target species of beche-de-mer harvested in Western Australia. At present, the minimum target lengths for these commercial beche-de-mer species are based on the Northern Territory's minimum sizes, which have been set based on size at sexual maturity.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of beche-de-mer. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Current research is focused on reporting of annual catch and effort statistics. A daily catch and effort logbook has been tested and designed for the fishery and was implemented in 2007. The logbook obtains species-specific, fine-scale catch and effort data and appropriate environmental information, such as depth fished.

Retained Species

Commercial landings (season 2009):

129 tonnes (live weight)

Landings

In 2009 the total beche-de-mer catch was 129 t live weight (Beche-de-mer Table 1), a decrease of 35% over last years catch of 196 t, mainly due to less catch from the newly

developing redfish fishery.

On a species-specific level, the 129 t catch was made up of 31 t (24%) *Holothuria scabra* (Sandfish) and 98 t (76%) *Actinopyga echinites* (Redfish) (Beche-de-Mer Figure 1). This is the third year that redfish has been caught in high numbers and represents a new target species within the fishery. The catch of sandfish, while up on the last 2 years is still relatively low.

Fishing effort/access level

Only 2 licensed vessels fished for beche-de-mer in 2009, the same as 2008 and 2007. This represents 33% of the potential number of vessels that have an endorsement to fish.

Total effort was 441 crew days – about 22% lower than in 2008 and similar to 2004 to 2008 average effort level (Beche-de-mer Table 1).

Stock Assessment

Assessment complete:	Yes
Assessment method:	Catch rate
Breeding stock levels:	Adequate

The overall catch rate for beche-de-mer (diving only in 2009) was 292 kg/crew day, which is the 2nd highest in the history of the fishery, after 2008. The principal reason for this was the continued development of a new target species (deepwater redfish), which had a CPUE of 350 kg/day and the overall lower level of effort. There was also a high catch rate in the existing sandfish fishery associated with reduced fishing for this species over the last 3 years (Beche-de-mer Figure 1).

Estimates of Maximum Sustainable Yield (MSY) of sandfish were obtained for the entire WA fishery and Kimberley sub-regions using a biomass dynamics model. Current average catch of sandfish is below the MSY (Beche-de-mer Table 2), indicating that the level of fishing is sustainable. However, large variability in the estimates of q (0.21 – 0.57) for the same species suggests that a cautious interpretation of the model outputs is required. The model is updated with new data every year.

The initial performance measures for the fishery relate to breeding stock maintenance as indicated by catches remaining in the range 50 – 150 t and catch rate remaining above 80 kg/crew day. Both the catch and catch rate measure was met.

Target catch ranges and performance indicators will be reviewed as finer-scale species-specific information becomes available

Non-Retained Species

Bycatch species impact: **Negligible**

No bycatch species are known to be taken in this fishery. Given the selective method of fishing used (diving or wading, collection by hand only), the minimal level of interaction with other species is likely to be maintained.

Protected species interaction: **Negligible**

There are currently no protected species known to be taken in this fishery.

Ecosystem Effects

Food chain effects: **Negligible**

This fishery harvests only a small amount of sandfish and redfish per annum. The effect from this harvesting on the rest of the ecosystem, given that the catch is spread over a wide region, would be insignificant.

In addition, predation on the beche-de-mer is relatively infrequent due to the toxins present in their body tissues. It is highly unlikely these animals are a major diet for higher-order predators, due to these toxins acting as an effective defence system.

Habitat effects: **Negligible**

Divers collect beche-de-mer as they drift over the bottom; there is minimal impact on the habitat as divers are highly selective in their fishing effort and no fishing gear or lines contact the seabed. The vessels work during the day and anchor at night, usually further inshore where they are protected from the open ocean that is subject to higher seas and wind. Most fishers are mindful of the habitat they choose to anchor over, so they avoid more diverse bottom habitat.

There are some areas where fishers can access beche-de-mer by wading through shallow water mangrove lagoons and estuaries. This is a minor component of the fishery. This method may be applied in areas of the Kimberley that are

accessible and prone to extreme tidal movements. Wading usually occurs on soft sandy substrates, with minimal impact on these habitats.

Social Effects

In 2009, two vessels with a total of nine crew were working in the fishery. Additional individuals are employed for the processing of the product. These activities are mostly located in the Northern Territory where the fishing fleet is based.

Economic Effects

Estimated annual value (to fishers)

for year 2009: \$430,000

The estimated annual value for 2009 was \$430,000 based on an average product price of \$10.00/kg (gutted and boiled) or \$3.33/kg live weight. This is a farm gate value and supports a substantial processing and value-adding sector.

Fishery Governance

Target catch range: 50 – 150 tonnes

Current fishing level of 129 tonnes is within the target range.

New management initiatives (2009/10)

A daily catch and effort logbook has been implemented and is beginning to provide species-specific information on catch and effort. This will enable species-specific management response and performance indicators to be developed.

External Factors

The remoteness of the currently fished stock and the large tidal ranges where it occurs are natural barriers to uncontrolled expansion of fishing of beche-de-mer. Marine park planning processes may also impact on the potential extent of the fishery.

NORTH COAST BIOREGION

BECHE-DE-MER TABLE 1

Catch and effort of Beche-de-mer in Western Australia since 1995.

Year	¹ Live Wt (t) (all species)	Live Wt (t) (Sandfish)	Live Wt (t) (Redfish)	Live Wt (t) (Teatfish)	Crew Days (all methods)
1995	93	93	0	0	737
1996	257	257	0	0	945
1997	382	371	9	2.8	1,852
1998	310	310	0	0	2,565
1999	176	176	0	0	1,757
2000	83	83	0	0	607
2001	90	88	2	0.2	663
2002	87	87	0	0	535
2003	122	121	1	0	1,019
2004	81	81	0	0.2	470
2005	78	75	0	0	545
2006	58	55	3	0.3	660
2007	113	26	87	0	392
2008 [^]	196 ²	27	169	0	564
2009	129	31	98	0	441

¹ Sandfish represented 99% of catch until 2006

² Redfish represented 86% of catch in 2008

[^] Diving only method used in recent years

BECHE-DE-MER TABLE 2

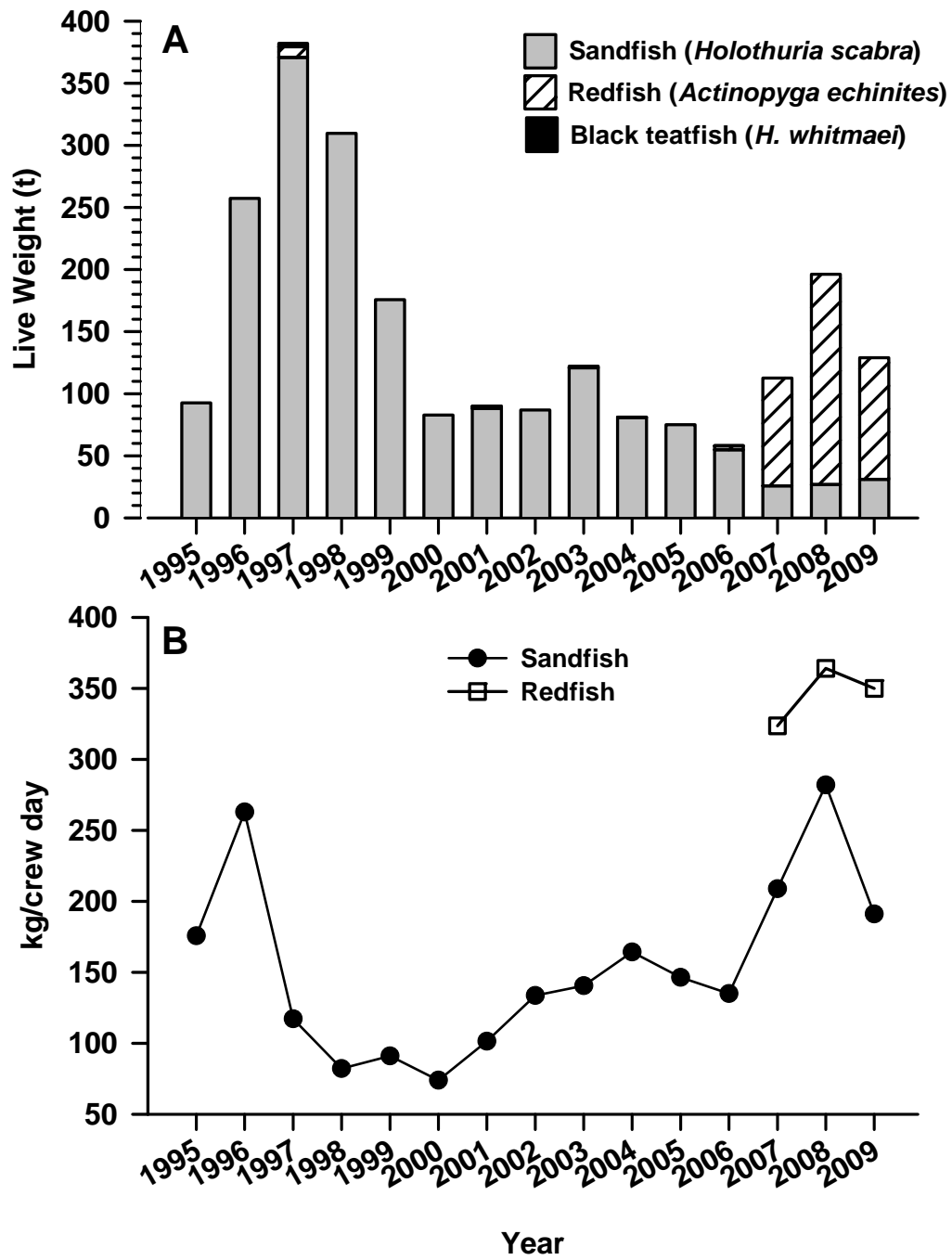
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

Area	MSY (t)	Current average catch (2005-2009) (t)	Parameter estimates*		
			r	K (t)	q
Entire Fishery	139	43	0.820	970	0.21
Kimberley region (Grid 1425 and 1426)	70	37	0.95	418	0.57

* r – intrinsic rate of increase

k – carrying capacity (Virgin biomass)

q – catchability or fishing power



BECHE-DE-MER FIGURE 1

A) Production (tonnes/live weight) by species, and B) catch rate (kg per crew day) from the Western Australian Beche-de-mer fishery

AQUACULTURE

Regional Research and Development Overview

Aquaculture in the north coast bioregion is dominated by the production of pearls from the species *Pinctada maxima* (south-sea pearls). This industry sector utilises both wild-caught and hatchery-reared oysters for the production of cultured pearls. The wild-stock fishery is reported in the North Coast bioregion section of this volume.

The Department of Fisheries also has a major role in the management and regulation of pearl hatcheries, seeding activities and pearl oyster farm leases.

A Memorandum of Understanding (MOU) between the Western Australian and Northern Territory fisheries ministers was signed in June 2006. The MOU recognises that WA and the NT comprise the entire Australian south-sea pearling industry and that product from both jurisdictions supplies the same market.

The Department of Fisheries is currently working with the pearling industry to investigate the potential for increasing the level of industry self-management in the pearl oyster fishery.

The operator of a fish farm producing barramundi (*Lates calcarifer*) in Cone Bay is successfully increasing production following approval by the EPA to increase output to 1,000 tonnes per annum.

The Department of Fisheries continues to oversee the development of several indigenous aquaculture projects in this region, targeting the aquaculture of barramundi in sea-cages and earthen ponds, cherabin (*Macrobrachium rosenbergii*), edible rock oysters (*Saccostrea* sp.) and ornamental species

COMPLIANCE & COMMUNITY EDUCATION

The North Coast is one of the largest bioregions in WA – stretching from Onslow to the Western Australia/Northern Territory border with over 2600 kilometres of coastline.

The North Coast Bioregion has many biodiversity rich areas including the Rowley Shoals, Montebello Islands, Barrow Islands and hundreds of islands and atolls. These areas attract many people – especially for fishing.

Tourism is a major part of the coastal towns in the North Coast with over 600,000 additional people visiting the area each year. The transient population usually increases in the cooler months from May to October including international, interstate and intrastate tourists.

Many of the towns in this bioregion support mining communities where the majority of the population are fly in/ fly out. Surveys have shown that a large proportion of mining community and tourists take part in fishing while visiting the bioregion.

Two district offices located in Broome and Karratha provide compliance and education across the region with eight permanent Fisheries and Marine Officers and one Community Education officer. During the peak season from May to October an additional two officer mobile patrol also operates in the area. Compliance is delivered to several sectors including commercial and recreational fisheries, pearling, aquaculture, fish habitat and bio-security.

The North Coast Region is sparsely populated in most areas with much of the terrain remote and difficult to access. Remote patrols are partaken for up to two weeks at a time to get to these areas. Specialised equipment is required for patrols including four wheel drive vehicles and a variety of vessels for inshore coastal and inland waters, when offshore patrols occur a 23 metre vessel is utilised.

A range of compliance duties are carried out in the bioregion including complaint investigation, catch, licence, gear, processor, retail and transport inspections. These are carried out through roadside checks, dive inspections, land & sea patrols and aerial surveillance.

FMOs not only spend time on compliance but also dedicate time to community education by maintaining a presence at a variety of expos, fishing competitions and community fairs. Annual fairs are held throughout the bioregion with the Department represented every year at most events. In addition, FMOs also coordinate and manage the Fisheries Volunteer program – where trained community members educate the public on bag and size limits and a variety of other fishing rules.

Education of school-aged children is the primary role of the community and education officer. In-school and school holiday programs are the main method of reaching students in both the Pilbara and Kimberley.

Activities during 2008/09

During 2008/09, the North Coast bioregion's FMOs delivered a total of 2665 officer hours of active compliance patrol time - a small increase from the previous year (North Coast Compliance Figure 1). FMOs also achieved 6,388 personal compliance contacts with the community and fishers.

In the commercial sector FMOs undertook prosecution action as a result of compliance operations in 2008/09. This resulted in 7 infringement warnings and 8 infringements notices being issued, with 32 matters resulting in prosecution action.

Compliance inspections were also carried out on Pearl oyster fishing and seeding operations, during transport of Pearl

oysters and at various Pearl oyster lease sites. Considerable travel time is required to reach many of the lease sites, due to their remote locations.

In the recreational sector 56 infringement warnings were issued, 77 infringement notices and 15 matters resulted in prosecution action.

Volunteer Fisheries Liaison Officer (VFLO) groups from across the bioregion were provided with training and support.

Initiatives in 2009/10

Pilbara based Fisheries Volunteers will go on an inland tour to mining communities including Tom Price, Pannawonica and Paraburdoo with the newly purchased education trailer. Schools and shopping centres will have access to the trailer where fisheries education messages will be communicated.

The North Coast bioregions FMOs will continue to use a risk assessment based approach to fisheries compliance to ensure areas and activities of a high risk of non-compliance are

targeted.

The FMOs will continue to assist with ongoing checks of bio-security of vessels entering the states' waters for introduced marine pests.

The Fisheries mobile patrol unit, Mobile 1, will focus on compliance during peak fishing periods in this bioregion. Together with the district officers they will work together to increase coverage across the region to try and target people in remote areas.

The Department of Fisheries received a grant for the community education officer to tour the Pilbara schools to implement fisheries education programs. Schools in Onslow, Karratha and Dampier will receive hands-on, in-school education activities.

The community education officer will run a joint holiday program with DEC in Karratha over the October school holidays. Both departments will work together to communicate marine environment messages.

NORTH COAST COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the North Coast bioregion during the 2008/09 financial year

PATROL HOURS DELIVERED TO THE BIOREGION	2,665 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	57
District Office contacts	70
Infringement warnings	7
Infringement notices	8
Prosecutions	32
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	6,030
District Office contacts	2,580
Infringement warnings	56
Infringement notices	77
Prosecutions	15
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	301
District Office contacts	1,833
Fishwatch reports***	

* Pearling contacts are excluded from these totals and detailed in North Coast Compliance Table 2.

** Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing related contacts within the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category. This table includes contacts made by *PV Walcott*. Contacts made by *PVs Hamelin* and *McLaughlan* are included in West Coast Compliance Table 1.

*** This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors. It also includes any calls relating to the Northern Inland bioregion that were referred to Karratha or Broome district staff.

NORTH COAST BIOREGION

NORTH COAST COMPLIANCE TABLE 2

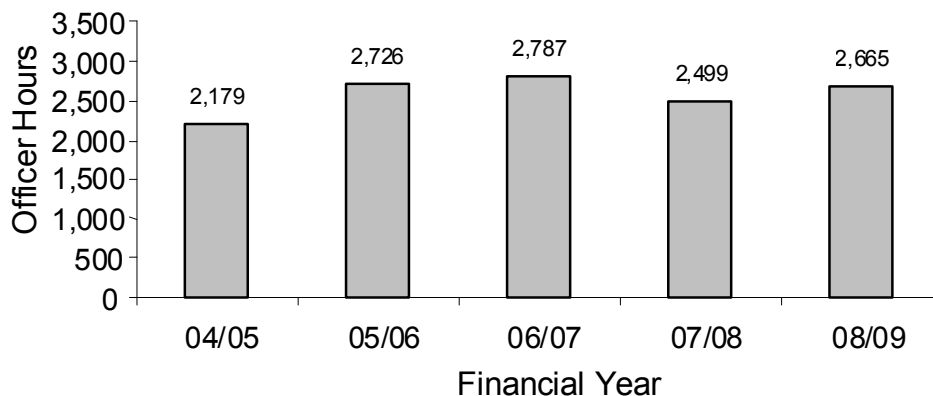
This table gives summary statistics for pearling compliance in all bioregions in the 2008/09 fishing season.

Total compliance hours*	2,598 Officer Hours
Field contacts by Pearling Officers	65
District Office contacts	57
Letters of Warning issued**	0
Prosecutions	3

* Includes all time spent on compliance-related tasks by District Staff, e.g. investigations, prosecutions, etc. but does not include 45 days of pearling activities by PV Walcott.

** No legislative capacity to issue infringement notices

North Coast Bioregion Compliance Patrol Hours



NORTH COAST COMPLIANCE FIGURE 1*

This figure gives the “On Patrol” officer hours showing the level of compliance patrol activity delivered to the North Coast bioregion over the previous five years. The 2008/09 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1 and Table 2. The totals exclude time spent on other compliance-related tasks, e.g. travel time between patrol areas, preparation and planning time.

*Does not include “on-patrol” hours delivered by PV Walcott (1,450 in 2008/09).

The total on-patrol hours for each of the Department’s 3 large patrol vessels is reported in the compliance summary of the most relevant bioregion: *PV Walcott* in North Coast, *PV McLaughlan* and *PV Hamelin* in West Coast.

SOUTH COAST BIOREGION

ABOUT THE BIOREGION	214
SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES	214
ECOSYSTEM MANAGEMENT	215
ECOSYSTEM BASED FISHERIES MANAGEMENT	215
FISHERIES	218
AQUACULTURE	260
COMPLIANCE AND COMMUNITY EDUCATION	261

SOUTH COAST BIOREGION

ABOUT THE BIOREGION

The continental shelf waters of the South Coast bioregion are generally temperate but low in nutrients, due to the seasonal winter presence of the tail of the tropical Leeuwin Current and limited terrestrial run-off. Sea surface temperatures typically range from approximately 15°C to 21°C, which is warmer than would normally be expected in these latitudes due to the influence of the Leeuwin Current. The effect of the Leeuwin Current, particularly west of Albany, limits the winter minimum temperatures away from terrestrial effects along the beaches to about 16 to 17°C.

Fish stocks in the region are predominantly temperate, with many species' distributions extending right across southern Australia. The occasional more tropical species that are found are thought to have been brought into the area as larvae, but are unlikely to form breeding populations.

The south coast is a high-energy environment, heavily influenced by large swells generated in the Southern Ocean. The coastline from Cape Leeuwin to Israelite Bay is characterised by white sand beaches separated by high granite headlands. East of Israelite Bay, there are long sandy beaches backed by large sand dunes, until replaced by high limestone cliffs at the South Australian border. There are few large areas of protected water along the south coast, the exceptions being around Albany and in the Recherche Archipelago off Esperance.

Along the western section of the coastline that receives significant winter rainfall, there are numerous estuaries fed by winter-flowing rivers. Several of these, such as Walpole/Nornalup Inlet and Oyster Harbour, are permanently open, but most are closed by sandbars and open only seasonally after heavy winter rains. The number of rivers and estuaries decreases to the east as the coastline becomes more arid. While these estuaries, influenced by terrestrial run-off, have higher nutrient levels (and some, such as Oyster Harbour and Wilson Inlet, are suffering eutrophication), their outflow to the ocean does not significantly influence the low nutrient status of coastal waters.

The marine habitats of the south coast are similar to the coastline, having fine, clear sand sea floors interspersed with occasional granite outcrops and limestone shoreline platforms and sub-surface reefs.

A mixture of seagrass and kelp habitats occurs along the south coast, with seagrass more abundant in protected waters and some of the more marine estuaries. The kelp habitats are diverse but dominated by the relatively small *Ecklonia radiata*, rather than the larger kelps expected in these latitudes where waters are typically colder and have higher nutrient levels.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

The major commercial fisheries of the South Coast bioregion are the abalone fishery, the purse seine fishery targeting pilchards and other small pelagics, and a demersal gillnet fishery for sharks. Other smaller commercial fisheries are the long-standing beach seine fishery for Australian salmon and herring, a trap fishery targeting southern rock lobsters and deep-water crabs, and the intermittent scallop fishery. There is also a commercial net fishery for finfish operating in a number of south coast estuaries. South coast commercial fishing vessel operators often hold a number of licences to create a viable year-round fishing operation.

As much of the south coast is remote or difficult to access, recreational beach and boat fishing tends to be concentrated around the main population and holiday centres. The major target species for beach and rock anglers are salmon, herring, whiting and trevally, while boat anglers target pink snapper, queen snapper, Bight redfish, a number of shark species, samson fish and King George whiting. The third major component of the recreational fishery is dinghy and shoreline fishing of estuaries and rivers, focused in the western half of the bioregion. Here the main angling targets are black bream and whiting (including King George whiting). Recreational netting, primarily targeting mullet, also occurs in these estuaries.

The predominant aquaculture activity undertaken on the south coast is the production of mussels and oysters from Oyster Harbour at Albany. This activity is restricted to this area where there are sufficient nutrient levels related to terrestrial run-off to provide the planktonic food necessary to promote growth of filter-feeding bivalves.

Other forms of aquaculture (e.g. sea cage farming) are restricted on the south coast by the high-energy environment and the very limited availability of protected deep waters typically required by this sector. As a consequence, most recent development activity has focused on land-based 'raceway' culture of abalone, using pumped sea water.

ECOSYSTEM MANAGEMENT

The inshore marine habitats of the south coast are largely unaffected by human activities. While there are few permanent closures to trawling in this region, the actual level of such activities is very small with about 98% of the region not affected by these activities.

The estuaries and near-shore marine embayments where there is restricted water exchange, for example Princess Royal and Oyster Harbours and Wilson Inlet, have experienced eutrophication events associated with high nutrient loads from adjacent land-based activity.

The Walpole–Nornalup Marine Park was declared on the 8th May 2009 and is the first marine protected area on the south coast. There are three existing fishing closures under s.43 of the Fish Resources Management Act 1994 surrounding the wreck of the ‘Perth’ (Albany), wreck of the ‘Sanko Harvest’ (east of Esperance), and Esperance Jetty.

The Australian Government’s Department of Environment Water, Heritage, Water and the Arts is undertaking a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay, with a view to completing a draft South West Marine Bioregional Plan (MBP) in 2010. The Draft Plan was expected to be released for a 3 month public review and this will include proposed marine protected areas.

The Department of Fisheries continues to provide advice to the Environmental Protection Authority on development proposals, which if implemented, have the potential to impact on the aquatic environment. The Department also continues to actively engage with the natural resource management groups for the south coast to promote sustainable use of the aquatic environment. New proposals currently being progressed for the South Coast include ones for mineral resource development and associated port facilities, and for petroleum exploration.

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets using the EBFM framework

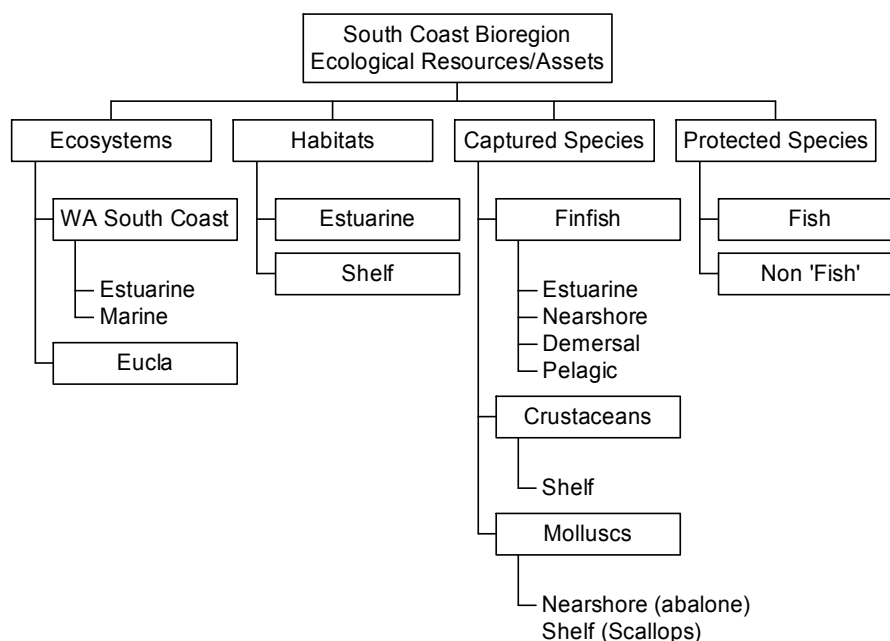
Under the Integrated Marine and Coastal Regionalisation for Australia scheme, the South Coast bioregion has been divided into 2 meso-scale regions: WA South Coast, Eucla (IMCRA, V 4.0, 2006). This sub-regional scale of management has now been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, *et al.*, 2010) see How to Use section for more details.

In terms of ecological assets, the Department has recognised the following ecological values for the IMCRA regions within the South Coast Bioregion:

- Ecosystem structure and biodiversity (on a meso-scale basis);
- Captured fish species
- Protected species (direct impact – capture or interaction);
- Benthic habitats; and
- External impacts.

For some issues a finer level of division of the IMCRA ecosystems is used by the Department. This relates to recent management initiatives necessary to recognise different suites of exploited fish and invertebrates across the continental shelf. These sub-components are defined by depth contours (Estuarine, Nearshore 0-20m; Demersal 20-250m and Pelagic). The full set of ecological assets identified for ongoing monitoring are presented in South Coast Ecosystem Management Figure 1.

SOUTH COAST BIOREGION



SOUTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the ecological assets identified and separately assessed for the South Coast Bioregion

Risk Assessment of Regional Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined South Coast Ecosystem Management Figure 1 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (South Coast Ecosystem

Management Table 1) provides an overview and cumulative assessment of the current risks to the ecological assets of the South Coast Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department’s Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

SOUTH COAST ECOSYSTEM MANAGEMENT TABLE 1: RISK LEVELS FOR EACH ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Moderate values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing activities.

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Estuarine	Marine	MODERATE (non fishing)	The most likely cause of changes to community structure in estuarine regions is changing rainfall levels and the manual opening or closing of bars at river mouths.
Marine	Marine	LOW	The recent assessment by Hall and Wise (in press) of finfish community structure using commercial data for the past 30 years found no evidence of any concerning trend in mean trophic level, mean length or FIB. Few other species are captured in this region.

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Eucla	Marine	NEGLIGIBLE	As above

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Finfish	Estuarine	MODERATE	The catch and catch rate of this suite has been reasonably stable for 10 years.
	Nearshore	HIGH	The capture of herring has been in decline for some years no. A study is currently underway to determine if this is related to stock issues or merely marketing problems
	Demersal	HIGH	There is a concern that the increase in targeting of demersal fishing on the south coast may need to be examined more closely.
	Pelagic	LOW	While the spawning biomass has returned to appropriate levels, the capture levels of pilchards and other pelagic fish has not returned to pre-virus levels.
Crustaceans	Shelf	MODERATE	The catch levels of lobsters and crabs remains at relatively low but consistent levels.
Molluscs	Nearshore	MODERATE	The stocks of abalone are maintained at appropriate levels
	Shelf	NEGLIGIBLE	The stocks of scallops varies annually and fishing is focused only when stocks are abundant

Protected species

Protected fish species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Non fish (birds)	MODERATE	The capture of shearwaters in purse seine operations has been addressed by a code of conduct
	Mammals	MODERATE	The potential for the capture of sealions and seals by all fishing operations in this region, but especially gill nets is to be investigated.
Protected 'Fish' Species	Fish	NEGLIGIBLE	There are few risks to the protected fish species in this region

Benthic habitat

Benthic Habitat	Risk	Status and Current Activities
Estuaries/ Nearshore	LOW (non fishing)	There are few fishing activities that would impact on nearshore or estuarine habitats. There may be risks at some locations due to coastal development activities.
Shelf	NEGLIGIBLE	The shelf region in this bioregion has very little habitat disturbance. Less than 3% of the area is trawled and there are no other activities that would materially impact on the habitats in these areas.

External Drivers (Non Fishing)

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	HIGH	The recent location of the pest algae <i>Codium fragile</i> in Albany highlights the issues that now face many ports in Australia
Climate	LOW	This area is not as likely to be impacted by climate change as West Coast and Gascoyne areas of WA.

FISHERIES

South Coast Crustacean Fisheries Report: Statistics Only

A. Thomson and P. Unsworth

Management input by N. Chambers

Fishery Description

The 'south coast crustacean fisheries' are pot-based fisheries, which operate from Augusta to the South Australian border. They include the Windy Harbour/Augusta Rock Lobster Managed Fishery, the Esperance Rock Lobster Managed Fishery (ERLF), the rock lobster pot fishery operating in the Albany and Great Australian Bight sectors, and the deep-sea crab fishery.

The fisheries are multi-species and take southern rock lobsters (*Jasus edwardsii*) and western rock lobsters (*Panulirus cygnus*) as well as deep-sea crab species including giant crabs (*Pseudocarcinus gigas*), crystal crabs (*Chaceon albus*) and champagne crabs (*Hypothalassia acerba*).

Southern rock lobsters comprise the majority of the catch in the eastern areas of the fishery, with crab species becoming more prevalent in the south-western region. Western rock lobsters are a significant component of the catch in the Windy Harbour fishery (not reported here due to confidentiality provisions relating to the small number of licensees).

Boundaries

Management boundaries for the south coast crustacean fisheries are shown in South Coast Crustacean Figure 1. The 'boundaries' of the deep sea crab component of the fishery (Condition 105) include all the waters of these fisheries deeper than 200 metres, excluding those of the ERLF, where crabs may only be taken by the holders of an Esperance Rock Lobster Managed Fishery Licence.

Management arrangements

Commercial

These commercial fisheries are managed primarily through input controls in the form of limited entry, pot numbers, size limits and seasonal closures.

In 2008/09, 2 vessels were licensed to fish for rock lobsters in the Windy Harbour/Augusta Rock Lobster Managed Fishery, 8 were licensed to fish in the Esperance Rock Lobster Managed Fishery and 28 vessels were licensed to fish for rock lobster in the Great Australian Bight and Albany zones. There were 24 licences that include condition 105 permitting them to fish for deep-sea crabs outside the Esperance sector.

The season for fishing for rock lobsters throughout the south coast crustacean fisheries mirrors the West Coast Rock Lobster Managed Fishery season (15 November to 30 June). Fishing for deep-sea crabs can currently occur all year, but during the rock lobster season operators must only use the number of pots endorsed on their rock lobster authorisation/licence.

Recreational

Recreational fishers generally only target rock lobsters. They are restricted to the use of 2 pots per person and divers are only permitted to take rock lobster by hand, or with the use of a loop or other device that is not capable of piercing the rock lobster.

Size limits, bag limits and seasonal closures apply and all recreational fishers are required to hold a current recreational fishing licence authorizing them to take rock lobster.

Landings and Effort

Commercial

Southern rock lobster **39 tonnes**

Deep-sea crab **24 tonnes**

The 2008/09 season total catch of southern rock lobsters was 39 t, an increase of 5% from the 2007/08 season (South Coast Crustacean Table 1). A catch of 18 t of southern rock lobsters was taken in the ERLF in 2008/09 – a decrease of 22% on the catch taken in the 2007/08 season (23 t).

The combined catch for the GAB and Albany southern rock lobster fishery zones in 2008/09 was 21 t, a 50% increase of the catch taken in 2007/08 (Table 1). The catch in the Albany zone was 3 t, a decrease of 25% compared to the 2007/08 season, however, the catch in the GAB zone increased by 80% to 18 t.

As a secondary target of the rock lobster fishery, a total of 24 t of deep sea crabs was caught (South Coast Crustacean Table 1). In the Albany zone this included 0.8 t of giant crabs (a decrease of 0.4 t over the 2007/08 season), 5.6 t of champagne crabs (a decrease of 2.5 t over 2007/08 season) and 12.4 t of crystal crabs (an decrease of 0.4 t over the 2007/08 season). In the ERLF, 2.1 t of giant crabs were landed (representing no change from 2007/08).

The fishing effort in the Esperance fishery (ERLF) continued to decline in 2008/09 (south coast crustacean table 1). The effort increased by 200% in the Albany zone, however, it is not possible to split the effort targeting lobsters from that targeting deep-sea crabs.

Recreational

Southern rock lobsters **<5 tonnes**

Estimates from mail surveys sent to a random selected sample of rock lobster licence holders suggest that the recreational catch of southern rock lobsters on the south coast is less than 5 t per year.

Numbers of recreational rock lobster licence holders that catch southern rock lobsters are small and estimating the

recreational catch more accurately would require a dedicated survey or at least a different sampling strategy to the current mail survey.

Fishery Governance

Target commercial catch range:

Southern rock lobsters **50 – 80 tonnes**

In 2008/09, the south coast catch of 39t was outside the target range. This target catch range will be reviewed as a part of the overall review of the management for this fishery, which is underway.

Current Fishing (or Effort) Level **Acceptable**

Comparative catch and effort levels for the deep-sea crab and lobster catches are provided by management zone, in South Coast Crustacean Table 1 and for lobsters in Figure 2.

New management initiatives (2009/10)

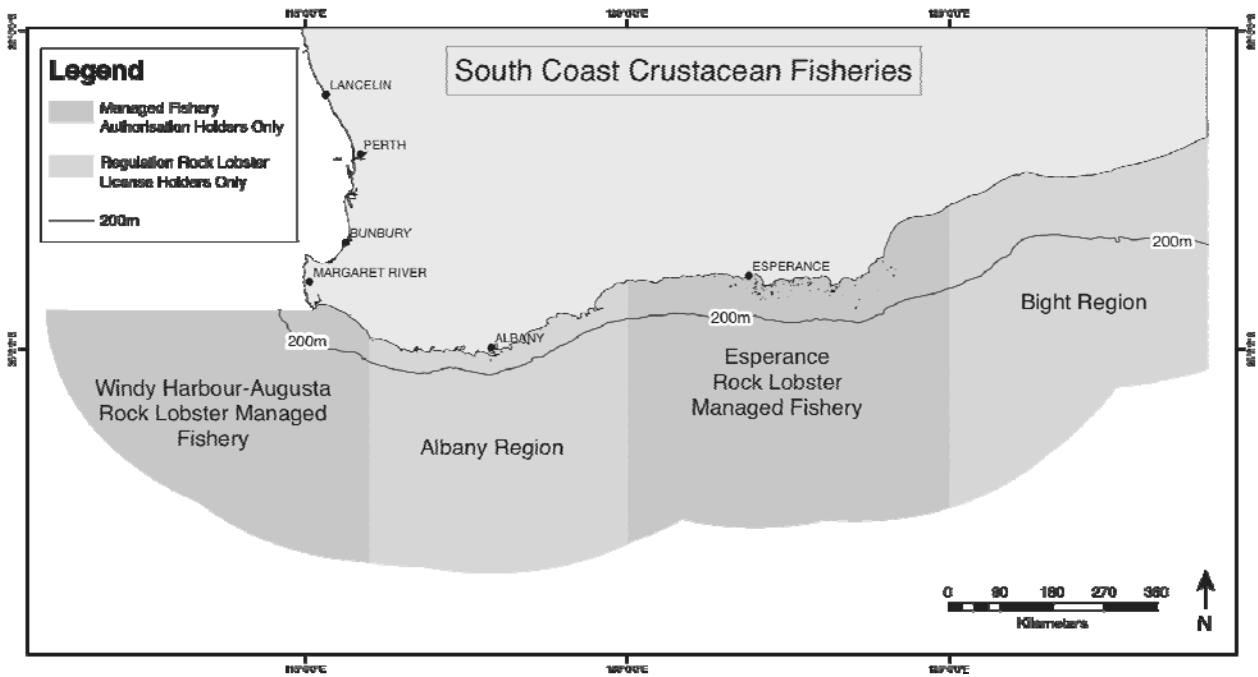
Since the release in January 2009 of the Fisheries Management Paper 232, a discussion paper on the future management of crustacean fisheries on the south coast, the Department has progressed the development of the single management plan for the fishery as indicated by the proposals within the paper. As per legislative arrangements the Department will be releasing a draft management plan for comment prior to its introduction.

SOUTH COAST CRUSTACEAN TABLE 1

Comparisons of fishing effort and southern rock lobster and crab catch in 2007/08 and 2008/09 in the south coast crustacean fisheries.

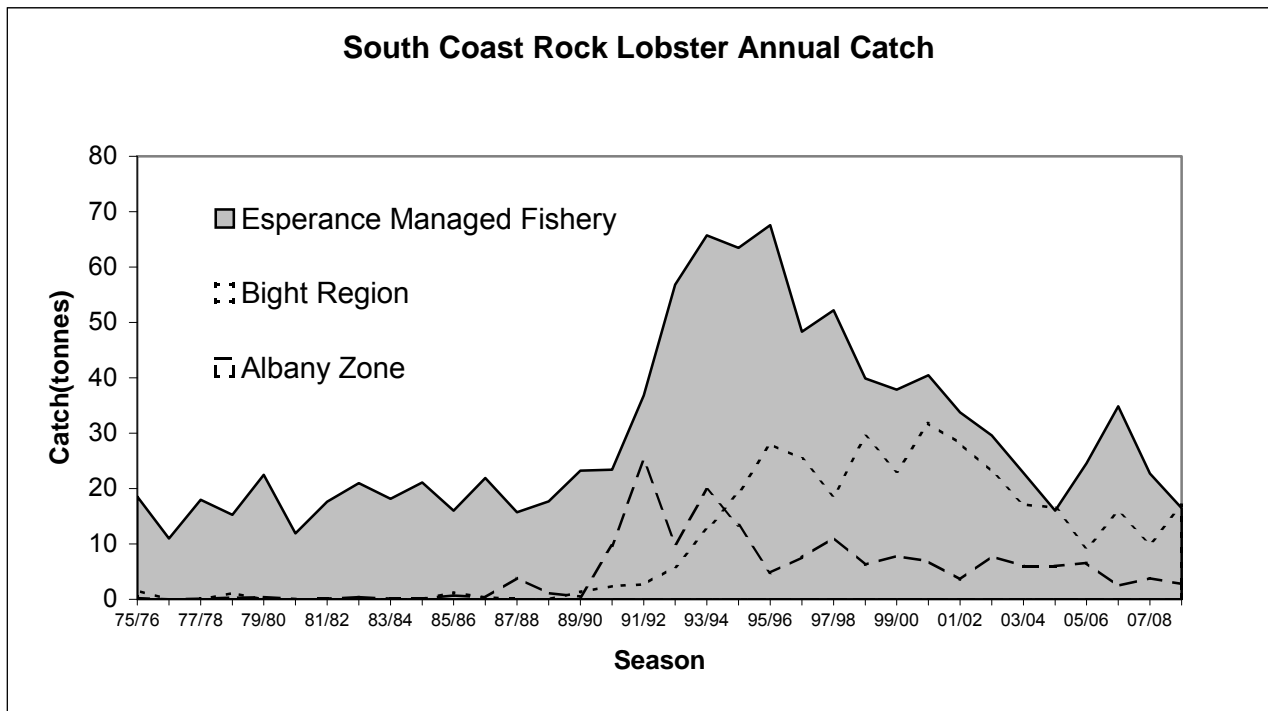
Management zone	Season	Pot lifts	Southern rock lobster catch (tonnes)	Deep-sea crabs catch (tonnes)
ERLF	2007/08	35,000	23	3
	2008/09	28,000	18	3
	difference	-20%	-20%	0%
Albany	2007/08	13,000	4	22
	2008/09	38,000	3	19
	difference	+200%	-25 %	-14%
Great Australian Bight	2007/08	26,000	10	0
	2008/09	43,000	18	2
	difference	+65%	+80%	-

SOUTH COAST BIOREGION



SOUTH COAST CRUSTACEAN FIGURE 1

Management boundaries in the South Coast crustacean fisheries.



SOUTH COAST CRUSTACEAN FIGURE 2

Seasonal catches of southern rock lobster by management area since 1975/76.

Greenlip/Brownlip Abalone Fishery Status Report

A. Hart, F. Fabris and T. Baharthah

Management input from M. Holtz

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial	
Fishing level	Acceptable	Greenlip	160 t
		Brownlip	39 t
		Recreational	3-4% of total catch

Fishery Description

The Western Australian greenlip and brownlip abalone fishery is a dive fishery that operates in the shallow coastal waters off the south-west and south coasts of Western Australia. The fishery targets 2 large species of abalone: greenlip abalone (*Haliotis laevigata*), and brownlip abalone (*H. conicopora*), both of which can grow to approximately 200 mm shell length.

Abalone divers operate from small fishery vessels (generally less than 9 metres in length). The principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) or SCUBA using an abalone 'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.

Governing legislation/fishing authority

Fish Resources Management Act 1994
 Fish Resources Management Regulations 1995
 Abalone Management Plan 1992
 Ministerial Policy Guideline no. 10
 Abalone Managed Fishery Licence
 Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)
 Recreational Fishing Licence
 Consultation process
 Meetings between the Department of Fisheries and industry
 Recreational Fishing Advisory Committee

Boundaries

Commercial

The Abalone Management Plan covers all Western Australian coastal waters, which are divided into eight management areas. Commercial fishing for greenlip/brownlip abalone is managed in three separate areas (Greenlip/Brownlip Abalone Figure 1).

Recreational

The recreational abalone fishery regulations relate to three zones: the Northern Zone (from Greenough River mouth to the Northern Territory border), the West Coast Zone (from

Busselton Jetty to Greenough River mouth) and the Southern Zone (from Busselton Jetty to the South Australian border). Greenlip and brownlip abalone are only fished in the Southern Zone.

Management arrangements

Commercial

The commercial greenlip/brownlip abalone fishery is part of the overall Abalone Managed Fishery which is managed primarily through output controls in the form of Total Allowable Commercial Catches (TACCs), set annually for each species in each area and allocated to licence holders as Individual Transferable Quotas (ITQs).

The overall TACC for 2009 was 213 t (whole weight). The TACC is administered through 16,100 ITQ units, with a minimum unit holding of 450 units. The licensing period runs from 1 April to 31 March of the following year.

The legal minimum length for greenlip and brownlip abalone is 140 mm shell length, although the commercial industry fishes to self-imposed size limits of 153 mm, 150 mm and 145 mm in various parts of the main stocks. In 'stunted stocks' areas, greenlip can be fished from 120 mm under special exemptions with such fishing strictly controlled to pre-arranged levels of catch and effort.

Recreational

The recreational component of the fishery for greenlip and brownlip abalone is managed under a mix of input and output controls and occurs primarily on the south and south-west coasts. Recreational fishers must purchase a dedicated abalone recreational fishing licence or an umbrella licence (which covers all licensed recreational fisheries). Licences are not restricted in number, but the recreational fishing season is limited to 7.5 months – from 1 October to 15 May.

The combined daily bag limit for greenlip and brownlip abalone is five per fisher, and the household possession limit (the maximum number that may be stored at a person's permanent place of residence) is 20.

General

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issues identified through this process were the

SOUTH COAST BIOREGION

breeding stock levels of greenlip and brownlip abalone. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Current research is focused on stock assessment using catch and effort statistics, meat weight indices, and length-frequency sampling. Commercial abalone divers are required to provide daily catch information on the weight and number of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. The divers also supply a random selection of abalone shells from each fishing day, and these are measured and used to estimate fishing mortality.

An annual standardized catch per unit effort (CPUE) index was developed that took into account diver, sub-area and month of fishing as well as technological improvements that aid fishing efficiency. This index forms the basis of the revised decision-rule framework for the quota setting in each area of the fishery.

Current research initiatives include the use of digital video imagery assessment by industry divers, who survey selected sites with an underwater video camera, fishery-independent survey data collected from 140 sites across the fishery, and mark-recapture analysis of growth and mortality in brownlip abalone.

The telephone diary survey estimates the statewide catch of greenlip and brownlip abalone at regular intervals. For the last survey, in 2007, around 500 licence holders were randomly selected from the licensing database, with selection stratified by licence type (abalone or umbrella) and respondent location (country or Perth metropolitan area). The licence holders were sent a diary to record their fishing activity and were contacted every 3 months by telephone for the duration of the abalone season.

Research on stock enhancement and greenlip abalone habitat continued in 2009, with funding successfully obtained from the Australian Seafood Cooperative Research Centre (Seafood CRC) for a project titled "*Bioeconomic evaluation of commercial scale stock enhancement in abalone*". Results from this project will inform industry and management on the viability of stock enhancement as a management tool for this fishery.

Retained Species

Commercial landings (season 2009): 199 tonnes

In 2009 the greenlip/brownlip catch was 199 t whole weight (Greenlip Brownlip Abalone Table 1), which was 1% higher than the 2008 catch of 197 t. The Area 1 (Nullarbor fishery) exploratory quota remained at 1.2 t but was not fished in 2009.

The greenlip catch of 160.2 t whole weight from a total quota of 171.3 t, was 2% higher than the catch in 2008. The brownlip catch of 39 t whole weight for the 2009 season was similar to last year's catch of 39.5 t, and 95% of the quota of 41.9 t (Greenlip Brownlip Abalone Table 1).

Recreational catch (season 2007): 8 tonnes

Recreational catch: 3 – 4% of total catch

The estimate of recreational catch of greenlip and brownlip abalone, based on the telephone diary survey of recreational licence holders in 2007, was 8 t (range: 0 – 16 t), which is similar to the 2006 estimate of 7 t. Given the catch estimates from 2004, 2006 and 2007, the recreational catch corresponds to approximately 3 – 4% of the total (commercial and recreational) catch (Greenlip Brownlip Abalone Table 2) and it is unlikely that this catch level would have differed greatly in 2009.

Fishing effort/access level

Commercial

Total fishing effort on the main stocks in 2009 was 1,205 days. This was slightly higher than 2008 (1,144 days).

Recreational

For the 2009 season, approximately 25,700 abalone licences were issued. This was a 5% increase over the 2007 figure of 24,500 licenses (Greenlip Brownlip Abalone Figure 2). Overall license numbers were stable for 6 years between 2001 and 2006, but have increased by 21% in the last 3 years (Greenlip Brownlip Abalone Figure 2). It is likely, however, that the vast majority of these new licenses have been issued to fishers targeting the Perth metropolitan roe's abalone fishery (see Roe's abalone report).

Effort estimates for recreational abalone fishing on the west coast (excluding the Perth metropolitan area), from the 2007 telephone diary survey, was 6,300 days (3,800 – 8,800 days), while the estimated effort on the south coast was 4,900 days (1,700 – 8,000 days) (Greenlip Brownlip Abalone Table 2).

Stock Assessment

Assessment complete: Yes

Assessment method:

Standardised Catch rates / Fishing mortality

Breeding stock levels: Adequate

A stock assessment of the greenlip/brownlip abalone fishery was undertaken for the 2009 fishing season, based on commercial catch and effort statistics, length-frequency and shell morphometry sampling, biological growth studies, and some fishery-independent surveys.

Standardised catch per unit effort (SCPUE): As a result of a recent review¹, the SCPUE for the greenlip fishery is now used as the principal indicator of the abundance of legal-sized abalone and the basis for the decision-rule framework. This indicator replaces the raw CPUE data (kg whole wt per diver per day) used in previous State of the Fisheries Reports, but these raw CPUE data will still be presented for comparative purposes this year.

¹ Hart A, Fabris F, Caputi C (2009). Performance indicators, biological reference points and decision rules for Western Australian abalone fisheries (*Haliotis* sp.): (1) Standardised catch per unit effort. Fisheries Research Report No. 185. Department of Fisheries, Western Australia. 32p.

In 2009, the SCPUE for the combined greenlip stocks was 34 kg whole weight per hour (Greenlip Brownlip Abalone Table 1). This index has been close to this level since 2002, which is close to the long-term average SCPUE of 35 kg per hour (Greenlip Brownlip Abalone Table 1).

Fishing mortality: This analysis determines the proportion of the available abalone stock that is being harvested. Fishing mortality of greenlip abalone declined between 2007 and 2008 for all areas, but increased again in 2009 (Greenlip Brownlip Abalone Figure 3a). This pattern is indicative of above average recruitment in 2008, returning to normal levels in 2009.

Fishing mortality of brownlip abalone also increased between 2008 and 2009, after having remained stable or falling among areas in the previous year (Greenlip Brownlip Abalone Figure 3b).

Breeding stock: Greenlip abalone mature between 80 and 110 mm shell length, and brownlip abalone mature between 90 and 130 mm shell length. These are both below the legal minimum size limit set across the fishery (140 mm shell length), which equates to an average meat weight of 140 g for greenlip and 160 g for brownlip. At these weights, animals are expected to have spawned at least twice before reaching legal size.

Industry-imposed length limits that are larger than the minimum legal limits have been set in areas of fast-growing stocks. In Area 2, there is a general 145 mm minimum length across the fishing grounds. In Area 3, fishers have imposed a minimum size limit of 153 mm shell length for the faster-growing portions of the fishing grounds, and 150 mm for the remainder.

For brownlip, the assessment showed that the TACC was being caught at high average weights and the TACC was therefore maintained at 41.9 t in 2010 (Greenlip Brownlip Abalone Table 1).

The main performance measures for the fishery relate to the maintenance of adequate breeding stocks in each area of the fishery. This is assessed using a combination of measures that reflect the average size of breeding individuals and the overall biomass of breeding stock.

In 2009, the average sizes of greenlip and brownlip caught were 193 g and 265 g respectively. These were well above the minimum breeding sizes of 140 g for greenlip and 160 g for brownlip. The effort (days fished) required to take the quota (1,205 days) were within the set range that indicates sufficient biomass of breeding stock for the fishery overall (907 – 1,339 days – see 'Fishery Governance' section).

Non-Retained Species

Bycatch species impact: **Negligible**

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

Protected species interaction: **Negligible**

The only protected species interaction occurring in this fishery is with the great white shark (*Carcharodon carcharias*), which has been known to attack divers. Most divers now use diving cages or electronic shark deterrent devices for their personal protection. However, divers are reporting encounters with *C. carcharias*, and this will be quantified in future reports.

Ecosystem Effects

Food chain effects: **Negligible**

Commercial abalone diving occurs over a small proportion of the total abalone habitat of the Western Australian coastline. In view of the relatively low exploitation rates and consequent maintenance of a high proportion of the natural biomass of abalone, it is considered unlikely that the fishery has any significant effect on the food chain in the region.

Habitat effects: **Negligible**

The fishing activity makes minimal contact with the habitat, which typically consists of hard rock surfaces in a high wave-energy environment. As abalone are drift algae feeders, their removal is considered to result in little change in algal growth cover in areas fished.

Social Effects

There are 14 vessels operating in the greenlip/brownlip commercial fishery, employing approximately 35 divers and deckhands. The dispersed nature of the greenlip and brownlip abalone fishery means that small coastal towns from Busselton to the South Australian border receive income from the activity of divers.

Recreational diving for greenlip and brownlip abalone is a small but active sector, with dive shops and vessel manufacturers' benefiting from this activity. The recreational fishery provides a major social benefit to those sectors of the community that appreciate the abalone as a delicacy. There were 25,700 licenses issued that would have allowed fishers to participate in the recreational abalone fishery, although most of these would have targeted the Roe's abalone fishery in the Perth metropolitan area.

Economic Effects

Estimated annual value (to commercial fishers)

for year 2009: **\$7.7 million**

The estimated average price received by commercial fishers was \$105/kg meat weight (\$39/kg whole weight) for greenlip and \$91/kg meat weight (\$36/kg whole weight) for brownlip abalone, resulting in a fishery valued at \$7.7 million, compared to \$9.2 million in 2008, and \$8.8 million in 2007.

Greenlip prices in 2009 were lower than 2008 (\$130/kg), and were also the lowest for the last 10 years.

SOUTH COAST BIOREGION

Fishery Governance

Target effort range: 907 – 1,339 days

To assess whether the catch quota set is appropriate (sustainable) relative to the stock available, the effort required to take a full season's quota (213 t in 2009) from the main stocks should fall within the effort range (907 – 1,339 diver days) derived from the 5-year period 1994 – 1998. This range reflects the acceptable variation in catch rates for the main stocks due to weather and natural recruitment cycles.

The fishing effort in 2008 was 1,205 days (main stocks), which is within the governance range and indicates that the fishery as a whole is performing satisfactorily.

The overall greenlip/brownlip quota for 2010 remained at 213 t, as in 2009 (Greenlip Brownlip Abalone Table 1).

Current effort level: Acceptable

New management initiatives (2010/11)

The AbMac (abalone management committee) was formally dissolved in early 2010. The commercial industry has

expressed interest in enhancing the value of their ITQs through the use of stock enhancement and management models to accommodate this activity are likely to be deliberated upon during 2010/11. Consultation also took place with industry on relatively minor operational changes to the Abalone Management Plan 1992. These matters are currently being progressed.

External Factors

In the last few years there have been a number of changes which impact on fishery governance, and particularly on catch rates. Lease divers are becoming more common, industry size limits have been varied substantially above the legal minimum sizes and the value of the abalone has decreased. Also, the increasing value of the Australian dollar in 2009/10 has exacerbated the overall depressed price of seafood products resulting from the Global Financial Crisis and consequently, abalone beach prices are low relative to previous years.

In addition, environmental effects, such as weather conditions, and the effect of technology changes, continue to have significant effects on diver efficiency.

GREENLIP/BROWNLIP ABALONE TABLE 1Greenlip and brownlip abalone catch and effort¹ by quota period.

Quota period ²	Greenlip TAC kg whole weight	Greenlip caught kg whole weight (all stocks)	Brownlip TAC kg whole weight	Brownlip caught kg whole weight ⁴	Combined catch kg whole weight	Diver days (main stocks only) ³	Greenlip Raw CPUE kg whole (meat) ⁴ wt per diver	Greenlip standardised CPUE (kg whole weight) per diver hour
1989		229,619	–	36,977	266,596	1,324	158 (59)	
1990	126,500	118,395	–	19,118	137,514	696	164 (62)	
1991	148,500	132,194	–	14,658	146,852	816	158 (59)	
1992	192,500	170,608	–	30,404	201,012	1,120	152 (57)	37
1993	197,450	173,397	–	31,153	204,550	1,238	140 (53)	37
1994	200,750	171,820	–	32,222	204,042	1,337	129 (48)	36
1995	187,264	145,467	–	27,061	172,528	1,087	134 (50)	32
1996	189,750	171,337	–	21,932	193,269	904	177 (66)	40
1997	207,350	182,317	–	26,297	208,614	1,059	172 (65)	35
1998	200,750	181,810	–	22,197	204,006	1,031	166 (62)	36
1999	184,023	175,765	28,000 ⁵	28,047	203,812	922	182 (68)	39
2000	194,691	189,511	34,875	34,179	223,690	1,029	178 (67)	41
2001	194,691	187,459	33,075	31,091	218,550	1,002	165 (62)	37
2002	194,691	166,828	33,075	27,458	194,286	1,027	134 (50)	34
2003	202,521	180,730	37,453	33,449	214,179	1,144 ³	136 (51)	33
2004	190,520	170,385	35,000	34,196	204,581	1,154 ³	129 (48)	34
2005	171,755	169,285	38,500	38,745	208,030	1,252	131 (49)	31
2006	171,755	168,752	39,750	37,265	206,017	1,161	133 (50)	31
2007	171,755	166,647	39,750	38,660	205,307	1,139	137 (51)	34
2008	163,220	157,224	41,900	39,515	196,739	1,144	135 (51)	34
2009	171,301	160,156	41,900	39,050	199,206	1,205	130 (49)	34
2010	171,221		41,900					

1. Data source: quota returns.

2. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.

3. Effort (diver days): main stocks are separated from stunted stocks, which are subject to controlled fishing regimes and not directly comparable.

4. Greenlip conversion factor (meat weight to whole weight) is 2.667. Brownlip conversion factor for meat weight to whole weight is 2.5.

5. Brownlip allocations not fixed across Areas 2 and 3 (ex-Zone 1 and 2) prior to 1999. Brownlip TAC fixed for the first year in 1999.

SOUTH COAST BIOREGION

GREENLIP/BROWNLIP ABALONE TABLE 2

Summary of telephone diary surveys of recreational effort (fisher days), catch rate (abalone per fisher day) and catch (tonnes whole weight) for the greenlip and brownlip abalone fisheries in 2004, 2006, and 2007.

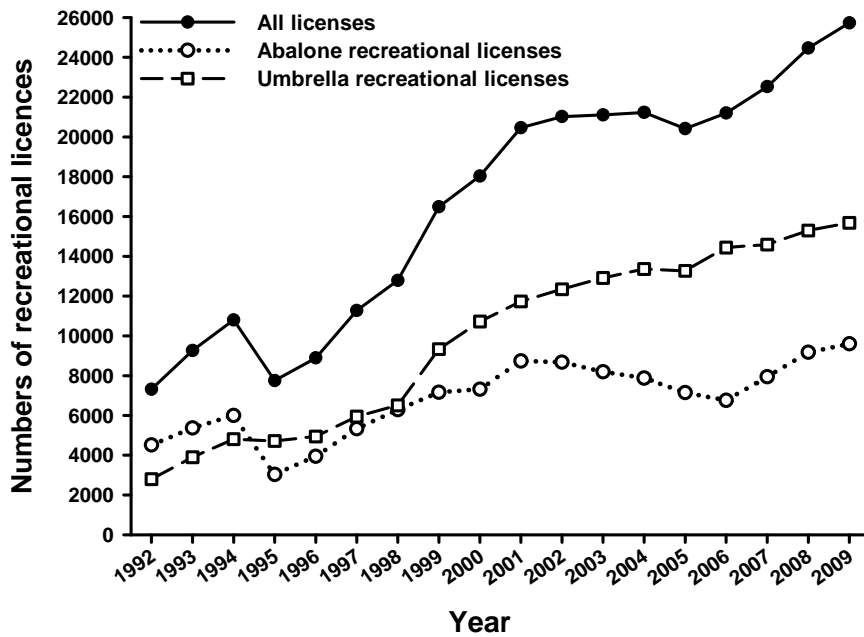
Location	Year	Effort	Greenlip		Brownlip	
			Catch Rate	Catch (tonnes)	Catch Rate	Catch (tonnes)
West Coast	2004	10,100 (6,500 – 13,600)	0.6	4 (2–6)	0.4	3 (1–5)
	2006	8,000 (4,700 – 11,300)	0.3	2 (0–3)	0.4	3 (0–5)
	2007	6,300 (3,800 – 8,800)	0.7	3 (0–6)	0.1	<1 (0–1)
South Coast ¹	2004	2,700 (1,700 – 3,700)	2.4	2 (1–5)	<0.1	<1 (0–1)
	2006	2,800 (1,600 – 3,900)	1.6	2 (0–4)	0.5	1 (0–2)
	2007	4,900 (1,700 – 8,000)	1.8	4 (0–8)	0.2	<1 (0–1)

1. Survey area is South Coast bioregion (i.e. east of Black Point).



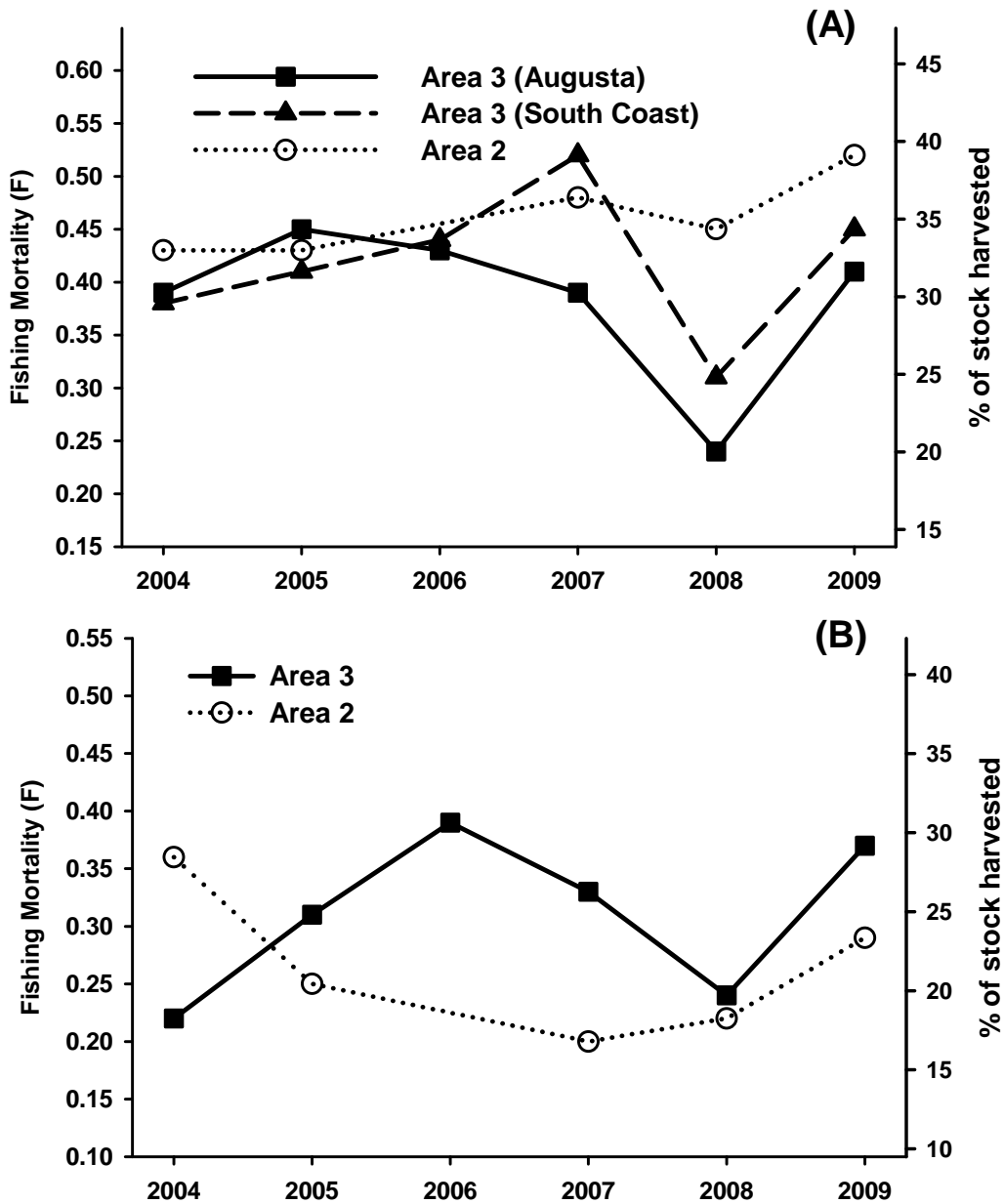
GREENLIP/BROWNLIP ABALONE FIGURE 1

Maps showing the distribution of (a) greenlip and (b) brownlip abalone in Western Australia, and (c) the management areas used to set quotas for the commercial fishery. Area 4 currently has no quota allocated.



GREENLIP/BROWNLIP ABALONE FIGURE 2

The number of licences issued in the recreational abalone fishery, by licence type, for the period since 1992. Data are license counts at the end of the Perth metro abalone season (mid-December).



GREENLIP/BROWNLIP ABALONE FIGURE 3

Fishing mortality for greenlip (A) and brownlip (B) abalone. Estimates of fishing mortality (F) apply only to harvest-size animals, and are derived from catch-curve analysis using length-frequency data, and annualised growth increments based on following growth models. West Coast Greenlip: $L_{\infty}=185$ mm, $K = 0.30$; South Coast Greenlip: $L_{\infty}=179$ mm, $K = 0.25$; Brownlip: $L_{\infty}=200$ mm, $K = 0.30$. Natural mortality (M) is assumed to be 0.25.

South Coast Nearshore and Estuarine Finfish Resources Status Report

K. Smith and J. Brown

Management input from N. Chambers

Main Features

Status	Current Landings (2009)
Stock levels :	Commercial total 618 t (finfish only)
Australian herring Uncertain	South Coast Salmon Fishery 257 t (salmon only)
Australian salmon Acceptable	South Coast herring trap net fishery 124 t
Sea mullet Acceptable	South Coast Estuarine Fishery 217 t (finfish only)
Black bream (Stokes Inlet) Acceptable	Recreational not available for current year.
Black bream (Beaufort Inlet) Acceptable	Most recent survey was in 2000/01.
Black bream (Wilson Inlet) Acceptable	2000/01 finfish catch 368 t (key species only)
Black bream (Oyster Harbour) Acceptable	
Black bream (Walpole-Nornalup Inlet) Not assessed	
Cobbler (Wilson Inlet) Acceptable	
Cobbler (Oyster Harbour) Acceptable	
Fishing Level Acceptable	

Fishery Description

Commercial - Nearshore

Beach-based commercial fishers in nearshore waters of the South Coast Bioregion target various finfish species, mainly using trap nets (herring only), beach seines, haul nets and gill nets. The main targets are the western species of Australian salmon (*Arripis truttaceus*) and Australian herring (*Arripis georgianus*), with small quantities of southern sea garfish (*Hyporhamphus melanochir*) also taken.

Australian salmon form large migratory schools, particularly during the autumn spawning season, that move along the coast in nearshore waters between South Australia and Kalbarri (WA). The species is targeted in WA by 2 commercial fisheries – the South Coast Salmon Managed Fishery and the South-West Coast Salmon Managed Fishery (see later in this report). Fishers target schools of migrating fish mainly during late summer and autumn. Salmon fishing is conducted by teams of fishers setting beach seine nets using either row boats or small jet-powered boats.

Most of the commercial catch of Australian herring in WA is taken on beaches along the south coast using herring trap nets (also known as ‘G’ trap nets). Trap nets are used principally during the autumn migration of this species. Seine nets, gill nets and line fishing in the South Coast Bioregion and West Coast Bioregions take the remainder of commercial herring landings.

Commercial - Estuarine

Approximately 25 major estuaries exist in the South Coast Bioregion, extending from Black Point in the west, to the WA/SA border to the east. Of which, 13 are conditionally

open to commercial fishing as part of the South Coast Estuarine Managed Fishery. This is a multi-species fishery targeting many finfish species, with the main fishing methods being gill net and haul net. The main target species are cobbler (*Cnidoglanis macrocephalus*), black bream (*Acanthopagrus butcheri*), sea mullet (*Mugil cephalus*) and Australian herring.

Recreational

Most finfish caught recreationally in South Coast estuaries and nearshore waters are taken by line fishing. Shore and boat-based fishing are both popular. The most commonly captured recreational species include Australian herring, whiting (various species), trevally (*Pseudocaranx* spp.), black bream (estuaries only), Australian salmon and southern sea garfish.

A relatively small amount of recreational net fishing occurs in the South Coast Bioregion. Recreational net fishing is mainly used to target sea mullet.

Governing legislation/fishing authority

Commercial

South Coast Estuarine Fishery Management Plan 2005

South Coast Estuarine Managed Fishery Licence

Fish Resources Management Act 1994 and subsidiary legislation

Fisheries Notice No. 478 of 1991 (Section 43 Order) (Herring ‘G’ nets)

SOUTH COAST BIOREGION

Fishing Boat Licence Condition 42 (Herring 'G' nets)
South Coast Salmon Fishery Management Plan 1982
South Coast Salmon Managed Fishery Licence
Proclaimed Fishing Zone Notice (South Coast) 1975
Salmon Block Net Prohibition Notice 1996
Salmon and Snapper Purse Seining Prohibition Notice 1987
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation processes

Meetings between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council) and Recfishwest

Boundaries

Commercial - Nearshore

Australian herring can be taken commercially by holders of an unrestricted fishing boat licence on the south coast, east of Black Point. The use of trap nets is restricted to holders of fishing boat licenses with Condition 42, who operate at 10 specific beaches along the south coast.

The South Coast Salmon Managed Fishery: WA waters from Cape Beaufort to the eastern boundary of the State on the south coast of Western Australia.

Commercial - Estuarine

The South Coast Estuarine Fishery encompasses 'the waters of all estuaries on the south coast of Western Australia between Cape Beaufort and 129° east longitude, including Princess Royal Harbour and Oyster Harbour, and all the rivers, streams and all the tributaries that flow into those estuaries.' The areas that are open to commercial fishing are (from west-to-east) Broke Inlet, Irwin Inlet, Wilson Inlet, Princess Royal Harbour, Oyster Harbour, Waychincup Inlet, Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Culham Inlet, Jerdacuttup Lakes, Oldfield Inlet and Stokes Inlet.

Recreational

Recreational line fishing is permitted in most areas within estuaries and nearshore waters of the South Coast Bioregion. Some spatial closures exist, including closures around Dive Wrecks.

A limited number of areas within estuaries and nearshore waters of the South Coast Bioregion are open to recreational netting. Recreational net fishers must hold a licence. Recreational net fishing regulations are complex – please refer to the 'Recreational Net Fishing Guide' for details.

Management arrangements

Commercial

The south coast nearshore and estuarine commercial fisheries are managed primarily through input controls in the form of limited entry and gear restrictions, as well as seasonal and

time closures, area closures and size limits.

The South Coast Salmon Fishery management plan provides for licence holders to operate from assigned beaches between Shoal Cape and Cape Beaufort, with each fishing team having access to a single nominated beach only. These are the only fishers with authority to land and sell Australian salmon in the South Coast Bioregion.

The Herring Trap Net Notice (Order 478 of 1991) prohibits the use of herring trap nets except by licensed commercial fishers using a fishing boat with the appropriate fishing boat licence condition (Condition 42). Holders of fishing boat licences with this condition may take Australian herring using 'G' trap nets on 10 separately nominated south coast beaches. There is a closed season for the use of 'G' trap nets (10 February to 25 March each year) that closely matches the peak Australian salmon migration season along the south coast. Australian herring may also be commercially caught by beach seine, set net and line methods by any licensed commercial fisher holding an unrestricted Fishing Boat Licence, provided the use of this method is permitted in the particular area and the waters being fished are not subject to other fishery management arrangements.

Recreational

Recreational fishers in South Coast estuaries and nearshore waters take a diverse array of finfish species. South Coast size and possession limits apply to these species when caught recreationally in the Bioregion. Refer to the 'Recreational Fishing Guide - South Coast Bioregion' for details.

As many of the recreationally targeted species are also targeted by the commercial sector, resource-sharing issues are a major consideration in these fisheries.

Key species

Australian herring and sea mullet are assigned to the 'low risk' category. Australian salmon and black bream are assigned to the 'medium risk' category. Cobbler is assigned to the 'high risk' category.

Research summary

Monitoring of fisheries and fish stocks in South Coast estuaries and nearshore waters is based on commercial catch and effort statistics (CAES) from compulsory monthly returns, recreational catch and effort data from recreational fishing surveys and fishery-independent surveys to monitor annual juvenile recruitment by various fish species (including herring, salmon, whiting, mullet and cobbler).

While commercial fishery catch levels are determined annually from data reported in compulsory monthly commercial returns, recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted. Relevant surveys include a shore-based creel survey on the west and south coasts in 1994 and 1995 (Ayvazian *et al.* 1997¹), a national phone survey in 2000/01

¹ Ayvazian SG, Lenanton RCJ, Wise B, Steckis R and Nowara G. 1997. Western Australian salmon and Australian herring creel survey. FRDC Final Report. Project No. 93/79. 93 pp. WA Fisheries, Perth

(Henry and Lyle 2003¹) and an estuary creel survey in 2002/03 (Smallwood and Sumner 2007²).

Fishery-independent surveys of juvenile Australian herring, salmon, whiting and mullet species are conducted annually at 6 beach sites along the south and lower west coasts of WA. Using a beach seine net, the number of juveniles of each species caught per haul are used to generate a relative index of annual recruitment for the south-west region, which is then used to forecast adult abundance and commercial fishery catches 2-3 years later for herring and 3-4 years later for salmon. A relative index of annual recruitment of cobbler in Wilson Inlet is generated from catch rates during an annual fishery-independent trapping program. Catch rates are then used to forecast adult abundance and fishery catches in Wilson Inlet 4 to 5 years later.

The interpretation of trends in recruitment, catch and catch rates is assisted by the substantial amount of biological information already available for key nearshore and estuarine species.

A 12-month, state NRM-funded research project designed to provide more rigorous monitoring and assessment of the status of Australian herring commenced in mid-2009. Volunteer anglers and commercial fishers provided samples of herring to enable researchers to determine the age structure of recreational and commercial catches in the West Coast and South Coast Bioregions. This information will be used to assess the feasibility of ongoing age-based assessments and to develop methods, if appropriate, to monitor levels of annual fishing mortality for herring. The NRM-funded project is also examining aspects of stock structure, including the proportions of herring in the West Coast fishery that originate from nursery sites in the South Coast Bioregion.

Retained Species

Total commercial finfish landings (2009):

401 tonnes in nearshore waters

217 tonnes in estuarine waters

Commercial landings by fishery (2009):

South Coast Salmon 257 tonnes (salmon only)

Herring trap net 124 tonnes (herring only)

South Coast Estuarine 217 tonnes (finfish only)

The commercial catches reported in South Coast Nearshore and Estuarine Table 1 are taken by estuarine fisheries and beach-based nearshore fisheries using trap nets (herring only), gill nets, haul nets and beach seines. Minor quantities of the same species that are taken by other methods (e.g. fish traps) are not included in Table 1. Catches by all methods and all fisheries are included in the catches reported for key

species in the following sections and in individual stock assessments.

In 2009, the total commercial catch of finfish by estuarine and beach-based fisheries in the South Coast Bioregion included approximately 29 species. The majority of the catch consisted of Australian salmon (42% by weight) caught by the South Coast Salmon Managed Fishery, Australian herring (25%) caught primarily by the trap net fishery and cobbler (14%) caught by the South Coast Estuarine Managed Fishery.

In 2009, the nearshore catch was comprised mainly of salmon (64% by weight) and herring (33%). The estuarine catch was comprised mainly of cobbler (40%), black bream (23%), sea mullet (12%) and Australian herring (9%).

Since 2000, 96% of landings by the South Coast Estuarine Fishery have been finfish. The majority of finfish landings were taken by gill nets (88%) and haul nets (11%). A small proportion (1%), mainly leatherjackets (*Monacanthidae*) in Princess Royal Harbour, was taken by fish traps.

Key finfish species - nearshore

Australian herring: This species is targeted commercially in Western Australia and South Australia. Negligible quantities are also taken commercially in Victoria. The proportion of total commercial landings taken in South Australia has remained relatively constant since the mid-1970s at approximately 27%.

Since 2000, 83% of total commercial landings of Australian herring in WA have been taken in the South Coast Bioregion, with the remaining 17% taken in the West Coast Bioregion. Within the South Coast Bioregion, 92% of landings were taken by the trap net fishery (i.e. Condition 42 licence holders), 3% taken in estuaries and the remainder taken by other fishers in nearshore waters. All trap net fishery landings were taken in the Albany area.

Since 2000, the total state annual commercial catch of herring steadily declined from 818 t in 2000 to 184 t in 2009 (South Coast Nearshore and Estuarine Figure 1). Annual landings in both bioregions followed a similar downward trend – declining from 700 t to 151 t in the South Coast and from 143 t (in 2001) to 32 t in the West Coast Bioregion. Commercial fishery landings in South Australia also followed this trend.

Total WA commercial landings of herring peaked at 1537 t in 1991, when an historical peak catch of 1427 t was taken in the South Coast Bioregion. The annual South Coast catch declined sharply to 633 t in 1993, and then fluctuated between 626-1001 t per year from 1993 to 2000. Annual landings declined rapidly from 705 t in 2000 to 203 t in 2005. The decline continued at a slower rate after 2005, reaching 151 t in 2009.

The downward trend in the total South Coast catch essentially reflects declining catches by the trap net fishery. The cause of the decline is believed to be a combination of factors – reduced availability of fish due to multiple recent years of low recruitment and lack of targeting in response to low market demand.

Australian salmon: Since 2000, 67% of total commercial landings of Australian salmon in WA have been taken in the South Coast Bioregion, with the remaining 33% taken in the West Coast Bioregion. Within the South Coast Bioregion,

¹ Henry GW and Lyle JM. 2003. The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

² Smallwood CB and Sumner NR. 2007. A 12-month survey of recreational estuarine fishing in the South Coast bioregion of Western Australia during 2002/03. Fisheries Research Report 159. Department of Fisheries, Perth.

SOUTH COAST BIOREGION

almost 100% of landings were taken by the South Coast Salmon Managed Fishery.

Total WA landings of salmon have been declining since 1995 (South Coast Nearshore and Estuarine Figure 2). This trend reflects declining catches on the south coast, where the annual catch has steadily declined from an historical peak of 4046 t in 1995 to 258 t in 2009. By contrast, the West Coast catch trend has been stable (see West Coast Nearshore and Estuarine report). As for herring, the cause of the decline in the South Coast salmon catch is believed to be a combination of factors – reduced availability of fish due to low recruitment in recent years and lack of targeting in response to low market demand.

Key finfish species - estuarine

Cobbler: Commercial targeting of cobbler is essentially restricted to estuaries. From 2000 to 2009, 95% of commercial landings of cobbler were caught in estuaries of the South Coast Bioregion, with the remaining 5% from the West Coast Bioregion. Over this period, total annual landings in the South Coast Bioregion ranged from 40 t (in 2004) to 95 t (in 2003), with 79% of these landings caught in Wilson Inlet, 8% from Oyster Harbour, 7% from Hamersley Inlet and 1% from Princess Royal Harbour.

In 2009, 71 t of cobbler was caught in Wilson Inlet, which was 82% of the total cobbler catch in the South Coast Bioregion. Wilson Inlet has historically produced the vast majority of South Coast landings of cobbler.

In Wilson Inlet, annual cobbler landings steadily increased after the 1940s (minimal catch at this time) until the mid 1980s. Since 1985, annual landings have varied substantially but the overall trend has been stable. From 1985 to 2009, the average annual catch was 52 t. Annual landings reached an historical peak of 79 t in 1985 and again in 2003.

Fluctuations in landings are believed to mainly reflect variations in the availability of cobbler due to variations in recruitment.

Sea mullet: From 2000 to 2009, 42% (by weight) of total commercial landings of sea mullet in WA were taken in the West Coast Bioregion, with 45% from the Gascoyne, 12% from the South Coast and 1% from the North Coast Bioregions.

The historical peak in annual sea mullet landings within the South Coast Bioregion was 92 t in 1992. Annual landings have since declined gradually, reflecting an ongoing reduction in commercial effort in estuarine waters as a result of a fishery adjustment scheme (licence buy-backs). Since 2000, the total annual South Coast commercial catch of sea mullet has fluctuated between 22 (in 2000) and 62 t (in 2007).

From 2000 to 2009, 27% of total commercial landings of sea mullet in the South Coast Bioregion were taken in Wilson Inlet, 15% in Oyster Harbour, 15% in Gordon Inlet, 14% in Beaufort Inlet and 10% in Jerdacuttup Lakes. Minor sea mullet landings were reported in all other estuaries open to commercial fishing over this period. Overall, 97% of landings were taken in estuaries.

Black bream: From 2000 to 2009, 95% of commercial landings of black bream were caught in the South Coast Bioregion, with the remaining 5% from the West Coast Bioregion. In the South Coast Bioregion, total landings over this period were mainly taken in Beaufort Inlet (33% of landings), Stokes Inlet (27%), Wilson (17%) and 12% in Oyster Harbour. Minor bream landings were reported in all other estuaries open to commercial fishing over this period.

Since 2000, total annual South Coast landings of bream have ranged from 30 t (in 2000) to 63 t (in 2005), including 50 t taken in 2009.

Since 1980, Stokes Inlet has contributed the greatest proportion of bream landings of any single estuary (34%) and had the most stable trend in annual landings (average 11 t per year 1980-2009). Culham Inlet has contributed 21% of total landings since 1980. However, most landings were between 1987 and 1995. In 1992, total landings peaked at 97 t in Culham Inlet after favourable environmental conditions led to strong recruitment and subsequent high catches in that system.

Beaufort Inlet has contributed 17% of total landings since 1980. Minimal landings were taken in this estuary prior to 1993. From 1993 to 2005, landings gradually increased and have remained relatively high in subsequent years. Annual landings of bream in Wilson Inlet (contributed 8% of landings since 1980) have followed an almost identical trend. Landings in Oyster Harbour and Oldfield Inlet have also increased markedly since the mid 1990s. These simultaneous increases in various estuaries resulted in an overall increase in South Coast bream landings from the mid 1990s until 2005, followed by a stable trend in total landings from 2005 to 2009.

Recreational catch estimate (2009): NA

Most recent catch estimate (2000/01)

Nearshore + estuarine: 368 tonnes
(key finfish species only)

Most recent catch estimate (2002/03)

Estuarine only 53 tonnes
(key finfish species only)

The recreational catch levels of finfish in nearshore and estuarine waters of the South Coast Bioregion were not estimated for 2009. The most recent nearshore estimates are from the National Recreational and Indigenous Fishing Survey conducted in 2000/01 (South Coast Nearshore and Estuarine Table 2). The most recent estuarine estimates are from a creel survey in 2002/03 (South Coast Nearshore and Estuarine Table 3). While the dominant species in the catch are probably similar to those caught in recent surveys, the catch and effort levels by recreational fishers may have changed substantially. Therefore, current total catch level cannot be estimated.

Overall, the most abundant species in the retained catch (nearshore and estuarine combined) in 2000/01 were

Australian herring (45% by number), King George whiting (*Sillaginodes punctata*) (12%), trevally (*Pseudocaranx* spp.) (10%), whiting (various species, excluding King George) (8%), black bream (7%) and salmon (3%). The nearshore and estuarine waters in the region from Denmark to Esperance contributed 90% of all catches. Shore fishers caught 73% of retained fish in nearshore waters and 28% in estuaries.

In nearshore waters, the most abundant species in the retained catch in 2000/01 were Australian herring (52% by number), trevally (11%), King George whiting (10%), whiting (various species, excluding King George) (9%) and salmon (3%). In estuarine waters, the most abundant species in the retained catch in 2000/01 were black bream (39% by number), King George whiting (23%), Australian herring (11%), mullet (Mugilidae) (6%) and trevally (4%).

The 2002/03 survey involved 17 estuaries, including 11 of the 13 estuaries open to commercial fishing (no commercial catches were taken in the remaining 2 estuaries during the study period). The most commonly reported species were King George whiting, black bream, Australian herring, skipjack trevally (*Pseudocaranx georgianus*), pink snapper (*Pagrus auratus*), flathead (Platycephalidae), tarwhine (*Rhabdosargus sarba*) and garfish, comprising approximately 80% of all fish (by number) retained by recreational fishers during the survey.

In the commercially-fished estuaries, the recreational catch of these 7 species was estimated to be approximately 29% (by weight) of the combined recreational and commercial catch of these species during the survey period. A total of 48 species were reported in the recreational catch from south coast estuaries. However, the total recreational catch (by weight) of all species could not be estimated in 2002/03 due to uncertainties associated with small samples of less abundant species and limited data on the average size of fish in the catch.

With the inclusion of less abundant species and catches taken in estuaries closed to commercial fishing, the recreational catch share of recreationally-targeted finfish species in South Coast estuaries is estimated to be 30-40%. If the landings of non-recreational species (cobble, sea mullet and yellow-eye mullet) are also included, the recreational catch share of total finfish landings is estimated to be approximately 20%.

In 2002/03, the highest recreational fishing catch and effort of any south coast estuary was reported from the Walpole/Nornalup Inlet, which is closed to commercial fishing. The main species taken in this estuary was black bream, with an estimated recreational catch of 15 t during the survey period.

Approximate recreational catch shares (by weight):

The recreational catch share of total finfish landings in nearshore and estuarine waters of the South Coast Bioregion cannot be determined for the current year. Approximate catch shares have been estimated where data are available.

Key species

6% of South Coast Australian salmon catch

11% of South Coast Australian herring catch

50% of South Coast black bream catch

65-75% of South Coast King George whiting catch

99% of South Coast other whiting catch

99% of South Coast trevally catch

Estuaries

20% of total finfish catch

Fishing effort/access level

Commercial

Since 1990, the number of licences in nearshore and estuarine commercial fisheries has been substantially reduced via Voluntary Fishery Adjustment Schemes (i.e. licence buy-backs). The removal of licences has eliminated a significant amount of latent effort (inactive licences) that previously existed in these fisheries.

Fishing effort in nearshore and estuarine fisheries is sometimes reported as the number of units of access (vessels, teams, licences, etc). These measures of effort provide a general indication of effort changes over time and are often the only types of effort data available throughout the history of each fishery. Where possible, effort is also calculated as the number of days fished by each method. It is considered that 'method days fished' generally provides a more accurate measure of the effort undertaken in each fishery.

South Coast Estuarine Fishery: Declines in total fishery effort over the past decade reflect a reduction in the number of licensees in the fishery due to a Voluntary Fisheries Adjustment Scheme. This resulted in the number of licensees being reduced from 66 in 1987 to 25 in 2002.

The total annual reported fishing days peaked at 6,747 days in 1992 and then steadily declined until about 2004.

Similarly, the average number of boats fishing per month peaked at 42.9 in 1992 and then declined. Total effort has followed a stable trend since 2004 with the number of fishing days per year ranging from 3,638 to 3972 and the average number of boats fishing per month ranging from 15 to 18. In 2009, the fishery reported a total of 3690 fishing days and an average of 17 boats fished per month.

In 2009, 52% of effort (method days) occurred in Wilson Inlet, 15% in Princess Royal Harbour, 13% in Oyster Harbour, 6% in Irwin Inlet, 5% in Beaufort Inlet, 4% in Broke Inlet and the remainder in 7 other estuaries. All of the 13 estuaries in the fishery were fished in 2009.

Herring trap net fishery: The number of herring trap net teams that operate during each trap net fishing season provides an approximate measure of effort in this fishery. The total number of licensed teams reached a peak of 30 in 1984, and has since been reduced by a Voluntary Fisheries Adjustment Scheme to the current level of 11 (operating from 10 beaches). In 2009, only 5 teams recorded effort during the

SOUTH COAST BIOREGION

season. This is a continuation of the low participation level in this fishery in recent times. Commercial fishers report that these historically-low effort levels are in response to the lack of markets and low wholesale prices paid for Australian herring.

South Coast Salmon Fishery: The commercial method of fishing for Australian salmon (i.e. beach-based netting) includes a considerable amount of time spent observing or searching for fish ('spotting'). Hence effort in this fishery is difficult to accurately quantify. The number of licensed teams that operate during each fishing season provides an approximate measure of effort in this fishery. Since 1999, there have been 18 licencees in this fishery, who collectively have operated a total of between 9 teams (in 2007) and 21 teams (in 2001 and 2002) per year. Effort (number of teams) has followed a declining trend since 2002. In 2009, salmon landings were reported by 16 teams.

Recreational

Current estimates of recreational effort for the South Coast Bioregion are unavailable.

The 2000/01 National Recreational and Indigenous Fishing Survey, which included all methods and Bioregions, provided the most recent information on total recreational fishing effort in the South Coast Bioregion. About 90% of the nearshore and estuarine 'fishing events' that were targeting finfish during the survey used line fishing (bait or lure). About 85% of all line fishing events occurred in nearshore waters. The estimated nearshore line fishing effort in 2000/01 comprised 223,158 shore-based and 50,368 boat-based fishing events during the 12-month survey period. In estuaries, the line fishing effort comprised 21,800 shore-based and 30,087 boat-based fishing events.

Recreational fishing effort in 17 south coast estuaries was estimated by a creel survey conducted in 2002/03. Total effort during the survey period was estimated at 254,171 fisher hours or 86,482 fisher days. This total included boat-based (202,658 hours), shore-based (47,816 hours) and house boat (3,698 hours) fishing. Recreational netting and charter boat effort was not quantified in this survey, but was considered to have been negligible (less than 2% of total effort).

In the 2002/03 survey, recreational fishing effort was estimated to have occurred mainly in Walpole/Nornalup Inlet (33% of total effort), Oyster Harbour (29%), Princess Royal Harbour (12%), Wilson Inlet (12%) and Wellstead Estuary (6%).

Stock Assessment

Assessment complete	Yes
Assessment method	Catch rates
Breeding stock levels:	
Australian herring	Uncertain
Australian salmon	Acceptable
Sea mullet	Acceptable
Black bream (Stokes Inlet)	Acceptable
Black bream (Beaufort Inlet)	Acceptable

Black bream (Wilson Inlet)	Acceptable
Black bream (Oyster Harbour)	Acceptable
Black bream (Walpole-Nornalup Inlet)	Not assessed
Cobbler (Wilson Inlet)	Acceptable
Cobbler (Oyster Harbour)	Acceptable

Australian herring: Australian herring form a single, genetically homogeneous breeding stock across southern Australia. Spawning occurs mainly along the lower west coast of WA. Eggs and larvae are dispersed by the Leeuwin Current to coastal nurseries distributed from the West Coast Bioregion to Victoria. A strong current can result in high annual recruitment outside the West Coast Bioregion due to greater larval dispersal. Herring caught by the trap net fishery in the South Coast Bioregion are mainly pre-spawning fish undergoing a westward migration to the West Coast Bioregion, where they will spawn during May-June. These fish originate from juvenile nurseries in the South Coast Bioregion, South Australia and (to a lesser extent) Victoria. Herring caught in the West Coast Bioregion are a combination of these fish, plus fish originating from local juvenile nurseries in the West Coast Bioregion.

Since 2000, commercial catch and catch rates suggest declining availability of herring in the South Coast Bioregion, in southern parts of the West Coast Bioregion (Capes, Geographe Bay and Bunbury regions) and in South Australia, but stable or increasing availability in Perth metropolitan waters (South Coast Nearshore and Estuarine Figures 1 and 3). Voluntary recreational logbook fisher catch rates also suggest a stable trend in the availability of Australian herring in Perth metropolitan waters from 2006 to 2009. Declining catches in the southern areas reflect the reduced availability of fish due to declining recruitment (especially 2005 and 2006) in the southern areas (South Coast Nearshore and Estuarine Figure 4). Stable metropolitan catch rates possibly reflect more stable levels of annual recruitment in this area.

The cause of low recruitment in the South Coast Bioregion in recent years is not known. The effect of low South Coast stock abundance on the status of the entire stock is uncertain. Research is underway to examine the extent of connectivity of herring populations between Bioregions, including annual variations in connectivity.

Australian salmon: Australian salmon form a single breeding stock across southern Australia. Spawning occurs mainly along the lower west coast of WA. Eggs and larvae are dispersed by the Leeuwin Current to coastal nurseries distributed from the West Coast Bioregion to Victoria. As for herring, salmon in the South Coast Bioregion undertake a westward migration to the West Coast Bioregion, where they spawn during autumn. Unlike herring, salmon then migrate back to the South Coast. Traditionally, salmon have been targeted by commercial fishers during the autumn (mainly March/April) pre-spawning migration, but in recent years salmon has also been targeted during the late winter/spring post-spawning migrations. From 2000 to 2004, only 2% of total landings were taken during the July-December period. From 2005 to 2009, 32% of total landings were taken during the July-December period.

Annual commercial landings of salmon in the South Coast Bioregion have historically been highly variable, ranging from 753 (in 2009) to 4223 t (in 1968). The South Coast commercial catch and catch rate have been declining since 2002 (South Coast Nearshore and Estuarine Figures 2 and 5). The catch was 753 t in 2009, which was similar to the previous minimum of 755 t in 1978. Reduced targeting of salmon by commercial fishers is believed to be the main reason for lower South Coast catch levels, due to the lack of markets and low wholesale prices paid for this species.

The commercial catch and catch rate in the West Coast Bioregion continue to follow a stable trend (South Coast Nearshore and Estuarine Figures 2 and 5). The total West Coast commercial catch was 258 t in 2009.

Salmon recruitment has been variable since recruitment surveys commenced in 1994, with relatively high levels in 2008 and 2009 (South Coast Nearshore and Estuarine Figure 4). Higher recruitment in 2008 and 2009 is predicted to result in higher commercial catch rates 3-4 years later.

Sea mullet: A single breeding stock of sea mullet is believed to occur in the South Coast Bioregion. Adults typically occur in estuaries, except in winter when they migrate to ocean waters to spawn. Juveniles recruit to estuaries, where they remain until maturity.

Sea mullet abundance in Oyster Harbour is assumed to be representative of regional abundance. This estuary is permanently open to the sea. Catch rates of sea mullet in other estuaries that are seasonally closed can vary according to the extent of connectivity to the sea (i.e. sand bar openings) rather than regional abundance.

The annual commercial catch and catch rates in Oyster Harbour suggest a stable trend in the availability of sea mullet in the South Coast Bioregion from 1980 to 2002 (South Coast Nearshore and Estuarine Figure 6). Higher catch rates from 2002 to 2007 suggest greater availability during these years. The catch rates in 2008 and 2009 suggest recent sea mullet availability has been similar to the long-term average level.

Black bream: Black bream are restricted to estuaries. Each estuary hosts a discrete breeding stock of bream, which is genetically distinct to other estuarine populations.

The majority of commercial bream landings in the South Coast Bioregion are taken in four main estuaries - Stokes Inlet, Beaufort Inlet, Wilson Inlet and Oyster Harbour. Commercial catch rates in these estuaries were relatively low and followed a stable trend from 1980 until 1995, then steadily increased until about 2005 (South Coast Nearshore and Estuarine Figure 7). Since 2005, catch rates have been relatively stable in Beaufort and Stokes Inlets, declined slightly in Wilson Inlet and continued to increase in Oyster Harbour.

Bream landings vary in response to environmental factors in individual estuaries. Simultaneous increases in catch rates in numerous South Coast estuaries from 1995 to 2005 suggest that a widespread factor, such as rainfall, has influenced bream availability and recruitment across the region.

The current status of bream in Walpole-Nornalup Inlet (closed to commercial fishing) cannot be assessed due to lack of recent data from the recreational fishery.

Cobbler: Commercial targeting of cobbler is essentially restricted to estuaries. Each estuary hosts a discrete breeding stock of cobbler, which is genetically distinct to other estuarine populations and also distinct to cobbler populations in adjacent ocean waters. Historically, commercial targeting of cobbler in the South Coast Bioregion has mainly occurred in Wilson Inlet and in the estuaries around Albany (Oyster Harbour, Princess Royal Harbour).

Commercial catch rates suggest a stable long-term trend in the availability of cobbler in Wilson Inlet and Oyster Harbour since 1980 (South Coast Nearshore and Estuarine Figure 8). Catch rates suggest a slight increase in availability in Oyster Harbour after 2000. In Wilson Inlet, catch rates exhibit substantial annual variations that are believed to reflect large variations in recruitment. In particular, catch rates suggested relatively high cobbler availability in the mid 1990s and mid 2000s. The catch rate in 2009 was also relatively high. The Department of Fisheries has conducted annual fishery-independent surveys of juvenile recruitment of cobbler in Wilson Inlet since 2006. Information from these surveys will assist in predicting variations in future catch rates.

Non-Retained Species

Bycatch species impact:

Low

The small-scale commercial fisheries in nearshore and estuarine waters mainly use gill, seine and haul nets that are deployed in a targeted manner. Few non-target species are taken. Mesh size regulations ensure that target species caught by these methods are within an appropriate size range. Minimal discarding occurs because virtually all fish taken can be retained and marketed.

Recreational fishers mainly use line-based methods in nearshore and estuarine waters. This method can result in the capture and release of a significant number of non-target species and undersized fish. The risks associated with post-release mortality vary considerably among species. In general, fish in nearshore and estuarine waters are captured from shallow depths and suffer less barotrauma-related injuries than deep water species.

Protected species interaction:

Negligible

It is compulsory for commercial fishers to report all interactions with protected and listed marine species. New Zealand fur seals and Australian sea lions are occasionally surrounded by beach seine nets used in the South Coast nearshore and estuarine fisheries, but are released immediately by the fishers. This is possible because seine netting is a labour-intensive operation and the fishing team will immediately notice a seal in the net. Fishers are able to release a seal from their seine net without injury to the animal.

The abundance of fur seals on the south coast has steadily increased over the last 15 years, resulting in an increasing level of interaction with fishers, especially in estuaries of the Albany region (R. Campbell, pers. comm.). There have been no reports of incidental mortalities of seals in these fisheries and it is believed that the present level of interaction (direct and indirect) is not a significant threat to the populations of

SOUTH COAST BIOREGION

fur seals and sea lions. An assessment of the impact of interactions is performed on an annual basis and, if required, appropriate management plans will be devised to mitigate these interactions.

Recreational fishers using line-fishing methods are unlikely to capture protected species. Interactions are expected to be insignificant or nil.

Ecosystem Effects

Food chain effects: **Low**

Excessive removal by commercial and recreational fisheries of certain species, such as Australian herring or salmon, from the food chain could potentially impact on prey and predator species including larger fish, cetaceans and seabirds.

However, commercial fishing effort directed towards these species in recent years has been relatively low.

Habitat effects: **Negligible**

The operation of gill nets and haul nets over predominantly sand and mud bottoms is unlikely to have any impact on these habitats in estuaries and nearshore waters. Similarly, the line fishing methods used by recreational fishers have a negligible impact on the bottom substrates. Anchoring by recreational fishing vessels may have localised impacts on habitats such as seagrass.

Haul nets may be deployed low or medium density seagrass. This type of net tends to 'roll' over the surface of seagrass beds without removing attached leaves or uprooting plants. At times, haul nets may collect floating vegetation including seagrass leaves or algae.

Social Effects

Commercial

In 2009, there were approximately 44 commercial fishers involved in the South Coast Salmon Fishery and approximately 16 commercial fishers involved in the South Coast herring trap net fishery. In 2009, the South Coast Estuarine Fishery employed an average of 13.8 fishers per month. Additional employment is created by these fisheries in the processing and distribution networks and retail fish sales sectors.

Herring and salmon fisheries in the South Coast Bioregion supply WA bait and human consumption markets. The South Coast Estuarine Fishery is an important source of fresh local fish to regional centres. Additionally, a small proportion of estuarine landings are sold to zoos across Australia as animal food.

The use of trap nets and seine nets by herring and salmon fishers may temporarily impact on beach access by members of the public.

Recreational

The 2000/01 National Recreational and Indigenous Fishing Survey estimated that approximately 12% of the State's total recreational fishing effort occurs in the South Coast

Bioregion (Henry and Lyle 2003¹, Barharthah 2006²). Fish resources in estuaries and nearshore waters of the Bioregion are a focus for recreational fishers and have a high social value in the region.

Within the South Coast Bioregion, approximately 21% of the recreational fishing effort is estimated to occur in estuaries and rivers. A high proportion of people who fish in each south coast estuary are non-residents, travelling from Perth, other WA regions or interstate. Consequently, fishing in south coast estuaries has a great benefit to local tourism.

Australian herring is the most common finfish species retained by recreational fishers in the South Coast Bioregion (and in WA) and therefore has high social value. In 2000/01 Australian herring were estimated to comprise 15% of all finfish retained by South Coast recreational fishers.

Economic Effects

Estimated annual commercial value (to fishers) for 2008/09:

South Coast Estuarine Fishery	\$983,290
	(finfish only)
South Coast Salmon Fishery + Herring trap net fishery	\$260,478

Fishery Governance

Commercial Current Fishing (or Effort) Level

South Coast Estuarine Fishery	Acceptable
Herring trap net fishery	Acceptable
South Coast Salmon Fishery	Acceptable

The current effort levels directed towards Australian herring and Australian salmon are very low compared to historic levels and considered acceptable at this time.

Target commercial catch range:

South Coast Estuarine Fishery	200 – 500 tonnes
South Coast herring	475 – 1200 tonnes
South Coast Salmon Fishery	1200 – 2800 tonnes
	(includes West Coast landings)

The 2009 South Coast Estuarine Fishery total catch of finfish (217 t) was within the target range of 200-500 t.

The 2009 South Coast catch of Australian herring (151 t) was below the target range of 200-500 t. Low catches in 2009 are

¹ Henry GW and Lyle JM. 2003. The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

² Barharthah T. 2006. Department of Fisheries community survey 2005. Fisheries Occasional Paper No. 33. Department of Fisheries, Perth.

believed to be due to the combined effects of low availability of fish in the South Coast Bioregion due to low recent recruitment and lack of targeting due to weak market demand.

The total state commercial catch of Australian salmon in 2009 (753 t) was below the target range of 1200-2800 t, reflecting low catches in the South Coast Bioregion. Low South Coast catches in 2009 are believed to be due to the combined effects of lack of targeting due to weak market demand, low catchability due to environmental factors and low availability of fish due to low recent recruitment in 2006 and 2007 (South Coast Nearshore and Estuarine Figure 4).

Recreational

Current Fishing (or Effort) Level **Not available**

Target catch range: **Not developed**

New management initiatives (for the next year)

An Order prohibiting the use of herring “G” nets is in its final stages of being drafted. This order will include a list of fishing boat licences that are excepted from the order and therefore enable those licences to continue fishing using herring “G” nets. Once the Order has been gazetted condition 42 will be removed from all fishing boat licenses. In October 2009 the mixed bag limit for Category 3 fish on the west coast will be reduced from 40 to 30.

With the closure to a section of Geographe Bay now permanent and the closure to the Voluntary Fishery Adjustment Scheme for West Coast Salmon fishers there are no new management initiatives for the south or west coast salmon fisheries.

External Factors

Nearshore

It is likely that annual variation in coastal currents (particularly the Leeuwin and Capes Currents) influences the recruitment patterns of larvae of nearshore species such as herring and salmon and thus their subsequent recruitment into each region. Coastal currents also influence the distribution and catchability of adult fish. For example, warmer beach water temperatures are associated with lower catchability of salmon.

On the south coast, an increased abundance of fur seals (R. Campbell, personal communication), which consume Australian herring and Australian salmon, could have impacted on stock levels in recent years. Australian salmon also consume herring.

Fluctuating market demand is a significant factor affecting the annual commercial catch level of many species. Limited demand and low wholesale prices paid for Australian herring and Australian salmon in recent years have limited commercial catch and effort levels. By purchasing only a limited quantity of herring and salmon each year, fish processors effectively restrict the catch level. Commercial fishers sometimes elect not to capture a school of fish, or release part of their catch, when a market is not available.

Estuaries

Variations in the abundance of target species in south coast estuaries are largely driven by environmental factors, independent of fishing. These factors, which are outside the control of the Department of Fisheries, often have a dominant influence on the commercial catch and effort from year-to-year. For example, high rainfall may contribute to higher catches of black bream.

Catchment processes, such as clearing of vegetation, flow regulation and nutrient input, can have major downstream effects on estuary condition and on fishery production. Attempts to quantify the influence of these complex, interacting factors on fishery production are difficult, with the limited biological and environmental monitoring data that are available from south coast estuaries.

The influence of environmental factors on recruitment to estuaries is further complicated by the practice of human intervention to breach estuarine sandbars, mostly for reasons related to estuarine amenity coupled with ecosystem ‘health’.

Increased predation by the expanding fur seal population along the south coast may be impacting on the abundance of some target species. Declining levels of effort expended in Oyster Harbour and Princess Royal Harbour since 2002 largely reflect attempts by commercial fishers to avoid interactions with fur seals, which have increased in numbers in recent years and have become problematic to the fishers due to damage to gear and the removal of fish from nets.

SOUTH COAST BIOREGION

SOUTH COAST NEARSHORE AND ESTUARINE TABLE 1

Total annual catches from the estuarine and beach-based nearshore commercial fisheries in the South Coast Bioregion, 2005 to 2009.

Species	Scientific name	Catch (tonnes)				
		2005	2006	2007	2008	2009
Australian salmon	<i>Arripis truttaceus</i>	689.4	790.7	246.2	545.1	258.0
Cobbler	<i>Cnidogobius macrocephalus</i>	49.4	44.5	68.1	77.4	86.6
Australian herring	<i>Arripis georgianus</i>	203.1	302.1	192.2	236.3	151.3
Black bream	<i>Acanthopagrus butcheri</i>	63.5	34.0	46.2	37.8	49.9
Sea mullet	<i>Mugil cephalus</i>	32.8	27.3	59.3	23.3	26.3
Sea Garfish	<i>Hyporhamphus melanochir</i>	12.7	15.7	18.0	16.8	7.6
Flathead	Platycephalidae	12.0	8.8	9.1	9.2	5.2
King George whiting	<i>Sillaginodes punctata</i>	11.9	5.8	8.0	9.1	6.3
Leatherjacket	Monacanthidae	10.5	12.6	6.7	5.5	2.2
Tarwhine	<i>Rhabdosargus sarba</i>	4.3	3.7	3.1	5.3	2.7
Yellow-eye mullet	<i>Aldrichetta forsteri</i>	3.7	3.6	3.0	4.6	3.4
Pink snapper	<i>Pagrus auratus</i>	0.9	1.9	3.2	3.6	2.1
Yellowtail scad	<i>Trachurus novaezelandiae</i>	5.3	3.5	1.1	0.3	0.2
Trumpeters	Teraponidae	1.9	3.4	2.5	0.3	1.7
Seapike	<i>Sphyræna obtusa</i>	0.6	1.3	2.4	2.9	1.9
Flounder	Pleuronectidae	3.1	2.7	1.7	1.1	0.2
Trevally	<i>Pseudocaranx georgianus</i>	0.7	3.4	3.1	2.4	2.9
Yellow-finned whiting	<i>Sillago schombergkii</i>	2.5	0.1	0.1	1.1	0.6
Other finfish	Teleostei	4.3	3.8	3.7	4.2	3.4
Other baitfish (not Whitebait)	Clupeidae	1.5	0.9	1.3	0.5	0.9
Sharks and rays	Elasmobranchii	1.7	3.5	2.9	3.8	1.6
TOTAL		1115.6	1273.3	681.8	990.7	615.0

SOUTH COAST NEARSHORE AND ESTUARINE TABLE 2

Estimated total recreational catches of key species in nearshore and estuarine waters in the South Coast Bioregion in 2000/01 (Henry and Lyle 2003¹).

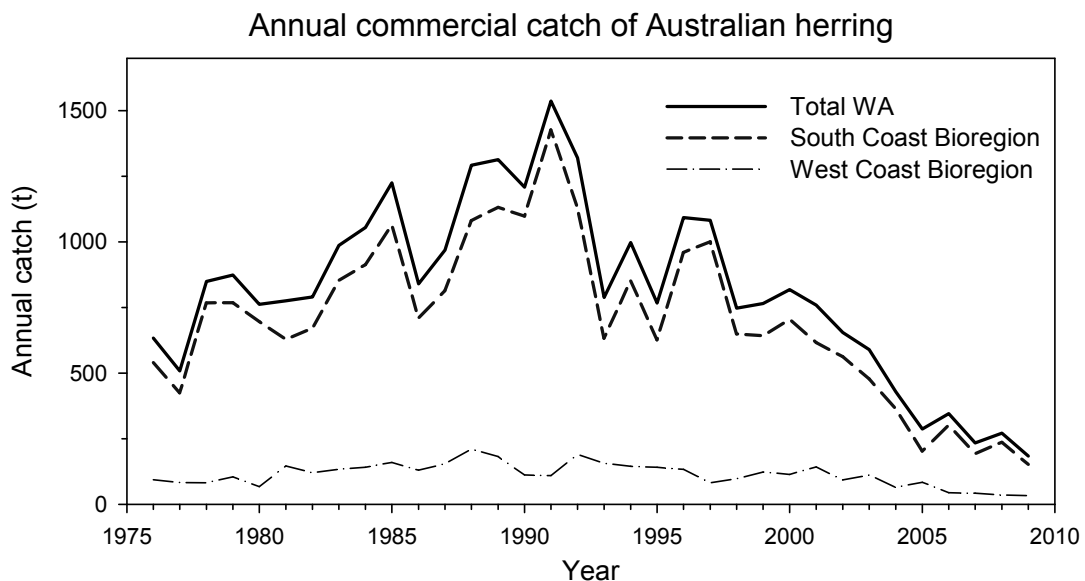
Species	Scientific name	2000/01 Catch (tonnes)
Australian salmon	<i>Arripis truttaceus</i>	117
Trevally	<i>Pseudocaranx</i> spp.	93
Australian herring	<i>Arripis georgianus</i>	79
King George whiting	<i>Sillaginodes punctata</i>	40
Black bream	<i>Acanthopagrus butcheri</i>	28
Whiting	<i>Sillago</i> spp.	11
TOTAL		368

¹ Henry GW and Lyle JM. 2003. The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

SOUTH COAST NEARSHORE AND ESTUARINE TABLE 3

Estimated total recreational catches of key species in estuaries in the South Coast Bioregion in 2002/03 (Smallwood and Sumner 2007).¹

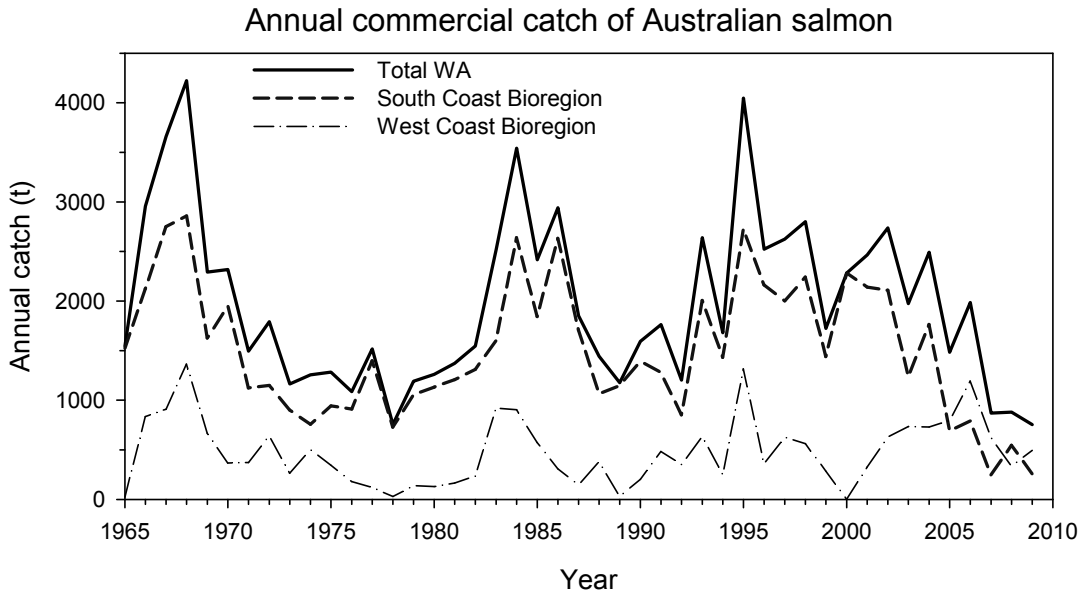
Species	Scientific name	2002/03 Catch (tonnes)
Black bream	<i>Acanthopagrus butcheri</i>	23.3
King George whiting	<i>Sillaginodes punctata</i>	10.9
Trevally	<i>Pseudocaranx</i> spp.	6.1
Australian herring	<i>Arripis georgianus</i>	4.1
Southern blue-spotted flathead	<i>Platycephalus speculator</i>	2.6
Pink snapper	<i>Pagrus auratus</i>	2.6
Tarwhine	<i>Rhabdosargus sarba</i>	0.5
Southern sea garfish	<i>Hyporhamphus melanochir</i>	0.2

**SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 1**

Total annual commercial catches of Australian herring in the South Coast and West Coast Bioregions, 1976 – 2009.

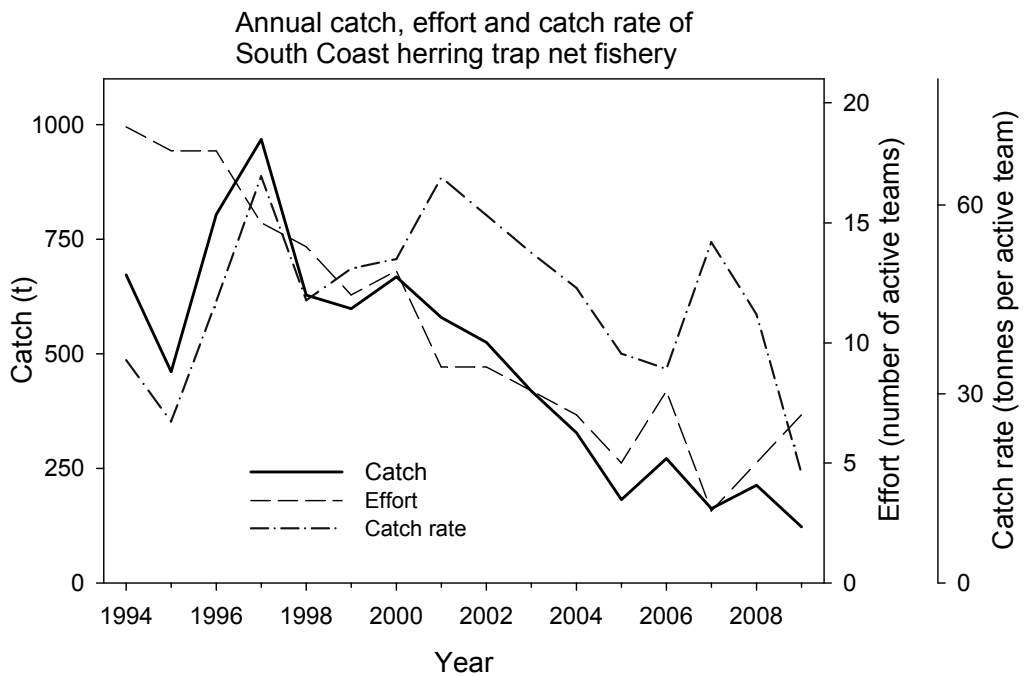
¹ Smallwood CB and Sumner NR. 2007. A 12-month survey of recreational estuarine fishing in the South Coast bioregion of Western Australia during 2002/03. Fisheries Research Report 159. Department of Fisheries, Perth.

SOUTH COAST BIOREGION



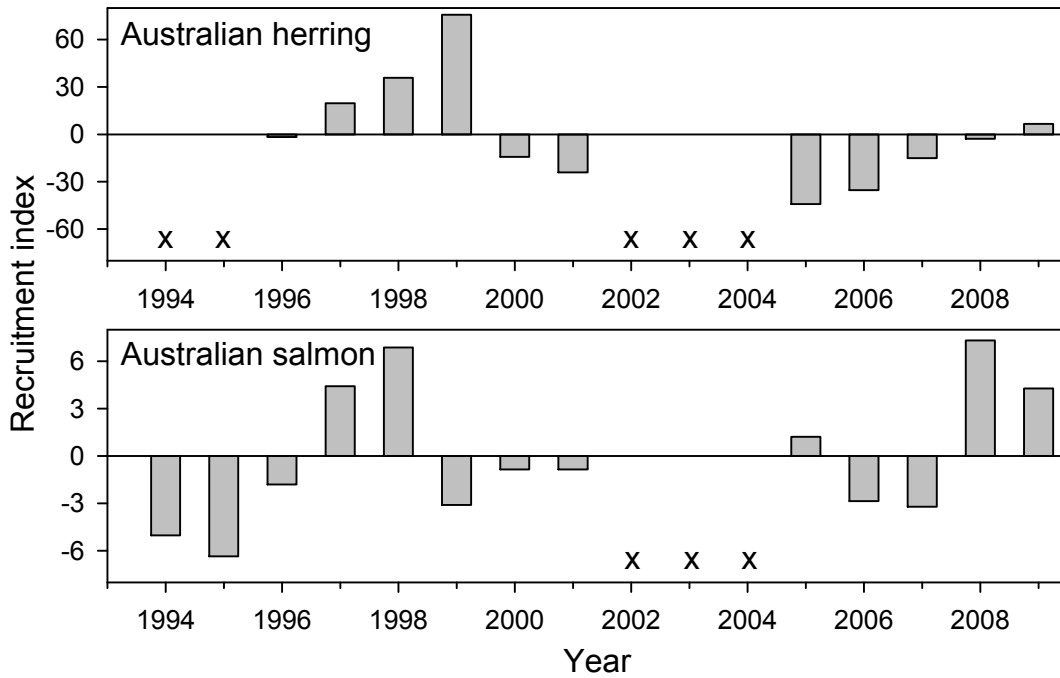
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 2

Total annual commercial catches of Australian salmon in the South Coast and West Coast Bioregions, 1965 – 2009.



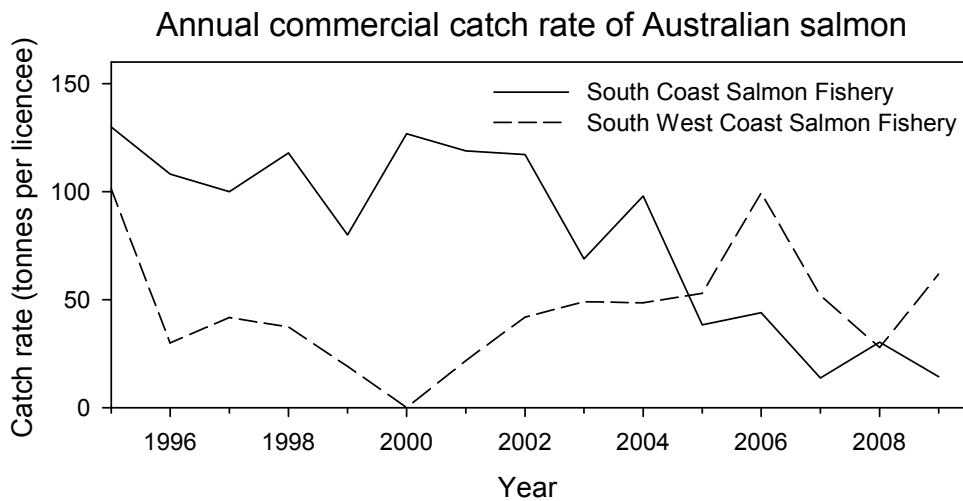
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 3

Total annual catch, effort and catch rate of Australian herring by the South Coast commercial trap net fishery, 1994 – 2009.



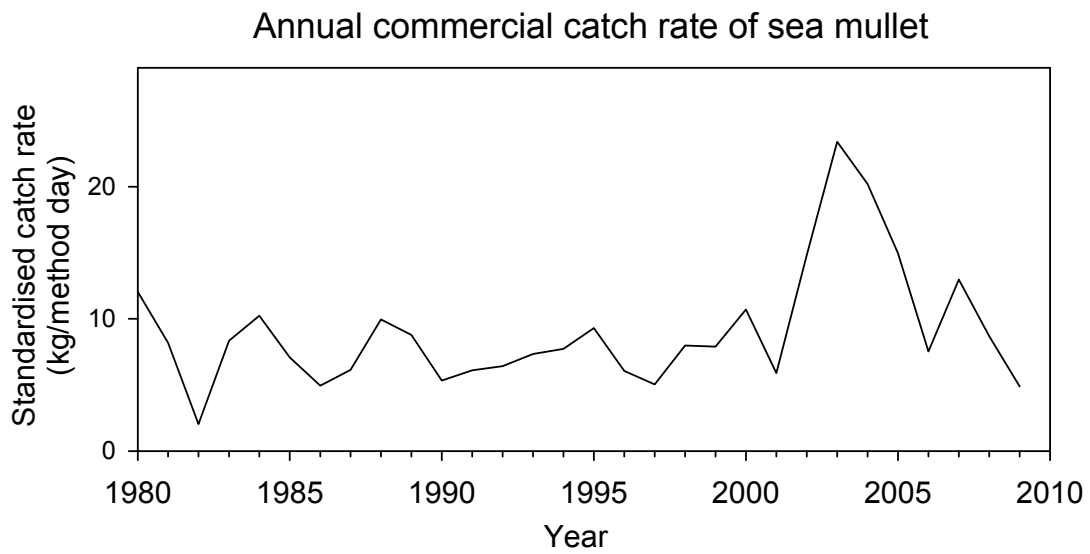
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 4

Annual fishery-independent recruitment indices for Australian herring and Australian salmon in the South Coast Bioregion, 1994 – 2009. (x – no sampling conducted in that year)



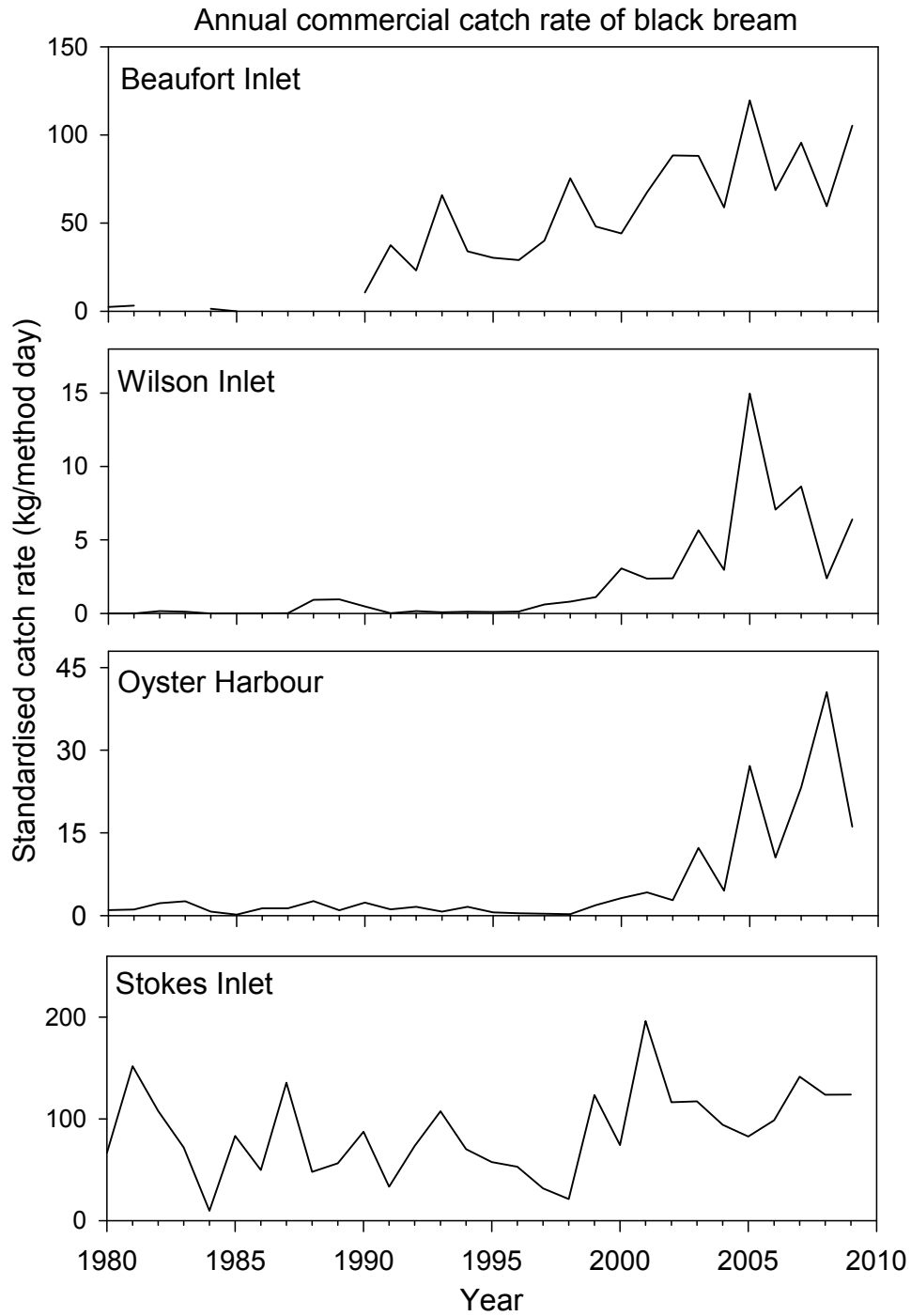
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 5

Total annual commercial catch rates of Australian salmon in the South Coast Salmon Fishery (South Coast Bioregion) and the South West Coast Salmon Fishery (West Coast Bioregion), 1995 – 2009.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 6

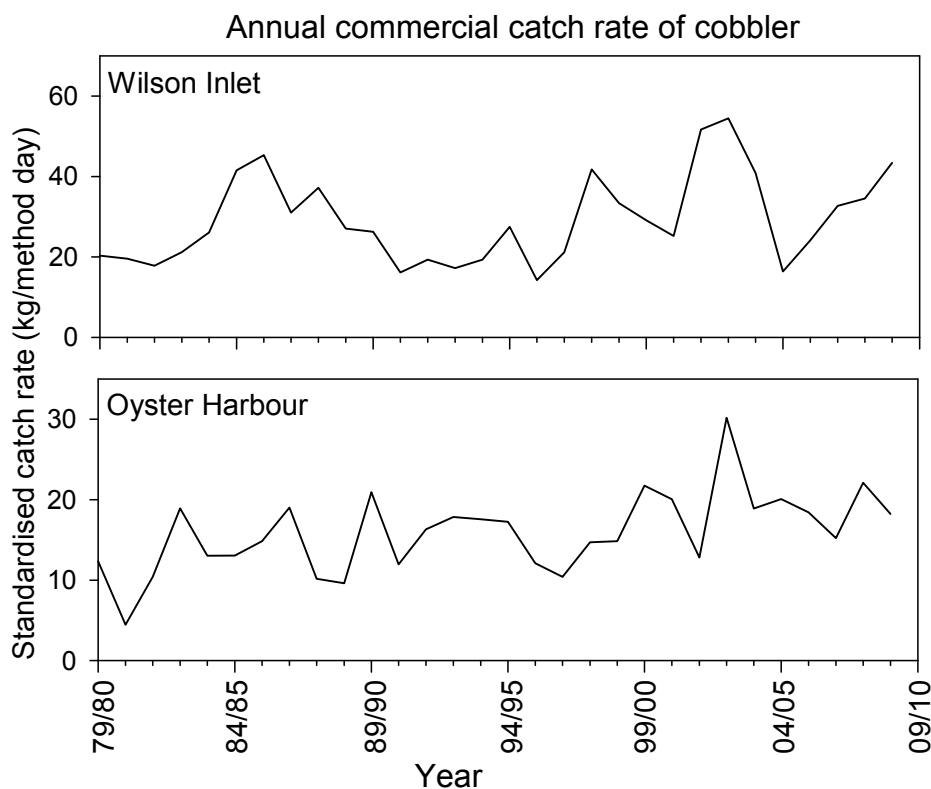
Annual commercial catch rate of sea mullet in Oyster Harbour, 1980 – 2009.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 7

Annual commercial catch rates of black bream in Beaufort Inlet, Wilson Inlet, Oyster Harbour and Stokes Inlet, 1980 – 2009.

SOUTH COAST BIOREGION



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 8

Annual commercial catch rates of cobbler in Wilson Inlet and Oyster Harbour, 19/79/80 – 2008/09.

South Coast Purse Seine Fishery Report: Statistics Only

B. Molony and E. Lai

Management input from Noel Chambers

Fishery Description

This fishery is based on the capture of pilchards (*Sardinops sagax*) by purse seine nets in the waters between Cape Leeuwin and the Western Australia/South Australia border. The management plan also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus teres*).

Boundaries

The Fishery consists of three major management zones. The Albany Zone (including the King George Sound zone) extends from Point D'Entrecasteaux to Cape Knob. The Bremer Bay Zone extends from Cape Knob to longitude 120°E. The Esperance Zone from 120°E to the WA/SA border. An additional zone exists between Cape Leeuwin and Point D'Entrecasteaux but has not been significantly fished to date.

Management arrangements

This fishery is primarily managed through output controls in the form of individually transferable quota (ITQ) units. Each zone in the fishery has been allocated a set amount of ITQ units whose values are reviewed annually and changed, if necessary, depending on the results of stock assessment. The sum of ITQ holdings within each zone for any one year equates to an annual total allowable catch (TAC). The total quota units allocated across each of the five zones in the fishery amount to 890 and remained unchanged from the previous season. The quota season for the South Coast Purse Seine Managed Fishery runs from 1 July to 30 June each year. The Albany zone has an annual TAC of 2683 tonnes, while both the Bremer Bay and Esperance zones have an annual TAC of 1500 tonnes each.

Landings and Effort

Commercial pilchard catches during the 2008/09 season were 2,001.8 t, up from 1,735.3 t in 2007/08, extending the trend of gradually increasing total catches in this fishery since the late 1990s (South Coast Purse Seine Figure 1). An additional 4 t of other species were also landed, dominated by yellowtail scad. Increased catches were reported despite a decline in overall effort in this fishery in 2008/09 (effort decreased by approximately 6% compared to 2007/08 effort). Most of the commercial catches continue to be reported from the Albany Zone (1,350.9 t), with much lower catches reported in the Bremer Bay and Esperance Zones (511.7 t and 139 t, respectively). However, catches from the Bremer Bay and Esperance Zones in 2008/9 were much higher than those reported in 2007/08. Nonetheless, overall effort and catches remain below those recorded during the late 1980s and 1990s.

Fishery Governance

Target commercial effort range: Not available

For the 2008/09 season, the catch was well below the total TAC for the entire fishery (5,683 t). The fleet and infrastructure for this fishery is rebuilding, but irregular

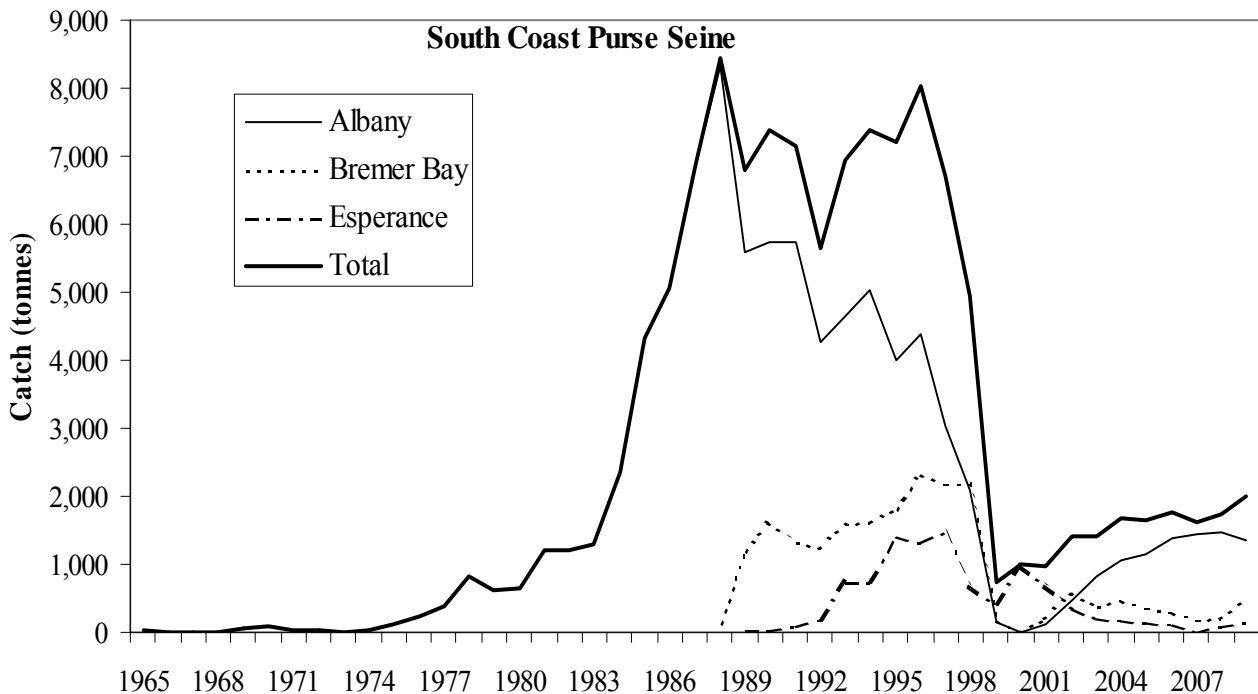
availability of market-sized fish, particularly in Bremer Bay and Esperance, influence how much of the TAC is caught. These factors, combined with the variability in unit holdings within the fishery and resultant variability in fishing behaviour by different operators, mean that it is currently difficult to estimate a target effort range for the fishery.

Current Fishing (or Effort) Level: Acceptable

Based on the most recent assessment (completed in 2006) and the recent history of the fishery, the level of spawning biomass in each major management zone is likely to be appropriate and the current level of fishing is acceptable.

New management initiatives (2010/11)

As a result of the code of conduct from the working group established by the Department of Fisheries in 2006 to reduce interactions in the south coast purse seine fishery, the fishery continues to reduce the number and severity of interactions with fleshy footed shearwaters. The Department has introduced a new catch and disposal record book for this fishery, the book is designed to allow for easy recording of protected species interactions.



SOUTH COAST PURSE SEINE FIGURE 1

Annual catches of pilchards along the south coast, by fishing zone

Demersal Gillnet and Longline Fisheries Status Report

R. McAuley and T. Leary

Management input from Nikki Sarginson

Main Features	
Status	Current Landings (2008/09)
Demersal Gillnet and Demersal Longline Fishery	
Stock level	Total sharks and rays 1238 t
Gummy shark Acceptable	Scalefish 220 t
Dusky shark Depleted	Indicator species
Sandbar shark Depleted	Gummy shark 600 t
Whiskery shark Recovering	Dusky shark 170 t
Fishing Level	Sandbar shark 81 t
JASDGDLF Zone 1 Acceptable	Whiskery shark 141 t
JASDGDLF Zone 2 Acceptable	Catch of sharks and rays by other commercial fisheries (2008/09) 9 t
WCDGDLF Acceptable	Recreational catch (2005/06) <5% of commercial catch

Fishery Description

The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF) and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) employ demersal gillnets and demersal longlines with power-hauled reels along the south and lower west coasts. The majority of operators use demersal gillnets to target sharks, with demersal scalefish also being a legitimate component of the catch. The main shark species targeted by fishers on the south coast are gummy shark (*Mustelus antarcticus*) and dusky shark (*Carcharhinus obscurus*), while on the west coast fishers primarily target dusky shark and sandbar shark (*Carcharhinus plumbeus*). Whiskery shark (*Furgaleus macki*) is also an important component of both fisheries' catch. As their stocks span multiple bioregional boundaries, dusky, sandbar and whiskery sharks are assessed and monitored as indicators of the Statewide inshore demersal suite of species. Gummy sharks, on the other hand, are an indicator species of the south coast bioregion inshore demersal suite. The two fisheries are reported together here because extensive research has demonstrated that they share these key unit stocks.

Governing legislation/fishing authority

South Coast

Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992

Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery Licences

West Coast

West Coast Demersal Gillnet and Demersal Longline (Interim) Management Plan 1997

West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery Permits

Consultation processes

Meetings between the Department of Fisheries and the WA Demersal Gillnet and Longline Association; the Western Australian Fishing Industry Council; regional meetings with authorisation holders and masters; and direct correspondence.

Boundaries

The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery spans the waters from 33°S latitude to the WA/SA border and comprises two separate management zones. Zone 1 extends southwards from 33°S to 116°30'E longitude off the south coast. Zone 2 extends from 116°30'E to the WA/SA border (129°E).

The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery technically extends northwards from 33°S latitude to North West Cape (114°06'E longitude). However, the use of shark fishing gear has been prohibited north of 26°30'S (Steep Point) since 1993. Demersal gillnet and longline fishing inside the 250 metre depth contour has also been prohibited off the Metropolitan coast (between latitudes 31° S and 33° S) since 15 November 2007.

See Figure 1 for management boundaries of both fisheries.

Management arrangements

The southern and west coast fisheries are regulated through two complementary management plans. The JASDGLF management plan was introduced in 1988 and is managed by the Western Australian Government on behalf of a Joint Authority comprising the Western Australian and Commonwealth Governments. The WCDGDLF is administered by the Western Australian Government under a management plan introduced in 1997.

Both fisheries are managed via input controls in the form of transferable time/gear effort units, with additional restrictions on mesh and hook sizes, net height ('drop') and maximum net length. Historically, each unit has permitted the use of one length of net or an equivalent number of hooks for one month. However, since 2006/07, the Department has been working with operators to transition the fishery to a more explicit hourly effort management system, with the objectives of removing latent effort capacity and restricting effort within each management zone to 2001/02 levels. Once formally implemented, through amendments to the management plans, all units will permit the use of 27 m of gillnet or 9 hooks on a longline for either 288 hours (in the WCDGDLF), 264 hours (in Zones 1 and 3 of the JASDGLF) or 380 hours (in Zone 2 of the JASDGLF).

Additional measures to address remaining sustainability concerns for key stocks were introduced during the 2006/07 season. These included:

- a two month closure of the fisheries (16 August to 15 October), including the inshore waters to 200m depth throughout all of the WCDGDLF and the waters of the South Coast west of 118° E (in the JASDGLF) to assist in the recovery of the over-exploited whiskery shark stock;
- a maximum size limit for dusky sharks to protect their breeding stock; and
- a prohibition of metal trace wire and large hooks, which had previously been used to target large whaler sharks.

The above shark management arrangements are supported by more precautionary regulations in non-target fisheries, including the State-wide commercial protection of all sharks and rays, which is intended to restrict their landings to a handful of fisheries.

In addition, to further assist in the protection of medium-high risk whaler shark stocks, a maximum size limit for whaler sharks taken by recreational fishers within the waters of the South Coast and West Coast Bioregions, was introduced in February 2009.

The metropolitan zone has now been closed to the WCDGDLF. To offset the Metropolitan Area Closure and mitigate against shifts in effort to northern grounds of the WCDGDLF, the Government established a Voluntary Fisheries Adjustment Scheme with the aim of buying-back 33% of WCDGDLF entitlement. This scheme is now closed and approximately 35% of entitlement was reduced.

In April 2009, the temperate demersal gillnet and demersal longline fisheries were declared approved Wildlife Trade Operations following re-assessment under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The accreditation allows continued

export of product from these fisheries for a period of three years.

Research summary

Major FRDC-funded studies of the shark fishery on the south and west coasts of Western Australia, undertaken over the period 1993–2004, have provided a detailed basis for monitoring and assessing the fishery. The extensive biological and fishery information gained from these studies have been reported in three FRDC final reports, numerous international journal publications and the data have been used to develop stock assessment models for the fisheries' key target stocks to determine their likely responses to current levels of exploitation and to test alternative harvest regimes.

Current research monitoring involves analysis of fishing returns data and periodic biological sampling of commercial and fishery-independent catches. To support the new fishery management arrangements that were introduced in 2006, improve assessments of key stocks and to facilitate the more detailed reporting requirements of the fisheries' export accreditation under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act, a new daily/trip catch and effort reporting system was introduced in 2006/07. To resolve initial instances of missing, misreported and confounded catches in daily/trip logbook data, an extensive data recovery and correction exercise has been undertaken and all logbook data for 2006/07 to 2008/09 are reported below (see Demersal Gillnet and Longline Tables 1-3 and Figures 2-4).

In addition to research on the fisheries' target stocks, some tactical research has been completed on grey nurse shark (*Carcharias taurus*) and Australian sea lion (*Neophoca cinerea*) bycatch issues. Two National Heritage Trust funded projects investigated movements and aggregation site locations of grey nurse sharks and a recent FRDC-funded project examined the relative spatial risks of sea lion interactions with demersal gillnets.

Retained Species

Commercial landings (seasons 2006/07 - 2008/09):

All sharks (and rays):	1,275 tonnes (2006/07)
	1,505 tonnes (2007/08)
	1238 tonnes (2008/09)
Key shark species:	1,008 tonnes (2006/07)
	1,226 tonnes (2007/08)
	993 tonnes (2008/09)
Gummy:	575 tonnes (2006/07)
	755 tonnes (2007/08)
	600 tonnes (2008/09)
Dusky: 158 tonnes	(2006/07)
	142 tonnes (2007/08)
	170 tonnes (2008/09)

SOUTH COAST BIOREGION

Whiskery:	147 tonnes (2006/07)
	171 tonnes (2007/08)
	141 tonnes (2008/09)
Sandbar:	128 tonnes (2006/07)
	159 tonnes (2007/08)
	81 tonnes (2008/09)

Other finfish (i.e. non shark) catch: In addition to their primary catch of sharks, the JASDGDLF and WCDGDLF land a number of scalefish species, which totalled 240 t in 2006/07, 227 t in 2007/08 and 220 t in 2008/09 (Demersal Gillnet and Longline Figure 4). This included catches of 64.2 to of demersal scalefish from the West Coast Bioregion in 2008/9 (Demersal Gillnet and Longline Table 3). For details of other fisheries' demersal scalefish catches in the same bioregions that the demersal gillnet and demersal longline fisheries operate, see Demersal Scalefish Fishery Status Report (pp. xx-yy) and South Coast Wetline Fishery Report (pp. xxx-yyy).

Shark catches in other fisheries: Sharks were also historically caught off the south and west coasts in a variety of other commercial fisheries. However, due to the very poor standard of reported species identification of non-targeted shark catches and their contribution to identified sustainability risks to some stocks (eg. dusky shark), the retention of sharks and rays was prohibited in most non-target fisheries in November 2006 throughout the State by commercially protecting all sharks and rays (elasmobranchs). Reported elasmobranch catches by vessels operating in other managed fisheries between North West Cape and the South Australian border consequently declined to 5 t in 2006/07, 3.4 t in 2007/08 and 3.9 t in 2008/09.

Recreational catch estimate (season 2005/06): **< 5% of total catch**

The recreational catch of sharks by fishers operating from trailer-boats between Augusta and Kalbarri was estimated from two Department of Fisheries surveys conducted in 1996/97 and 2005/06. The total recreational shark catch was estimated to have declined from ca. 7,000 sharks per year in 1996/97 to ca. 5,500 sharks per year in 2005/06, although only about half of these were reported to have been retained. The reported species composition of the retained catch in 2005/06 was similar to that of the Demersal Gillnet and Demersal Longline fisheries, Whaler shark species were the most commonly retained group (31%), followed by hound sharks (gummy, whiskery, etc.; 28%), wobbegongs (14%) and hammerheads (10%). Assuming an average weight of 5 kg per shark, then the west coast recreational take of sharks at the time of the survey would have been about 13.5 t, or approximately 3% of the west coast commercial shark catch in that year. However, as WCDGDLF catches (and effort) have declined by approximately 70% since 2005/06 and recreational fishing effort is likely to have increased over the same period, the relative magnitude of recreational shark catches, particularly in the west coast bioregion, requires re-evaluation.

Fishing effort/access level

There are 57 licences in the JASDGDLF, 24 in Zone 1 and 33 in Zone 2. However, only 9 Zone 1 and 17 Zone 2 vessels reported active fishing returns during 2008/09 (6 Zone 1 and 15 Zone 2 vessels in 2006/07 and 7 Zone 1 and 17 Zone 2 vessels in 2007/08). At the commencement of the 2008/09 fishing season there were 26 permits in the WCDGDLF. As a result of the WCDGDLF Voluntary Fisheries Adjustment Scheme, the Government had bought back 6 WCDGDLF permits by the end of the 2008/09 season. Only 6 (the same as 2007/08 and one less than 2006/07) reported active fishing returns during the year.

As gillnetting is by far the dominant method employed in the fisheries, effort is expressed in standardised units of kilometre gillnet hours (km gn hr) by converting the historically small amount of longline effort into the equivalent gillnet effort by comparing longline catches with gillnet Catch Per Unit Effort (CPUE). Fishing effort is shown for the 3 reported years in Demersal Gillnet and Longline Tables 1-3 and in Demersal Gillnet and Longline Figure 5. Effort was below target levels of 36,663 km gn hr for Zone 1, 115,012 km gn hr for Zone 2 and 55,522 km gn hr, for the WCDGDLF in all zones and years, except during 2008/09, when Zone 1 effort was estimated to have been 106% of its target level. It should be noted that as more than 30% of WCDGDLF units were removed via a Voluntary Fisheries Adjustment Scheme in 2008/09, the target effort level will be proportionally reduced in next year's report.

Stock Assessment

Assessment complete:	Yes
Assessment method:	
Gummy shark	CPUE
	(relative to previous age structured model)
Dusky shark	CPUE
	(relative to previous direct survey)
Sandbar shark	CPUE
	(relative to previous direct survey)
Whiskery shark	Age Structured Model
Breeding stock levels:	
Gummy shark	acceptable
Dusky shark	unacceptable
Sandbar shark	unacceptable
Whiskery shark	recovering

Stock assessments are carried out for the four indicator shark species caught by the fishery using a combination of catch and effort data, periodic empirical estimates of fishing mortality rates, biological information and dynamic biomass and demographic models. Historical catch and effort data are corrected to account for missing fishing returns and inaccurately reported species compositions prior to 1989/90 and an increasing efficiency of 2% yr⁻¹ prior to 1995/96. Missing, misreported and confounded catches in the daily/trip

logbook data submitted since 2006/07 were recovered and/or corrected using fishers' personal records, fish processor returns, face to face and phone interviews with fishers or were derived from average fish weights from accurately-reported logbook records or from observed size compositions of demersal gillnet and demersal longline catches and available length weight relationships.

Trends in the status of the fisheries' four key species are assessed using corrected gillnet-only catch and effort data taken from each one degree x one degree reporting block that overlaps the species' primary distributions within the fishery (as defined below). Due to the introduction of an annual two month whiskery shark 'pupping' closure in 2006 and the prohibition of demersal gillnet fishing in the metropolitan region in November 2007, historical data from west of 118°E during August, September and October and from latitudes 31°S to 33°S have been excluded from analysis. To investigate apparent changes in CPUE data arising from the shift to daily/trip logbook reporting and to account for uncertainty in the combined time series of catch and effort data, two methods have been used to calculate an 'effective' annual CPUE for each species. The first divides the sum of monthly block catches by the sum of monthly block effort (ratio of the means) and the second calculates the annual mean of the monthly block CPUE values (mean of the ratio). However, until some discrepancies between the two sets of effective CPUE estimates can be resolved, inferences on stock status are made from both trends.

Gummy shark: The best (median) estimate from age-structured modelling indicated that the Western Australian gummy shark stock was 42.7% of its virgin biomass (hereafter referred to as B_0) in 1997/98, slightly above its minimum acceptable level of 40% of B_0 . Subsequent catches and upwards trends in both estimates of effective catch rates (taken from the area off the south coast between 116°E and 129°E longitudes) have indicated little cause for concern (Demersal Gillnet and Longline Figure 6). As gummy shark catches are almost exclusively comprised of adults, the increasing trends in CPUE suggest that the breeding biomass is increasing. However, as catches since 2006-07 have been between 28% and 68% above the upper limit of their target catch range and the stock has not been comprehensively assessed since 1998, a new model that incorporates contemporary catch, effort and size or age data requires development.

Dusky shark: The status of the Western Australian dusky shark stock was first assessed in 1999 and again in 2005, using revised demographic modelling techniques, updated biological parameters and additional fishing mortality rate estimates. Subsequent assessments have relied on analysis of catch and CPUE trends in relation to the stock's estimated demographic rates prior to 2005.

The updated demographic analysis confirmed that rates of demersal gillnet and longline fishing mortality were most likely to have been sustainable for sharks born between 1994 and 1995. However, the model also predicted that additional low levels (1–2% yr^{-1}) of fishing mortality applied to sharks older than 10 years of age would result in negative rates of population growth. These results suggest that the stock is highly susceptible to unrecognised mortality of older sharks and provide a plausible explanation for the declining trend

observed in one of the effective CPUE trends (ratio of the means) since 1994/95. However, the same downwards trend is not evident in the mean of ratios estimates (Demersal Gillnet and Longline Figure 7).

Because dusky sharks give birth to live young, there is likely to be a relatively direct relationship between recruitment and breeding stock biomass. Therefore, the declining CPUE of juvenile dusky sharks in the gillnet fishery evident in one of the effective CPUE series, may indicate declining breeding stock biomass. However, discrepancies between the different effective CPUE trends require further investigation.

Whiskery shark: Between 2005/06 and 2008/09, both estimates of effective whiskery shark CPUE remained stable above 1990s levels. When applied separately in the age-structured population model, which was last updated in 2007, both effective CPUE series indicated that the whiskery shark stock has begun to recover after its significant depletion during the 1980s and continued gradual decline through the 1990s (Demersal Gillnet and Longline Figure 8).

Median estimates of total biomass were calculated to have increased by an average of 3.5% to 3.6% per year between 2006/07 and 2008/09. The best estimates of total biomass in 2008/09 were 37.4% and 47.6% of B_0 , with 95% confidence that the stock was between 35.9% and 38.8% or between 44.4% and 49.4% of B_0 , respectively. When combined, results from the two models suggest that total biomass in 2008/09 was 42.5% ($\pm 0.95\%$) of B_0 . The model estimated that mature female biomass had, on average, increased by between 6.3% and 7.3% per year between 2006/07 and 2008/09. As the full benefits of additional management measures, designed to reduce whiskery catches and improve recruitment to the stock (see management arrangements above), have not yet become evident, stock recovery is expected to accelerate when sharks born during the closed season begin to reach reproductive age in 2012.

Sandbar shark: Sandbar shark stock assessment was undertaken using empirically-derived estimates of fishing mortality and demographic modelling techniques, similar to those used for dusky shark. As age-specific fishing mortality rates were estimated for the period 2001/02 to 2003/04, subsequent assessments of this stock have relied on analysis of catch and CPUE trends. The model indicated that combined levels of fishing mortality from the northern shark fisheries, the temperate demersal gillnet and longline fisheries and non-target fisheries (corresponding to combined catches of 250 – 440 tonnes per year) were increasingly unsustainable between 2001 and 2004 and had probably been so since at least 1997/98. Given these results, the combined targeted catch of 918 tonnes in 2004/05 (762 tonnes of which was reported by the northern shark fisheries) is considered to have been highly unsustainable.

Although both estimates of effective sandbar shark CPUE reflect an increase in catch rates since 2005/06, one shows a marked decline between 2002/03 and 2005/06, while the other is stable for the same period (Demersal Gillnet and Longline Figure 9). The declining trend evident in the former data is consistent with the model-predicted decline in recruitment beginning in the late 1990s. Furthermore, fishery-independent survey data collected from the area between northern Shark Bay and Eighty Mile Beach, where mature sandbar sharks are prevalent, suggest a significant decline in

SOUTH COAST BIOREGION

breeding stock abundance between 2002 and 2005. As breeding biomass is already likely to be close to the minimum acceptable limit (40% of B_0) and possibly continuing to decline, this stock requires careful monitoring and may require additional species-specific recovery measures in the future.

Other sharks: The four indicator species of the temperate shark 'suite' account for approximately 80% of the fisheries' and bioregional shark catch. As they also represent the range of life history strategies of other shark species caught by the fisheries, their status is believed to generally reflect the status of other sharks in the South and West coast bioregion. However, as dusky and sandbar sharks have among the lowest intrinsic population growth rates of all continental shelf distributed sharks and because previous impacts on their stocks were largely a result of targeted fishing activities, remaining concerns for their sustainability may not represent the risks faced by the rest of the species suite.

Non-Retained Species

Bycatch species impact: **Low**

The catch composition of the fishery was examined in detail for the period 1994 to 1999 (McAuley and Simpfendorfer 2003). There is some discarded bycatch of unsaleable species of sharks, rays and scalefish. During ESD risk assessment of these fisheries in 2002, all impacts on stocks of bycatch species were determined to be low risk. As fishing effort is now explicitly capped at approximately 65% of the level of mid to late 1990s, bycatch levels in all management zones are expected to be proportionally reduced. Recent multi-fisheries bycatch risk assessment has identified the Port Jackson shark among the higher risk bycatch species in the west coast bioregion (Evans, in prep)¹. Although this species is one of the largest components of the demersal gillnet and demersal longline fisheries bycatch and is recorded as bycatch in other commercial fisheries, cumulative risks were assessed as low-moderate.

Protected species interaction: **Negligible-Low**

Observed rates of protected species captures were very low throughout the fishery during the mid to late 1990s (McAuley and Simpfendorfer 2003). Marine mammal captures were observed at a rate of just over 1 per 10,000 km gillnet hours, seabirds at 1 capture per 25,000 km gillnet hours and turtles at 1 capture per 100,000 km gillnet hours. It should be noted that demersal gillnet and longline fishing are not permitted between Steep Point (26°30' S) and a line drawn north of North West Cape (114°06' E), or within 3 nautical miles of the Abrolhos Islands baselines, where populations of turtles and dugongs are present.

Small numbers of white sharks (*Carcharodon carcharias*) and grey nurse sharks (*Carcharias taurus*) have been reported in daily logbooks since 2006/07 (mean of 11/yr and < ca. 66/yr, respectively). In keeping with previous

observations, the majority of these sharks were reported to have been released alive. Evans (in prep) also assessed the cumulative bycatch risk to these species as low-moderate.

Two studies have highlighted risks to Australian sea lions from demersal gillnet captures in these fisheries. Evans (in prep) assessed sea lion bycatch risk to be moderate-high in the West Coast Bioregion and Campbell (in prep) suggested that several sea lion colonies in the south east of the State and at Beagle Island on the west coast to be at greatest risk. However, further work is required to estimate actual levels of sea lion bycatch in these fisheries or to verify the very low capture rate observed by McAuley and Simpfendorfer (2003).

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The level of effort is such that the gear is deployed infrequently over approximately 40% of the fisheries' area and under normal circumstances the physical impact of the gear on the bottom is minimal.

Social Effects

Direct: Estimated employment during the period 2006/07 to 2008/09 was between 49 and 65 skippers and crew in the JASDGLDF and between 9 and 18 in the WCDGLDF. Unlike other regions, sharks are generally not targeted by recreational fishers in Western Australia, thus their direct social importance to this group is negligible.

Indirect: Sharks are viewed as a menace by some members of the community due to their perceived danger to bathers and their predation of prized recreationally caught fish. However, others consider them to be important components of marine ecosystems that deserve to be conserved.

Economic Effects

Estimated annual commercial value (to fishers)

for year 2006/07:

JASDGLDF:	\$4.2 million (shark*)
	\$0.7 million (scalefish)
WCDGLDF:	\$0.9 million (shark*)
	\$0.4 million (scalefish)

for year 2007/08:

JASDGLDF:	\$5.2 million (shark*)
	\$0.8 million (scalefish)
WCDGLDF:	\$0.9 million (shark*)
	\$0.3 million (scalefish)

¹ Evans, R. *In prep*. Ranked Risk Assessment of Multiple fisheries: a new bioregional risk assessment method. Final report to the Western Australian Marine Science Institution.

for year 2008/09:

JASDGDLF:	\$4.6 million (shark*)
	\$0.9 million (scalefish)
WCDGDLF:	\$0.5 million (shark*)
	\$0.2 million (scalefish)

* As fishers do not specify the value of fins on their catch returns, fin values were calculated at an average of 3% of sharks' whole weight and value was conservatively estimated using a price of \$35/kg. Categories of shark which do not have saleable fins were excluded from fin valuation.

Fishery Governance

Current Fishing (or Effort) Level

JASDGDLF Zone 1	Acceptable
JASDGDLF Zone 2	Acceptable
WCDGDLF	Acceptable

Maximum acceptable effort levels for each management zone have been set at their respective 2001/02 levels. These levels are considered likely to deliver sustainable harvests of the fisheries' key target species and acceptably low levels of bycatch and protected species interactions. Under explicit hourly-gear input control arrangements, effort should not exceed these limits.

Target commercial catch range:

Key shark and ray species 725–1,095 tonnes

Individual target catch ranges for the key species in 2008/09 were as follows:

Gummy shark	350–450 tonnes
Dusky shark	200–300 tonnes
Sandbar shark	< 120 tonnes
Whiskery shark	175–225 tonnes

Gummy shark catches have exceeded the upper limit of their acceptable range since 2003-04, and reached historically high levels in 2006-07 (575 t), 2007-08 (755 t) and 2008-09 (600 t). Although these unprecedented catches are believed to be a result of increasing stock abundance, updated stock assessment modelling is required to evaluate their implications to stock sustainability.

Dusky shark catches were between 71% (2007/08) and 85% (2008/09) of their minimum acceptable level during the last 3 years. However, as over 30% of WCDGDLF units were removed in 2008/09 as a result of a Voluntary Fishery Adjustment Scheme, the acceptable dusky shark catch range will need to be adjusted downwards to 180-280 tonnes next year. In relation to this revised acceptable catch range, catches between 2006/07 and 2008/09 were between 79% and 95% of the minimum acceptable catch limit, consistent with the proportion of effort expended in the fisheries.

Catches of sandbar sharks exceeded the maximum acceptable catch of 120 t by 7% and 35% in 2006/07 and 2007/08. However, following a 66% reduction in WCDGDLF effort between 2005/06 and 2008/09, the sandbar catch declined to 81 tonnes in the most recent year reported. Recent catches of sandbar shark off the north coast are reported in the Northern Shark Fisheries Status Report.

New management initiatives (for 09/10)

The remaining components of the new JASDGDLF and WCDGDLF management arrangements foreshadowed in previous status reports are expected to be in place by the commencement of the 2009/2010 season (for the WCDGDLF) and by the end of 2009 (for the JASDGDLF). Currently, the outstanding elements of this package are:

- formal conversion of existing monthly gear units to hourly units;
- explicitly capping effort within each zone at their 2001/02 levels; and
- formal implementation of the vessel monitoring system.

To support and assess the success of these management changes, there will need to be increased monitoring of these fisheries, with a focus on size composition of catches and tagging to update harvest rates, particularly for dusky shark and sandbar sharks.

Following the outcomes of the Wetline Review, the Government has made a commitment to address the long-term sustainability of demersal scalefish on the West Coast by reducing both commercial and recreational catches of demersal scalefish by at least 50% of 2005/06 levels. Demersal scalefish is an important component of the temperate demersal gillnet and demersal longline fisheries catch, and these fisheries will be monitored against the demersal scalefish objectives on the West Coast, in addition to shark and ray sustainability objectives.

External Factors

There are a number of factors outside of the control of the fishery which are negatively impacting the performance of key temperate shark stocks. These include incidental catches of dusky shark, sandbar and gummy sharks in other State and Australian Government-managed fisheries and in overlapping WA-managed fisheries. For the sandbar population particularly, continued high catches of the breeding stock in the northern shark fisheries is a cause for considerable concern. The ongoing mortality of older juvenile and adult dusky sharks from entanglement in plastic packing straps may also be compromising future recruitment to this stock. Targeted gummy shark fishing by Australian Government-managed vessels also occurs to the east of Zone 2 of the JASDGDLF. However, as that fishery is tightly managed via quota controls, it is unlikely that current catches are causing any detrimental effect to the WA fisheries. All of these outside influences however need to be taken into account in the stock assessment process for these species and accommodated in the management strategy.

SOUTH COAST BIOREGION

DEMERSAL GILLNET AND LONGLINE TABLE 1

Summary of 2006/07 catch (t live wt.) by the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Data are given by management zone and also by bioregion (italicised). Indicator species and catches are highlighted in bold.

Name	Species or taxon	JASDGLF			Bioregion		Total
		Zone 1	Zone 2	WCDGDLF	South Coast	West Coast	
Gummy	<i>Mustelus antarcticus</i>	37.6	525.9	11.4	541.7	33.2	574.9
Dusky whaler	<i>Carcharhinus obscurus</i>	84.2	38.6	34.8	63.4	94.2	157.7
Whiskery	<i>Furgaleus macki</i>	39.9	80.7	26.8	97.8	49.6	147.4
Sandbar	<i>Carcharhinus plumbeus</i>	20.7	0.9	106.3	8.7	119.1	127.8
Hammerheads	Sphyrnidae	25.1	21.5	18.4	27.8	37.2	65.0
Wobbegongs	Orectolobidae	38.8	7.8	22.5	20.0	49.1	69.1
Bronze (copper) whaler	<i>Carcharhinus brachyurus</i>	16.3	18.8	7.9	26.4	16.5	42.9
Spinner (long nose grey)	<i>Carcharhinus brevipinna</i>	11.0	0.1	23.0	1.6	32.4	34.1
Rays	Batoidea	1.5	9.3	3.6	10.0	4.3	14.3
School	<i>Galeorhinus galeus</i>	0.0	1.8	0.0	1.8	0.0	1.9
Other elasmobranchs		8.6	16.4	15.5	27.1	23.5	50.6
Total elasmobranchs		283.6	721.8	270.0	826.4	459.1	1285.5
Queen Snapper	<i>Nemadactylus valenciennesi</i>	20.2	24.0	7.7	36.8	15.1	51.8
Blue Groper	<i>Achoerodus gouldii</i>	19.3	15.6	4.7	21.7	17.9	39.7
Pink snapper	<i>Pagrus auratus</i>	6.5	10.7	15.7	15.9	16.8	32.8
Dhufish	<i>Glaucosoma hebraicum</i>	13.2	1.5	9.6	5.1	19.2	24.4
Sweetlips	Haemulidae	0.0	0.0	14.5	0.0	14.5	14.5
Samsonfish	<i>Seriola hippos</i>	2.2	1.7	12.4	3.6	12.7	16.3
Mulloway	<i>Argyrosomus hololepidotus</i>	1.0	7.1	6.4	7.4	7.2	14.6
Redfishes	<i>Centroberyx</i> spp.	2.9	4.3	0.7	6.5	1.4	7.9
Boarfishes	Pentacerotidae	0.9	4.0	0.6	4.5	1.0	5.5
Baldchin groper	<i>Choerodon rubescens</i>	0.4	0.0	2.1	0.0	3.7	3.7
Other scalefish		8.4	9.4	11.2	12.9	16.1	29.0
Total scalefish		74.7	78.3	87.0	114.5	125.5	240.1
<i>'Demersal scalefish suite' component</i>		64.6	62.9	62.8	94.0	96.3	190.2
Fishing effort (equivalent km gillnet hours x 1000)		33.8	62.3	47.9			141.5

DEMERSAL GILLNET AND LONGLINE TABLE 2

Summary of 2007/08 catch (t live wt.) by the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Data are given by management zone and also by bioregion (italicised). Indicator species and catches are highlighted in bold.

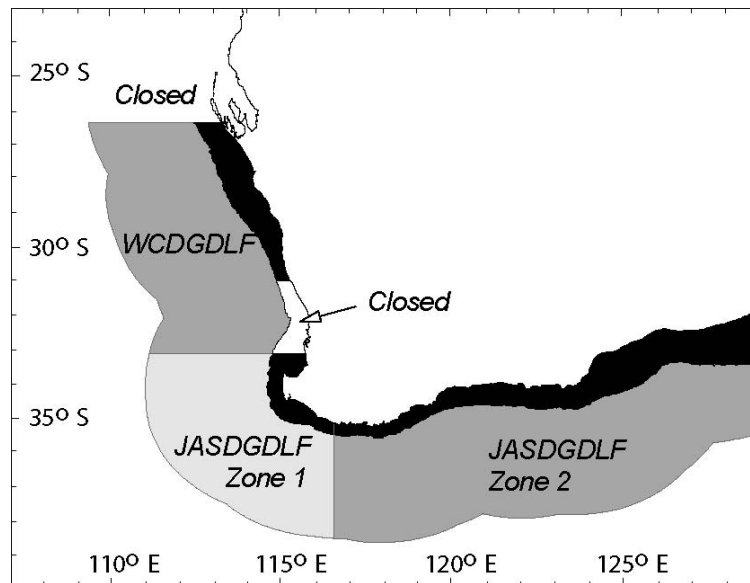
Name	Species or taxon	JASDGLF			Bioregion		Total
		Zone 1	Zone 2	WCDGDLF	South Coast	West Coast	
Gummy	<i>Mustelus antarcticus</i>	44.6	693.1	17.3	720.2	34.8	755.0
Dusky whaler	<i>Carcharhinus obscurus</i>	71.5	43.4	27.0	66.5	75.4	141.9
Whiskery	<i>Furgaleus macki</i>	44.8	110.3	15.5	132.4	38.2	170.6
Sandbar	<i>Carcharhinus plumbeus</i>	6.7	1.1	150.8	1.9	156.6	158.5
Hammerheads	Sphyrnidae	16.6	30.3	15.1	34.6	27.4	62.0
Wobbegongs	Orectolobidae	32.2	9.5	11.4	18.4	34.7	53.2
Bronze (copper) whaler	<i>Carcharhinus brachyurus</i>	12.0	43.9	2.4	48.0	10.3	58.3
Spinner (long nose grey)	<i>Carcharhinus brevipinna</i>	14.5	5.5	14.9	8.2	26.6	34.8
Rays	Batoidea	1.7	7.8	3.0	9.3	3.2	12.5
School	<i>Galeorhinus galeus</i>	0.0	14.4	0.0	14.4	0.0	14.4
Other elasmobranchs		4.6	13.7	25.8	18.2	31.0	49.2
Total elasmobranchs		249.3	972.9	283.0	1072.1	438.3	1510.4
Queen Snapper	<i>Nemadactylus valenciennesi</i>	16.7	33.7	3.3	43.3	10.4	53.7
Blue Groper	<i>Achoerodus gouldii</i>	18.9	20.4	3.1	28.1	14.4	42.5
Pink snapper	<i>Pagrus auratus</i>	8.4	13.1	9.9	17.4	14.0	31.4
Dhufish	<i>Glaucosoma hebraicum</i>	13.9	1.4	9.5	5.0	19.9	24.8
Sweetlips	Haemulidae	0.0	0.0	17.1	0.0	17.1	17.1
Samsonfish	<i>Seriola hippos</i>	1.2	2.8	6.2	3.9	6.4	10.3
Mulloway	<i>Argyrosomus hololepidotus</i>	1.7	4.5	4.4	4.6	6.0	10.7
Redfishes	<i>Centroberyx</i> spp.	0.8	6.8	0.3	7.4	0.5	7.9
Boarfishes	Pentacerotidae	1.1	4.7	0.3	5.3	0.8	6.1
Baldchin groper	<i>Choerodon rubescens</i>	0.2	0.0	1.8	0.0	2.0	2.0
Other scalefish		6.3	7.2	7.4	10.0	10.9	20.9
Total scalefish		69.1	94.6	63.6	125.0	102.4	227.3
'Demersal scalefish suite' component		61.0	82.0	49.5	108.9	83.6	192.5
Fishing effort (equivalent km gillnet hours x 1000)		34.7	89.1	52.4			175.5

SOUTH COAST BIOREGION

DEMERSAL GILLNET AND LONGLINE TABLE 3

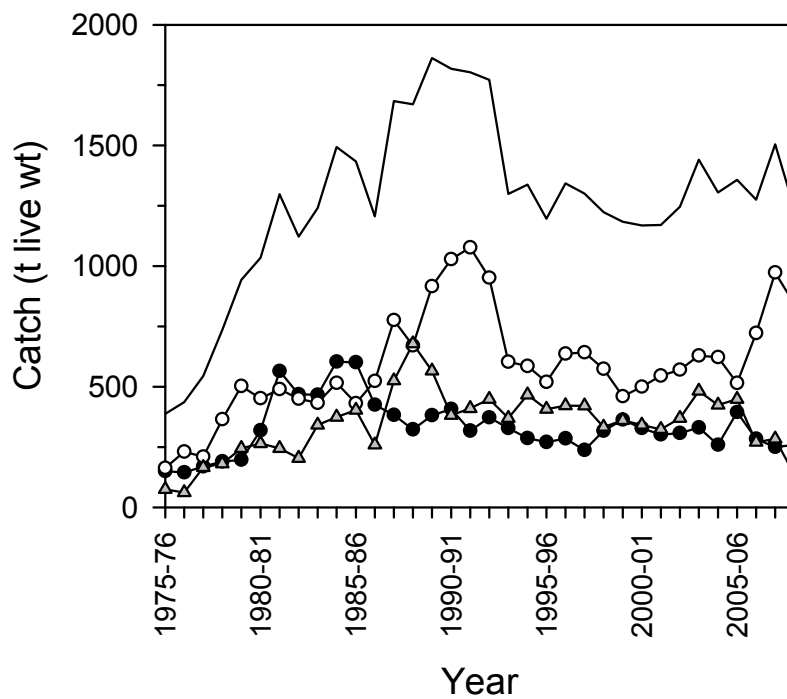
Summary of 2008/09 catch (t live wt.) by the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Data are given by management zone and also by bioregion (italicised). Indicator species and catches are highlighted in bold.

Name	Species or taxon	JASDGLF			Bioregion		Total
		Zone 1	Zone 2	WCDGDLF	South Coast	West Coast	
Gummy	<i>Mustelus antarcticus</i>	28.9	570.6	0.8	580.1	20.2	600.3
Dusky whaler	<i>Carcharhinus obscurus</i>	93.4	53.9	23.0	87.3	83.0	170.2
Whiskery	<i>Furgaleus macki</i>	41.4	90.4	9.4	102.7	38.5	141.2
Sandbar	<i>Carcharhinus plumbeus</i>	8.4	1.9	70.8	8.4	72.7	81.1
Hammerheads	Sphyrnidae	18.6	41.1	6.7	46.3	20.2	66.4
Wobbegongs	Orectolobidae	31.6	11.3	6.2	24.5	24.6	49.2
Bronze (copper) whaler	<i>Carcharhinus brachyurus</i>	12.5	35.8	0.4	39.4	9.3	48.7
Spinner (long nose grey)	<i>Carcharhinus brevipinna</i>	19.4	2.3	8.4	7.0	23.1	30.1
Rays	Batoidea	2.2	15.0	1.4	15.9	2.8	18.6
School	<i>Galeorhinus galeus</i>	0.0	6.0	0.0	6.0	0.0	6.0
Other elasmobranchs		2.3	14.7	8.9	15.7	11.0	26.7
Total		258.9	842.9	135.9	933.2	305.3	1238.4
Queen Snapper	<i>Nemadactylus valenciennesi</i>	21.6	38.7	0.1	51.5	8.9	60.4
Blue Groper	<i>Achoerodus gouldii</i>	27.0	28.0	0.4	40.4	15.1	55.4
Pink snapper	<i>Pagrus auratus</i>	6.3	12.5	5.6	15.8	8.6	24.4
Dhufish	<i>Glaucosoma hebraicum</i>	14.6	2.2	4.6	6.9	14.5	21.4
Sweetlips	Haemulidae	0.0	0.0	9.1	0.0	9.1	9.1
Samsonfish	<i>Seriola hippos</i>	2.2	2.3	3.4	3.0	4.9	7.9
Mulloway	<i>Argyrosomus hololepidotus</i>	2.0	1.0	1.9	1.4	3.4	4.9
Redfishes	<i>Centroberyx</i> spp.	2.3	8.8	0.0	10.2	0.9	11.1
Boarfishes	Pentacerotidae	1.1	5.0	0.1	5.6	0.6	6.2
Baldchin groper	<i>Choerodon rubescens</i>	0.1	0.0	1.8	0.0	3.2	3.2
Other scalefish		6.0	5.3	4.8	7.8	8.2	16.1
Total		83.0	103.8	33.2	142.6	77.4	220.0
<i>'Demersal scalefish suite' component</i>		73.6	96.8	25.9	132.2	64.2	196.4
Fishing effort (equivalent km gillnet hours x 1000)		38.7	103.6	27.1			169.3



DEMERSAL GILLNET AND LONGLINE FIGURE 1

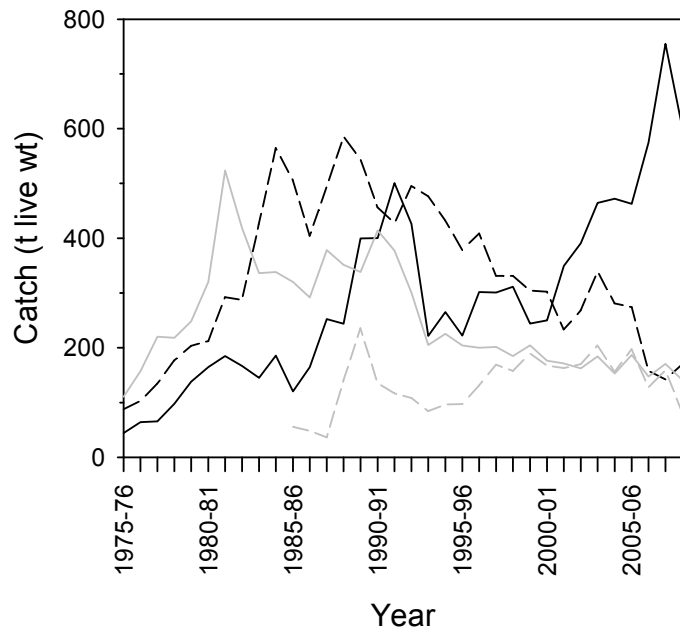
Management boundaries of the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Black shading represents fished areas of less than 200m depth.



DEMERSAL GILLNET AND LONGLINE FIGURE 2

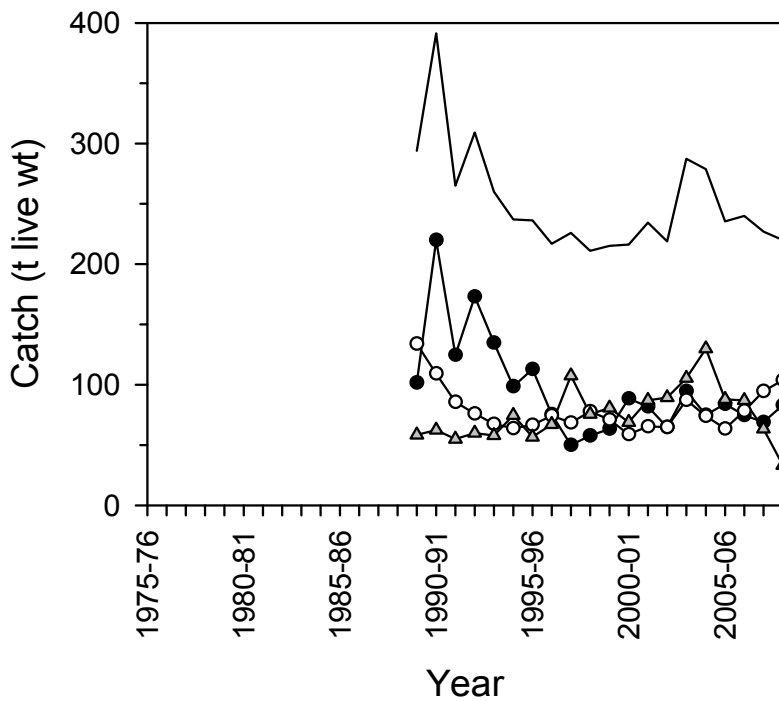
Total elasmobranch catches. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; grey triangles = WCDGDLF; plain black line = total from the three management zones.

SOUTH COAST BIOREGION



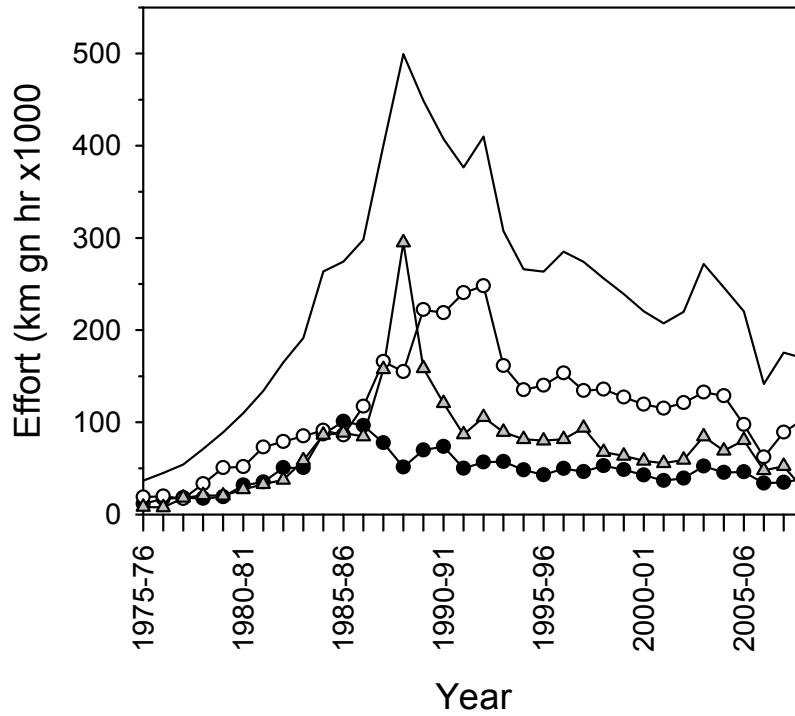
DEMERSAL GILLNET AND LONGLINE FIGURE 3

Shark indicator species catches (all management zones). Solid black line = gummy shark; dashed black line = dusky shark; solid grey line = whisky shark; dashed grey line = sandbar shark.



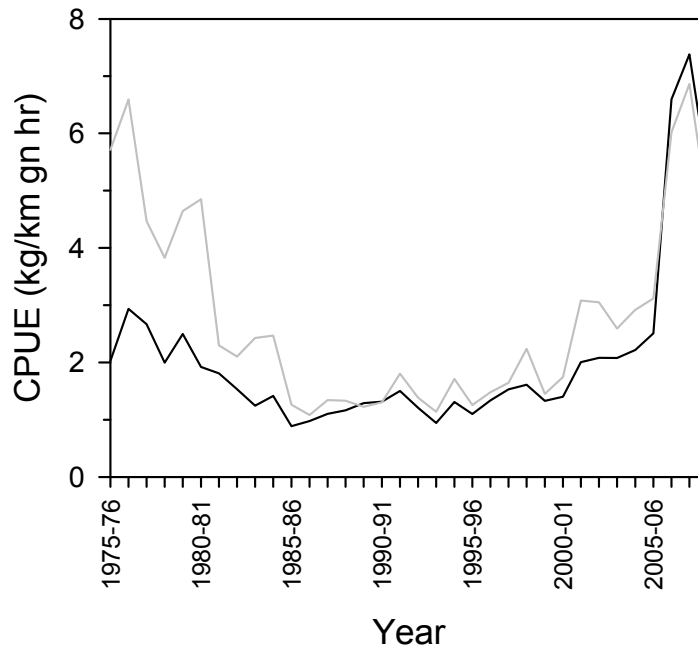
DEMERSAL GILLNET AND LONGLINE FIGURE 4

Total scalefish catch. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; grey triangles = WCDGLF; plain black line = total from the three management zones. Catches prior to 1989/90 cannot be distinguished from other gillnet and longline catches and have been omitted.



DEMERSAL GILLNET AND LONGLINE FIGURE 5

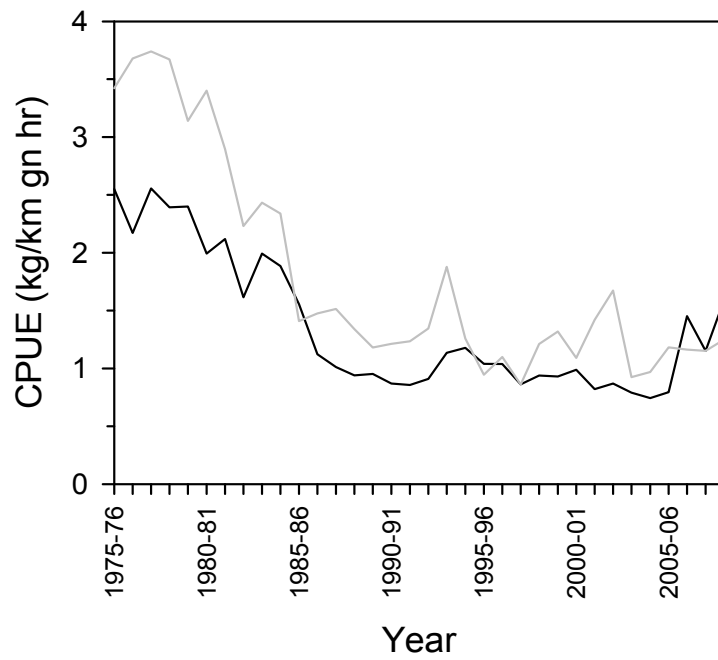
Standardised demersal gillnet and demersal longline effort. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; Grey triangles = WCDGLF and plain black line = total of the three management zones.



DEMERSAL GILLNET AND LONGLINE FIGURE 6

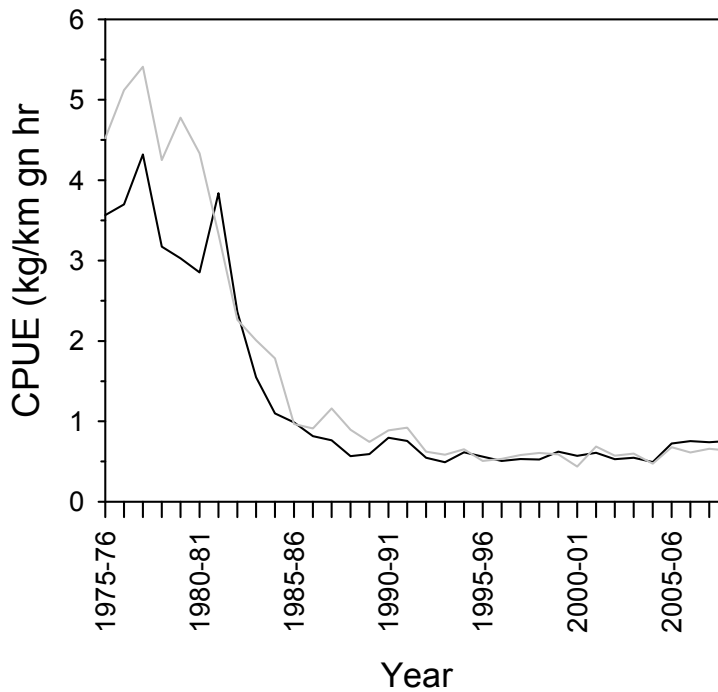
Gummy shark effective CPUE. Black line = ratio of the means estimates; grey line = mean of the ratios estimates.

SOUTH COAST BIOREGION



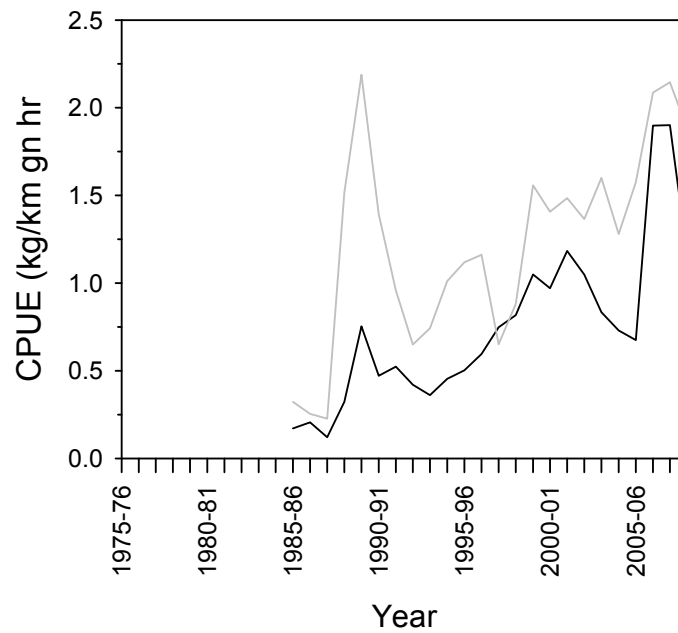
DEMERSAL GILLNET AND LONGLINE FIGURE 7

Dusky shark effective CPUE. Black line = ratio of the means estimates; grey line = mean of the ratios estimates.



DEMERSAL GILLNET AND LONGLINE FIGURE 8

Dusky shark effective CPUE. Black line = ratio of the means estimates; grey line = mean of the ratios estimates.



DEMERSAL GILLNET AND LONGLINE FIGURE 9

Sandbar shark effective CPUE. Black line = ratio of the means estimates; grey line = mean of the ratios estimates.

South Coast Demersal Line Fishery Report: Statistics Only

B. Molony and E. Lai

Management input from Natalie Moore

Fishery Description

Commercial

Operators in this fishery target scalefish stocks in oceanic waters of the South Coast Bioregion, primarily using wetline methods such as droplines and handlines to take both offshore and inshore demersal scalefish species such as pink snapper, Bight redfish and queen snapper. Haul nets and set nets are also used to take nearshore scalefish species such as herring, whiting and mullet.

The take of scalefish by trap and trawl methods, salmon by line and beach netting and pilchards by purse seine in the South Coast Bioregion are separately managed fishery activities. The capture of these species by the temperate demersal gillnet and longline fisheries operating in the South Coast Bioregion are also managed separately (see Demersal Gillnet and Longline Fisheries Status Report).

Recreational

Recreational fishers also fish for this suite of species within this bioregion.

Boundaries

The fishery operates along the in the South Coast Bioregion, from 115° 30' to the WA/SA border.

Management arrangements

Commercial

This fishery is not currently governed by any specific legislation and, as a result, there is no requirement to hold a specific authorisation to use wetline gear, other than a Fishing Boat Licence (for the boat) and a Commercial Fishing Licence (for the fisher).

Total Landings (Season 2009): 105.0 tonnes

Commercial

Estimates of catches are monitored through a mandatory CAES logbook system. Pink snapper, queen snapper and Bight redfish, which comprise the bulk of the commercial catch, are proposed as possible indicator species for this resource in this Bioregion. These species selected as indicators will be assessed in the future to monitor the status of the resource and fishery. The catch of 105 t during 2009 is

SOUTH COAST BIOREGION

similar the catch levels taken in the previous 8 years during which time the catches have fluctuated between 85 t and 145 t (South Coast Wetline Figure 1). The slightly lower catch reported in 2009 may be due to some catches being allocated to the West Coast Bioregion as a result of recent management and boundary changes.

Recreational

Estimates of recreational catches are unavailable at this time. New recreational arrangements may result in broad estimates being available in the future.

Fishery Governance

Target commercial catch range: Not available

This is the first year of separately reporting these catches in a stand alone report and a formal catch range has not been developed. Given that the last years catch falls within the 85 t -145 t catch ranges seen during the past decade there is no immediate concerns, however, the catch levels in future years will be monitored closely given changes to other fisheries (see below).

Current Fishing (or Effort) Level Not available

This fishery is likely to undergo review in the near future. An interim catch range will be included next year.

New management initiatives (2010/2011)

Since January 2008, there has been a substantial risk of shifts in effort and resultant increases in catches of scalefish off the south coast following the introduction of the *West Coast Demersal Scalefish (Interim) Management Plan 2007* and recent reductions in effort applied to the West Coast Rock Lobster Managed Fishery.

In the absence of assessments of demersal scalefish stocks off the south coast such as pink snapper, queen snapper and Bight redfish, a potential increase in fishing mortality may increase the risks to unacceptable levels. Furthermore, recent data suggests that hapuku stocks off the south coast are possibly being overfished.

The nearshore species targeted by open access inshore (oceanic) netters are also vulnerable and the recent increase in this activity has led to resource sharing and user group conflict.

The Department will continue to monitor the fishery and may develop more formal management arrangements for wetline fishing off the south coast should a significant increase in effort and catch occur. These arrangements will aim to restrict effort and catches of demersal scalefish and may help to address social issues such as easing the conflict between users that share the inshore scalefish resource.

AQUACULTURE

Regional Research and Development Overview

Abalone is considered a key species for aquaculture development on the south coast of WA.

The future expansion of an abalone farm near Bremer Bay will be subject to the development of a biosecurity plan, which the proponent is developing with input by the Department of Fisheries.

The Department of Fisheries has approved an application for an offshore abalone farm near Augusta, which is linked to a proposed land-based hatchery. The operator is currently undertaking trials to assess abalone growth and survival in the offshore production system.

The Department of Fisheries is close to releasing a new Abalone Aquaculture Policy, which was developed in consultation with the wild-capture and aquaculture industry sectors. The Department continues to closely monitor an abalone disease outbreak off the coast of Victoria and has implemented measures to prevent the entry of the virus into Western Australia.

The Department of Fisheries is also reviewing licensing and leasing arrangements for the mussel industry on the south coast.

COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Commercial and recreational fisheries compliance in the South Coast bioregion is undertaken by Fisheries and Marine Officers (FMO's) based at Albany and Esperance. These officers undertake a variety of compliance activities including land and at-sea inspection of vessels, catches, fishing gear, marine safety equipment and verification of licenses.

The Southern Region Community Education Officer oversees education and volunteer initiatives. South Coast Natural Resource Management Inc. provided funding for a Marine Education Officer position for the South Coast.

Activities during 2008/09

Due to the variety of commercial and recreational fisheries, expanse of coastline and variable and seasonal weather conditions, Fisheries and Marine Officers employ a risk management driven approach to prioritise and plan compliance activities.

Overall, Fisheries and Marine Officers delivered a total of 2393 hours of "in-field" compliance activity during 2008/09 (South Coast Compliance Table 1) representing a decrease from the previous year. (South Coast Compliance Figure 1).

Officers made contact with a total of 334 commercial fishers in the field, with the majority of the commercial compliance effort directed towards the Managed Abalone Fishery. Generally only minor breaches were detected, mainly in terms of quota management and incorrect completion of catch and disposal records. Illegal (unlicensed) commercial abalone operations continue to be a major concern in the South Coast bioregion threatening the sustainability of the commercial and recreational abalone fishery. Officers from the southern region conducted joint investigations with other compliance units into organized unlicensed illegal abalone operations.

The remainder of the commercial fishery compliance effort was directed to the wide range of minor commercial fisheries operating in the bioregion. Particular attention was paid to the south coast estuarine fishery to undertake spot checks of net lengths and catch inspections, inspections of deep-sea crab and rock lobster catches and quota checks and monitoring in the Purse Seine Fishery.

During the year, 12 infringement warnings and 17 infringement notices were issued and a further 7 cases resulted in prosecution action being instigated against commercial fishers. In addition to 'black market' abalone operations, illegal sale of other fish by unlicensed individuals or groups continues to be an issue of concern in the region.

Recreational compliance activities concentrated mainly on checking shore and boat based anglers, net fishers and shellfish collectors. Fisheries and Marine Officers (FMOs) made contact with a total of 2754 recreational fishers. During 2008/09, 32 infringement warnings and 12 infringement notices were issued and no prosecutions were instigated against recreational fishers.

Compliance patrols in recreational fisheries principally involve checks to ensure that fishers are adhering to size and bag limits and complying with restrictions that apply in the

recreational net fishery. The areas of highest risk of non-compliance with the management arrangements were considered to be abalone, marine finfish and estuarine netting. There continues to be a growing awareness of the open season and availability of abalone on the south coast.

Community and school education programs in the bioregion were conducted by the Marine Education Officer. Activities included the delivery of Marine Discovery West incursions and excursions to over 800 primary and secondary students across the region. A further 490 people took part in structured community education activities such as school holiday programs and workshops. A number of regional shows and community festivals were also attended with around 2500 contacts made. Where possible education initiatives were delivered in collaboration with other environmental education providers.

The education program in this bioregion has been supported by Fisheries Volunteers who have conducted recreational fisher walks and talks and have assisted with the delivery of school holiday programs, sustainable fishing clinics and attendance at regional shows and festivals.

Initiatives in 2009/10

Compliance and management personnel continue to refine compliance planning to deliver greater efficiencies and outcomes through the use of risk assessments and intelligence processes. This has resulted in greater capacity to target specific offence types utilising risk analysis to deploy resources more efficiently.

The compliance program will maintain its focus on the new management arrangements for the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JADGDLF), which include effort restrictions, the whiskey pugging closure and strict adherence to reporting requirements for the Vessel Monitoring System (VMS). Abalone compliance activities will continue to focus on targeted inspections of landings based on analysis of the existing and updated intelligence. A major operation will be undertaken to address compliance risks arising from intelligence received for the South Coast Crustacean Fishery.

FMO's will structure recreational fishing compliance programs to address a growing concern of increased catches of demersal scalefish by recreational fishers due the additional effort from fishers relocating from the West Coast as a result of the new West Coast rules and license fees. The program will include operations aimed at ensuring compliance with possession limits as well as investigations into suspected illegal fish sales.

The recent development of the Walpole – Nornalup Inlets Marine Park will see the personnel in the southern bioregion engaged in a range of tasks including delivery of marine park compliance services and education programs. Operational plans are being developed with the Department of Environment and Conservation with a focus on joint operations to maximize the management presence in the marine park.

SOUTH COAST BIOREGION

The marine education program for the south coast will continue to expand its presence in schools and build on existing networks within the wider community. The Marine education Officer will continue to work with other

departments and agencies to deliver a program that will incorporate the management initiatives for the Walpole-Nornalup Marine Park.

SOUTH COAST COMPLIANCE TABLE 1

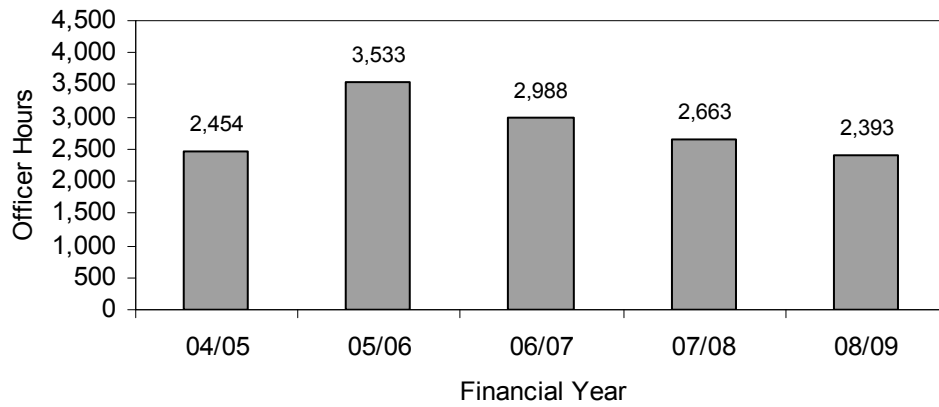
Summary of compliance and educative contacts and detected offences within the South Coast bioregion during the 2008/09 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,393 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	334
District Office contacts	256
Infringement warnings	12
Infringement notices	17
Prosecutions	7
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	2754
District Office contacts	667
Infringement warnings	32
Infringement notices	12
Prosecutions	0
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	88
District Office contacts	280
Fishwatch reports**	

*Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "Other" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of these contacts are recreational in nature (e.g. personal contacts in Marine Protected Areas), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises etc. are also included in this category.

**This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors. It also includes any calls relating to the southern inland bioregion that were referred to Albany or Esperance District staff.

South Coast Bioregion Compliance Patrol Hours



SOUTH COAST COMPLIANCE FIGURE 1

“On Patrol” Officer Hours showing the level of compliance patrol activity delivered to the South Coast bioregion over the previous 5 years. The 08/09 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. (The totals exclude time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.)

NORTHERN INLAND BIOREGION

ABOUT THE BIOREGION	265
SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES	265
ECOSYSTEM MANAGEMENT	265
ECOSYSTEM BASED FISHERIES MANAGEMENT	265
FISHERIES	267
AQUACULTURE	269
COMPLIANCE AND COMMUNITY EDUCATION	269

NORTHERN INLAND BIOREGION

ABOUT THE BIOREGION

The Northern Inland bioregion, encompassing the northern half of Western Australia, is predominantly a desert area, with few permanent water bodies. As a result of occasional summer cyclones, the various river systems flow at flood levels for short periods before drying-out to residual waterholes. The only exceptions to this are man-made dams, which trap rainfall for water supply purposes and irrigation.

The only significant fishable water body in the region is Lake Argyle, created by the damming the Ord River. The continuous release of water from the dam has resulted in the Ord River maintaining its freshwater fish populations year-round, as does the lake, where some freshwater native fish populations have expanded.

Populations of reptiles, such as the protected freshwater crocodile, are also supported by the expanded food chain of native fish, and are thought to have increased significantly from their original billabong-based populations.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

The creation of Lake Argyle has produced a unique inland aquatic environment which is now home to various fishing and tourism-related activities. The lake supports the State's only commercial freshwater fishery – for the silver cobbler or catfish – together with a processing facility supplying predominantly Western Australian and interstate markets. The lake and its associated river system also support recreational fishing for the freshwater component of the barramundi stock and cherabin (freshwater prawns).

Aquaculture development operations in the region have previously included the production of barramundi from a cage operation in Lake Argyle, and a small but growing pond production of redclaw crayfish in the Ord River irrigation system around Kununurra.

ECOSYSTEM MANAGEMENT

As one of the key ecosystem risks is the introduction of non-endemic species, the Department has an approval process in place for assessing proposals to translocate live non-endemic fish species into and within Western Australia, so as to minimise the environmental risks to freshwater ecosystems associated with this activity.

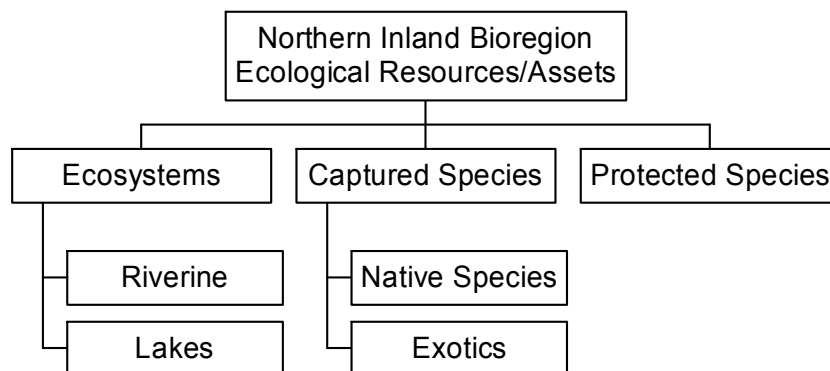
ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets using the EBFM framework

The Department is now implementing an Ecosystem Based Fisheries Management (EBFM) framework (see How to Use section for more details. In terms of ecological assets, the Department has recognised the following ecological values for the Northern Inland Bioregion:

- Ecosystem structure and biodiversity;
- Captured fish species
- Protected species (direct impact – capture or interaction);

The full set of ecological assets identified for ongoing monitoring are presented in Northern Inland Ecosystem Management Figure 1



NORTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the ecological assets identified and separately assessed for the Northern Inland Bioregion

Risk Assessment of Regional Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Northern Inland Figure 1 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (Northern Inland Ecosystem Management

Table 1) provides an overview and cumulative assessment of the current risks to the ecological assets of the Northern Inland Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department’s Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

NORTHERN INLAND ECOSYSTEM MANAGEMENT TABLE 1: RISK LEVELS FOR EACH ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Medium values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing activities.

Ecosystem Structure and Biodiversity

Ecosystem	Risk	Status and Current Activities
Ecosystems	LOW (non fishing)	Minimal threats and these would be due to non fishing activities

Captured fish species

Fish species	Risk	Status and Current Activities
Finfish Native	LOW	The stocks of freshwater fish are not under any material threat
Finfish Exotics	LOW	As above

Protected species

Protected fish species	Species	Risk	Status and Current Activities
Protected Species	Crocodiles	LOW	A small number of crocodiles have been reported captured in nets in Lake Argyle. The numbers are small and would not affect these stocks.

Summary of Monitoring and Assessment of Ecosystem Assets

The Department of Fisheries actively supports a number of studies into the native freshwater fish fauna and their habitats in northern river systems in conjunction with Murdoch University, the Department of Water and the Department of Environment

and Conservation, and through involvement with local natural resource management councils. New aquaculture ventures are also subject to strict environmental evaluation under the Department’s licensing and on-going arrangements, in conjunction with industry and TAFE.

The Department has introduced aquatic organism incursion and fish kill incident response programs in place.

FISHERIES

Lake Argyle Silver Cobbler Fishery Report: Statistics Only

S.J. Newman and C. Skepper

Management input from R. Green

Fishery Description

Commercial

The only commercial freshwater fishery in Western Australia is in Lake Argyle in the north-eastern Kimberley. This gillnet fishery specifically targets the silver cobbler (*Arius midgleyi*).

Recreational

A small, but increasing recreational and charter boat fishery for this species exists in Lake Argyle with fishing activities peaking during the dry season (winter months).

Boundaries

Commercial

The waters of the Lake Argyle Silver Cobbler Fishery (LAFCF) include all waters of Lake Argyle.

Recreational

Recreational anglers can fish in all creeks and tributaries that feed into the Ord River and Lake Argyle.

Management arrangements

Commercial

The LASCF is a limited entry fishery, with six current (licence condition) endorsement holders permitted to operate in the Fishery. A licence condition restricts the net type permitted, with fishers only permitted to use set nets that have a minimum mesh size of 159mm and maximum net drop of 30 meshes.

Under the *Lake Argyle Fishery Notice 1994*, endorsement holders are allowed to use no more than 1500 metres of net at any one time, and all nets must be suitably marked with licence identification. All fishers are prohibited from taking any fish whatsoever by means of nets during the period from 1 November to 31 December in any year. This seasonal closure is aimed at protecting fish during the spawning season. Also, at this time of the year water temperatures in the lake are high resulting in spoilage of fish in the nets. Fishers in the LAFCF are not permitted to take barramundi (*Lates calcarifer*) at any time.

In 2001, a voluntary industry Code of Practice was introduced to the LASCF, to implement sustainable fishing practices and to reduce conflict with other stakeholder groups in Lake Argyle. The Code specifies the accepted means of operation in the Fishery, and outlines contingency procedures for lost or abandoned fishing gear.

In response to concerns from licence holders, charter operators, the general public and conservation groups of interactions between commercial fishing operations and protected species, a Bycatch Action Plan was developed for the LASCF. The Bycatch Action Plan aims to minimise the incidental capture of protected species in Lake Argyle (including freshwater crocodiles, freshwater turtles, and

birds) during commercial gillnetting targeting the silver cobbler.

Governing legislation: Fisheries Notice no. 665 '*Lake Argyle Fishery Notice 1994*' (Section 43 order); Condition 55, 56, 292 on a Fishing Boat Licence.

Consultation: Department–industry meeting. Meetings with the Department of Environment and Conservation.

Recreational

There are currently no size limits in place for silver cobbler. There is a bag limit of 8 fish that applies to any species in the Family Ariidae.

Legislation: *Fish Resources Management Act 1994*, *Fish Resources Management Regulations 1995* and subsidiary legislation.

Consultation: Department – stakeholder meetings

Landings and Effort

Commercial (season 2009):

Not reportable due to confidentiality limitations.

The fishery first developed in 1979 with increasing catches reported until 1988 (138 t). Catch levels then fluctuated between 90 t and 145 t until 1997 (Lake Argyle Silver Cobbler Figure 1), after which they increased to a peak of 231 t in 2000. Owing to voluntary reductions in effort, catches declined in both 2001 and 2002. From 2003 to 2005, the level of catch has ranged from 131 to 165 t. In 2006, the catch dropped to 78 tonnes. Data since 2008 cannot be reported due to confidentiality limitations (Lake Argyle Silver Cobbler Figure 1).

In 2008, Argyle bream (sooty grunter, *Hephaestus jenkinsi*) were reported in the landed catch for the first time. No Argyle bream were reported in the 2009 catch.

Nominal effort in this gillnet fishery is calculated as the total number of fishing days by all boats multiplied by the average daily total net length fished per boat divided by 100 to give '100 m net days'. Effort has been declining since 2003 (Lake Argyle Silver Cobbler Figure 1).

Recreational:

Charter <1 tonne

Limited data are currently available on recreational fishing in this region. The reported charter boat catch for Lake Argyle from 2002 to 2009 was less than 1 t of silver cobbler per annum. There are no data available on general angling catches.

Fishery Governance

Commercial

Target commercial catch range: 95-155 tonnes

The target catch range under the current management regime is in the range of 95–155 t of silver cobbler. Applying an autoregressive moving average control quality procedure to the annual catches from 1990 to 2002 derived the range. Confidence intervals are obtained by estimating the variation of the observations compared with the variation of the predictions using the 13 years of catch data. While the catch from 2007 to 2008 has been within the target catch range, the 2009 catch is below the range.

Current Fishing (or Effort) Level Acceptable

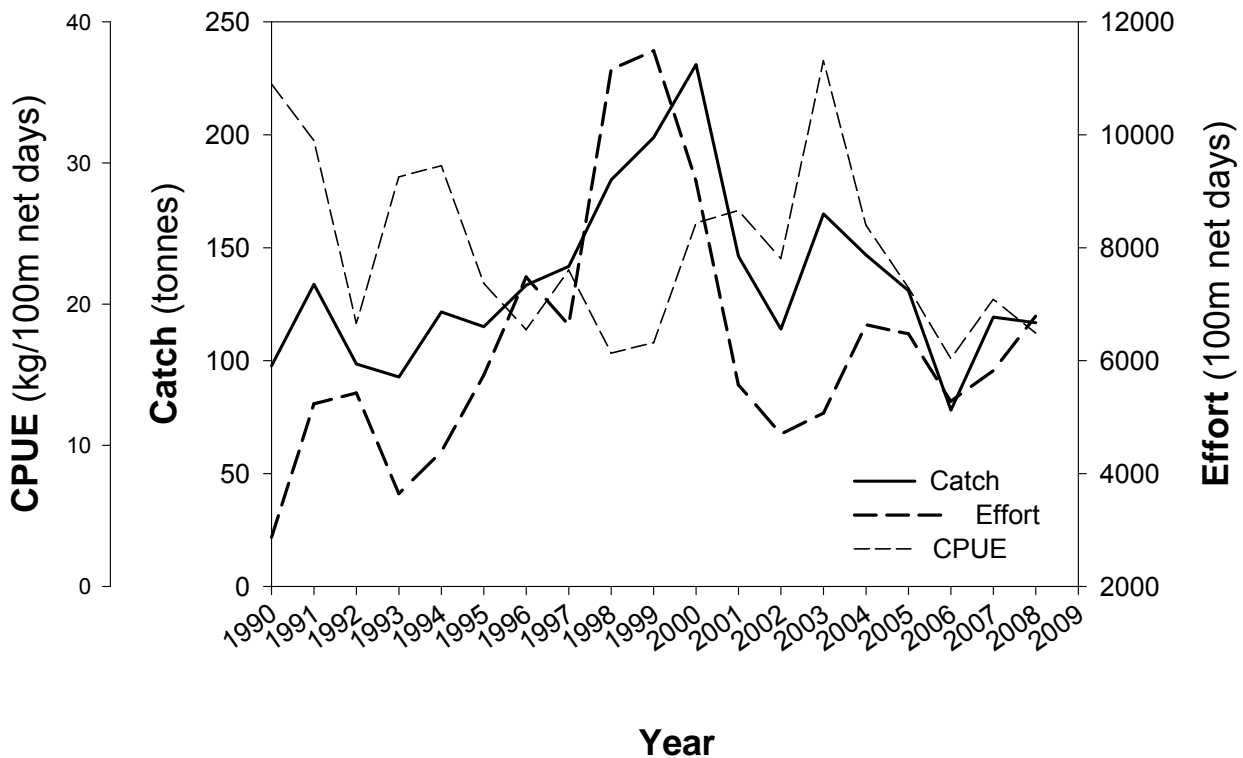
The level of catch in the fishery in 2009 was well below that reported in 2008 and 2007. This has mostly been a result of the reduced level of fishing effort within the fishery in 2009.

The 2009 level of catch and effort was significantly below the range reported over the past 5 years. The current levels of catch and effort are considered acceptable, as reduced effort levels to take the 2009 catch are not reflective of what is considered a more historic level of effort.

New management initiatives (2009/10)

Future management measures for the LASCFC include: i) a review of the legislative management arrangements of the Fishery, including consideration of amendments to the *Lake Argyle Fishery Notice 1994*; ii) consideration of incorporating key elements of the LASCFC code of practice into the formal management arrangements for the Fishery in the future, iii) review of the latent effort present within the fishery, and iv) a possible shift in the seasonal closures to better accommodate the wet-season breeding period for the target species.

Lake Argyle Silver Cobbler Fishery



LAKE ARGYLE SILVER COBBLER FIGURE 1

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for silver cobbler in the Lake Argyle Silver Cobbler Fishery over the period from 1990 to 2008; 2009 data are not shown due to confidentiality requirements.

AQUACULTURE

Regional Research and Development Overview

The process to identify a site for providing for aquaculture around Lake Argyle as part of the implementation of the Ord Stage II final agreement is progressing slowly. The process is under way to issue an aquaculture lease in the Lake Argyle region for the Mirriuwung Gajjerong Aboriginal Corporation, in accordance with requirements for the Ord Stage II final agreement. An area will eventually be vested in the Minister

for aquaculture purposes. The lease was expected to be issued by the end of June 2008; however, the group has recently expressed its wish to consider an alternate site. The Department has also issued an Aquaculture Licence to allow the production of 500 tonnes per annum of barramundi in Lake Argyle; however, identifying a site suitable for land based support facilities has proved difficult.

COMPLIANCE & COMMUNITY EDUCATION

The Northern Inland bioregion includes the freshwater rivers, lakes, billabongs and wetlands primarily located in the Kimberley. Commercial fishing is permitted in Lake Argyle (man-made lake) and in the tidal area of the mouth of the lower Ord River.

Compliance and education for the freshwater systems in the North Inland bioregion focuses on:

- translocation inspections of non-endemic freshwater species;
- protected species interaction;
- monitoring of introduced fish species;
- aquaculture lease and licence compliance;
- localised depletion of barramundi as a target recreational species;
- cherabin catches; and
- commercial Silver Cobbler fishery in Lake Argyle.

Patrols continue to focus on the Fitzroy and Ord Rivers, due to the large number of campers and fishers accessing the inland Kimberley rivers during the peak tourism period of May to October and the area-specific barramundi size and possession limit legislation. Both the Fitzroy River and the Ord River are identified as major breeding areas for barramundi.

Officers pay particular attention to catch of any protected sawfish species, disused recreational fishing gear and localised impacts of fishers.

Activities during 2008/09

During 2008/09, Fisheries and Marine Officers (FMOs)

recorded 531 hours of active compliance patrol time in the Northern Inland bioregion – an increase compared to the previous year but aligned with historic levels of patrol activity (Northern Inland Compliance Patrol Hours Figure 1).

Across the Northern Inland bioregion, personal contact was made with 1299 fishers and non-fishers across the commercial, recreational and other sectors (Northern Inland Compliance Table 1). FMOs focused on freshwater fishing compliance in areas of known high visitation or local complaints regarding non-compliant netting.

Compliance and education was also undertaken in the Lake Argyle area, where FMOs inspected commercial silver cobbler fishers and aquaculture sites to ensure that compliance with management, protected species interaction and environmental objectives were being met.

Initiatives in 2009/10

Compliance service delivery will continue to target any areas of complaint and high levels of recreational fishing pressure. These locations are reviewed during annual risk-assessment processes.

Compliance activities relating to the only freshwater commercial fishery, which targets the Lake Argyle silver cobbler, will continue. The operators in this fishery are inspected to ensure that high levels of compliance and community confidence are maintained.

Improved levels of engagement with children in regional towns and remote Aboriginal communities are planned, through fishing clinics and school presentations promoting 'fish for the future' messages.

NORTHERN INLAND BIOREGION

NORTHERN INLAND COMPLIANCE TABLE 1

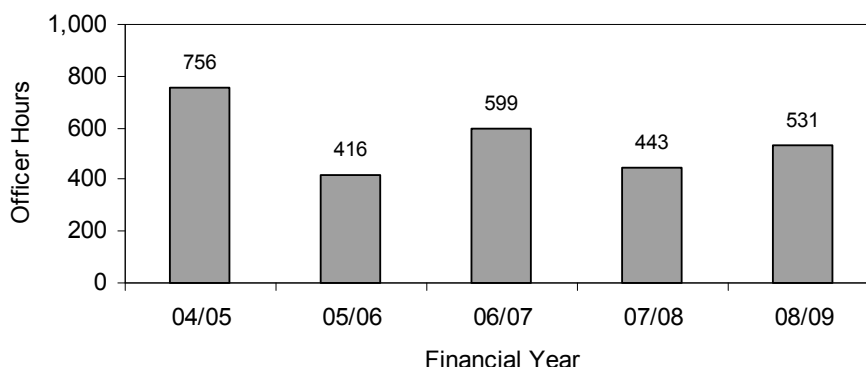
This table gives a summary of compliance and educative contacts and detected offences within the Northern Inland bioregion during the 2008/09 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	531 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	5
District Office contacts	0
Infringement warnings	0
Infringement notices	1
Prosecutions	2
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	939
District Office contacts	21
Infringement warnings	7
Infringement notices	26
Prosecutions	2
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	355
District Office contacts	0
Fishwatch reports**	Not recorded

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing-related contacts with the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc. are also included in this category.

** Fishwatch calls relating to the Northern Inland bioregion are not recorded, as the service provider reporting mechanism only details calls referred to district offices. Calls relating to the Northern Inland bioregion will be included in both the North Coast and Gascoyne Coast bioregion totals.

Northern Inland Bioregion Compliance Patrol Hours



NORTHERN INLAND COMPLIANCE FIGURE 1

This figure gives 'On Patrol' officer hours showing the level of compliance patrol activity delivered to the Northern Inland bioregion over the previous five years. The 2008/09 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. The totals exclude time spent on other compliance related tasks, e.g. travel time between patrol areas, preparation and planning time.

SOUTHERN INLAND BIOREGION

ABOUT THE BIOREGION	272
SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES	272
ECOSYSTEM MANAGEMENT	272
ECOSYSTEM BASED FISHERIES MANAGEMENT	272
FISHERIES	275
AQUACULTURE	276
COMPLIANCE AND COMMUNITY EDUCATION	277

SOUTHERN INLAND BIOREGION

ABOUT THE BIOREGION

This region contains WA's only natural permanent freshwater rivers, which are fed by rainfall through winter and spring. These permanent rivers are restricted to the high-rainfall south-west corner of the State and flow through the significant native forest areas. Some of the rivers are more saline in their upper reaches owing to the effects of agricultural clearing of native vegetation in more inland areas.

Across the remainder of the Southern Inland bioregion, rivers flow primarily during the 3 months of winter rainfall, with very occasional summer flows from inland rain-bearing depressions resulting from decaying cyclones. Most large fresh water bodies are man-made irrigation, water supply or stock-feeding dams. There is a diverse variety of natural water bodies in this region ranging from numerous small springs and billabongs, up to Lake Jasper, the largest permanent freshwater Lake in the south west region, with 440 ha of open water up to 10 m deep. In combination these diverse natural and man-made permanent waterbodies provide valuable habitat for fish and freshwater crustaceans during the summer months. Some natural salt lakes also occur but generally dry out over summer each year.

The few natural freshwater rivers and man-made lakes support a small native fish fauna and create an environment, particularly in forest areas, which is highly valued by the community for a variety of recreational pursuits.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

While there are no commercial fisheries in the Southern Inland bioregion, it provides significant recreational fishing opportunities. The major species fished recreationally are native marron, trout (both rainbow and brown trout) stocked by the Department of Fisheries into public dams and rivers, and feral redfin perch, an introduced, self-perpetuating stock. The native freshwater cobbler is also taken in small numbers, as are black bream artificially stocked into some inland impoundments.

Aquaculture development in the Southern Inland bioregion is dominated by the farm-dam production of yabbies, which can reach about 200 t annually depending on rainfall and market demand. Semi-intensive culture of marron in purpose-built pond systems provides around 60 t per year and has the potential to expand significantly.

Trout have historically been the mainstay of finfish aquaculture production in this region, originating from heat-tolerant stock maintained at the Department's Pemberton

Freshwater Research Centre. Silver perch are also grown in purpose-built ponds to supply local markets.

ECOSYSTEM MANAGEMENT

The conservation of the 13 species of freshwater native fish in freshwater ecosystems in the south-west of WA is a growing issue for the Department of Fisheries. Many of these species are endemic to WA, and under pressure through increasing salinity, feral fish populations, infrastructure (bridges and dams) and adjacent land-use development.

The Department works with representatives from the Department of Water and the Department of Environment and Conservation, to facilitate information exchange and identify research projects and associated funding sources to mitigate environmental impacts and so better protect native fish species.

The Department also has an approval process in place for assessing proposals to translocate live non-endemic fish species into and within Western Australia, so as to minimise the environmental risks to freshwater ecosystems associated with this activity.

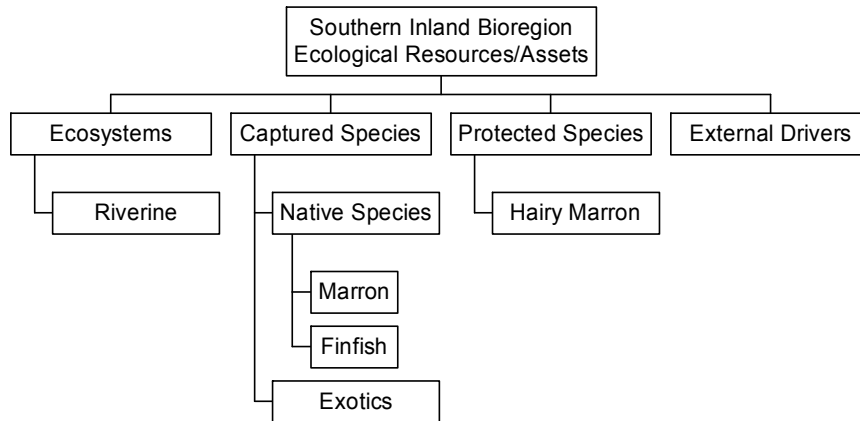
ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets using the EBFM framework

The Department is now implementing an Ecosystem Based Fisheries Management (EBFM) framework (see How to Use section for more details). In terms of ecological assets, the Department has recognised the following ecological values for the Southern Inland Bioregion:

- Ecosystem structure and biodiversity;
- Captured fish species
- Protected species (direct impact – capture or interaction);
- External Drivers

The full set of ecological assets identified for ongoing monitoring are presented in Southern Inland Ecosystem Management Figure 1



SOUTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the ecological assets identified and separately assessed for the Southern Inland Bioregion

Risk Assessment of Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Figure 1 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (Southern Inland Ecosystem Management Table 1) provides an overview and cumulative assessment of the current risks to

the ecological assets of the Southern Inland Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department’s Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

SOUTHERN INLAND ECOSYSTEM MANAGEMENT TABLE 1: RISK LEVELS FOR EACH ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Medium values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing activities.

Ecosystem Structure and Biodiversity

Ecosystem	Risk	Status and Current Activities
Riverine Ecosystems	HIGH (non fishing)	The community structure of most river and lake systems in this bioregion are substantially altered from historical levels. A survey of the main areas is underway through a state NRM funded project.

Captured fish species

Fish species	Risk	Status and Current Activities
Finfish Native	HIGH (non-fishing)	The abundance and distribution of most native fish have been severely impacted due to reduced rainfall and land management practices. This has lead to widespread fragmentation of native fish populations (ie regional extinctions, which without restocking will be permanent as their is no migration between lakes or catchments) and some species are already listed in danger of extinction
Crustaceans Native	MODERATE (non fishing)	The abidance of smooth marron has been monitored at regular intervals for a number of decades. The fishery arrangements have been through a number of significant updates to

SOUTHERN INLAND BIOREGION

Fish species	Risk	Status and Current Activities
		ensure that the catch is sustainable. The biggest threat to these stocks is from non fishing causes.
Exotics (Stocked)	MODERATE	Trout have been stocked into a limited number of streams in WA for decades. The trout are produced from the Pemberton Hatchery and are heat tolerant.

Protected species

Protected fish species	Species	Risk	Status and Current Activities
Protected Species	Hairy Marron Western Minnow (non fishing)	SIGNIFICANT	There is a monitoring and restoration program for hairy marron and there is a captive breeding program for endangered finfish (see details below)

External Drivers (non fishing)

External Drivers	Risk	Status and Current Activities
Pests and Diseases	HIGH	A high number of exotic fish species have been released into the south west catchments. There is an assessment program underway to determine the extent of this and which of these events can be addressed by eradication.

Summary of Monitoring and Assessment of Ecosystem Assets

Researchers from the Biodiversity and Biosecurity Branch are involved in several research projects related to freshwater biodiversity and conservation. One of these projects has been monitoring and assisting the restoration of hairy marron (freshwater crayfish) populations in the Margaret River. The critically endangered hairy marron (freshwater crayfish) is endemic to the Margaret River. However, the common, wide-spread smooth marron was accidentally introduced to the lower reaches of the river in the early 1980s. Over time, smooth marron have replaced hairy marron, first from the lower reaches (in the 1980s), then the middle reaches (in the 1990s) and at present hairy marron are only found in significant number in the upper reaches, but together with smooth marron.

Hairy crossed with smooth marron hybrids are common in the upper reaches of the Margaret River and the hybrids are fertile and appear to have similar ecological fitness. The displacement of hairy marron by smooth marron is most likely driven by hybridization of what appear to have been two geographically distinct sub-species. Maintaining populations of hairy marron in the upper reaches of the Margaret River is vital for the conservation of the sub-species and will require ongoing removal of smooth marron in combination with re-stocking pure hairy marron from the captive breeding program.

In 2005 The Department of Fisheries was successful in obtaining a grant from the SWCC (South West Catchments Council) to collect "hairy" marron from the wild and establish a breeding program to save this rare species from extinction.

DNA fingerprinting was developed in collaboration with UWA to distinguish between pure "hairy" marron and hybrids. The DNA testing identified 230 pure "hairy" marron that were transferred to the Department of Fisheries Pemberton Freshwater

Research Centre (PFRC) to establish a genetic repository of this critically endangered species. The breeding program has been very successful and has now progressed to the stage where sufficient "hairy" marron have been produced to permit restocking of the Margaret River with this critically endangered species. This will re-establish this species in its natural environment and prevent its extinction.

A different project funded by the Swan-Canning Research and Innovation Program (SCRIP) is aimed at determining the invasive potential of the feral cichlid (*Geophagus brasiliensis*) in Bennet Brook, a tributary of the Swan River. Recent salinity tolerance trials showed that this feral cichlid can easily cope with high salinities (>20 PPT). These results suggest that this feral cichlid could spread more widely throughout the Swan catchment in the future, posing a serious threat to native fish.

Most freshwater fish species are no longer present in large areas of their original range and some have been listed as critically endangered (e.g. Western trout minnow *Galaxias truttaceus hesperius*, and Margaret River marron *Cherax cainii*). While others have been listed as vulnerable to extinction (e.g. Balston's pygmy perch *Nannatherina balstoni*). This has resulted in a reduced abundance and distribution of many species in lakes, rivers and streams in the southwest bioregion.

The Department has therefore established a captive breeding program for the most critically endangered and vulnerable species at its Pemberton Freshwater Research Centre and Aquaculture and Native Fish Breeding Laboratory at the UWA Field Station Shenton Park (See Appendix 4). The project aims to: i) prevent extinction of endangered species by establishing living gene banks at research facilities; ii) develop techniques to breed endangered native fish and crustaceans; iii) produce endemic species suitable for restocking natural water bodies; iv) address human health concerns (e.g. Ross River virus) by restocking wetlands with native fish species that control mosquito populations.

FISHERIES

Licensed Recreational Marron Fishery Report: Statistics Only

Prepared by N.Sumner

Management input by Nathan Harrison

Fishery Description

Marron are endemic to Western Australia and are the third largest crayfish in the world. Recreational fishing occurs in freshwater dams and rivers throughout the southern part of the State extending from as far north as Geraldton, to Esperance in the east. Fishers may only use legal scoop nets, drop nets or snares to take marron.

Boundaries

The recreational marron fishery extends from the Hutt River north of Geraldton to waters near Esperance. The fishery operates in both freshwater dams and rivers although access to drinking water supply dams servicing the Perth metropolitan area and southwest regional centres are closed to the public by the Water Corporation.

Management arrangements

This fishery is managed through input controls of licences, closed seasons and gear restrictions, and the output controls of size and bag limits (see <http://www.fish.wa.gov.au/>).

All marron fishers require a special marron recreational fishing licence. Licensed fishers were permitted to fish for marron from 26th January to 18th February 2009. Three types of legal gear exist; scoop nets, drop nets and snares. In most waters there is a minimum size of 80 mm carapace length and a bag limit of 10 marron per day. However, Harvey Dam, Waroona Dam and Hutt River are managed as 'Trophy Waters' with a minimum legal size 90 mm carapace length and a daily bag limit and possession limit of 5 marron.

Landings and effort

Commercial component: Nil

**Recreational catch estimate
(season 2009)** 102,900 marron

The total catch for the 2009 season was estimated at approximately 102,900 ± 9,400 standard error (SE) marron or 30.6 ± 2.8 tonnes of marron (average weight marron 297g, based on logbook data). This is an increase (~100%) compared to the previous season (2008: 47,400 ± 4,400 marron or 14.1 ± 1.3 tonnes). The catch for 2009 is closer to the catch of 69,900 ± 6,900 marron or 20.8 ± 2.1 tonnes taken during 2007. The increase in catch in numbers is due to a increase in effort and increase in catch rate. The catch for 2009 is within the target catch range (see Fishery Governance below).

The overall CPUE (dams and rivers combined) recorded by fishers, based on phone surveys, was 4.0 marron per fisher per day. This is higher than the CPUE for the previous

season of 3.4 marron per fisher per day.

Note that the change in minimum legal size from 76 to 80 mm RCL during the 2007 season significantly increased the long-term, stable average weight of retained marron from 230g (1971-2006) to 300g in 2007.

Total effort for the 2009 season was estimated from phone surveys at around 25,700 days. Fishing effort significantly increased (~84%) compared to the previous season of 14,000 days. This increase was due to a increase (~69%) in the number of participating licensed fishers from 5,200 in 2008 to 8,800 in 2009. The average number of fishing days per fishermen increased slightly from 2.7 in 2008 to 2.9 during 2009. The season length was 23 days in 2007 and 2008. The season increased to 29 days in 2009. The effort for 2009 is closer to the effort of 20,300 days for the 2007 season.

The proportion of effort allocated to dams (~30%) and rivers (~70%) has remained stable between 2000 and 2009. Harvey and Wellington dams receive by far the most fishing effort, with Harvey Dam being the most popular dam since 2005. Effort is more widely spread among the rivers in the South-West. The Blackwood River is the most popular site (~25% effort) followed by the Warren River (~15%). The Collie, Murray, Preston and Donnelly all received similar amount of effort of around 5-10%.

Fishery Governance

Target catch (or effort) range:

96,000-136,000 marron

In 2006, the Recreational Freshwater Fisheries Stakeholder Subcommittee (RFFSS) proposed that, based on the available research data and the knowledge of the marron fishery, the fishery be managed to a maximum target catch of between 96,000-136,000 marron. It should be noted that under current management arrangements (short 16-29 day season since 2003) the average estimated recreational catch has been around 55,000 marron. The most likely explanation for the current low annual catch is not limited marron stocks but the sharp reduction in effort since 2003. In 2007 the marron season was increased from 16 to 23 days. The season was increased to 29 days in 2009. Assuming relative stable marron abundance, a limited growth in the fishery is allowed while maintaining catches at a sustainable level. Developments in marron abundance (fishery independent surveys) and marron catches (phone survey and logbook) will be monitored in future to determine the impact of the changes in season length and increase in legal minimum size.

SOUTHERN INLAND BIOREGION

Current fishing (or effort) level Acceptable

Fishing effort has been low under current management arrangements. Since 2003 when the reduced 16 day season was introduced effort (fishing days) dropped considerably from ~40,000 fishing days (2000-2002) to ~11,000 fishing days (2003-2006). The season length was extended from 16 to 23 days in 2007 and a significant increase in effort from ~11,000 (2003-2006) to ~17,000 fishing days (2007-2008)

was observed. The effort increased to 25,700 fishing days in 2009 with a 29 day season.

New management initiatives (2009/10)

For 2010 the marron season will start on 8 January and run for a 28 day period until 5 February.

AQUACULTURE

Regional Research and Development Overview

Previous research undertaken at the Pemberton Freshwater Research Centre focused on marron husbandry and selective breeding research, captive breeding programs for conserving endangered native fish and crayfish and evaluation of the use of grains in aquaculture feeds. Industry sectors continue to apply the results of the research to commercial operations.

A Ministerial Exemption issued to enable a commercial operator to collect marron from farm dams on a number of

private properties will expire in May 2010. The current policy only allows one property on a licence. Undertaken with the co-operation of local compliance officers in the southwest, information generated from the trial project, which ran for three years, will enable the Department of Fisheries to determine whether a review of the current policy is warranted.

COMPLIANCE AND COMMUNITY EDUCATION

Fisheries and Marine Officers (FMOs) based in Geraldton, Dongara, Jurien, Lancelin, Hillarys, Fremantle, Rockingham, Mandurah, Bunbury, Busselton, Albany and Esperance conduct recreational fishing compliance and education activities in the Southern Inland bioregion.

The Fisheries Volunteer program assists with the delivery of education in the Southern Inland bioregion. Although the volunteer program is based in major coastal centres, it is used particularly prior to - and during - the opening of the marron season to conduct peer-to-peer education.

The highest risk of non-compliance in the Southern Inland bioregion is within the recreational marron fishery. As the marron season lasts for just 23 days (28 days as of 2010), the risk of illegal fishing during the closed season (February-December) is extremely high. This illegal fishing is particularly high during the period from September to December, after the winter rains and prior to the next season opening.

Increasingly, dams and catchment areas once open to marroning are being closed by the Water Corporation, which presents further challenges to ensure compliance in these areas. A number of Water Corporation Rangers have been authorized as honorary FMO's to assist with the compliance of illegal fishing on Water Corporation dams. Some DEC officers have also been authorized as honorary FMO's and

play an important role in the marron compliance throughout the South West. During the open marron season, illegal activities (such as the use of scoop and drop nets in 'snare only' waters, take of undersize marron, and adherence to possession limits, particularly in trophy waters such as Harvey Weir) are a focus of compliance activities. FMOs continue to carry out joint initiatives with police to investigate the theft of marron from private properties and licensed aquaculture sites.

The other main fishery in the Southern Inland bioregion is the recreational trout fishery. Compliance and education in this fishery focuses on the illegal use of baits in 'artificial lure-only' waters, exceeding bag limits, fishing without a current freshwater recreational fishing licence, and the taking of trout during the closed season.

Compliance patrols for the other recreational fisheries in these inland areas, as well as inspections of fish wholesale and retail premises also form part of the compliance activities conducted by FMOs in the southern inland bioregion.

Commercial fishing activity in rivers is also included in the southern inland bioregion and some compliance patrols target fishing activity in the West Coast and South Coast estuarine fisheries. The compliance effort in this fishery focuses mainly on closed waters, setting times, net lengths and licensing.

Activities during 2008/09

During 2008/09, FMOs delivered 2341 hours of compliance patrol hours to the Southern Inland bioregion (Southern Inland Compliance Table 1) – which is an increase from the compliance hours delivered in the previous year.

Officers conducted patrols throughout the bioregion in vehicles, dinghies and canoes, making 1025 field contacts with recreational fishers and 101 contacts with commercial fishers. During the year, 31 infringement warnings and 24 infringement notices were issued with 36 prosecutions instigated for recreational offences.

The marron fishery continues to be the major focus for the compliance and education program in this bioregion. The 2009 marron season was the fourth year of the five year marron management strategy, public acceptance of the new rules is good and catches generally do not seem to have changed greatly in most areas. As was the case in 2008 the compliance activities for the 2009 marron season were developed from a risk assessment process, and targeted areas of high risk identified through that process. The marron season start date has been reviewed to permit better long term planning for recreational fishers and the Department of Fisheries. As of 2010 the new 28 day season start date will be the 8th January each year and end on the 5th February.

Aquaculture compliance activities (classified as 'commercial' In Table 1) are also a major focus in the Southern Inland bioregion for FMOs. Activities mainly involve inspection of aquaculture facilities, oversight of broodstock collection to ensure compliance with exemption conditions, and inspection of proposed aquaculture sites to ensure that the harvesting does not affect the wild stocks in WA waters. FMO's also

carry out joint patrols with police to investigate theft from farm dams.

Initiatives for 2009/10

Joint operations with regional Water Corporation Rangers and DEC officers will continue during 2009/10. These joint patrols will increase the compliance presence in the marron fishery and the expert knowledge the Water Corporation rangers have of the dam areas and activities greatly assist in the compliance operations.

Poaching of wildstock marron during the closed season and theft of marron from dams on private property and aquaculture facilities will be a focus for compliance activities. District FMOs will also continue to work in partnership with local police to develop joint initiatives, facilitate the transfer of intelligence information and respond to compliance situations.

The southern regional Community Education Officer will again be conducting several education activities promoting awareness of endemic freshwater fish and crustaceans of the south-west and highlighting potential threats, including feral fish species. Some of these activities will be carried out in partnership with other agencies and natural resource management groups to enable a holistic approach to catchment management and issues facing the sustainability of freshwater species.

The Volunteer program will be instrumental in delivering information to marron fishers and campers during the opening of the marron season at the Collie River, Harvey Dam and through the Blackwood River basin

SOUTHERN INLAND BIOREGION

SOUTHERN INLAND COMPLIANCE TABLE 1

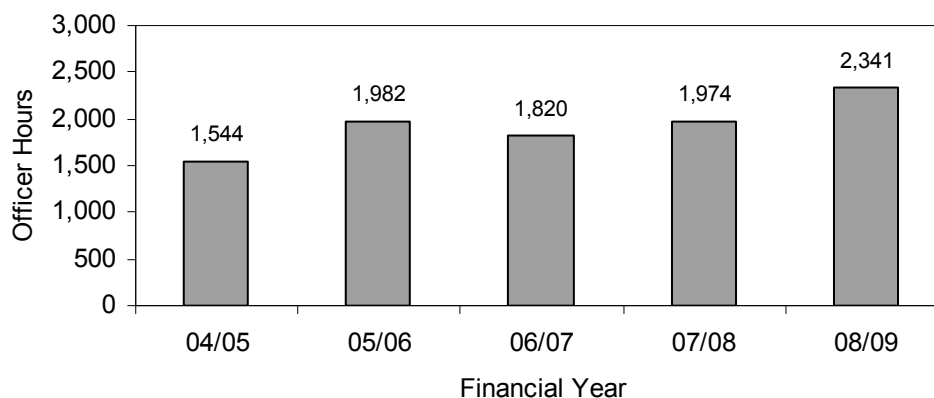
This table gives a summary of compliance and educative contacts and detected offences within the Southern Inland bioregion during the 2008/09 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,341 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	101
District Office contacts	0
Infringement warnings	1
Infringement notices	0
Prosecutions	0
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	1025
District Office contacts	2723
Infringement warnings	31
Infringement notices	24
Prosecutions	36
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	1099
District Office contacts	0
Fishwatch reports**	Not recorded

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing-related contacts with the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine protected areas), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category.

** Fishwatch calls relating to the Southern Inland bioregion are not recorded, as the service provider reporting mechanism only details calls referred to district offices. Calls relating to the Southern Inland bioregion will be included in both the South Coast and West Coast bioregion totals.

Southern Inland Bioregion Compliance Patrol Hours



SOUTHERN INLAND COMPLIANCE FIGURE 1

In this figure, "On Patrol" Officer Hours shows the level of compliance patrol activity delivered to the Southern Inland bioregion over the previous five years. The 2008/09 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. The totals exclude time spent on other compliance related tasks, e.g. travel time between patrol areas, preparation and planning time.

STATEWIDE

ECOSYSTEM BASED FISHERIES MANAGEMENT
FISHERIES

280

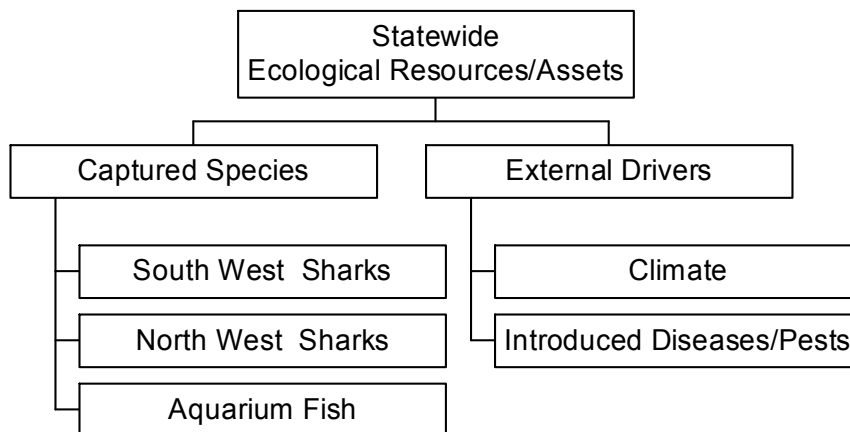
282

STATEWIDE

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of State-wide Ecological Assets using the EBFM framework

While the bioregional scale of management has been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (see How to Use section for more details), due to their life histories or broader impacts, a small number of ecological assets cannot realistically be managed at the bioregional level but need to be considered at either a statewide or at a multiple bioregional level.



STATEWIDE ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the State-wide ecological assets and external drivers identified and separately assessed.

Risk Assessment of Statewide Ecological Assets and External Drivers

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Figure 5 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table

(Statewide Ecosystem Management Table 1) provides an overview and cumulative assessment of the current risks to those ecological assets that function at a statewide level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These level risks are now used by the Department as a key input into the Department’s Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions for Statewide Issues.

STATEWIDE ECOSYSTEM MANAGEMENT TABLE 1 - RISK LEVELS FOR EACH ASSET.

Low and Medium values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required.

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Sharks	South and lower west	MODERATE	The stock levels of most sharks in these regions are now either at acceptable levels or are deemed to be recovery at acceptable rates following management intervention.
	Mid West – North	HIGH	The stocks levels of some sharks in these regions are at unacceptable levels or have a high level of uncertainty. Some of these risks are being by fishing that is occurring outside of the direct jurisdiction of WA.
Aquarium Fish	Marine	LOW	The level of capture is low and the management restrictions are such that that these species are not at risk.

External Drivers (NON FISHING)

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	HIGH	There is a high risk that some exotic species will be introduced into the state through the increasing levels of international shipping that is occurring at ports around the country. Many of these pest species are capable of invading beyond a single bioregion.
Climate	MODERATE in short term	The predictions for impacts of climate change affecting the Statewide ecosystems and process are moderate in the short term. The risk escalates to a higher level in the medium term.
	HIGH in Medium term	

Summary of Monitoring and Assessment of Statewide Assets

The Department is working closely with the Australian Government and other jurisdictions to develop and implement the National System for the Prevention and Management of Marine Pest Incursions that will minimise the biosecurity risks associated with increased shipping in all parts of the State. Within WA, this will be achieved through the Fish Resources Management Act 1994 and the Biosecurity and Agriculture Management Act 2007. Associated regulations and subsidiary legislation are currently being developed. Work has also been undertaken to develop monitoring designs for introduced marine species for most of the key Ports in WA. The design has been developed

in conjunction with the Invasive Marine Pests Program within DAFF (Department of Agriculture Fisheries and Forestry). This work is expected to contribute to introduced aquatic organism incursion and fish kill incident response programs already in place.

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch recognises that the vast and remote coastline of the region dictates that remote sensing (satellite imagery and aerial photography) will be the primary tool for resource condition monitoring. Future directions of the project will concentrate on developing remote sensing as a monitoring tool, and developing a suite of resource condition indicators that accurately portray the health of the numerous marine and coastal environments.

FISHERIES

Marine Aquarium Fish Managed Fishery Report: Statistics Only

S.J. Newman, C. Bruce and M. Cliff

Management input from S. Brand-Gardner and M. Holtz

Fishery Description

Commercial

The Marine Aquarium Fish Managed Fishery (MAF) has the capacity to target more than 250 species of fish under the management plan. However, the number of species targeted and/or landed by the fishery varies from year to year (e.g. in 2009 only 180 species were landed). By way of a Section 43 Order and Ministerial Exemption, fishermen also take coral, live rock, algae, seagrass and invertebrates. It is primarily a dive-based fishery that uses hand-held nets to capture the desired target species from boats up to 8 m in length. While the MAF operates throughout all Western Australian waters, catches are relatively low in volume due to the special handling requirements of live fish. Fishing operations are heavily weather-dependent due to the small vessels used and the potentially hazardous conditions (e.g. waves, swell) encountered. In addition, human constraints (i.e. physiological effects of decompression) limit the amount of effort exerted in the fishery, the depth of water and the offshore extent where collections can occur.

Recreational

There is no documented recreational fishery. If members of the public wish to collect specimens for their own private aquariums they are permitted to do so, but are restricted to normal recreational bag limits and, for some species, size limits. There is a complete ban on the recreational take of coral, live rock and totally protected fish such as leafy seadragons.

Boundaries

Commercial

The MAF operates in Western Australia's state waters spanning the coastline from the Northern Territory border in the north to the South Australian border in the south. The effort is spread over a total gazetted area of 20,781 km. During the past three years the fishery has been active in waters from Esperance to Broome with popular areas being around Perth, Geraldton, Carnarvon, Exmouth and Dampier.

Management arrangements

This fishery is managed primarily through input controls in the form of limited entry to the fishery and permanent closed areas. There are 12 licences in the fishery following the cancellation of 1 licence in 2009 in response to the expansion of the Ningaloo marine reserve. In 2009, 10 licences operated in the fishery.

Licencees are not permitted to operate within any waters closed to fishing (e.g. Rowley Shoals, Reef Protected Areas, sanctuary zones). The fishery is permitted to operate in general-purpose zones of marine parks for the collection of

fish and some invertebrates (usually excluding coral and live rock). Fishing is also prohibited on Cleaverville Reef in order to exclude the take of coral and associated organisms.

Fish caught in this fishery may not be used for food purposes, and operators are not permitted to take species covered by other specific commercial management arrangements or management plans.

The MAF is permitted to take most species from the Syngnathid family (seahorses and pipefish), which is listed under the *Environment Protection and Biodiversity Conservation Act 1999*. However, there is a total ban on the take of leafy seadragons (*Phycodurus eques*). If the current ESD trigger value of 2000 individual syngnathids is reached, a review will be initiated, and the results used to determine whether further management action is required.

Landings and Effort

A total of over 18,915 fish were landed in 2009. Collectors in this ornamental fishery can earn a high return from the capture of very small quantities of individuals. Therefore, the catches are small in comparison to the more common, food-fish fisheries. Fishers report the level of catch (kg, numbers or litres) by species or species group. A summary of the 2009 levels of catch is provided in Marine Aquarium Fish Table 1. The reported landings of aquarium fish for 2009 are less than those reported in 2008, with the syngnathid catch for 2009, being significantly less than that reported in 2008.

Effort in the fishery has decreased from 981 and 932 fishing days in 2007 and 2008, respectively, to 639 fishing days in 2009, with 10 licences reporting some level of activity (the level of effort in the MAF now includes the effort of both MAF licencees and also those fishers that hold an exemption authorisation to collect land hermit crabs - *Coenobita variabilis*). Effort in the fishery is concentrated in discrete areas adjacent to the limited number of boat landing sites along the Western Australian coastline.

Given that the specimens are collected for a live market, licences are restricted in terms of the quantities that they can safely handle and transport (for example, by boat to shore, by vehicle to the holding facility and then on to the retailer) without impacting on the quality of the product. The size of the holding facility and access to regular freight and infrastructure services (such as airports, particularly in the remote northern locations of WA) restricts the levels of effort that can be expended in the fishery at any given time.

The performance measures for the fishery relate to the catch of the syngnathids. The MAF is permitted to take species from the syngnathid family (seahorses and pipefish), which are listed under the Environment Protection and Biodiversity Conservation Act 1999. In 2009, the catch level of syngnathids was 340 and is significantly less than that reported in 2008. Note, that there is a prohibition on the take of leafy seadragons (*Phycodurus eques*) in the MAF.

Fishery Governance

Target commercial catch range: Not assessed

Current Fishing (or Effort) Level: Acceptable

The current effort level in the fishery is fairly constant from year to year and the operating extent of the fishery is low relative to the widespread distribution of the plethora of species targeted. No other fisheries exploit these species and

therefore there is limited potential for impact on breeding stocks. Therefore the current level of fishing activity is considered acceptable.

New management initiatives (2009/10)

Compulsory daily logbooks and a requirement to notify the Department prior to fishing for coral and live rock were introduced in 2009. Amendments to subsidiary legislation regulating the take of coral and live rock has provided an increase in the amount of live rock that can be taken by licencees and introduced a small daily bag limit of 5 kg of the coral species *Catalaphyllia jardinei* in the Dampier Archipelago region. The Australian Government Department of Environment and Water Resources approved the MAF as environmentally sustainable under the provisions of the Environment Protection and Biodiversity Conservation Act 1999 and therefore declared the fishery as an approved Wildlife Trade Operation (WTO) for three years.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Managed Fishery and associated endorsements in 2009.

Common Name	Quantity (numbers)	Weight (kg)	Litres (l)
Fish	18,575		
Syngnathidae (not included in Fish)	340		
Hermit crabs (land hermit crabs only - <i>Coenobita variabilis</i>) ¹	110,250		
Invertebrates	32,972		
Algae/Seagrasses			441
Hard coral		6,111	
Soft coral ²		5,450	
Live rock		3336	
Sponges	4,837		

1 This total includes both MAF licensees and also those fishers that hold an exemption authorisation to collect land hermit crabs - *Coenobita variabilis*.

2 The soft coral category includes 4,913kg of coral like anemone groups such as corallimorphs and zooanthids in the Class Anthozoa. These are harvested under an invertebrate Ministerial Exemption and are not part of the annual coral TAC.

3 Due to confidentiality provisions the reported catch of 'live feed (mainly shrimps)' cannot be shown in Marine Aquarium Fish Table 1 in 2009.

4 Due to confidentiality provisions the reported catch of Bryozoans cannot be shown in the Marine Aquarium Fish Table 1 in 2009.

Specimen Shell Managed Fishery Status Report

A. Hart, C. Bruce and M. Cliff

Management input from S. Brand-Gardner and M. Holtz

Main Features

Status		Current Landings	
Stock level	Acceptable	Specimen Shell Catch Total	
Fishing level	Acceptable	Shell numbers	8,644 shells

Fishery Description

The Specimen Shell Managed Fishery (SSF) is based on the collection of individual shells for the purposes of display, collection, cataloguing, classification and sale.

More than 200 different shellfish species are collected mainly by hand by a small group of divers operating from small boats in shallow coastal waters. While the fishery covers the entire Western Australian coastline, there is some concentration of effort in areas adjacent to population centres such as Karratha, Exmouth, Carnarvon, Geraldton, metropolitan Perth, Bunbury and Albany.

Governing legislation/fishing authority

Specimen Shell Management Plan 1995

Specimen Shell Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The fishing area includes all Western Australian waters between the high water mark and the 200 m isobath.

Management arrangements

This fishery is managed through input controls in the form of limited entry, gear restrictions and permanent closed areas. The primary controls in the fishery are operational limitations – depth, time and tide.

This is a limited entry fishery with 32 licences in the fishery, with 23 of the licences being active. Furthermore, a maximum of 2 divers are allowed in the water per license at any one time and specimens may only be collected by hand.

There are a number of closed areas where the SSF is not permitted to operate. This includes within various marine parks and aquatic reserves and other closed waters such as Reef Observation Areas and Fish Habitat Protection Areas. Much of the west side of North-West Cape and the Ningaloo Marine Park are prohibited areas for the fishery. The exclusion of Marmion Marine Park in the Perth metropolitan

area is also important because of its populations of 2 rare cowrie species.

The SSF is not permitted to take any mollusc species for which separate management arrangements exist – such as abalone, mussels, scallops and pearl oysters.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of specimen shell species. Boxed text in this status report provides the annual assessment of performance for this issue.

Some minor-scale collection of dead shells is also undertaken above the high water mark by collectors operating under the authority of a commercial fishing licence, mainly for sale into the souvenir, pet supply and hobby craft markets. However, this activity does not form part of the Specimen Shell Managed Fishery.

Research summary

Current fishery-dependent data collection systems monitor the catch (species-specific), effort and catch rates for the fishery. Fishers within the SSF provide monthly returns under the statutory catch and effort system (CAES). These returns contain information on catch (species, numbers and spatial area), and days and hours fished by month and year.

In August 2004, fishers commenced reporting using 10 x 10 nautical mile (nm) grids rather than 60 x 60 nm grids, providing a finer spatial scale to the data collected. At the same time, they began collecting additional information on sightings of the 8 mollusc species identified as potentially 'vulnerable.' These data are used as the basis to provide research advice for fisheries management.

Retained Species

Commercial landings (season 2009): 8,644 shells

Recreational catch estimate (season 2009):

Unknown

Commercial Landings

In 2009, the total number of specimen shells collected was 8,644, distributed over a wide range of species. In the past 5

years, more than 492 separate species of molluscs have been collected, with an average of more than 200 species per year – the majority in low numbers.

There is some focus of effort on mollusc families most popular with shell collectors, such as cowries, cones, murexes and volutes. For example, *Cypraea venusta*, *C. marginata* and *C. friendii* (including identified sub-species) make up approximately 18% of those collected in 2008 and 31% of those collected in 2009. Cypraeidae or cowries are noted for their localised variations in both shape and colour, making them attractive to collectors.

(Note reported total landings exclude *Trochus hanleyanus* taken by the Marine Aquarium Fishery.)

Fishing effort/access level

Although there are 32 licences in the fishery, only about 9 of these are regularly active. Effort has been stable over the past 5 years, at an average of around 1,130 days fished. In 2009, 1,057 days were fished.

Recreational component: **Not assessed**

Shell collecting is a popular recreational pastime, and members of the public are permitted to collect shells for their private collections. The recreational catch, while unknown, is considered to be declining, as evidenced by declining membership in shell collecting associations.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

During the 2009 season the catch rate was approximately 8 shells per day (excluding *Trochus hanleyanus*).

Ponder and Grayson (1998) examined the specimen shell industry on a nationwide basis, rating vulnerability to over-exploitation on the basis of species biology, accessibility to collection, and rarity. Species collected in Western Australia which were identified by Ponder and Grayson as potentially vulnerable comprised of 6 cowries (*Cypraea (Austrocypraea) reevei*, *Cypraea (Zoila) friendii vercoi*, *Cypraea (Zoila) marginata (albanyensis)*, *Cypraea (Zoila) marginata (consueta)*, *Cypraea (Zoila) rosselli* and *Cypraea (Zoila) venusta*) and 2 volutes (*Amoria damoni (keatsiana)* and *Amoria damoni (reevei)*).

‘Shell sighting’ is a new abundance category. It is a measure of the population of vulnerable shells that is observed but not taken, and provides evidence for the breeding stock being conserved each year. Of the 8 vulnerable species (including related sub-species), an overall average of approximately 61% in 2005, 59% in 2006, 64% in 2007, 77% in 2008 and 61% in 2009 of the shells sighted were not harvested. The measure of the number of shells sighted is reported correctly in about 22% of the cases where one of the vulnerable species is reported.

The figures for ‘sighted’ versus ‘taken’ of vulnerable shells is continually improving by licensees, but the majority of licences still record this poorly. It is anticipated that current

sightings are an under estimate of the available populations.

The reporting of catch and effort on the finer spatial scale of 10 x 10 nm blocks from August 2004 is also providing more accurate information on the distribution of certain species. The 2009 season has seen a wider adoption by licensees of the smaller spatial resolution grid blocks rather than reporting the 60 x 60 nm blocks.

All species collected in Western Australia, including the 8 prized species, occur over wide geographic ranges (hundreds or thousands of kilometres) and wide depth ranges (up to 200 m) where a substantial portion of the population cannot for logistical and safety reasons be collected.

Even in shallow waters, many localities cannot be fished because of the lack of access to the beach and the small boats used, and collecting is prohibited in many of the more easily reached areas which are now in marine parks and reserves. Additional protection is afforded by the fact that collectors will ignore any specimens with slight visual imperfections, but their reproductive potential in the population remains undiminished. In summary, it is considered that the fishery has very little likelihood of having an unacceptable impact on breeding stocks.

The performance measures for the fishery relate to the maintenance of breeding stocks, as indicated by catch levels and catch rates. In 2009, the catch level of approximately 8,644 shells and catch rate of 8 shells/day were both only slightly lower than the ranges set, i.e. 10,000 – 25,000 shells and 10 – 40 shells/day.

Non-Retained Species

Bycatch species impact: **Negligible**

There is no bycatch in this fishery owing to the highly selective fishing methods.

Protected species interaction: **Negligible**

The fishery had no reported interactions with protected species during 2009. Reports of interactions with protected species are required to be recorded on monthly catch and effort returns.

Ecosystem Effects

Food chain effects: **Negligible**

Habitat effects: **Negligible**

Social Effects

In 2009 there was 32 authorisation holders in this fishery with around 9 licences recording consistent activity, the number of people employed regularly in the fishery (licensees plus crew/ dive buddies) is likely to be around 12.

STATEWIDE

There was also around 19 people (licensees plus crew/dive buddies) that operated occasionally in this fishery. With many of the licences there might be the additional employment of people to prepare the shells for collection, pack and distribute the shells and also, some licensees might have shop fronts, therefore, employing shop assistants. The number employed in this area is unknown.

Economic Effects

Estimated annual value (to fishers)

for year 2009: **Not assessed**

Fishery Governance

Target catch range: **10,000 – 25,000 shells**

A preliminary performance measure has been developed of a total annual catch range from 10,000 to 25,000 shells, which encompasses the range of catches taken from 2000 to 2003. This performance measure has been developed to ensure that any major change in the patterns of fishing is noticed and investigated. If it is triggered, this may not necessarily

indicate any problem with the stocks, but rather fluctuations in the natural environment or market dynamics.

New management initiatives (2009/10)

A recent amendment to the Specimen Shell Management Plan strengthened the clause pertaining to the taking and selling of specimen shells to improve the ability of the Department of Fisheries to successfully prosecute cases of black market sale, purchase and dealing of shell.

A Ministerial Exemption was granted on 26 March 2009, which permits the use of up to 2 fishing boats of any size (provided that the boats are not used simultaneously), the use of up to 2 nominated divers who are not nominated on the Managed Fishery Licence (provided no more than 2 people are in the water at any one time), collection of dead shells of non-commercial abalone species and specimen shells of the genus *Pecten*. This Exemption is in place while management plan amendments are progressed.

An Exemption has been granted for one licensee to trial the use of a remote operated vehicle to collect shells in water depths of 60 to 300 metres.

APPENDICES

APPENDIX 1	288
APPENDIX 2	291
APPENDIX 3	300
APPENDIX 4	308
APPENDIX 5	318
GLOSSARY OF ACRONYMS	319

APPENDIX 1

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APPENDICES

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APPENDIX 2

Table of catches from fishers' statutory monthly returns for 2008/09

This table contains the landed¹ and estimated live weight² of species recorded in the compulsory catch and fishing effort returns provided by commercial fishers each month. These data include the catch taken as by-product as well as the targeted catch.

These catch data may differ slightly from some of the catch estimates presented for specific fisheries as the latter may include additional data from other sources, such as research log books and processors. The figures may also differ slightly from previously reported figures, as additional data may have been received by the Department of Fisheries. The table represents the latest year for which a complete set of data is available.

While scientific names have been included wherever possible, it should be noted that many fish recorded under a common name cannot be identified as belonging to a particular single species and therefore must be reported as being part of a commercial grouping of several species. For example, the common name 'jobfish' may be used for several species of the genus *Pristipomoides*.

Data for species with live weight catches of less than 500 kg have been combined into the general or 'other' category within each class.

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
FISH			
Amberjack	<i>Seriola dumerilli</i>	17,483	17,483
Australian sardine (Pilchard)	<i>Sardinops sagax ocellatus</i>	2,108,604	2,108,604
Barracuda (northern pike)	<i>Sphyræna spp</i>	808	808
Barramundi (giant perch)	<i>Lates calcarifer</i>	36,612	55,130
Bass grouper	<i>Polyprion americanus</i>	1,162	1,162
Bigeye (not tuna)	Priacanthidae	11,096	11,096
Boarfish	<i>Pentacerotidae</i>	5,356	5,995
Bonito	<i>Sarda australis</i>	857	857
Bream, black	<i>Acanthopagrus butcheri</i>	43,018	43,040
Bream, monocle	<i>Scolopsis spp.</i>	10,540	10,540
Bream, Mozambique	<i>Wattsia mossambica</i>	1,112	1,112
Bream, Robinson's	<i>Gymnocranius grandoculis</i>	32,453	32,453
Bream, silver (tarwhine)	<i>Rhabdosargus sarba</i>	4,770	4,795
Bream, western yellowfin	<i>Acanthopagrus latus</i>	7,945	7,945
Catfish, sea (golden cobbler)	Ariidae	7,981	7,981
Chinaman fish (not cod)	<i>Symphorus nematophorus</i>	7,799	7,799
Cobbler	<i>Cnidoglanis macrocephalus</i>	66,925	93,506
Cobbler, silver	<i>Arius midgleyi</i>	46,200	76,493
Cod	Serranidae	46,742	46,830
Cod, bar (grey-banded, eight-bar)	<i>Epinephelus octofasciatus</i>	12,498	12,498
Cod, breaksea	<i>Epinephelides armatus</i>	5,089	5,103
Cod, chinaman	<i>Epinephelus rivulatus</i>	1,019	1,019
Cod, Rankin	<i>Epinephelus multinotatus</i>	119,348	119,348

APPENDICES

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
FISH (continued)			
Cod, spotted	<i>Epinephelus microdon, E. areolatus, E. bilobatus</i>	57,596	57,596
Dhufish, West Australian (jewfish)	<i>Glaucosoma hebraicum</i>	82,130	85,652
Emperor, blue-lined (grass; black snapper)	<i>Lethrinus laticaudis</i>	2,183	2,183
Emperor, blue-spot	<i>Lethrinus hutchinsi</i>	215,089	215,089
Emperor, red	<i>Lutjanus sebae</i>	333,408	333,408
Emperor, red-spot (snapper)	<i>Lethrinus lentjan</i>	33,901	33,901
Emperor, spangled	<i>Lethrinus nebulosus</i>	53,494	53,494
Emperor, sweetlip	<i>Lethrinus miniatus</i>	57,804	57,828
Emperor, yellow-tailed	<i>Lethrinus atkinsoni</i>	672	672
Flagfish (Spanish flag)	<i>Lutjanus vitta, L. quinquelineatus, L. carponotatus, L. lutjanus</i>	67,974	67,974
Flathead	Platycephalidae	7,458	7,615
Flounder	Bothidae	857	899
Garfish, sea	<i>Hyporhamphus melanochir</i>	28,904	28,904
Groper (wrasses)	Labridae	1,034	1,125
Groper, baldchin	<i>Choerodon rubescens</i>	12,975	13,089
Groper, blue	<i>Achoerodus gouldii</i>	45,550	55,782
Halibut	<i>Psettodes erumei</i>	1,481	1,481
Hapuku	<i>Polyprion oxygeneios</i>	21,184	21,184
Herring, Australian	<i>Arripis georgianus</i>	181,557	181,568
Herring, Perth	<i>Nematalosa vlaminghi</i>	1,011	1,011
Javelin fish	<i>Pomadasys</i> spp.	39,185	39,185
Jobfish (goldband snapper) –see Snapper, goldband			
Jobfish, rosy –see Snapper, rosy			
Jobfish (sharptooth snapper) –see Snapper, sharptooth			
Kingfish, black (cobia)	<i>Rachycentron canadum</i>	10,634	10,634
Kingfish, yellowtail	<i>Seriola lalandi</i>	671	684
Knifejaw	<i>Oplegnathus woodwardi</i>	1,383	1,417
Leather jacket	Monacanthidae	15,053	25,784
Mackerel, grey (broad-barred)	<i>Scomberomorus semifasciatus</i>	20,088	20,301
Mackerel, scaly	<i>Sardinella lemuru</i>	59,312	59,312

APPENDICES

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
FISH (continued)			
Mackerel, shark	<i>Grammatorcynus bicarinatus</i>	543	544
Mackerel, Spanish	<i>Scomberomorus commerson</i>	226,031	319,711
Mangrove jack	<i>Lutjanus argentimaculatus</i>	12,927	12,927
Morwong	Cheilodactylidae	521	521
Mullet, red	Mullidae	17,054	17,054
Mullet, sea	<i>Mugil cephalus</i>	243,570	243,586
Mullet, yellow-eye	<i>Aldrichetta forsteri</i>	24,245	24,245
Mulloway	<i>Argyrosomus hololepidotus</i>	11,923	12,449
Mulloway, northern (black jew)	<i>Protonibea diacanthus</i>	2,374	3,057
Parrot fish	Scaridae	6,558	6,558
Perch, darktail sea (maroon sea) -see Snapper, marron			
Perch, Moses –see Snapper, Moses			
Perch, pearl	<i>Glaucosoma buergeri</i>	39,048	39,048
Perch, red, maroon sea perch	<i>Lutjanus spp (large)</i>	26,542	26,542
Perch, yellowtail	<i>Amniataba caudavittatus</i>	1,562	1,562
Perches, other	Lutjanidae	3,580	3,580
Pike, sea	<i>Sphyaena novaehollandiae</i>	3,176	3,176
Pomfret, black	<i>Parastromateus niger</i>	2,005	2,053
Queenfish	<i>Scomberoides commersonianus</i>	576	1353
Redfish, bight	<i>Centroberyx gerrardi</i>	47,998	49,371
Redfish, yelloweye	<i>Centroberyx australis</i>	31,928	34,710
Rockcod, blackspotted	<i>Epinephelus malabaricus</i>	18,885	18,885
Rockcod, goldspotted	<i>Epinephelus coioides</i>	15,380	15,380
Salmon, Western Australian	<i>Arripis truttaceus</i>	979,068	986,759
Samson fish (sea kingfish)	<i>Seriola hippos</i>	38,908	40,118
Scad, yellowtail	<i>Trachurus novaezelandiae</i>	6,077	6,077
Shark, blacktip	<i>Carcharhinus spp.</i>	23,722	61,061
Shark, bronze whaler (dusky whaler)	<i>Carcharhinus obscurus</i>	111,186	176,658
Shark, common saw	<i>Pristiphorus cirratus</i>	4,692	10,931
Shark, eastern school	<i>Galeorhinus galeus</i>	3,773	5,999
Shark, golden (copper whaler)	<i>Carcharhinus brachyurus</i>	30,237	48,074
Shark, gummy	<i>Mustelus antarcticus</i>	374,605	595,613

APPENDICES

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
FISH (continued)			
Shark, hammerhead	Sphyrnidae	53,502	96,302
Shark, mako (shortfin)	<i>Isurus oxyrinchus</i>	1,668	2,652
Shark, pencil	<i>Hypogaleus hyugaensis</i>	999	1,589
Shark, spinner (long-nose grey)	<i>Carcharhinus brevipinna</i>	18,324	29,084
Shark, thickskin (sandbar)	<i>Carcharhinus plumbeus</i>	79,906	172,096
Shark, tiger	<i>Galeocerdo cuvier</i>	20,886	58,611
Shark, whiskery	<i>Furgaleus macki</i>	93,559	140,329
Shark, wobbegong	Orectolobidae	30,554	48,561
Shark, other		1,480	2,468
Shovelnose (fiddler rays)	Rhinobatidae & Rhynchobatidae	935	3,114
Skates and rays, other		8,167	21,467
Snapper, bullnose (variegated emperor)	<i>Lethrinus ravus</i>	3,536	3,536
Snapper, crimson (formerly red snapper)	<i>Lutjanus erythropterus</i>	203,698	203,698
Snapper, frypan	<i>Argyrops spinifer</i>	46,961	46,965
Snapper, goldband	<i>Pristipomoides multidens</i>	699,184	699,184
Snapper, long nose	<i>Lethrinus olivaceus</i>	10,410	10,410
Snapper, maroon (formerly maroon sea perch)	<i>Lutjanus lemniscatus</i>	9,385	9,385
Snapper, Moses (formerly Moses Perch)	<i>Lutjanus russelli</i>	37,593	37,593
Snapper, nor-west	Lethrinidae	3,074	3,074
Snapper, pink	<i>Pagrus auratus</i>	416,334	420,229
Snapper, queen	<i>Nemadactylus valenciennesi</i>	59,418	67,503
Snapper, red (swallowtail) –see Snapper, crimson			
Snapper, rosy (formerly Rosy jobfish)	<i>Pristipomoides filamentosus</i>	40,098	40,098
Snapper, ruby	<i>Etelis</i> spp.	29,473	29,473
Snapper, saddletail sea (formerly scarlet sea perch)	<i>Lutjanus malabaricus</i>	179,887	179,887
Snapper, sharptooth	<i>Pristipomoides typus</i>	5,215	5,215
Sprat, blue	<i>Spratelloides robustus</i>	17,760	17,760
Sweep	<i>Scorpis aequipinnis</i>	1,626	1,702
Sweetlip	Haemulidae	52,855	52,855
Tailor	<i>Pomatomus saltatrix</i>	22,625	22,625
Threadfin	Polynemidae	19,147	22,754
Threadfin bream (butterfish)	Nemipteridae	148,280	148,280
Threadfin, giant (king salmon)	<i>Eleutheronema tetradactylum</i>	65,289	71,404

APPENDICES

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
FISH (continued)			
Trevalla, deepsea	<i>Hyperoglyphe antarctica</i>	5,901	5,901
Trevally, golden	<i>Gnathanodon speciosus</i>	1,047	1,047
Trevally, other (skippy)	Carangidae	116,058	116,059
Trevally, skipjack	<i>Pseudocaranx dentex</i>	9,059	9,157
Tripletail	<i>Lobotes surinamensis</i>	6,026	6,159
Trout, coral	<i>Plectropomus maculatus</i>	14,698	14,698
Trout, spotted (duskytail grouper)	<i>Epinephelus bleekeri</i>	3,961	3,961
Trumpeters	Terapontidae	1,041	1,041
Tuna, other	Scombridae	1,154	1,200
Tuskfish, bluebone	<i>Choerodon</i> spp.	9,110	9,110
Whitebait	<i>Hyperlophus vittatus</i>	99,775	99,775
Whiting, King George	<i>Sillaginodes punctata</i>	14,438	14,571
Whiting, western sand	<i>Sillago schomburgkii</i>	159,638	159,842
Other fish		141,568	221,160
TOTAL FISH		9,222,001	10,150,555
CRABS			
Crab, blue swimmer (blue manna, sand)	<i>Portunus pelagicus</i>	833,423	833,423
Crab, champagne (spiny)	<i>Hypothalassia acerba</i>	9,945	9,945
Crab, crystal (snow)	<i>Chaceon bicolor</i>	153,673	153,673
Crab, giant (king)	<i>Pseudocarcinus gigas</i>	4,826	4,826
Crab, mud	<i>Scylla</i> spp.	4,495	4,495
Crabs, other		306	306
TOTAL CRABS		1,006,668	1,006,668
PRAWNS			
Prawn, banana	<i>Fenneropenaeus merguensis</i>	206,113	206,113
Prawn, brown tiger	<i>Penaeus esculentus</i>	897,754	897,754
Prawn, coral	<i>Metapenaeopsis</i> spp	108,807	108,807
Prawn, endeavour	<i>Metapenaeus</i> spp.	207,184	207,184
Prawn, western king	<i>Melicertus latisulcatus</i>	1,191,496	1,191,496
Prawns, other	Penaeidae	429	429
TOTAL PRAWNS		2,611,783	2,611,783

APPENDICES

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
LOBSTERS			
Bugs	Scyllaridae	12,840	12,875
Rock lobster, southern	<i>Jasus edwardsii</i>	40,050	40,050
Rock lobster, western	<i>Panulirus cygnus</i>	7,596,622	7,596,622
TOTAL LOBSTERS		7,649,512	7,649,547
MOLLUSCS			
Abalone, brownlip	<i>Haliotis conicopora</i>	16,865	41,615
Abalone, greenlip	<i>Haliotis laevigata</i>	50,848	135,608
Abalone, Roe's	<i>Haliotis roei</i>	74,522	92,830
Cuttlefish	Sepiidae	47,910	47,989
Octopus	<i>Octopus</i> spp. (mainly <i>O. tetricus</i>)	58,880	75,858
Scallop, saucer	<i>Amusium balloti</i>	721,673	3,578,245
Squid	<i>Sepioteuthis</i> spp., <i>Loligo</i> spp.	45,886	45,896
TOTAL MOLLUSCS		1,016,584	4,018,041
OTHER CLASSES			
Beche de Mer	Holothuridae	53,303	159,909
TOTAL OTHER CLASSES		53,303	159,909
GRAND TOTAL		21,559,851	25,596,503

1. Landed weight: refers to the mass (or weight) of a product at the time of landing, regardless of the state in which it is landed. That is, the fish may be whole, gutted or filleted etc. This unit is of limited use for further analysis except where it is known that the product is very homogenous in nature. Where more detailed analysis of the data is required the landed weight is generally converted to a more meaningful measure, the most frequently used being termed live or whole weight or 'nominal catch'.
2. Live weight: refers to the landings converted to a live weight basis. This is often referred to as the 'live weight equivalent of the landings', shortened to the 'live weight'. Although live weight may be the preferred unit it is rarely obtained as a direct measure. This is because it would usually have to be made on board a fishing vessel where the practical difficulties associated with the working conditions render it impossible. Live weight has to be derived and this is usually done by applying a conversion factor to the landed weight.

More information may be obtained from the 'CWP Handbook of Fishery Statistical Standards' at the website
<http://www.fao.org/fishery/cwp/handbook/B/en>

Estimated Western Australian Aquaculture Production for 2008/09

Taken from Aqua Info Number 28 2008/09

Highlights for 2008/09

There were 476 licensed aquaculture producers

The farm gate value of aquaculture production in WA (excluding marine algae and pearl oysters) was over \$11.3 million

The most valuable industry sector was barramundi (\$4.8 million), followed by mussels (\$1.6 million), marron (\$1.4 million) and yabbies (\$0.8 million)

The industry sector with the most participants was marron with 179 productive licences.

Introduction

The statistics contained in this document represent the reported production and estimated value of the aquaculture industry in Western Australia for the financial year 2008/09. Comparisons to the previous four years have also been presented. The following summaries were produced from information held within the Aquaculture Production Returns Database at the Department of Fisheries, Research Division, Hillarys.

Quarterly records received from industry are summarised by the Department of Fisheries and reported to Parliament by the Minister for Fisheries. They are also used in the yearly Department of Fisheries State of the Fisheries report, the annual report provided by Australian Bureau of Agricultural and Resource Economics (ABARE) and other publications.

Producers' returns constitute the official production and value figures for the aquaculture industry and these are dependent on the accuracy of licensees' returns. The data presented are based on the Aquaculture Production Returns Database, as of the 9th March 2010.

Note that all production reported in tonnes throughout this document refers to whole weight and the farm gate value refers to the value of product at the first point of recorded sale.

The Industry in 2008/09

A total of 476 aquaculture licence holders were required to submit quarterly returns for one or more quarters in the 2008/09 financial year. Of the 476 licences, 245 i.e. 51% recorded production on their returns. Marron had the largest number of producers with 179 licences recording production (Table 1).

Estimated aquaculture production increased by four per cent to 1121 tonnes in 2008/09 from the 1083 tonnes produced in 2007/08 (excludes algae, pearl oysters, and ornamental species) (Table 2). Finfish and ornamental production increased while freshwater crustacean and mussel production decreased.

The estimated value of Western Australian aquaculture (excluding algae and pearl oysters) increased by 12 per cent from \$10.2 million to over \$11.3 million in 2008/09 (Table 3). Finfish aquaculture made up nearly half the earnings for 2008/09.

APPENDICES

TABLE 1.

Growout production for the Western Australian aquaculture industry in 2008/09

Common name	Productive licences	Quantity	Units*	Average price/ unit	Value
Barramundi	7	455.2	tonnes	\$10.53	\$4 793 106
Mussels	18	433.5	tonnes	\$3.73	\$1 618 594
Marron	179	52.9	tonnes	\$27.40	\$1 448 677
Yabbies	12	44.1	tonnes	\$18.38	\$ 810 608
Silver perch	9	28.5	tonnes	\$14.23	\$ 405 506
Ornamental fish & crustaceans	14	45 892	No.	n/a	\$ 218 908
Koi carp	11	44 270	No.	\$3.80	\$ 168 279
Rainbow trout	9	12.0	tonnes	\$11.59	\$ 139 160
Goldfish	8	36 199	No.	\$2.04	\$ 73 992
Other species with <5 producers	<5	*		*	\$1 675 305
Algae	<5	*		*	*
Total (not including algae or pearls)					\$11 352 133

* Industry figures have not been included where there are less than five productive licensees in a category, to protect the confidentiality of individual producers.

* Tonnes refer to whole weight

Data Comparisons Over the Past Five Production Years (2004/05-2008/09)

TABLE 2.

Estimated quantity of growout production of aquaculture species/categories in Western Australia over the past five financial years.

Common name	Units	2004/05	2005/06	2006/07	2007/08	2008/09
Barramundi	tonnes	283.8	18.5	43.1	365.9	455.2↑
Mussels	tonnes	729.6	765.2	621.9	481.2	433.5↓
Marron	tonnes	49.9	49.3	58.1	51.1	52.9↑
Yabbies	tonnes	73.5	69.3	87.9	60.8	44.1↓
Silver perch	tonnes	20.4	20.7	26.5	16.9	28.5↑
Rainbow trout	tonnes	20.7	29.6	11.7	13.3	12.0↓
Ornamental fish & crustaceans	No.	48 437	68 876	61 483	55 072	45 892↓
Koi carp	No.	55 684	26 149	30 124	35 620	44 270↑
Goldfish	No.	39 384	34 244	35 831	33 918	36 199↑

* Industry figures have not been included where there are less than five productive licensees in a category, to protect the confidentiality of individual producers.

**Totals exclude species estimated by individual numbers.

TABLE 3.

Estimated farm gate value (\$) of growout aquaculture species/categories in Western Australia over the past five financial years.

Common name/ Category	2004/05	2005/06	2006/07	2007/08	2008/09
Barramundi	\$1 525 947	\$ 162 733	\$ 467 280	\$3 870 070	\$4 793 106↑
Mussels	\$2 088 691	\$2 159 056	\$1 811 798	\$1 531 849	\$1 618 594↑
Marron	\$1 172 066	\$1 160 834	\$1 387 386	\$1 298 701	\$1 448 677↑
Yabbies	\$1 119 524	\$1 036 980	\$1 381 214	\$1 059 532	\$ 810 608↓
Silver perch	\$ 225 974	\$ 258 949	\$ 317 321	\$ 245 128	\$ 405 506↑
Ornamental fish & crustaceans	\$ 196 800	\$ 161 412	\$ 294 330	\$ 237 258	\$ 218 908↓
Koi carp	\$ 237 887	\$ 248 098	\$ 137 193	\$ 160 596	\$ 168 279↑
Rainbow trout	\$ 148 410	\$ 172 459	\$ 110 125	\$ 135 005	\$ 139 160↑
Goldfish	\$ 58 002	\$ 55 797	\$ 65 442	\$ 80 724	\$ 73 992↓
Other	\$ 312 395	\$ 624 347	\$ 883 064	\$1 554 289	\$1 675 305↑
Total (not including algae & pearls)	\$7 085 696	\$6 040 665	\$6 855 152	\$10 173 151	\$11 352 133

APPENDIX 3

Research Division – Other Activities

Pemberton Freshwater Research Centre activities 2009/10

The Pemberton Freshwater Research Centre (PFRC) is the largest freshwater hatchery and research facility in Western Australia. Located on the Lefroy Brook in Pemberton it consists of two neighbouring sites, the original PFRC hatchery and the Dr Noel Morrissy Research Ponds located on Thomson's Flat. The original PFRC hatchery site contains 10 earthen ponds, 22 concrete ponds, trout hatching and larval rearing troughs, 48 tank trout nutrition facility, and a training centre. The nearby Dr Noel Morrissy Research Ponds feature 25 earthen ponds, ranging in size from 150m² breeding ponds to 1000m² commercial grow-scale ponds, 28 tanks and a post-harvest handling facility. This site on Thomsons Flat also includes an area that is leased to the Pemberton Aquaculture Producers (PAP) for marron processing and marketing.

PFRC staff are responsible for the maintenance and production of trout, native fish and crayfish at the facility. They are also responsible for stocking trout into public waters and packing trout and marron for sale to commercial farmers. Efficient management and operation of a large production and research facility for fish and crayfish such as PFRC requires a high level of expertise. As a result PFRC staff provide a key regional extension service to aquaculture, recreational fishing and conservation client groups.

PFRC provides facilities, expertise and stock to support research and industry development in four key areas of conservation, recreational fishing, aquaculture and freshwater fisheries.

Key PFRC projects in 2009/10 are briefly discussed below:

Trout production for recreational fishing, aquaculture and research

Trout production at PFRC provides fingerlings and yearlings for recreational fishing, aquaculture and research. Two species of trout are produced at PFRC Brown trout (*Salmo trutta*) for recreational fishing and Rainbow trout (*Oncorhynchus mykiss*) for both aquaculture and recreational fishing.

In 2009/10 the PFRC produced 688,000 fry. These consisted of 658,000 Rainbow trout fry and 30,000 Brown trout fry, representing a decrease in production of 6% and 500% respectively, compared with 2008/09. The majority of production (81%) consisting of 532,000 Rainbow trout fry and 28,000 Brown trout fry were stocked into public waterways to support recreational fishing. A further 96,000 Rainbow trout (14%) were sold to individuals and clubs for stocking private farm dams for recreational fishing and tourism, included in the 96,000 trout fry sold to the recreational groups were 28,000 rainbow triploid fry. All the triploids were sold to private waters for recreational fishing.

The remaining 5% of trout produced 32,000 were retained for future brood stock for PFRC, yearling stocking, research and sales for private waters.

In 2009/10 during the Winter-Spring months some 23,000 Rainbow yearlings as well as 2,680 Rainbow and 400 Brown trout ex brood stock, were released to public waters for recreational fishing.

Trout research for recreational fishing and aquaculture

In late 2006 the Department commenced a review of trout production at PFRC to consider two key factors: Brown trout embryo survival and Rainbow trout brood stock selection strategies. In 2007 the Department commenced research to evaluate hatchery production techniques for producing sterile triploid trout and develop improved protocols using hydrostatic pressure and tetraploids.

Brown trout embryo survival

In 2005 Brown trout embryo survival was sub-optimal, however prior to disposing of this valuable line, that is highly regarded by recreational fishers, Research Division staff commenced a study to confirm the extent of this problem and determine the contributing factors. Factors being investigated include poor sperm motility, water quality or climate change.

Investigations by the department into brown trout sperm motility showed that some trout were not producing motile sperm. This resulted in modifications to hatchery protocols to include assessment of sperm quality prior to egg fertilisation. In 2009/10 sperm motility assessment using basic visual evaluation of sperm quality resulted in a 500% improvement in brown trout fertilisation rates. However, visual assessment of sperm motility is labour intensive. Consequently sperm motility assessment has been postponed until the purchase of computing equipment and software.

Rainbow trout brood stock selection

The current breeding strategy for both Rainbow and Brown trout at PFRC focuses upon random selection of brood stock. However, trout production at PFRC has two key client groups with different objectives, recreational fishing and aquaculture. Therefore, it is likely that breeding objectives for these two groups may be different. Accordingly Research division staff commenced discussions with both major client groups to establish and prioritise breeding objectives. This will ensure that in coming years, brood stock selection strategies at PFRC can be implemented to produce trout with traits that specifically meet the needs of key client groups.

The genetic line of rainbow trout at PFRC is unique. In 2008/09 staff completed a series of temperature tolerance

experiments that demonstrated that the PFRC rainbow trout genetic line can withstand water temperatures of up to 28°C without any mortalities. This temperature tolerance is superior to most domesticated lines elsewhere and is significant in regards to adapting to global warming.

Sterile triploid trout production

Triploids are valuable for stocking as they cannot reproduce and continue to grow after reaching sexual maturity. The PFRC hatchery has produced triploids for many years using temperature shock to retain the first polar body of fertilised eggs. However, temperature shocking is known to have considerable variability in triploidy rates. To address this in 2006 PFRC obtained a hydrostatic pressure chamber for manipulating chromosome numbers to produce triploids and tetraploids.

Protocols for the production of triploids and tetraploids using hydrostatic pressure were developed. Juveniles were produced, however resource limitations prevented the percentage of triploids and tetraploids being analysed in either 2008/09 or 2009/10. These samples have been frozen and will be analysed when finances permit.

Native fish and crayfish conservation and biodiversity research

In response to a declining prevalence of native fish in the southwest PFRC established brood stock populations of two endemic species Pygmy Perch (*Edelia vittata*) and Western Minnows (*Galaxias occidentalis*). The aim of this research project is to develop large-scale pond production techniques for these species to enable stocking of public and private water bodies. It is thought that the decline in prevalence of native fish is related to the increased spread of introduced *Gambusia* (*Gambusia affinis*), but research at PFRC indicates that other factors may also be responsible. Although *Gambusia* were originally introduced to control mosquito populations, it has been shown that the native Pygmy perch consume more mosquito larvae. Therefore, while production and stocking of Pygmy perch has direct conservation and biodiversity benefits, it is also likely to result in human health benefits through a reduction in mosquito numbers and Ross River virus.

Broodstock populations of two other freshwater native fish species that have been listed as critically endangered, the Trout Minnow (*G. truttaceus*) and Balson's Pygmy Perch (*N. Balstoni*), are also being established at PFRC in an effort to close their lifecycles, develop large scale production techniques and restock waterbodies within their original distribution.

In 2005/06 a captive breeding program to conserve marron

biodiversity was established at PFRC. The key focus of this program was to establish a breeding population of the Margaret River marron, which has been listed as critically endangered. The South West Catchments Council (SWCC) provided funding to develop a molecular genetic test (RAPID's) to identify "pure" marron from hybrids in collaboration with UWA. This resulted in the establishment of the only "pure" brood stock population of the rare Margaret River marron at PFRC. These broodstock produced over 1200 juveniles in the first year of this project. These juveniles have been reared to sexual maturity at PFRC. In July 2009 these marron bred in the ponds at PFRC and 2500 progeny were tagged and restocked in the Margaret River.

In addition, captive breeding populations from three other river systems were established at PFRC. These broodstock represent the genetic biodiversity of the northern, central and eastern marron populations found in Western Australia. Their progeny will be available for 1) marron farmers wishing to increase the genetic diversity of their stocks, 2) wild fisheries research involving the release and recapture of tagged juveniles in the recreational marron fishery, and 3) restocking both catchments and farm dams in each of the three regions.

Marron aquaculture research and development

In 2006 the FRDC project 2000/215 "Improved performance of marron using genetic and pond management strategies" was completed. Working with industry on commercial marron farms Research Division staff validated and established current best practice farming techniques. This showed that correctly constructed and professionally managed marron farms can achieve production levels that are twice that of those which do not follow best practice.

The project also showed that poor brood stock selection, where farmers sell their largest marron and breed from the remaining slower growing animals had reduced the growth rate of marron on commercial farms. To address this, the Research Division staff initiated a selective breeding program that resulted in a 100% improvement in growth rate. In 2007 PFRC produced around 25,000 juveniles for sale to industry. A repository population of the better performing genetic lines was retained at PFRC for future selective breeding and sale of progeny to industry. Increased demand for these juveniles has necessitated re-establishing the breeding program at PFRC.

Activities of the Fish Health Unit during 2009/10

The Fish Health Unit of the Department of Fisheries was formed in 1988 and is based at South Perth within the Animal Health Laboratories of the Department of Agriculture. The unit is staffed by 1 full-time and 2 part-time fish pathologists, one research scientist, one laboratory manager and one technical officer. During the year, the unit operated at reduced capacity since one part-time pathologist left in December 2009 and was not replaced.

The unit is accredited to ISO 17025 and provides a diagnostic service to the fishing and aquaculture industry in Western Australia, investigates 'fish kills', contributes to policy advice developed by the Department, carries out research on diseases of aquatic organisms, and has a minor extension role. Greater emphasis has been placed on staff visiting aquaculture farms to encourage sustainable farming practices.

Key activities and achievements of the unit during 2009/10 were as follows:

- The fish health laboratory received a total of 107 diagnostic cases during the 2009/10 – a decrease on the previous period. This reflects the general downturn in aquaculture and pearling activity.
- The provision of export health certificates for yabbies and marron has continued its downward trend since 2002, when 55 certificates were issued, to none in this reporting period. This decline in export activity is due to the continuing drought and to changes in export destinations within the industry.
- The provision of pearling translocation certificates also showed a decline to 6 cases, reflecting the downturn in the economy, changes within the industry and also the adoption of a new translocation protocol requiring much less testing.
- Staff spent time assisting a number of sea-cage culture farms in WA coastal waters. This is a growing area of activity in Western Australia.
- There were seven cases of notifiable diseases reported in 2009/10, a large increase on the previous year when none were reported. The diseases were mostly records

of iridovirus in ornamental fish, but there were three submissions of the fungus disease "Epizootic Ulcerative Syndrome" from the Canning River and Hardy Inlet in October, and one case in an imported Siamese fighting fish in November.

- Investigation of disease in pearl oysters (*Pinctada maxima*) through two Fisheries Research and Development Corporation (FRDC) funded projects; FRDC 2008/30 to develop methods to detect stress in oysters and FRDC 2008/31 to investigate novel Chlamydia-like bodies in pearl oysters has continued. The resignation and non-replacement of one of the contract research officers involved has resulted in a considerable extra workload for the remaining Fish Health staff. The cause of the mortalities since 2006 has not yet been determined.
- Under the WA Government's Natural Resource Management (NRM) strategy \$235 000 was obtained to purchase of a real-time PCR machine and a laser microdissection microscope.
- In collaboration with staff from the Department of Water and the Water and Rivers Commission, 10 reports of 'fish kills' throughout the State were investigated. This was about half the number investigated last year. Most 'fish kills' were due either to poor water quality or toxic algal blooms.
- A range of national committees including the national Aquatic Animal Health Committee, the National Animal Health Strategy Advisory Group and Biosecurity Australia frequently seek the expertise of the Fish Health Unit. This reflects the greater emphasis on national coordination and consultation on aquatic animal health issues under the national AQUAPLAN 2005-2010 biosecurity strategy.
- The laboratory continued in its role as one of 6 regional resource centres for aquatic animal health within the Network of Aquaculture Centres (NACA) in the Asia-Pacific.

Indian Ocean Territories Fishery Status Report

S.J. Newman, M. Pember, C. Skepper and L. Bellchambers

Management input from R. Green

Main Features

Status		Current Landings	
Stock level	Some species at risk	Total	Not assessed
Fishing Level	Not Assessed	Main Commercial Fishery	Not reportable

Fishery Description

Commercial

In November 2002, the territorial seas (out to 12 nautical miles) of the Cocos (Keeling) Islands and Christmas Island were declared as 'excepted waters' from the *Fisheries Management Act 1991*. Management responsibilities for these waters were transferred from the Australian Fisheries Management Authority (AFMA) to the Department of Transport and Regional Services. The Government of Western Australia's Department of Fisheries (the Department) has now taken on management responsibilities for the marine waters of the Indian Ocean Territories out to 12 nm, under a Service Delivery Arrangement with the Commonwealth Attorney General's Department (AGD), and AFMA continues to manage the waters from 12nm to 40 nm. The location of the Indian Ocean Territories and their proximity to the Western Australian coast are illustrated in Indian Ocean Territories Figure 1.

Under the Service Delivery Arrangement with the AGD, the Department now manages commercial, recreational, charter and aquaculture activities at the Cocos (Keeling) Islands and Christmas Island, in addition to providing fish health diagnostic services, biosecurity, fish habitat protection advice, fish pathology and licensing services. The Commonwealth Minister for Home Affairs currently holds responsibility for these excepted waters under the *Fish Resources Management Act 1994 (WA) (CI/CKI)* (the 'Applied Act').

The commercial Christmas Island Line Fishery (CILF) primarily targets pelagic species, mainly wahoo (*Acanthocybium solandri*) and yellowfin tuna (*Thunnus albacares*). In addition, limited demersal fishing activities are also undertaken targeting deepwater snappers and groupers.

The Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) primarily targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge jocularis*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*).

Recreational

Large amounts of recreational fishing are undertaken around the Cocos (Keeling) Islands and Christmas Island targeting both finfish and invertebrate species. The Cocos (Keeling) Islands consist of a diverse range of fishable habitats that include a sheltered lagoon, fringing reefs and offshore 'blue water' environments that support a range of demersal and

pelagic fish species, as well as various crustaceans (e.g. crabs) and molluscs (e.g. gong gong), which are highly sought after by fishers for both individual and community purposes. Christmas Island has a limited amount of habitat available for fishing with no lagoon present, fringing reef surrounding the island and offshore 'blue water' environments that support a limited range of demersal and pelagic fish species, as well as some invertebrates in comparison to the Cocos (Keeling) Islands.

Governing legislation/fishing authority

Commercial

Fish Resources Management Act 1994 (WA) (CI/CKI) (the 'Applied Act')

Fish Resources Management Regulations 1995(WA) (CKI/CI) and subsidiary legislation

Fishing Boat Licenses with conditions

Cocos (Keeling) Islands Marine Aquarium Fish Fishery – Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption).

Recreational

Fish Resources Management Act 1994 (WA) (CI/CKI) (the 'Applied Act')

Fish Resources Management Regulations 1995 (WA) (CKI/CI) and subsidiary legislation.

Consultation processes

Commercial

Department–industry/community consultation – Christmas Island and Cocos (Keeling) Islands.

Recreational

Community Consultation - Cocos (Keeling) Islands and Christmas Island.

Boundaries

Commercial

The territorial seas from the shoreline out to a distance of 12 nautical miles around the Cocos (Keeling) Islands and Christmas Island (Indian Ocean Territories Figure 1).

APPENDICES

Recreational

The territorial seas from the shoreline out to a distance of 12 nautical miles around the Cocos (Keeling) Islands and Christmas Island.

Management arrangements

Commercial

The Christmas Island Line Fishery (CILF) is managed primarily through input controls in the form of limited entry to the fishery and gear restrictions. There are 3 licenses in the fishery. In 2009, all 3 licenses operated in the fishery. The CILF also has output controls in the form of quota limits on both demersal and pelagic species to be harvested.

The commercial Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) is managed through input controls in the form of a limited entry fishery (there is only 1 licence in the fishery) and gear restrictions. The fishery also has a number of output controls in the form of limits on the species permitted to be harvested, limits on the total number of individuals of all species combined that can be harvested in a year and limits of the number of individuals within a Family that can be harvested within a year.

Recreational

Island-specific fisheries management arrangements for the Indian Ocean Territories are currently being developed. This will include assigning species to a number of risk categories and the development of species-specific or species group specific bag and size limits.

Research summary

Risk assessment workshops were undertaken in 2006, 2007 and 2009, to identify and refine fisheries research and management priorities at the Indian Ocean Territories. Following these workshops finfish fisheries research has focused on collecting biological material to assess the wahoo stocks and on collecting tissue samples from a suite of species at the Cocos (Keeling) Islands and Christmas Island to examine their connectivity with other sites along the Western Australian coast and locations to the north. Invertebrate fisheries research has focused on surveys to assess the abundance and biology of gong gong (*Lambis lambis*) and also to understand the abundance and distribution of bêche-de-mer (*Holothurians*) and clams (*Tridacna* spp.). Biodiversity research has also established a reef-monitoring program to detect changes in reef health due to natural and anthropogenic impacts.

Retained Species

Commercial landings

(season 2009)

Not reportable

Wahoo (*Acanthocybium solandri*) is the main target species of the CILF. Other pelagic species are also targeted during the trolling operations and include yellowfin tuna (*Thunnus albacares*) and to a lesser extent mahi mahi (*Coryphaena hippurus*). Some commercial fishing activities are also undertaken for demersal fish species, mainly deep slope species such as ruby snapper (*Etelis* spp.). The commercial

catch for Christmas Island consists of catch data from only 3 vessels and thus the exact catch data is not reportable due to confidentiality provisions. However, it can be reported that the total catch was less than 6t. The catch in 2009 was slightly higher than that reported in 2008.

The CKIMAFF targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge jocularis*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*). As there is only one license in the CKIMAFF the catch data is not reportable due to confidentiality provisions.

Recreational catch estimate

(season 2009)

Not assessed

There are large recreational fishing fleets operating around the Cocos (Keeling) Islands and Christmas Island. The amount and magnitude of the recreational fishing catch and effort at these islands has not been assessed. Recreational bag limits, area closures, and gear restrictions have been proposed.

Fishing effort/access level

Commercial:

Effort in the CILF has been relatively stable over the past two years. Effort in the Fishery is weather dependent and is limited by access to the water through the principal boat ramp at Flying Fish Cove, and to a lesser extent the Ethel Beach boat ramp.

Effort in the CKIMAFF has been similar over the last few years providing a similar level of catch.

Recreational

Effort by recreational anglers at both Cocos (Keeling) and Christmas Island is weather dependent. At the Cocos (Keeling) Islands the prevailing weather conditions determine what part of the Island complex is subject to fishing activities. Access to the water at Christmas Island is limited to the principal boat ramp at Flying Fish Cove, and to a lesser extent the Ethel Beach boat ramp.

Stock Assessment

Assessment complete:

Yes

Assessment method:

Risk Assessment

Breeding stock level:

Some species at risk

Beche de Mer: In 2006 a large-scale assessment of the bêche-de-mer communities inhabiting the lagoon and outer reef at the Cocos (Keeling) Islands was undertaken to determine the status of key holothurian stocks and enable recommendations to be made regarding the feasibility of a commercial bêche-de-mer fishery being developed in the region. Analysis of abundance and distribution data found that the bêche-de-mer community is strongly influenced by habitat and although some species are wide-ranging and found in relatively high densities, they tend to be of low economic value. In contrast, species of moderate to high value were recorded at densities too low to support commercial fisheries and typically had very restricted

distributions. The bêche-de-mer community found at the Cocos (Keeling) Islands is near to pristine, due to a lack of historical fishing pressure. Bêche-de-mer stocks are very sensitive to fishing pressure and have been heavily overexploited in other areas of the Indian and Pacific Oceans.

Gong Gong: The common spider conch or gong gong (*Lambis lambis*) is a heavily recreationally targeted gastropod inhabiting shallow waters of the lagoon. This species is vulnerable to over-fishing as it is highly accessible and presumably shares biological traits with other exploited conch species, including slow growth and late maturity. Monitoring data collected in 2007, 2008 and 2009 indicate that the current abundance of gong gong is substantially lower than that recorded historically. While heavy fishing pressure has presumably contributed to the reduction in gong gong numbers, further monitoring is required to determine the role of recruitment variability in maintaining gong gong populations at the Cocos (Keeling) Islands and changes in the lagoon system.

Giant Clams: The sustainability of giant clam (*Tridacna* spp.) and coral species were identified as potential concerns during recent risk assessments undertaken for the marine resources of the Cocos (Keeling) Islands by the Department of Fisheries. To address these concerns, research has been expanded to assess the status of *Tridacna* clams at the islands. In addition, an on-going reef monitoring program has been established. The implementation of these initiatives will enable the Department of Fisheries to assess the health of the coral reef ecosystems at the Cocos (Keeling) Islands and effectively detect change, both spatially and temporally, resulting in better management of the natural resources of the Atoll.

Finfish: Data on the abundance of finfish species is being collated and collected to determine changes over time. A number of recent surveys have been undertaken at both localities (Hobbs, Choat pers. comm.). Some species appear to have exhibited marked declines in abundance. For example, Lincoln Smith et al. (1995) reported that the squaretail coral trout (*Plectropomus areolatus*) was abundant on shallow reefs (<10m) and was one of the species most commonly recorded on deep reefs (15-20m). Cocos Malay community members have advised that these species were targeted in the waters of the lagoon using lines. This species is now extremely low in abundance at the Cocos (Keeling) Islands (Choat pers. comm.), suggesting local depletion and/or overexploitation of the stock (we presently know very little about the stock structure of species in the Indian Ocean Territories, in particular gene flow and linkages with other populations elsewhere in the Indian Ocean).

The pelagic species that are targeted by the CILF (e.g. wahoo, yellowfin tuna) are likely to be part of a wider Indian Ocean stock. However, the demersal species are likely to be localized stocks that are reliant upon self-recruitment (a key research gap).

There is anecdotal evidence of localised depletion of some deep slope species like rosy snapper (*Pristipomoides filamentosus*) and ruby snapper (*Etelis carbunculus*) around Christmas Island. An increasing number of recreational fishers are using electric-powered lines to target deep-slope demersal finfish species at the Indian Ocean Territories,

thereby increasing the effective fishing effort for these species.

Aquarium Fish: The CKIMAFF targets *Centropyge jocularis* and to a lesser extent *Centropyge flavissima*. *Centropyge jocularis* is endemic to the Cocos and Christmas Islands and inhabits fringing reefs from 15 to 70 m. Little is known about the biology of *C. jocularis* although Allen et al. (2007) describe this species as being abundant on Christmas Island.

Non-Retained Species

Bycatch species impact: **Negligible**

Fishing in the CILF for pelagic species such as wahoo uses specialised trolling gear to target the fish and involves limited discarding. Species occasionally caught and sometimes retained but generally discarded include billfish, barracuda, shark, mackerel tuna and trevally. A high proportion of the above species are expected to survive capture and release by the fishery. Consequently, it is considered likely that the pelagic fishery has a negligible impact on stocks of discarded species. Fishing for demersal species in the CILF particularly those in the deep slope waters involves limited discarding as most species are retained for processing.

The fishing techniques used to capture fish in the CKIMAFF involve using hand or scoop nets, or a small seine net of specific dimensions (the seine net cannot exceed 16 metres in length, must have a mesh of less than or equal to 28mm and a drop of not more than 3 metres) and may use SCUBA equipment. Thus, the CKIMAFF has negligible bycatch due to the highly selective nature of fishing activities.

Protected species interaction: **Negligible**

The line fishing methods used in CILF are not known to catch any protected species. However, there is some potential for lines to inadvertently catch seabirds at Christmas Island.

No protected species interactions have been reported for the CKIMAFF.

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The line fishing methods used in the CILF and the hand collection method used in the CKIMAFF are likely to have minimal impact on the habitat.

Social Effects

Commercial

At least 3 people were employed in the CILF around Christmas Island during 2009. This estimate is based on the number of vessels reporting catches and the average number of crew on each boat.

At least 2 people were employed in the CKIMAFF around Cocos (Keeling) Islands during 2009.

APPENDICES

Recreational

Due to their sport fishing and eating qualities, wahoo and other pelagic species are popular target species for recreational anglers and fishing charter operators at the Indian Ocean Territories, particularly at Christmas Island. They are usually captured from small boats, although shore-based fishing is also undertaken.

A large variety of demersal and lagoon finfish and invertebrate species are caught by recreational/customary fishers at Cocos (Keeling) Islands involving the use of a large number of small vessels. Similarly, recreational fishers at Christmas Island undertake fishing activities from a number of small vessels and also fishing from the shore and catch a large variety of demersal finfish species including a large number of deep slope species.

Economic Effects

Estimated annual commercial value (to fishers)

for year 2009: Not assessed

The value of the CILF is not known. The value of the CKIMAFF is also unknown, although *C. jocularis* commands a high price on the international market.

Fishery Governance

Commercial

Current Fishing (or Effort) Level Not assessed

Target commercial catch range Not assessed

The potential fishing effort for both pelagic and demersal fish species at both the Cocos (Keeling) Islands and at Christmas Island is high with a capacity to operate over the entire extent of the fishable area at each island group. Given the restricted amount of habitat and fishing area available it is expected that fishing pressure on some species at Cocos (Keeling) Islands or Christmas Island is above optimum levels.

The catch of the CKIMAFF has been small since its inception in 1993. There is little incentive for the single licensee to

increase catch or effort since market viability and high prices are maintained by only having small numbers of fish available for sale.

New management initiatives (2011)

Following initial community and stakeholder consultation, the Department released the Cocos (Keeling) Islands recreational fishing guidelines for public comment in December 2006 and the Christmas Island Fisheries Management Strategy for public comment in May 2007. The Cocos (Keeling) Islands guidelines were solely focused on the recreational fishing sector, while the Christmas Island fisheries management strategy included recreational guidelines, commercial fishing models and charter fishing concepts for community feedback.

Following extensive community consultation, initial research surveys and observation of fishing practices, the need for increased protection to ensure sustainability has been identified for a number of species.

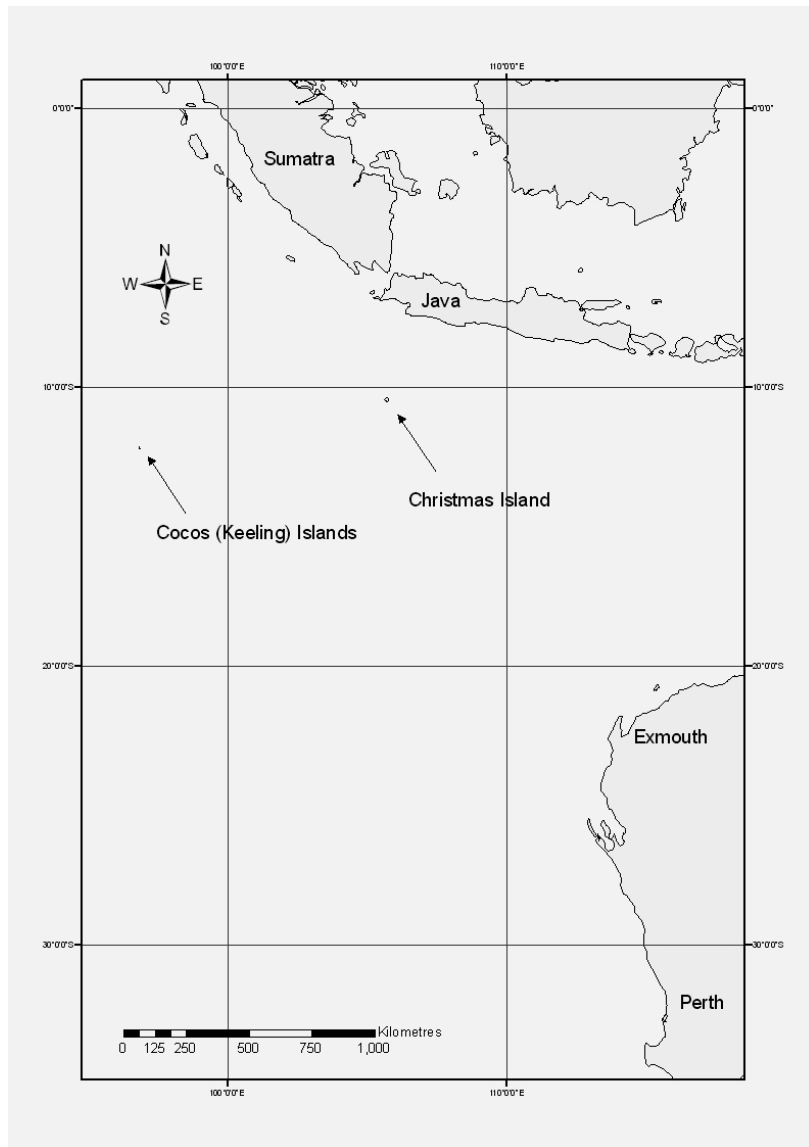
Island-specific fisheries management arrangements for the Indian Ocean Territories are currently being developed. This will include assigning species to a number of risk categories and the development of species-specific or species group specific bag and size limits.

The Department is reviewing the management arrangements for the Christmas Island Line fishery and the Cocos (Keeling) Islands Marine Aquarium Fish Fishery.

The effective implementation of any future fisheries management legislation at the Indian Ocean Territories, will require the development of community education and compliance enforcement programs.

External Factors

The demersal fish and invertebrate populations of Cocos (Keeling) Islands and Christmas Island are likely to consist of small, isolated populations that are expected to experience highly variable recruitment due to environmental fluctuations.

**INDIAN OCEAN TERRITORIES FIGURE 1**

Location of the Cocos (Keeling) Islands and Christmas Island comprising the Indian Ocean Territories within the Indian Ocean and illustrating their proximity to the Western Australian coast.

APPENDIX 4

Annual performance for commercial fisheries subject to export approval under the Australian Government's Environment Protection and Biodiversity Conservation Act 1999

The following table provides a summary of the issues and performance measures for fisheries subject to the above Act and their annual performance. The period assessed in each case is the most recent season for which complete data are available. As a result of the duration required for data collection and analysis, the years being assessed in this volume are the 2008/09 season or the calendar year 2009.

In addition to this summary, more detailed information on the annual performance of each fishery is provided in the

relevant status reports presented throughout this volume. Within the individual status reports, each performance measure assessed is shown in a highlighted box to assist the reader.

It should also be noted that where naturally occurring fluctuations in fish stocks have required management adjustments or where improvements have been made to methods of analysis, these have in some cases (asterisked) required a revision of the performance measure this year.

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
<i>Fishery:</i> Abalone <i>Date of certification:</i> March 2008 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> September 2014	Greenlip/brownlip abalone Areas 2/3 (spawning stock)	Effort range 907–1,339 diver days; minimum meat weight 140 g greenlip, 160 g brownlip	Acceptable	
	Roe's abalone Area 1 (spawning stock)	Effort range 14–43 diver days; total catch 9.9 t	Acceptable	Adverse weather conditions limited fishing A reduction to 5t recommended for 2009
	Roe's abalone Area 2 (spawning stock)	Effort range 80–106 diver days; total catch 19.8 t	Acceptable	
	Roe's abalone Area 5 (spawning stock)	Effort range 100–140 diver days; total catch 20 t	Acceptable	85% of quota taken in Area 5 due to adverse weather.
	Roe's abalone Area 6 (spawning stock)	Effort range 80–127 diver days; total catch 12 t	Acceptable	
	Roe's abalone Area 7 (spawning stock)	Effort range 175–215 diver days; total catch 36 t	Acceptable	Effort was lower due to reduced TACC

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
	Roe's abalone Area 8 (spawning stock)	Effort range 140–200 diver days; total catch 12t	Acceptable	
<i>Fishery:</i> Abrolhos Islands and Mid West Trawl <i>Date of certification:</i> 17 March 2005 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> March 2013	Scallops (spawning stock)	The residual stock index determines a predicted catch that sets the length of the next season	Acceptable	The recruit survey indicated low abundance and pre-season surveys indicated small meat size and poor quality so season did not open.
<i>Fishery:</i> Beche-de-mer <i>Date of certification:</i> December 2004 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> December 2010	Beche-de-mer species (spawning stock)	The preliminary acceptable catch range is 50–150 t: catch rate above 80 kg/ crew-day fished	Acceptable	Total catch above range due to additional target species (deep water redfish. Target catch range will be revised as more information becomes available
<i>Fishery:</i> Broome Prawn <i>Date of certification:</i> August 2004, extended April 2010 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> August 2010	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any one year	Acceptable	Very low level of effort this year.
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–90 t (7-year catch range)	Acceptable	As above
<i>Fishery:</i> Exmouth Gulf Prawn <i>Date of certification:</i> March 2003 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> February 2013	Tiger prawn (spawning stock)	Catch rate above 25 kg/hr (6 fathom quad gear) revised from original 8–10 kg/hr (7.5 fathom twin gear)	Acceptable	
	King prawn (spawning stock)	Total catch within acceptable range of 350–500 t	Acceptable	Below range due to conservative harvesting strategies
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 120–300 t	Acceptable	
	Banana prawn (spawning stock)	Total catch within acceptable range of 10–60 t for years with significant rainfall and 0–2 t for years with low rainfall	Acceptable	Low recorded catch correlates to low rainfall

APPENDICES

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–100 t	Acceptable	
	Discarded fish (abundance)	The major species of bycatch are found in significant numbers outside of the trawled areas	Acceptable	
	Impact to mud/shell (habitat)	< 40% of mud/shell habitat in Exmouth Gulf trawled	Acceptable	
	Discarding fish (provisioning)	Reduction in amount of discards and ratio of discards to target catch from levels prior to introduction of BRDs	Acceptable	
<i>Fishery:</i> Kimberley Prawn <i>Date of certification:</i> November 2004, extended April 2010 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> August 2010	Banana prawn (spawning stock)	Total catch within acceptable range of 200–450 t	Acceptable	Close to target range.
	Brown tiger prawn (spawning stock)	Total catch within acceptable range of 15–60 t	Acceptable	Very low landings due to low effort
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 7–80 t	Acceptable	As above
	Coral prawns (spawning stock)	Total catch within acceptable range of 0–6 tonnes (10-year catch range)	Acceptable	As above
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–1 t	Acceptable	
	Squid (spawning stock)	Total catch within acceptable range of 1–50 t	Acceptable	
<i>Fishery:</i> Mackerel <i>Date of certification:</i> November 2009 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> November 2014	Spanish mackerel (spawning stock)	Total catch within acceptable range of 246–410 t: acceptable regional catch ranges: Kimberley 110–205 t: Pilbara 80–126 t: Gascoyne/West Coast 56–79 t	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
<i>Fishery:</i> Marine Aquarium Managed Fishery <i>Date of certification:</i> October 2008 <i>Approval type:</i> Approved Wildlife Trade Operation Exemptions <i>Expiry date:</i> October 2011	Seahorses of hippocampus species	Number taken - 340	Acceptable	
<i>Fishery:</i> Northern Demersal Scalefish <i>Date of certification:</i> June 2010 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> June 2015	Red emperor and goldband snapper (spawning stock)	Spawning biomass > 40% of virgin spawning biomass with lower limit of 30%; total annual catches should not increase > 20% above average catches of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years	Acceptable	Total catch was just above the upper limit, but catches of goldband were on target and red emperor was below.
	Cods/groupers (spawning stock)	Total annual catch should not increase >20% above average catch of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years.	Acceptable	
<i>Fishery:</i> Onslow and Nickol Bay Prawn <i>Date of certification:</i> November 2004, extended April 2010 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> August 2010	Banana prawns (spawning stock)	Nickol Bay: total catch in high rainfall years within acceptable range of 40–220 t; in low rainfall years within acceptable range of 0–40 t.	Acceptable	
		Onslow: total catch within acceptable range of 2–90 t	Acceptable	
	Brown tiger prawn (spawning stock)*	Acceptable catch ranges of Nickol Bay 2–40 t and Onslow 10–120 t	Acceptable	
	Western king prawn (spawning stock)	Acceptable catch ranges of Nickol Bay 20–70 t and Onslow 10–55 t	Acceptable	Below target due to low effort.
	Endeavour prawn (spawning stock)	Total catch within acceptable ranges; Nickol Bay 1-10 t and Onslow 5-20 t.	Acceptable	As above

APPENDICES

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
	Coral prawns (spawning stock)	Total catch within acceptable range of Nickol Bay 1–15 t (10-year catch range) and Onslow 4–20 t	Acceptable	As above
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–2 t	Acceptable	
<p><i>Fishery:</i> Pearl Oyster <i>Date of certification:</i> September 2003, extended October 2008 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> October 2013</p>	Silver-lipped (gold-lipped) pearl oyster (spawning stock)	Fished area should be < 60% of species distribution; catch rates should not decrease by > 50% from historical averages of 29.5 oysters/hr (Zone 2) and 34.8 oysters/hr (Zone 3); > 30% of Zone 1 catch should be > 150 mm shell length	Acceptable	Catch rates in Zones 2 and 3 above performance levels due to very good stock levels.
<p><i>Fishery:</i> Pilbara Trap <i>Date of certification:</i> November 2004 <i>Approval type::</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> December 2007 Under review by DEWHA</p>	Long-lived target species (spawning stock) – includes Rankin cod, red emperor, scarlet perch, goldband snapper, red snapper, spangled emperor	Spawning biomass of Rankin cod and red emperor should remain above minimum limit of 40% of virgin spawning biomass Annual trap catch should not increase > 20% above average catch of previous 4 years No decrease in annual trap catch rates in > 2 consecutive years	Acceptable	
<p><i>Fishery:</i> Pilbara Trawl <i>Date of certification:</i> November 2004 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> October 2009</p>	Long-lived target species (spawning stock) – includes Rankin cod, red emperor, scarlet perch, goldband snapper, red snapper, spangled emperor	Spawning biomass of Rankin cod and red emperor should remain above minimum limit of 40% of virgin spawning biomass; annual trawl catch should not increase > 20% above average catch of previous 4 years; no decrease in annual trawl catch rates in > 2 consecutive years	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
	Short-lived target species (spawning stock)	Median spawning biomass of blue-spot emperor should be > 40% of the 1993 spawning biomass in Area 1; annual catch of each short-lived target species should not increase > 20% above the average annual catch of the previous 4 years; annual catch rate of each short-lived target species should not decrease in two consecutive years	Acceptable	
	Bycatch of protected species – dolphins	Number of dolphins caught by the fishery should be < 75/yr, assuming 100% catch mortality; all skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	
	Bycatch of protected species – turtles	Number of turtles caught should be reduced by 50% of 2002 level following implementation of mitigation devices; number of turtles released alive should be greater than or equal to 72% of total captures per year; all skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	
	Bycatch of protected species – syngnathids	Number of pipefish caught and released alive should be < 500/yr; number of seahorses caught and released alive should be < 60/yr; all skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	

APPENDICES

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
	Bycatch of protected species – sawfish	Number of sawfish caught should be < 120/yr; number of sawfish released alive should be increased to 50% of captures by 2008; all skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	
	General ecosystem – large epibenthos	The total area of the Pilbara demersal fish fishery (encompassing both trawl and trap fisheries) that is closed to trawling is 80%; the total area of the Pilbara demersal fish fishery between depths of 30 m and 120 m should remain at or below the current level of 60%	Acceptable	
<p><i>Fishery:</i> Salmon <i>Date of certification:</i> November 2004, extended November 2009 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> November 2014</p>	Western Australian salmon (spawning stock)	Expected catch range under the current management regime is 1,200–2,800 t	Acceptable	Catch below target level due to limited targeting and low catchability along the South Coast. West Coast catch below historical level, so overall acceptable.
<p><i>Fishery:</i> Shark Bay Crab Interim Managed Fishery <i>Date of certification:</i> November 2004 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> November 2010</p>	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
<p><i>Fishery:</i> Shark Bay Prawn <i>Date of certification:</i> February 2003 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> February 2013</p>	Tiger prawn (spawning stock)	Level of spawning stock present based on fishery independent surveys during the spawning season to be between 25-30 kg/hr (5.5 fathom quad gear) This figure is revised from the original fishery dependent information in July and August of 2 kg/hr, with a preferred level between 3 and 4 kg/hr	Below but acceptable	The new threshold level is based on a revised spatial area and after the area has been closed to fishing. 2009 was below the threshold level but is still adequate due to a conservative threshold level being set.
	King prawn (spawning stock)	Total catch within historical acceptable range of 1,100–1,600 t, given no change in effort	Below but acceptable	
	Coral and endeavour prawns (spawning stock)	Total catch within historical acceptable ranges given no change in effort: coral 80–280 t, endeavour 1–30 t	Acceptable	
	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	BRDs are mandatory in all net so this performance measure is no longer valid. For the 2009 season, 5 turtles were recorded as caught in nets and were recorded as being returned to the sea alive.
	Discarded fish (abundance)	Majority of bycatch species are found in relatively significant numbers outside of trawled areas	Acceptable	
	Impact to sand/shell (habitat)	< 40% of sand/shell habitat in Shark Bay trawled	Acceptable	
	Impact to coral/sponge (habitat)	<20% of the remaining coral/sponge habitat in Shark Bay to be contained within the legally trawled area	Acceptable	
Discarding fish (provisioning)	Reduction in amount of discards and ratio of discards to target catch from pre-catch reduction device levels	Acceptable		

APPENDICES

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
<p><i>Fishery:</i> Shark Bay Scallop <i>Date of certification:</i> February 2003 <i>Approval type:</i> Export exemption <i>Expiry date:</i> February 2013</p>	Scallop (spawning stock)	Monitoring of recruits/residual stock to ensure the start date of the season is set so that there is adequate level of breeding stock present when spawning commences	Acceptable	
	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	BRDs are mandatory in all net so this performance measure is no longer valid. For the 2009 season, 13 turtles were recorded as caught in nets and were recorded as being returned to the sea alive.
<p><i>Fishery:</i> Shark Bay Snapper <i>Date of certification:</i> September 2009 <i>Approval type:</i> Export exemption <i>Expiry date:</i> September 2014</p>	Pink snapper (spawning stock)	Catch rate not to fall below 500 kg/standard June–July boat day	Acceptable	The performance measure needs to be reviewed following significant reductions in quota and the move (in 2008) to higher resolution catch & effort reporting (daily/trip logbooks).
<p><i>Fishery:</i> South Coast Crustacean <i>Date of certification:</i> September 2004 <i>Approval type:</i> Wildlife Trade Order <i>Expiry date:</i> February 2009</p>	Southern rock lobster (spawning stock)	Catch to remain below 40 t for Esperance fishery	Acceptable	New management arrangements for south coast crustacean fisheries should be finalised In 2010
<p><i>Fishery:</i> Specimen Shell <i>Date of certification:</i> 25 May 2005 <i>Approval type:</i> Export exemption <i>Expiry date:</i> May 2010</p>	Specimen shell species (spawning stock)	Preliminary acceptable catch range is from 10,000–25,000 shells; acceptable catch rate 10–40 shells per day	Acceptable	
<p><i>Fishery:</i> Temperate Shark Fisheries <i>Date of certification:</i> April 2009 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> March 2012</p>	Scalefish bycatch	To stay within historical trends as a %age of total catch.		

Fishery details	Issue/species	Performance measure	Current performance in 2008/09 or 2009	Comment
<i>Fishery:</i> Western Rock Lobster <i>Date of certification:</i> August 2002 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> September 2012	Western rock lobster (spawning stock)	Spawning biomass at Abrolhos Islands and coastal regions to remain above respective levels during the early 1980s with 75% certainty	Acceptable	
	Octopus (spawning stock)	Catch rate not to drop outside of historic range by > 10%	Acceptable	
	Sea lion (captures)	No increase in rate of capture	Acceptable	No sea lion captures were reported
	Leatherback turtle (captures)	No increase in rate of interactions	Acceptable	
	Whales and dolphins (captures)	No increase in rate of interactions	Acceptable	Indicator requires revision as whale populations are increasing hence level of interactions will also increase.
<i>Fishery:</i> West Coast Deep Sea Crab <i>Date of certification:</i> May 2010 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> May 2013	Champagne crab (spawning stock)	Catch to remain below historical high of 50 t per annum	Acceptable	
	Crystal Crab (spawning stock)	Catch to remain within range 100–250 t per annum	Acceptable	As the fishery has moved to catch quota, the performance measure needs to be updated.
<i>Fishery:</i> West Coast and South Coast Purse Seine <i>Date of certification:</i> February 2009 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> February 2012	Bycatch and environment	Identify byproduct, bycatch (including protected species) and impacts on the marine environment Develop strategy for mitigating interactions with flesh-footed shearwaters and dolphins; and Identify long-term trends in composition and quantity of other bycatch.		
	Target species	Quota and catch to remain less than 10% of spawning biomass.		

APPENDIX 5

Fisheries Research Division staff adjunct positions and Supervision of students

Staff Member	Position
	Adjunct Researcher, Centre for Marine Futures, University of Western Australia
Lynda Bellchambers	Honours supervision, Oceans Institute, University of Western Australia, supervises Jean-Philippe Dumas - Prey preference of western rock lobster, <i>Panulirus cygnus</i> .
Richard Evans	Adjunct Research Fellow, School of Plant Biology, University of Western Australia.
	Adjunct Lecturer, Centre for Fish and Fisheries Research, Murdoch University
David Fairclough	PhD co-supervision, Murdoch University, supervises Elaine Lek - "Comparisons of the biology of three sympatric species of wrasse (Labridae) in Western Australia".
	Adjunct Senior Lecturer, School of Animal Biology, University of Western Australia
	PhD co-supervision, University of Western Australia, supervises Andrew Limbourn - "Nutritional condition of <i>Panulirus cygnus</i> post puerulus."
Danielle Johnston	Honours student co-supervision, Murdoch University, supervises Broderick Hosie - "Genetic relationship of blue swimmer crabs <i>Portunus pelagicus</i> between southwest fisheries in Western Australia"
	Adjunct Professor, Murdoch University, School of Veterinary and Biomedical Sciences
	PhD co-supervision, Murdoch University, supervises Susan Keoh - "Diseases of Asian seabass or barramundi"
	MSc Co-Supervisor, University of Tasmania, supervises Graeme Knowles "Immunity and stress response in oysters"
Sagiv Kolkovski	MSc co-supervision, Edith Cowan University, supervises Justin King - 'Artemia production'
	Adjunct Associate Professor, The University of Western Australia
	Honours supervision, University of Western Australia, supervises Raymond Ninyette - Aquaponics
	PhD supervision, University of Western Australia, supervises Miriam Sullivan- Aquarium fish welfare
Rod Lenanton	Associate Professor, Faculty of Sustainability, Environmental and Life Sciences, School of Biological Sciences and Biotechnology, Murdoch University.
Brett Molony	Member of Marine and Freshwater Course Consultative Committee, Edith Cowan University.
	Adjunct Professor, Marine Ecology Group, School of Plant Biology, University of Western Australia.
Stephen Newman	Adjunct Associate Professor, Centre for Fish and Fisheries Research, Murdoch University
	Honours student co-supervision, Murdoch University, supervises Nick Breheny – "Larval fish assemblages in the three adjacent marine embayments of Owen Anchorage, Cockburn Sound and Warnbro Sound".
Corey Wakefield	

GLOSSARY OF ACRONYMS

AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AGD	(Australian Government) Attorney General's Department
AIMWTF	Abrolhos Islands and Mid West Trawl Managed Fishery
BPF	Broome Prawn Fishery
BRD	Bycatch Reduction Device
CAES	Catch and Effort Statistics
CAP	Commercial Access Panel
CDR	Catch and disposal record
CI/CKI	Christmas Island and Cocos (Keeling) Island
CILF	Christmas Island Line Fishery
CKIMAFF	Cocos (Keeling) Islands Marine Aquarium Fish Fishery
CPUE	Catch Per Unit Effort
CW	Carapace Width
DEC	Department of Environment and Conservation (formerly Department of Conservation and Land Management)
DEWHA	(Australian Government) Department of Environment, Water, Heritage and the Arts
DVI	digital video imagery
EPBC	(Commonwealth) Environment Protection and Biodiversity Conservation (Act 1999)
ENA	Extended Nursery Area

ERLF	Esperance Rock Lobster Managed Fishery
ESD	Ecologically Sustainable Development
FED	Fish escapement device
FHPA	Fish Habitat Protection Area
FMO	Fisheries and Marine Officer
FRDC	Fisheries Research and Development Corporation
FV	Fisheries Volunteer (formerly VFLO)
GAB	Great Australian Bight
GDSF	Gascoyne Demersal Scalefish Fishery
GSMH	Great Southern Marine Hatcheries
IBSS	Independent Breeding Stock Survey
IFAAC	Integrated Fisheries Allocation Advisory Committee
IFM	Integrated Fisheries Management
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IQF	Individually Quick Frozen
ITE	Individually Transferable Effort
ITQ	Individually Transferable Quota
JANSF	Joint Authority Northern Shark Fishery
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
KGBF	Kimberley Gillnet and Barramundi Managed Fishery

APPENDICES

KPF	Kimberley Prawn Managed Fishery
LASCF	Lake Argyle Silver Cobbler Fishery
LML	Legal Minimum Length
MAF	Marine Aquarium Fish Managed Fishery
MBP	Marine Bioregional Plan
MOP	Mother-of-Pearl
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MPP	Management Planning Panel
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NBPF	Nickol Bay Prawn Managed Fishery
NDSF	Northern Demersal Scalefish Managed Fishery
NHT	Natural Heritage Trust
NPF	Northern Prawn Fishery
PER	Public Environmental Review
PFRC	Pemberton Freshwater Research Centre
PFTF	Pilbara Fish Trawl (Interim) Managed Fishery
RAP	Research Angler Program
RCL	Rostrum Carapace Length
RFAC	Recreational Fishing Advisory Committee
RFFSS	Recreational Freshwater Fisheries Stakeholder Subcommittee

RLIAC	Rock Lobster Industry Advisory Committee
ROA	Reef Observation Area
SBBSMNF	Shark Bay Beach Seine and Mesh Net Managed Fishery
SBSF	Shark Bay Snapper Managed Fishery
SCEF	South Coast Estuarine Managed Fishery
SFD	Standard Fishing Day
SHL	Sustainable Harvest Level
SLED	Sea Lion Exclusion Device
SMFG	Size Management Fish Ground
SRR	Spawning Stock–Recruitment Relationship
SSF	Specimen Shell Managed Fishery
SWBS	South West Beach Seine Fishery
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TAE	Total Allowable Effort
TL	Total Length
TPSA	Tiger Prawn Spawning Area
VMS	Vessel Monitoring System
WADNHFMAC	WA Demersal Net and Hook Fisheries Management Advisory Committee
WAFIC	WA Fishing Industry Council
WAFMRL	WA Fisheries and Marine Research Laboratories
WAMSI	WA Marine Science Institute

WANCSF	WA North Coast Shark Fishery
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WCBBF	West Coast Beach Bait Managed Fishery
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WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
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WCDSF	West Coast Demersal Scalefish Fishery
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WCEF	West Coast Estuarine Managed Fishery
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WCRLF	West Coast Rock Lobster Managed Fishery
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WDWTF	Western Deepwater Trawl Fishery
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WTO	Wildlife Trade Operation
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