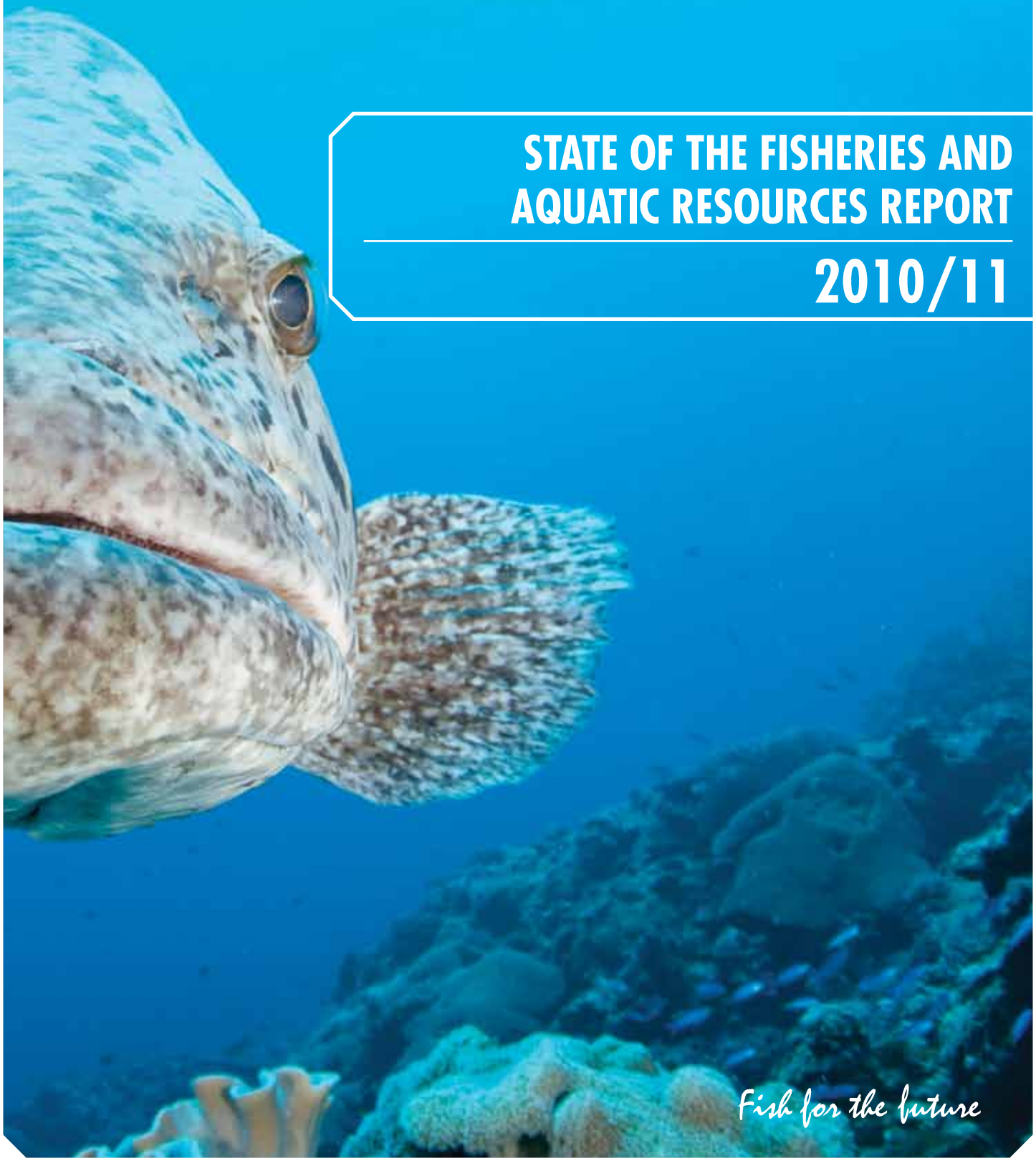
Government of **Western Australia**
Department of **Fisheries**

STATE OF THE FISHERIES AND AQUATIC RESOURCES REPORT

2010/11



Fish for the future

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OVERVIEW FROM THE CHIEF EXECUTIVE OFFICER

This is the second edition of the newly named *State of the Fisheries and Aquatic Resources Report.* Each year this report provides the public with an update on the status of all the fish and fisheries resources of Western Australia that are managed by the Department. 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 world leading approach not only details all the fisheries and fishing-related activities within each of the Bioregions but 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 *State of the Fisheries and Aquatic Resources Report* essentially summarises the outcomes of Departmental activities undertaken during 2010/11 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 overall health of the aquatic environment.

Western Australia is one of the first fisheries jurisdictions in the world to fully implement a comprehensive and practical EBFM framework. The move to adopt a holistic, regional approach to management planning and assessments is the logical extension from the 'Ecologically Sustainable Development (ESD) based' assessments that the Department has now completed for each of WA's major fisheries for the past decade. EBFM provides a more thorough basis for the overall management of aquatic resources because it explicitly considers all ecological resources and community values within a Bioregion to determine which may require direct management intervention. 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.

I am pleased with the finding in this report that most of the risks to the aquatic ecological resources in Western Australia are currently at acceptable levels. Given the comprehensive systems of management that are in place, fishing in WA does not present an unacceptable risk to the marine, estuarine and freshwater ecosystems underpinning them. The fishing methods that may affect the habitat (e.g. trawling) are highly regulated with over 90% of WA coastline effectively protected from these types of activities. 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' that require direct management continue to meet their annual performance targets. The only areas where the ecosystems and their component species are considered to be at unacceptable levels continue to be restricted to the estuarine and river systems in the south west region which are generally not the result of fishing related activities.

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, 94% had catches that are considered to be appropriate based on the status of the stocks involved and the current environmental conditions. Moreover, approximately 94% of fisheries are now targeting stocks where no additional management is required to either maintain or achieve an acceptable breeding stock level. Thus the new management arrangements introduced for the West Coast Demersal Scalefish (including snapper and dhufish) have been successful in reducing the catch levels of these species by 50% which was required to generate adequate recovery. The outcomes of monitoring programs to assess the changes in 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

August 2011

EDITOR'S INTRODUCTION

As outlined last year, the renamed *State of the Fisheries and Aquatic Resources Report 2010/11* 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.,* 2010[1]). Consequently, the format for this document is fully consistent with implementing a risk-based approach to resource management.

The introductory section for each Bioregion outlines each of the key ecological resources (assets) within the region and summarises their current overall (cumulative) risk status. The assets that are examined in each bioregion include each of the IMCRA[2] 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 the set of individual fishery reports are now resource-based rather than activity (sector) based with each report containing descriptions of all the commercial and recreational activities that are accessing a particular ecological resource (asset). Each of the different fisheries accessing the same category of ecological assets is 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 is also consistent with the Department's IFM initiative and should enable readers to more easily assess the interrelationships between fisheries and their cumulative effect within each Bioregion of the State.

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 2010/11* 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 FRMA[3] 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.

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. Thanks are again due to Ms Karen Santoro who has managed the coordination and publication processes to enable the production of this important report.



Dr Rick Fletcher
Director – Fisheries Research

August 2011

[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

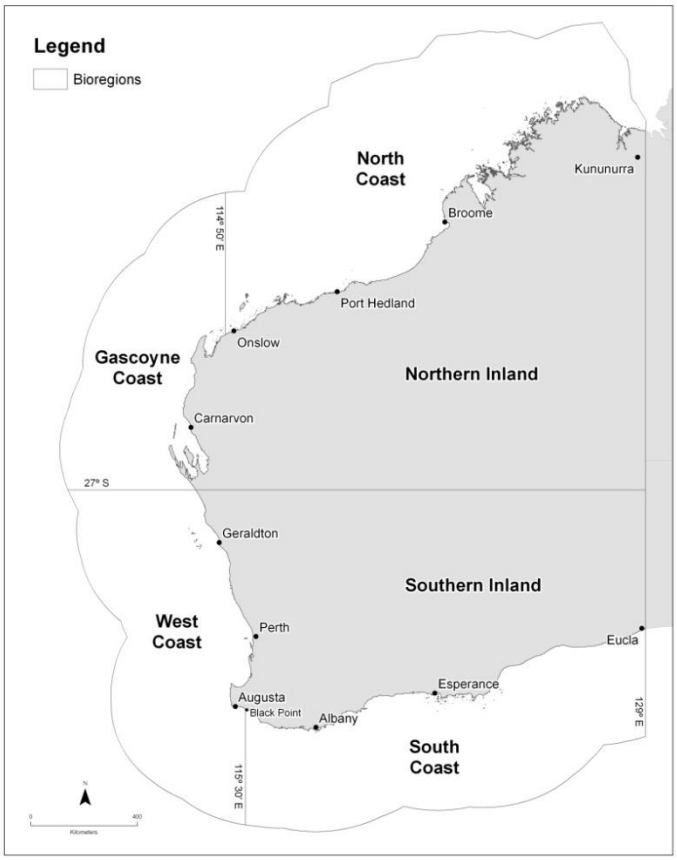
[2] Commonwealth of Australia (2006) A guide to the Integrated Marine and Coastal Regionalisation of Australia - version 4.0 June 2006 (IMCRA v4.0). http://www.environment.gov.au/coasts/mbp/publications/imcra/pubs/imcra4.pdf

[3] Section 263 of the FRMA.

HOW TO USE THIS VOLUME

To obtain full benefit from the information provided in this edition of the *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* 2010/11 to Parliament) and especially those associated with the 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] and Resource Assessment Framework (DoF, 2011)[3]. 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.



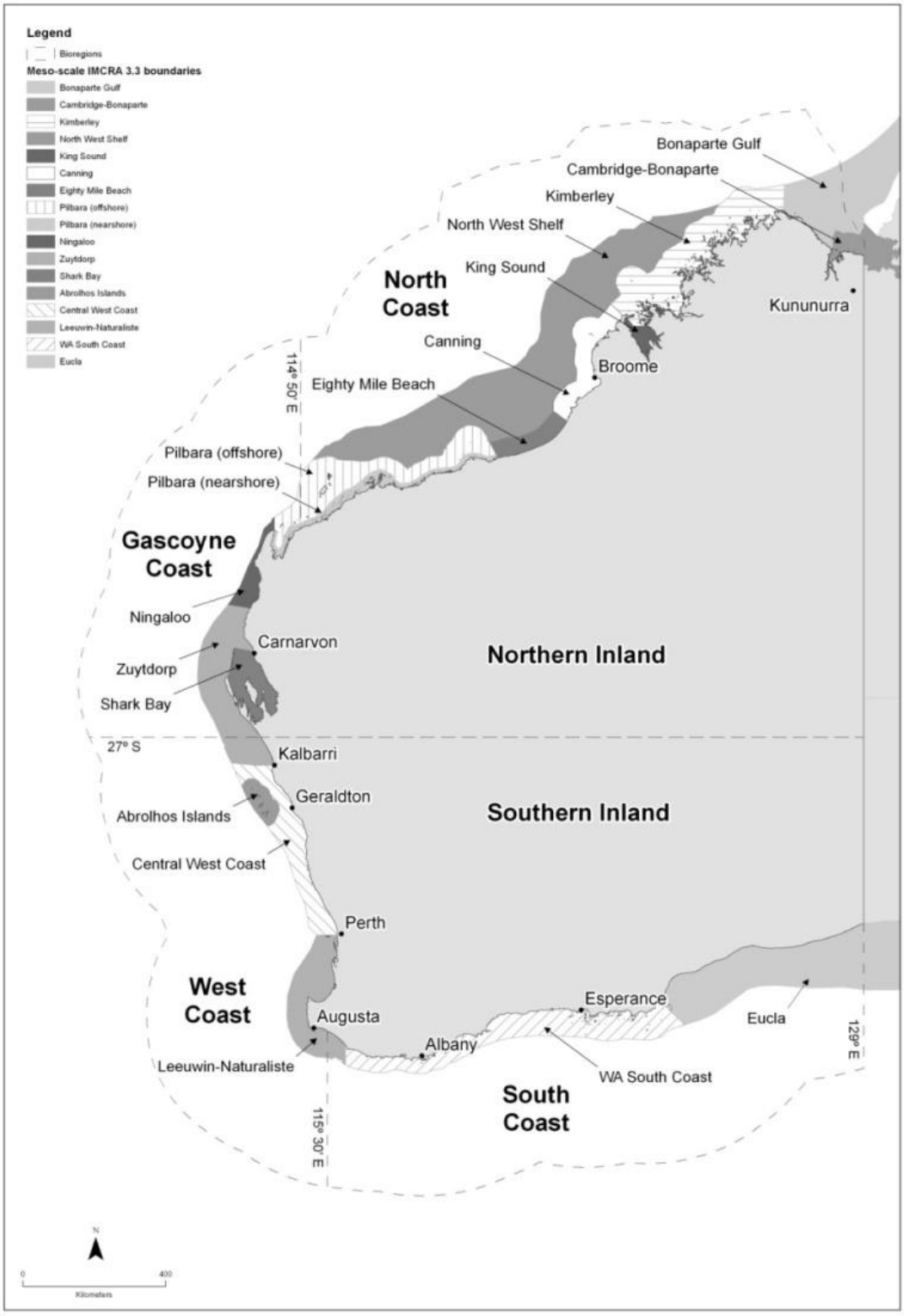
INTRODUCTION FIGURE 1

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

[3] Department of Fisheries (2011) Resource Assessment Framework for Finfish Resources in Western Australia. Fisheries Occasional Publication. No. 85 24pp.



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 boundaries[1].

[1] http://www.environment.gov.au/coasts/mbp/publications/imcra/pubs/imcra4.pdf

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 "*A guide to The Integrated Marine and Coastal Regionalisation of Australia*" - version 4.0 June 2006 (IMCRA v4.0)[1] except for the inclusion of the Gascoyne Coast as a separate Bioregion, reflecting its nature as the transition zone between tropical and temperate waters.

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, it only requires the consideration of each of these elements to determine which (if any) required direct management to achieve acceptable performance. Full details of how the EBFM process is undertaken are presented in Fletcher *et al.* (2010)[2] 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 divided into estuarine and marine categories and again where necessary the latter category was further divided into 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 (see also DoF, 2011).

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).

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)[3]. 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).

The accepted international definition of risk is "the uncertainty associated with achieving objectives" (ISO, 2009)[4], 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 hundreds of separate ecological assets, social, economic and governance issues and 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.

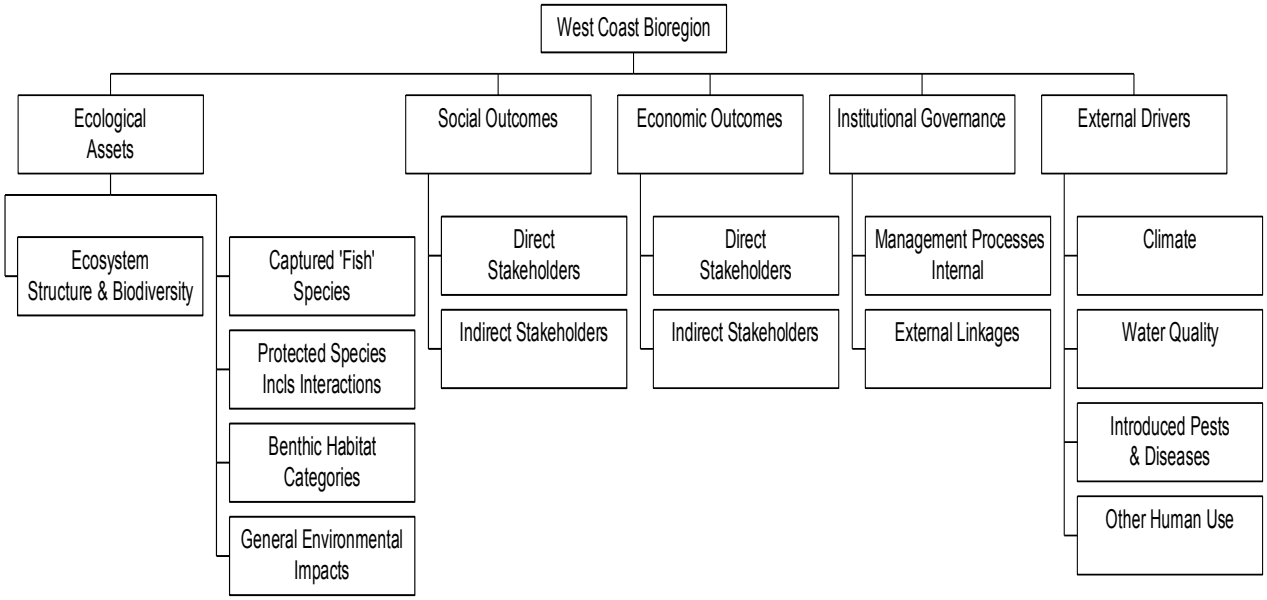
1http://www.environment.gov.au/coasts/mbp/publications/imcra/pubs/imcra4.pdf

[2] 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

[3] 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 http://www.fisheries-esd.com/a/pdf/EAFM%20BASED%20GUIDE%20FOR%20TMP%20DEVELOPMENT%20v6%201.pdf

[4] 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 2005[1]).

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

Breeding stock status

The assessments of breeding stock are undertaken using a number of techniques to determine if the stock is considered to be overfished or not (see below). In only some cases is the breeding stock measured directly, in most cases, the assessments 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 considered to be a function only of environmental effects or recruit survival, not the level of the breeding 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 considered to be recovering at an acceptable rate due to management action and/or natural processes.

Inadequate: 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 and management of the stock is not currently in an acceptable recovery phase.

Stock Assessment Method

Each of the stock assessment reports now clearly identifies what type of assessment method(s) have been used to determine the status of stocks. The specific methods used for monitoring and assessment vary among resources and indicator species which is affected by many factors including the level of ecological risk, the biology and the population dynamics of the relevant species; the type, size and value of the fishery exploiting the species; data availability and historical level of monitoring. The methods therefore 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 up to highly complex and expensive age structured simulation models. The range of methods have been categorised into five broad levels

Level 1	Catch data only
Level 2	Level 1 plus fishery-dependent effort or other relative abundance data
Level 3	Levels 1 and/or 2 plus fishery-dependent biological sampling of landed catch (e.g. average size; fishing mortality, etc. estimated from representative samples)
Level 4	Levels 1, 2 or 3 plus fishery-independent surveys of relative abundance, exploitation rate, recruitment etc.
Level 5	Levels 1 to 3 and/or 4 integrated within a simulation, stock assessment model.

Non-retained species

This refers to any species caught during a fishing operation which are not the target of, or retained by, the fishing operation, and can include both potential impact on unwanted 'bycatch' species and any interaction with protected' species. In each case, an explanation is provided of the situation and the level of risk to the stock from fishing operations. This section does not include release of target species for reasons such as under size, over bag limits etc. these issues are already covered in the assessments of retained species.

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', 'medium' or 'high') is provided.

Target catch (or effort) range

A target catch or effort range has been determined for each of the major commercial fisheries, 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). This identifies if the stock is being subjected to overfishing or not.

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.

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 the majority 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.

The catch or effort for each major fishery is assessed annually and if the catch or effort remains inside the acceptable range it is defined as having acceptable performance. Where the annual catch or effort for a fishery falls outside of this range and the rise or fall cannot be adequately explained (e.g. environmentally-induced fluctuations in recruitment levels – like prawns, or low market prices reduce desired catch levels – e.g. pearl oysters),

a management review or additional research to assess the underlying 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 also 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 2009/10 or the calendar year 2010, whichever is more appropriate. This includes estimates of the value of the fishery which 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 2009/10, following the analysis of data submitted by Fisheries and Marine Officers.

In contrast, the sections on departmental activities in the areas of fishery management, new compliance activities and research summaries are for the current year, and may include information up to June 2011.

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.

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 2010/11.

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 2010/11, 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). Four additional fisheries have breeding stocks considered to be recovering at acceptable rates (West Coast Demersal Scalefish Fishery, Shark Bay Snapper Fishery, Southern Shark Fishery[1], Cockburn Sound Crab Fishery).

The management arrangements introduced for the West Coast Demersal Scalefish Fishery over the past two years to reduce the total level of fishing mortality and catch on these stocks across all sectors by 50 per cent has been achieved with the catches reduced by 50%, so an initial level of stock recovery is considered to have been initiated. Monitoring of the status of the indicator species and the catches taken by all sectors is currently underway. The status of the key stocks for this fishery will be fully reviewed in 2012/13 to determine if the initial positive signs that management has been successful are likely to be ongoing.

For the Southern Shark Fishery, only one of the four target species (sandbar shark) has a breeding stock that will likely remain below acceptable levels for some time due to previous fishing activities (i.e. not from current fishing impacts). Following a detailed review of catch and effort data for the southern shark fishery, a re-assessment of the stocks has revealed that previous management interventions can now be seen to have had a positive impact on the sustainability of dusky shark and whiskery sharks.

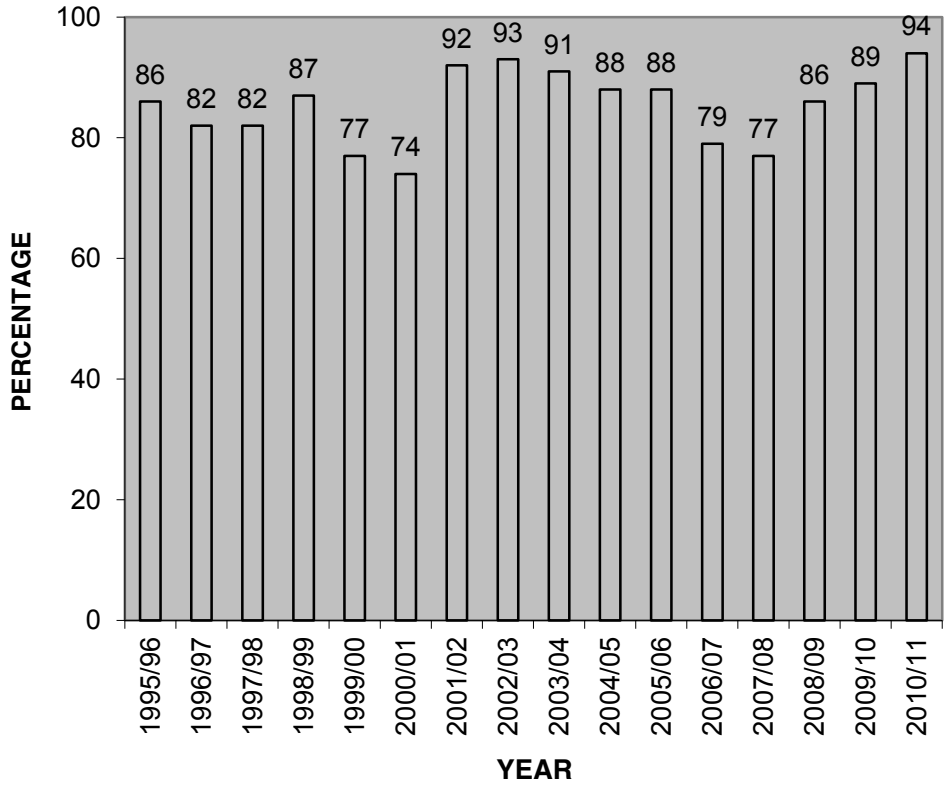
The Cockburn Sound Crab Fishery opened for the first time in 3 years due to continuing recovery of the breeding stock and improving recruitment. It was opened under precautionary management arrangements (restricted effort) to allow further recovery.

In conclusion, a combined total of 94 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 2009/10 and continues an upward trend from the low point measured in 07/08.

For two remaining fisheries, in the Northern Shark Fishery the sandbar shark stock continues to be depleted, while the south coast herring fishery continues to have an uncertain status. Note that the sandbar shark stock is shared between the northern and southern shark fisheries, with catches in the north currently at zero due to uncertainty for the industry regarding ongoing viability of operating in this region.

Research is continuing 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, reduced fishing effort, or some combination of the above.

[1] The Southern Shark Fishery is reported in the South Coast Bioregion as the Demersal Gillnet and Longline Fishery.



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 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. An additional consideration is that market conditions, fleet rationalization or other factors may result in ongoing changes to the amount of effort expended in a fishery which will in turn influence the appropriateness of acceptable catch ranges for certain fisheries.

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 1).

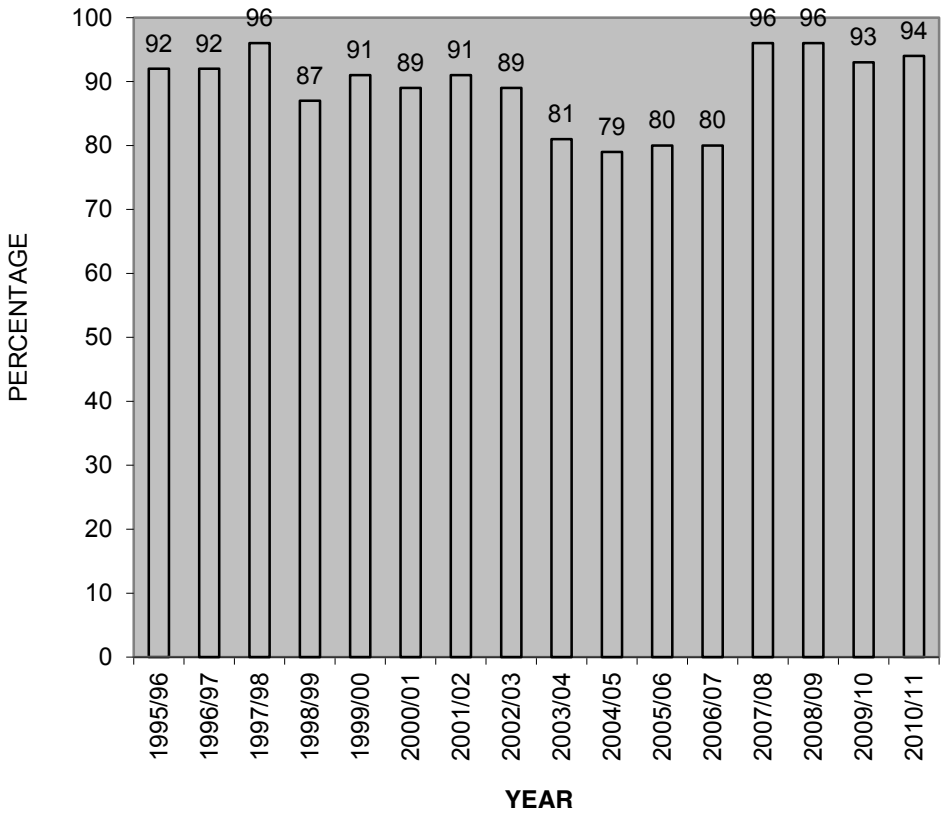
Comparisons between the actual catches (or effort) with the target ranges have been undertaken for 33 of the 38 fisheries referred to in Overview Table 1. The fisheries for which there are target ranges account for most of the commercial value of WA's landed catch. For the mackerel and deep-sea crab fisheries, effort ranges are not yet available so catch ranges will continue to be used. This approach will also be used for the states' pilchard (purse seine) fisheries as it may not be possible to determine meaningful effort ranges; the

three south coast purse seine fisheries are now included in this year's comparisons because there has been increasing consistency in achieving significant catches. In the case of the Cockburn Sound crab fishery the recent period of breeding stock recovery has led to a stock level adequate to allow some fishing to resume but it is too early for target ranges of catch and effort to be developed. Similarly the recent significant expansions in the Shark Bay Crab fishery catch are not thought to pose a risk to the breeding stock but do indicate that a target catch range needs to be developed to ensure this remains the case. Finally, some fisheries had negligible fishing activity for economic reasons and were therefore not assessed.

Of the 33 fisheries where 'target ranges' were available and a material level of fishing was undertaken in 2009/10, ten were catch-quota managed [through a TAC allocated through Individually Transferable Quotas (ITQ)] with 23 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 23 effort-controlled fisheries, 21 produced catches that were within (16) or acceptably below (5) their target catch ranges. The two fisheries identified where the catch levels were considered to unacceptably lower (1) or higher (1) than the target range were the Pilbara trawl fishery and the Kimberley Gillnet and Barramundi fishery respectively. 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. In the Kimberley Gillnet and Barramundi Fishery there has been a considerable increase in barramundi catch in recent years and it has yet to be determined whether this is sustainable.

In summary, 31 (94 per cent) of the 33 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 four years reflecting the successful management strategies that have been developed and implemented.



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 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 and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION						
West coast rock lobster	Length Based Population Dynamics Model (Level 5)	> early 1980s level	Adequate	5500t ± 10% catch limit for season	5899 t (includes Windy Harbour and Augusta)	Acceptable. TACC of 5,500 tonnes ± 10% set for the 2009/10 season to accommodate the recent series of low puerulus settlements.
Roe's abalone	Catch Rates & Direct Survey (Level 4)	Effort (by zone) remains < within range Survey catch rate > minimum	Adequate	101.8 (Q) (530 – 640 days)	91.4 t (567 days)	Acceptable. Effort range adjusted downward by 15% from previous range (620 – 750 days) to account for increased efficiency in the fishery
Abrolhos Islands and mid west trawl	Direct Survey & Catch Rates (Level 4)	Fishing ceases at catch rate threshold.	Adequate	95 – 1,830	806 t	Acceptable. Total landings were well within the acceptable range. There were areas of high scallop abundance but due to some areas of small size scallop meat the stock was not fished to its full potential catch.

Fishery/ Resource	Stock assessment method and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION (continued)						
Octopus	Catch Rates (Level 2)	CPUE > 70kg/day	Adequate	50 - 250	174 t	Acceptable. Fishery in developing phase. Target range to be reviewed when additional information is available.
Cockburn Sound crab	Direct Survey (Level 4)	Residual stock above threshold	Recovering	Not Applicable	56 t	The fishery re-opened for the first time in 3 years due to continuing recovery of the breeding stock and improving recruitment.
Deep sea crab	Catch & Catch Rate (Level 2)	Catch range	Adequate	154 (Q)	145 t	Acceptable. Total Allowable Commercial Catch began in 2008 so an acceptable effort range is yet to be determined.
Estuarine fisheries (west coast)	No	NA	NA	75 – 220 (Peel-Harvey only)	125 t (PH)	Acceptable. Catches of west coast estuarine finfish have been stable since 2000.
West coast beach bait	Catch (Level 1)	Catch range	Adequate	60 – 275 (whitebait only)	101 t	Acceptable. Yearly fluctuations in whitebait catch still match environmental variations.
West coast purse seine	Catch (Level 1)	Catch range	Adequate	0 - 3000 (Q)	10 t	Continued low catches due to market competition, irregular availability of fish and low fishing effort levels.

Fishery/ Resource	Stock assessment method and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION (continued)						
West coast demersal scalefish	Fishing Mortality (F) (Level 3)	F < 3/2 M	Recovering	< 449 – 469 (All Demersal Scalefish) <450 (Demersal Suite)	421 t 340 t – West Coast Demersal Scalefish (interim) Managed Fishery 81 t – Other fisheries, including West Coast Demersal Gillnet and Longline (Interim) Managed Fishery	Acceptable Total catches of demersal scalefish have now been reduced by at least 50% of those of 2005/06. This level of reduction is expected to sufficiently decrease fishing mortality to allow rebuilding of the resource, so the stock is deemed to be recovering. The next stock assessment (in 2012/13) will determine whether this expected recovery has translated into a longer term likelihood of the resource being at or rebuilding to an adequate level.
GASCOYNE BIOREGION						
Shark Bay prawn	Direct Survey (Level 4)	Survey catch rates > minimum level	Adequate	1,501 – 2,330	1,545 t	Acceptable. King and tiger prawns were within the historical target range.
Exmouth Gulf prawn	Direct Survey (Level 4)	Survey catch rates > minimum level	Adequate	771 – 1,276	779 t	Acceptable. The total catch was in the target range but catches of king prawns were below their individual target level.

Fishery/ Resource	Stock assessment method and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
GASCOYNE BIOREGION (continued)						
Shark Bay scallop	Catch Rates and Direct Survey (Level 4)	Fishing ceases at threshold level	Adequate	1,250 – 3,000	1592 t	Acceptable The scallop catch was within the target range.
Shark Bay Crabs	Catch Rates (Level 2)	Catch rate > minimum level	Adequate	Under development	852 t	Catch comes from a dedicated trap fishery and byproduct from prawn trawling. Due to recent increases in total catches, a more detailed assessment is being undertaken.
Shark Bay beach seine and mesh net	Catch Rates (Level 2)	Catch rate > minimum level	Adequate	235 – 335	249 t	Acceptable. Total catch was similar to 2009 while total effort declined slightly. Catch rates of key species were generally maintained.
Shark Bay snapper	Age structured Model (Level 5)	% unfished levels. Target 40%; Limit 30%	Recovering	277 (Q) (380 - 540 days)	263 t (432 days) plus 63 recreational catch	Acceptable. At current TACC levels, the spawning biomass is projected to recover to the target level by around 2014. The next assessment is currently scheduled for 2012.

Fishery/ Resource	Stock assessment method and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION						
Onslow prawn	Catch (Level 1)	Catch range	Adequate	60 – 180	29 t	Acceptable. Tiger prawn landings within the target catch range but king and endeavour prawn landings were extremely low and below the target catch range. The low catch was associated with low fishing effort.
Nickol Bay prawn	Catch (Level 1)	Catch range	Adequate	90 – 300	40 t	Acceptable. Catch of banana prawns were low but within the projected catch range and at the lower end of the species target catch range. King and tiger prawn landings were very low due to limited targeting and low abundance.
Broome prawn	Catch (Level 1)	Catch range	Adequate	55 – 260	3 t	NA Very low level of effort this year.
Kimberley prawn	Catch (Level 1)	Catch range	Adequate	240 – 500	256 t	Acceptable. Banana prawn catch was within target and projected range. Tiger and endeavour prawns were slightly below target ranges due to low effort.

Fishery/ Resource	Stock assessment method and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (continued)						
Kimberley gillnet and barramundi	Catch Rates (Level 2)	Rates > minimum level	Adequate	25 – 40 (barramundi)	57 t	Not Acceptable. The 2009 and 2010 catches of barramundi were both above the catch range due to increased effort levels. A more detailed assessment of these stocks may be required.
Northern demersal scalefish	Catch Rates & Age structured Model (Level 2 & 5)	% unfished levels. Target 40%; Limit 30%	Adequate	Total 600 – 1,000 (goldband <501) (red emperor <201)	Total 1,116 t (goldband 522) (red emperor 141)	Acceptable. Total catch was above the upper limit by ~10%, which is acceptable. The catches of goldband snapper were ~5% above the target while the red emperor was ~30% below target. Catch ranges for this fishery need revision. A stock assessment due in 2012/2013 will inform this revision.
Pilbara fish trawl	Catch Rates & Age structured Model (Level 2 & 5)	% unfished levels. Target 40%; Limit 30%	Adequate	2,000 – 2,800	1,259 t	Not Acceptable Reduced catch may partly be due to 20% reduction in effort in Areas 1 and 2 in 2009 and new net designs that deal with bycatch issues. Cause yet to be fully determined.

Fishery/ Resource	Stock assessment method and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (continued)						
Pilbara demersal trap and line	Catch Rates & Age structured Model (Level 2 & 5)	% unfished levels. Target 40%; Limit 30%	Adequate	400 – 600 (trap) 50 – 115 (line)	489 t (trap) 117 t (line)	Acceptable The trap catch was within the acceptable range. The line catch is similar to 2009 however the catch of ruby snapper has increased for two consecutive years. A stock assessment will be undertaken in 2011.
Mackerel	Catch (Level 1)	Catch range	Adequate	410 (Q) 246 - 410 (all except grey mackerel)	284 t	Acceptable. Catch rates are increasing in the Gascoyne/West Coast and Pilbara and stable in the Kimberley. As the quota is accumulated over three zones, a catch range will continue to be used to assess acceptability.
Tropical shark	Demographic and Catch (Level 3)	Under review	Uncertain	< 20 (sandbar)	Less than three licences operated.	Acceptable No fishing this year
Pearl oyster	Fished Area & Catch Rates (Level 4)	Area < 60% Rates > min.	Adequate	1,555,000 oysters (Q) (14,071 – 20,551 dive hours)	394,947 oysters (4,447 dive hours)	Acceptable Pearl oyster catches are up from the previous year's historical low, but still only 25% of TAC due to exceptional abundance and market uncertainty.

Fishery/ Resource	Stock assessment method and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (continued)						
Beche-de-mer	Catch and Catch Rate (Level 2)	Catch range	Adequate	Sandfish 20 – 100 Redfish 40 - 150	Sandfish 35 Redfish 86	Acceptable. Species-specific indicators introduced for the first time in this fishery.
SOUTH COAST BIOREGION						
South coast crustacean	No	NA	NA	50 – 80 (southern rock lobster)	72.7 t (southern rock lobster and deep sea crab combined)	Acceptable The management arrangements, including the acceptable catch range, are currently being reviewed.
Abalone (greenlip/ brownlip)	Standardised Catch Rate Ave Weight & Fishing Mortality (Level 3)	Indicators > threshold value	Adequate	213 (Q) (907 – 1,339 days)	205 t (1,196 days)	Acceptable. No issues
Estuarine fisheries (south coast)	Catch Rates (Level 2)	> Minimum level	Adequate	200 – 500	223 t	Acceptable Stock levels of key species are considered adequate.
WA salmon	Catch (Level 1)	Catch Range	Adequate	1,200 – 2,800	360 t	Acceptable Recent catches continue to be low relative to historic levels, due to low effort from limited market demand. A review of the target catch range is to be undertaken.

Fishery/ Resource	Stock assessment method and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
SOUTH COAST BIOREGION (continued)						
Australian herring	Catch (Level 1)	Catch Range	Uncertain	475 – 1,200 (south coast only)	183 t (south coast only)	Acceptable Commercial catch continues to be low relative to historic levels due to poor recruitment and low effort levels resulting from poor markets. A review of the target catch range is to be undertaken.
Albany/King George Sound purse seine	Catch (Level 1)	Catch < TAC	Adequate	2,683 (Q)	1,796 t	Acceptable. Catches increased more than 30% from 2008/09 levels. Stock levels are considered adequate and catch levels are acceptable.
Bremer Bay purse seine	Catch (Level 1)	Catch < TAC	Adequate	1,500 (Q	422 t	Acceptable. Decline in effort and catch from 2008/09 but stock considered to be recovering.
Esperance purse seine	Catch (Level 1)	Catch < TAC	Adequate	1,500 (Q)	429 t	Acceptable. Stock levels are considered adequate and catch levels are acceptable. Catches more than double that of 2008/09 but remains well below TAC.

Fishery/ Resource	Stock assessment method and level	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 - 2009/10 or 2010	Catch (or effort) level acceptable and explanation if needed
SOUTH COAST BIOREGION (continued)						
Temperate Shark	Catch Rate – Age Structured Model (Level 3 & 5)	Mature biomass above 40% or is increasing	Gummy and whiskery sharks - adequate. Dusky and sandbar likely to be recovering	725 – 1,095 (key species only)	996 t (key species only)	Acceptable. Previous management limited overall fishing effort to acceptable levels. Gummy shark catch exceeds their historical target range due to increasing catch rates; dusky shark catches are within target range; whiskery catch slightly below acceptable range due to seasonal closure and effort reductions; catches of sandbar in the southern part of their distribution are acceptable.
NORTHERN INLAND BIOREGION						
Lake Argyle catfish	Catch (Level 1)	Catch range	Adequate	95 - 155	Less than three licences operated	Acceptable. Catch has declined due to reduced effort.

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, which can be up to several hundred kilometres wide along the West Coast, flows most strongly in autumn/winter (April to August) 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 20 m (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 trawl, dive and pot 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:

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 recently announced Capes Marine Park between Cape Leeuwin and Cape Naturaliste (West Coast Ecosystem Management, Figure 2).

The Department has recently received funding through the Royalties for Regions program to establish ongoing ecosystem monitoring and research to underpin management of the Capes Marine Park.

The Australian Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) 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 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%)

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)[2] scheme, 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).

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)[3] 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.

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

[2] 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

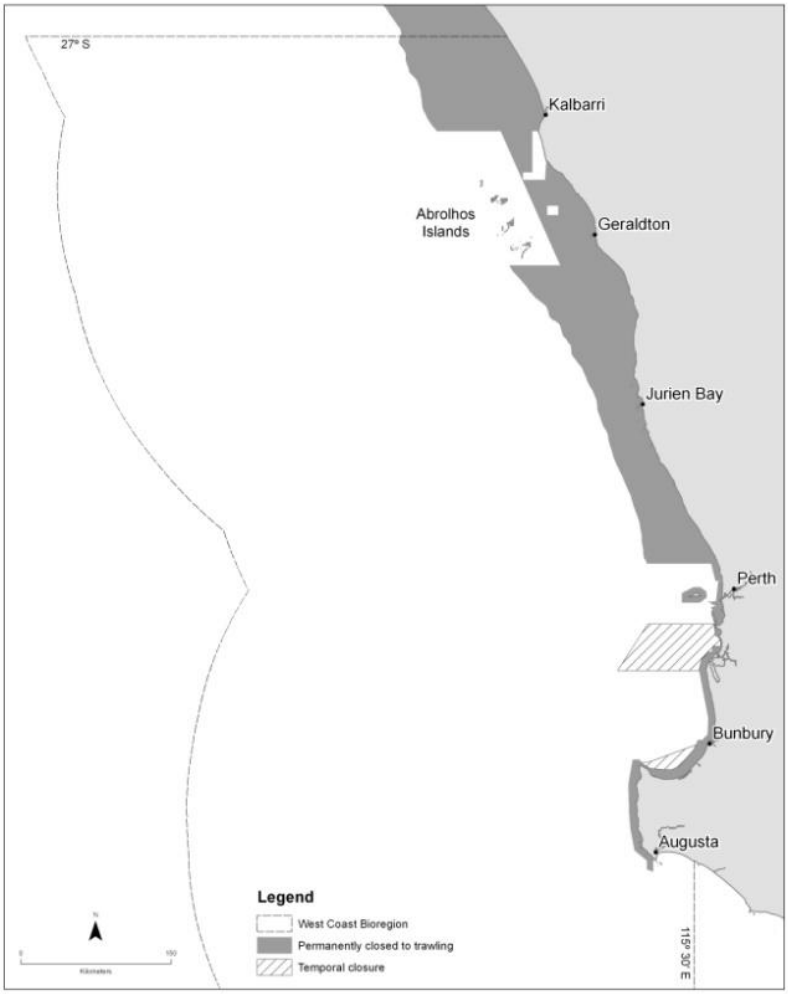
[3] Fletcher, W.J., Shaw, J., Metcalf, S.J. & D.J. Gaughan (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34 (2010) 1226–1238

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:

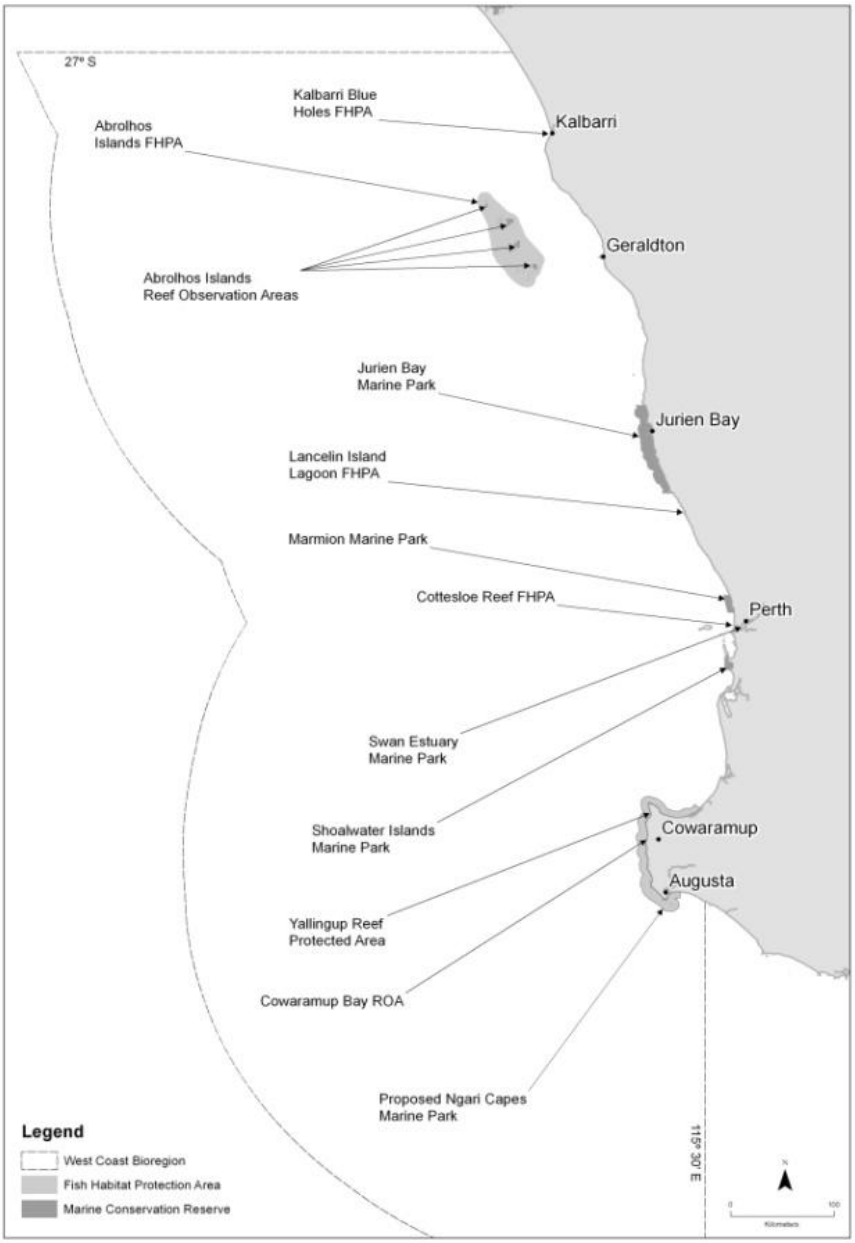
- Ecosystem structure and biodiversity (on a meso-scale basis – subdivided into marine, estuarine/embayments);
- Captured fish species
- Protected species (direct impact – capture or interaction);
- Benthic habitat; and
- External impacts.

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.



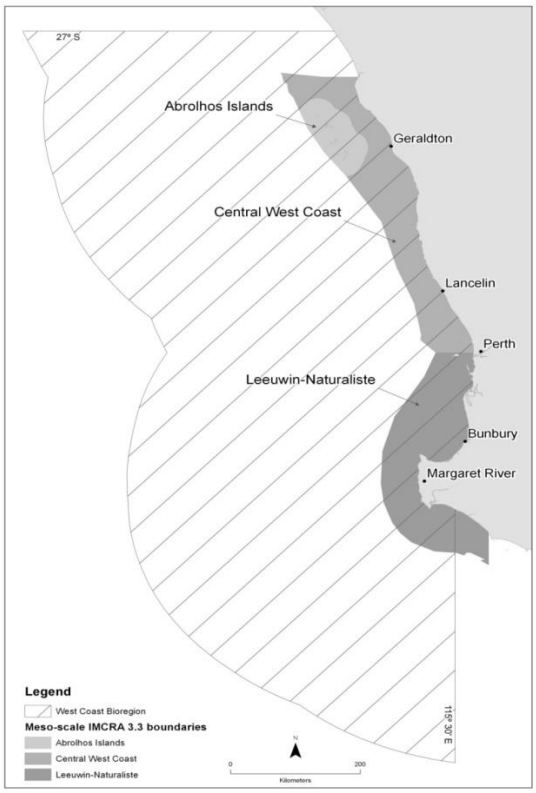
WEST COAST ECOSYSTEM MANAGEMENT FIGURE 1

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

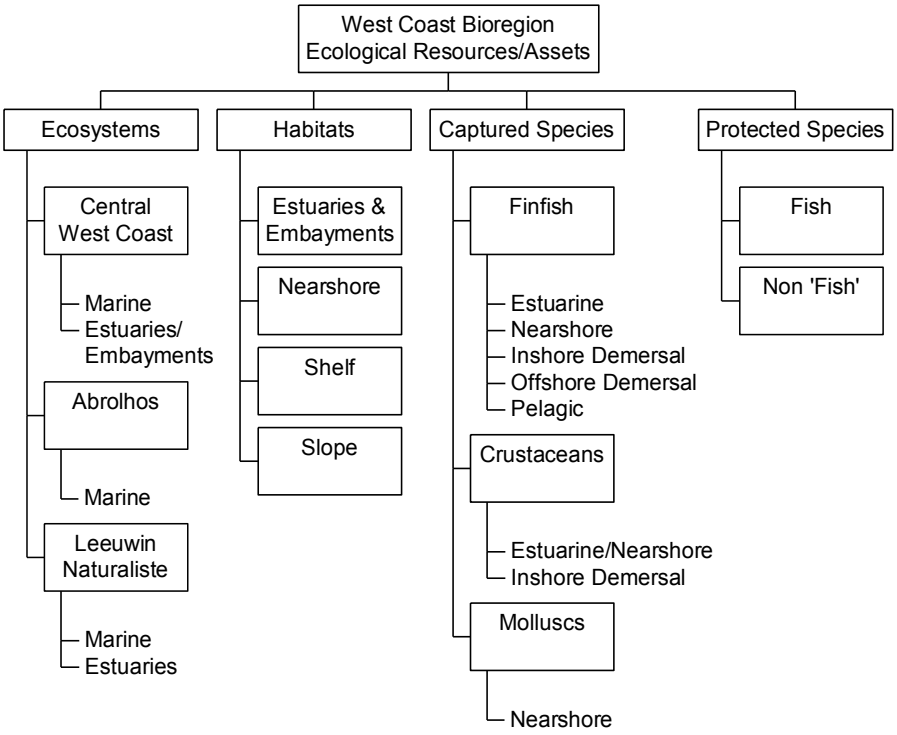
Map showing current and proposed formal marine protected areas in the west coast bioregion various areas of which are either consistent with IUCN categories I, II, III, IV or V.



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 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 Fisheries Research and Development Corporation (FRDC), will compare ecosystem structure in a newly created deep water closed area with that in nearby fished areas. A key objective of this project will be to enable potential ecosystem impacts of lobster fishing in these deeper water ecosystems to be quantified.

Ecosystem	Aquatic zone	Risk	Status and Current Activities
	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.
	Inshore demersal (20-250m depth)	MODERATE	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 now been implemented. Determining catch shares for commercial and recreational users has been underway and a review in late 2010 confirmed that the catch levels have been reduced to desired levels. These stocks are now therefore considered to be in a recovery phase.
	Offshore demersal (>250m depth)	MODERATE	While the indicator species in this deepwater location are vulnerable to overfishing the current catch levels are low and therefore the stocks are not at risk. Long term 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 in this region (eg. Peel/Harvey) 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 has ensured that the lobster spawning stock is at acceptable levels despite recent low puerulus recruitment which is also now showing signs of recovery.
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., 2009[1]).

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 small trawl fishery has to operate using grids. Little Penguins are considered most at risk from boat strikes and non-fishing activities. Few other issues were identified.
	Mammals	LOW	Sea lion exclusion devices now implemented for rock lobster pots near sea lion breeding islands which has reduced the 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.
	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

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

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 could be 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 suitable reference area in deep water was closed to lobster fishing in March 2011. Work during 2010/2011 has concentrated on the production of detailed substrate and benthic biota maps for the reference area and the development of sampling methodologies to effectively monitor benthic habitats in fished and unfished areas. Continued monitoring will provide the contrast required to enable the potential impacts of lobster fishing on deep water ecosystems to be quantified.

Work on examining the role of lobsters in shallow waters has also continued as part of WAMSI through a number of projects run by ECU. These are being completed in Jurien Bay and the Marmion Marine Parks. There is also work being undertaken on these interactions by the Department, CSIRO and UWA at the Rottnest Island protected areas,

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 4.2

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.

The Biodiversity and Biosecurity branch have implemented a series of biosecurity related projects during 2010 – 2011. All projects aim to detect the presence of introduced marine pests (IMPs) using a suite of tools including ongoing background monitoring and large-scale port monitoring. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. A large-scale, nationally approved survey of Fremantle Port has been completed that will inform the Department of the status of IMPs in this port. A background monitoring program is also continuing within Fremantle Port waters with financial assistance from the Fremantle Port Authority. Other biosecurity activities include a survey of the Careening Bay Naval waters at Garden Island for the possible presence of the invasive mussel *Perna viridis*, an additional survey of Fremantle Port Waters for the possible presence of the introduced barnacles *Balanus improvisus* and *Amphibalanus pulchellus*, and a survey of Mandurah waters and canals for the possible presence of the invasive Asian paddle crab *Charybdis japonica*.

A project supported by WAMSI 4.4, has developed a bycatch risk assessment method to rapidly assess the cumulative risk to sustainability of multiple fisheries. 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. 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 RRAMF analyses reveal all bycatch species received low to moderate risk scores in these Bioregions (see FRR 212). The RRAMF for the TEPS showed that while most species have high biological risk, the low interaction rates reported by fisheries maintained low to moderate risk categories for most species groups.A trial has also been conducted 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 analyses are in the final stages of completion have been written up as a Fisheries Research Report.

FISHERIES
West Coast Rock Lobster Fishery Status Report

Main Features

Status		Current Landings (Season 2009/10)	
Stock level	Acceptable	Commercial catch	5899 t
Fishing Level	Acceptable	Recreational catch	243 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 fishery was one of the first limited entry fisheries in the world and it has used a sophisticated Individual Transferable Effort (ITE) based system for over 20 years. With annual production historically averaging about 11,000 t it has generally been Australia's most valuable single species wild capture fishery and was the first fishery in the world to achieve Marine Stewardship Council (MSC) certification.

Recreational
The recreational rock lobster fishery primarily targets western rock lobsters using baited traps (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

Other subsidiary legislation

Recreational Fishing Licence

Consultation processes

Commercial
Rock Lobster Industry Advisory Committee (RLIAC)

Western Rock Lobster Council (WRLC)

Western Australian Fishing Industry Council (WAFIC)

Recreational
Recfishwest

Boundaries

Commercial
The fishery is situated along the west coast of Australia between Latitudes 21°44′ and 34°24′ S. The fishery is managed in 3 zones: south of latitude 30° S (Zone C), north of latitude 30° S (Zone B) and the Abrolhos Islands Area (also generally referred to as Zone A).

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 metres 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 (see above), 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 and biological characteristics including, for example, different maximum legal lengths for female rock lobsters.

This fishery has, until recently, been managed using a total allowable effort (TAE) system and associated input controls. Under this system, licences have units of entitlement associated with them. These units have a value in terms of the number of pots that can be used per unit. The total number of pots that may be used in each zone is divided by the number of units allocated for that zone to determine the unit value. Units can be transferred between licences conferring access to the same zone, allowing market forces to determine the most efficient use of entitlement. Unit values have declined over time to maintain sustainability as fishing efficiency has increased.

The management arrangements also include the protection of females in breeding condition. From 2009/10, a minimum size limit of 77 mm carapace length applied for the entire season. A maximum legal length for female rock lobsters also applies. In the 2009/10 season, this was reduced in Zone B and the Abrolhos Islands Area from 105 mm carapace length

to 95 mm, and from 115 mm carapace length to 105 mm carapace length in Zone C. Gear controls, including a minimum escape gap size (increased from 54 mm to 55 mm in 2009/10) and a limit on the size and configuration of pots, also play a significant role in controlling exploitation rates. In 2009/10, the Zone B and C season opened on 15 November and was initially scheduled to close on 30 June, with the Abrolhos Islands Area operating from 15 March and initially scheduled to close on 30 June (but see below).

With below-average puerulus settlement occurring between 2006/07 and 2009/10, significant effort reductions were implemented for the 2009/10 season to reduce the level of catch (exploitation) to maintain breeding stock levels at appropriate levels in out-years. Unit values for the 2009/10 season were reduced in Zones A, B and C to 0.36, 0.4 and 0.44 pots per unit respectively. Weekend closures were retained and fishing was also prohibited on Fridays during peak catch periods. These amendments were designed to limit the 2009/10 season catch to 5,500 tonnes ± 10%, with specific catch targets and limits for each zone for the first half or "whites" part of the season (15 November – 14 March) and the second half or "reds" (15 March – 30 June) part of the season.

To achieve these targets numerous "in season" adjustments to the management package were made, including "block" closures and a further reduction to the Zone C unit value were made during the season. This was done at industry's request to maintain catches within acceptable levels and to assist industry in spreading the available catch throughout the whole season to achieve more optimal economic outcomes.

Despite the legislated closure date for the season having been set at 30 June 2010, as the zonal catch limits were met before this date, the closure of Zones A, B and C occurred on the 17th May, 15th June and 10th May respectively.

A summary of all the management changes for the 2009/10 West Coast Rock Lobster season can be found in table 1.

Recreational

The recreational component of the western rock lobster fishery is managed under fisheries regulations, providing for a mix of input and output management controls on individual recreational fishers. Management of the recreational sector was traditionally designed to complement arrangements for the commercial fishery, but is now managed independently under the principles of Integrated Fisheries Management (see below).

Input controls include the requirement for a recreational fishing licence (either a specific rock lobster licence or an "umbrella" licence covering all licensed recreational fisheries). Fishers are restricted to two pots per licence holder, although the total number of licences is not restricted. As with the commercial sector, recreational pots must meet the specific size requirements, have gaps to allow under-size rock lobsters to escape and have floats that are clearly identified. Divers are also restricted to catching by hand, snare or blunt crook to minimise the damage to lobsters. Fishing for rock lobsters at the Abrolhos Islands is restricted to potting only.

The recreational fishing 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 diving is prohibited.

In the West Coast Bioregion a daily bag limit of 6 rock lobsters per person and a boat limit of 12 rock lobsters applies and there is a possession limit of 24 lobsters per person.

Integrated Fisheries Management

In March 2008, through the Integrated Fisheries Management process, the Minister determined that the Total Allowable Catch for the western rock lobster resource would be allocated as 95% to the commercial sector, 5% to the recreational sector and one tonne to customary fishers. The 2009/10 season was the first season when these shares formally applied and the recreational sector caught 4.0% of the catch in the West Coast Rock Lobster Fishery.

Research summary

Research activities for the WCRLF 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. The independent monitoring of breeding stock levels was expanded in 2009 to include a deepwater area to the north of the fishery (Big Bank). Big Bank closed to fishing for the first time in 2008/09 and results from this monitoring will provide vital information on changes in lobster abundances in response to this closure.

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 potential ecosystem effects of rock lobster fishing in deep water. A Fisheries Research and Development Corporation (FRDC) funded project to examine the effects of western rock lobster fishing on the deep-water ecosystem off the west coast of Western Australia has 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. Further aims include developing cost-effective methods to monitor benthic communities in this closed area and the subsequent collection of baseline information on its lobster stock size, habitats and community structure. This will facilitate comparisons this area once it has been closed to fishing. 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 Rottnest 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 four 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, and/or a decline in the abundance of the rock lobster breeding stock, particularly in the northern region of the fishery. A report on this workshop can be found on the Departments website (http://www.fish.wa.gov.au/docs/o p/op071/fop71.pdf).

A follow-up workshop re-examining the low puerulus settlements and preliminary outcomes of research projects identified in the 2009 puerulus workshop will be conducted in 2011. The outcomes and a report from this workshop are currently being developed and will be available on the Departments website in the second half of 2011.

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, to 2009/10.

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.

A third assessment of the Western Rock Lobster Stock Assessment Model took place in May 2011 and was conducted by a leading world expert in modelling exploited populations who has conducted many similar assessments for other commercial fisheries. This review concluded that our current model is consistent with world's best practice and appropriate for use in the management of the WRL fishery. Some additional work is required to examine the influence of fixed parameters and the impact of parameter starting values. The report will be released on the Department's website in the second half on 2011.

To assess the economic performance of the fishery a specific project, funded through the Seafood CRC project has begun. This project is updating the maximum economic yield assessment, in light of the introduction of 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 2009/10):

899 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 2009/10 catch for the WCRLF, forecast from puerulus settlement 3 to 4 years previously, was 8700 t but given the series of poor puerulus settlements, additional management changes designed to limit the catch to 5,500 t (+10%) were introduced to ensure adequate egg production levels would be maintained (see above), the total catch by the WCRLF for the 2009/10 season was 5899 t. This was 45.0% lower than the long-term average catch (1981/82 to 2006/07) of 10,760 t and 22.3% lower than the previous season's 7593 t. In 2009/10, the catches in A, B and C Zones were 1103, 2095 and 2701 t, respectively, with A Zone 17.6% down, B Zone 19.0% down and C Zone 26.3% 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 2009/10 voluntary research log book data. This was 4% below the average of 0.031 per pot lift over the historical range (1985/86 to 2003/04).

This catch rate translates to an estimated 66300 octopus caught in all regions of the fishery during 2009/10. Octopus catches were estimated for A, B and C Zones as 7266, 25733, and 33301, 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 ± 10% (0.013–0.033 octopus per pot lift).

Recreational catch estimate (season 2009/10):

243 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 subsequent comparisons have produced slightly different ratios, 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 2009/10 was estimated at 243 t based on the adjusted mail survey, with 169 t taken by potting and 74 t by diving. This represents 4% of the total catch of lobsters for this season.

Comparative catch estimates for 2008/09 were 225 t, with 162 t by potting and 63 t by diving. The estimated recreational catch in 2009/10 was therefore 8% above the 2008/09 catch. The 2009/10 season catch estimate was close to the catch prediction of 265 t produced by the model constructed using adjusted mail survey catch estimates.

Fishing effort/access level

Commercial

In 2009/10 the numbers of vessels fishing for lobster were 80 in A Zone, 71 in B Zone and 146 in C Zone. Thus, in comparison to the 395 active boats in 2008/09, a fleet of 297 vessels fished in 2009/10, which was a reduction of 25%.

The nominal fishing effort was 2.2 million pot lifts in 2009/10 – 52% lower than the 4.6 million pot lifts for 2008/09 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 2009/10 season.

The 2009/10 nominal effort for A, B and C Zones was 0.24, 0.85 and 1.1 million pot lifts respectively, which was 50.6, 44.1 and 56.7% lower than the previous season's pot lifts.

Recreational

A total of 43 787 licenses were sold that permitted fishing for lobsters during some part of the 2009/10 season (made up of specific rock lobster licenses plus umbrella licenses) with an estimated 25,990 (60%) utilized for lobster fishing. This was very close to the forecasted number of 25,900. 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 2009/10 was 4% higher than the number of active licenses (25,050) for the 2008/09 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 27 and 11 days respectively during the 2009/10 fishing season. These rates were similar in the 2008/09 fishing season.

Finally, the average diary-adjusted catch taken by active pot and diving fishers were 21 and 12 lobsters respectively during the 2009/10 fishing season. In the 2008/09 season the average number of lobsters caught by pot and dive fishers was 19 and 11 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 and level:

Level 5 - Size-structured simulation model

Breeding stock levels: **Adequate**

Targeted commercial catch next season (2010/11): **5,500 tonnes TACC**

Projected recreational catch next season (2010/11): **165 ± 50 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 2009/10 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 the fishery-independent breeding stock survey (IBSS) indices. Since 2009/10 the development of a fully integrated stock-assessment model that incorporates information from 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 a previous stock assessment review of the fishery (May 2010).

The current focus for stock assessment has been to determine the effect 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).

The first IBSS survey in Big Bank in 2009 resulted in a low catch rate in this area, particularly among the smaller recruits to the fishery. This supported the assessment that identified that the migration north had been negatively influenced by the environmental conditions in recent years. The FRDC projects that included oceanographic larval modelling identified the breeding stock in the northern area as been particularly important to successful settlement. This supports the continued closure of the Big Bank areas and the reduced fishing effort to enhance the migration into this area.

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

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 2009/10 fishing season however the increase in CPUE to 2.68 kg/pot lift (61.4% more than the previous year) relates more to the significant reduction in exploitation during this season and the carryover from the reduced effort in the previous (2008/09) 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 0.78 and 1.09 lobsters per person per fishing day in the 2009/10 fishing season. These catch rates are very similar to the 0.70 lobsters for potting and 1.05 lobsters for diving in the 2008/09 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. Whilst the annual indices of puerulus settlement for 2010/11 were at relatively low levels at nearly all sampling sites (West Coast Rock Lobster Figure 6), this level of settlement was still a marked improvement on the previous settlement period. The low level for 2010/11 was expected based on the cooler than average water temperatures in February-April 2010 and the very low winter rainfall of 2010. The low (but improved) 2010/11 settlement will first affect the available stock of lobsters during the "reds" of 2013/14 and the 'whites' of 2014/15.

Non-Retained Species

By-catch species impact: Low

The catches of fish as by-catch species caught during normal rock lobster fishing operations are now required to be recorded and provided to the Department as part of the fishers statutory catch declaration. These data show that approximately 6 t of fish were captured during the 2009/10 fishing season.

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 stops 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 – 2009/10 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 2009/10 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 should now be even lower.

The performance measure for the fishery is that there is no increase in interactions with turtles. In 2009/10, 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 increase 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 2009/10 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 Abrolhos Islands estimated that potting might impact on less than 0.3% of the surface area of fragile habitat (corals) at the Abrolhos, 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 $183 million. Employment is seasonal, the fishing season covering seven and a half months from 15 November to 30 June.

A total of 297 vessels and 832 people were engaged directly in fishing for rock lobsters in 2009/10. 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.

Economic Effects

Estimated annual commercial value (to fishers) for year 2009/10: $183 million

The price that commercial fishers received for the western rock lobster in 2009/10 was an estimated average of $31.00/kg in all zones of the fishery. This was 23.5% increase on the $25.10/kg paid in 2008/09. The overall value of the fishery declined from the previous season's value of $191 million as a result of a catch limit of 5,500 t being introduced as a new management strategy.

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

Fishery Governance

Commercial
Current Fishing Level: Acceptable

Commercial catch target (2010/11):

5,500 tonnes (± 10%)

Between 1975/76 and 2009/10 commercial catches have averaged 10,951 t and ranged from 5,899 t in 2009/10 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 settlement 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. These actions are designed to ensure a carryover of lobsters into what would have otherwise have been low catch years (2010/11 - 2013/14). For the 2008/09 season this involved restricting the catch to below 7,800 t which required significant effort reductions 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 nominal catch target set at 5,500 t with the actual catch of 5,899 t falling within the 10% tolerance limits.

Recreational
Current Fishing Level Acceptable

Target recreational catch (2009/10): 290 tonnes

Between 1986/87 and 2009/10 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. Under IFM, which allocates the commercial and recreational sectors 95 and 5% of the total catch respectively, the limit on recreational catch for 2009/10 based on a commercial catch of 5500 t was 290 t.

The recreational catch estimate for the 2009/10 season was 243 ± 25 t (95% confidence interval of the mean) which was below their allocation.

New management initiatives (2010/11)

Following a request from the WA Fishing Industry Council and support from the Western Rock Lobster Council, in April 2010 the Minister announced his in-principle support for the commercial fishery to move to a catch quota system from the 2010/11 season. Following further consultation with the WA Fishing Industry Council, the Western Rock Lobster Council and the Rock Lobster Industry Advisory Committee, the Minister has confirmed this intention.

Management arrangements for the 2010/11 season are expected to be the first step in the transition to a "full" quota system. The core element of the package will be the allocation of the 5,500 t Total Allowable Commercial Catch as individual catch limits to each licence to overcome the "race to fish", thus providing fishers with greater opportunity to optimise the economic return from the available catch.

The fishery is also due for re-assessment by the MSC in November 2011. This re-assessment process will commence during 2010/11.

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. More recently the Indian Ocean Dipole (IOD) that influences the wind conditions during winter/spring close to the settlement period has also been identified as affecting the settlement. Catches are also dependent upon the environmental conditions at the time of fishing.

The fishery has been affected now by five years of El Nino conditions and/or positive IOD, which has generally resulted in below average puerulus settlement due to the weaker Leeuwin Current strength and westerly winds. The 2010/11 settlement levels were a slight improvement on 2009/10, and appeared to have returned to historical relationship between water temperature and settlement levels. The environmental and breeding stock 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 FRDC project examining climate change effects on fisheries will continue work in this area.

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 as well as the changes to the management of the fishery including the introduction of individual catch limits

Contributors

S. de Lestang, A. Thomson, M. Rossbach, J. Kennedy and G. Baudains.

WEST COAST ROCK LOBSTER TABLE 1

Initial Management Package and Changes for the 2009/10 Season

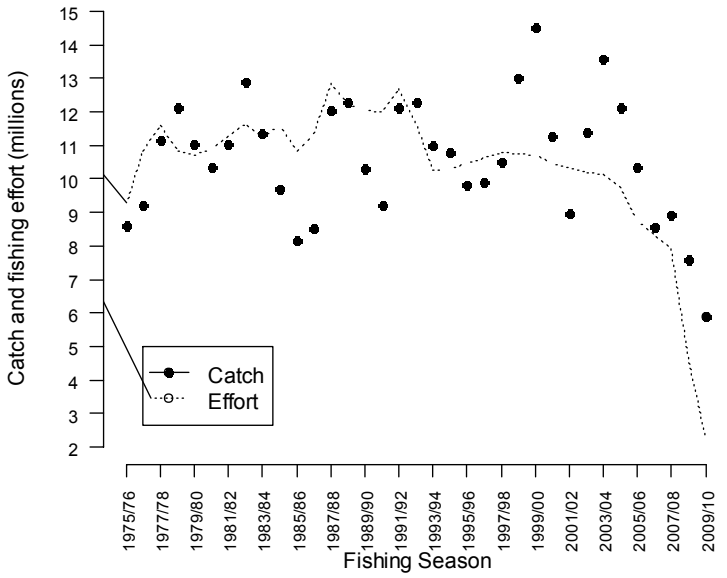
Initial Management Package Announced in September 2009 for the 2009/10 Season	
Effort reduction: unit values (number of pots per unit) of:	Zone A – 0. 36;
	Zone B – 0.40; and
	Zone C – 0.44.
Temporal closures:	Zone A – 4 days a week all season;
	Zone B - 4 days a week fishing during “whites” and “reds” peaks (1 December to 14 January and 15 March to 14 April);
	Zone C – 4 days a week fishing during “whites” and “reds” peaks (15 December – 14 January and 15 March – 14 April; and
	Zone B & C – 5 days a week fishing for rest of the season.
Maximum female size changes:	Zone A & B – 105mm to 95mm; and
	Zone C – 115 mm to 105 mm
Minimum size of 77 mm to apply for the entire season.	
Escape gaps increased from 54 mm to 55 mm.	
Total Allowable Commercial Catch (TACC) of 5,500 tonnes ± 10% introduced for the 2009/10 season.	
Big Bank to remain closed.	
The requirement for rock lobster processors to submit weekly catch returns, each week for the duration of the season (in addition to their monthly reporting requirements).	
Management Changes, December 2009	
Prohibit fishing in Zone B between 25 December 2009 and 10 January 2010 inclusive.	
Continue the prohibition on fishing on Friday, Saturday and Sunday each week throughout the remainder of the first half of the season catch target period in Zone B.	
Prohibit fishing in Zone C between 25 December 2009 and 3 January 2010 inclusive.	
Zone B summer closure removed.	
Management Changes, January 2010	
Closure in Zone B extended to 25 January.	
Prohibit fishing in Zone C between 18 January and 1 February.	
Prohibit fishing on Fridays in Zone C from 1 February to end of season.	
Zone C re-opened on 25 January.	

Management Changes, February 2010
Prohibit fishing in Zone C between 12 March and 21 March.
Change unit value in Zone C to 0.30 effective as of 21 March.
Zone A fishers prohibited from fishing in Zone B for the remainder of the season as of 15 February (normally permitted to remain in Zone B until 14 March).
Prohibit fishing in Zone B (by Zone B fishers) between 12 March and 11 April.
Zone B fishers permitted to fish Friday's as of 11 April through to the end of the season.
Pot soaking areas at the Abrolhos Islands formalised.
Management Changes, May 2010
Zone C closed for the remainder of the season – effective 10 May.
Zone A closed for the remainder of the season – effective 17 May.
Management Changes, June 2010
Zone B closed for the remainder of the season – effective 15 June.

WEST COAST ROCK LOBSTER TABLE 2.

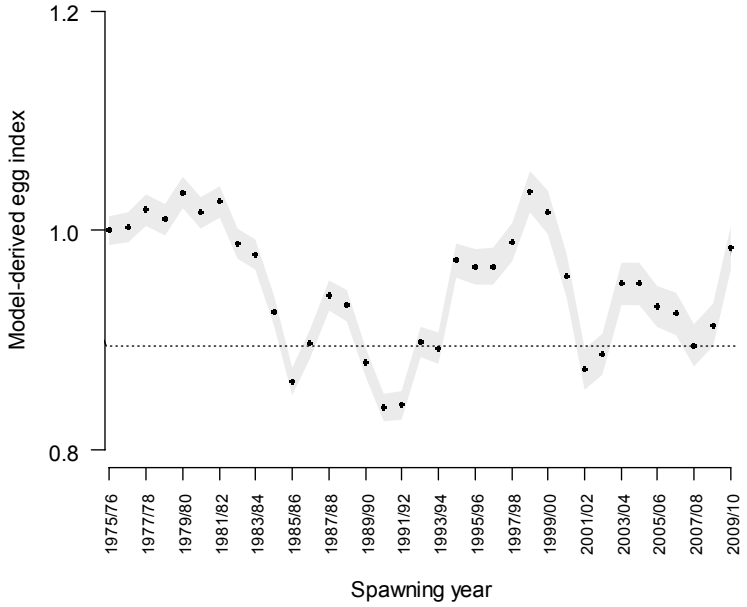
Catches of by-catch in lobster pots recorded in compulsory Catch and Effort monthly returns (CAES) during 2009/10.

Bycatch Species	Catch (kg)
Baldchin Groper	2798
Barcheek Coral Trout	2
Blue Morwong	2
Breaksea Cod	488
Chinaman Rockcod	93
Cod, General	11
Eightbar Grouper (Grey Banded Cod)	3
Emperors, General	180
Leatherjackets, General	70
Other Fish Varieties	25
Pigfishes, General	17
Redthroat Emperor	175
Snapper, Pink	1885
Sweetlips	10
Trevallies, General	6
Western Australian Dhufish	245
Western Blue Groper	10
Wobbegongs/Catsharks, General	6
Grand Total	6026



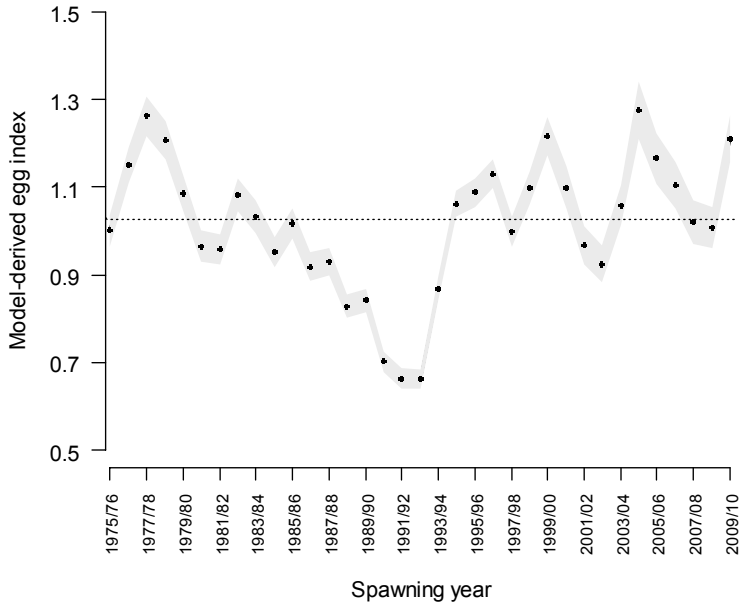
WEST COAST ROCK LOBSTER FIGURE 1

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 2009/10.



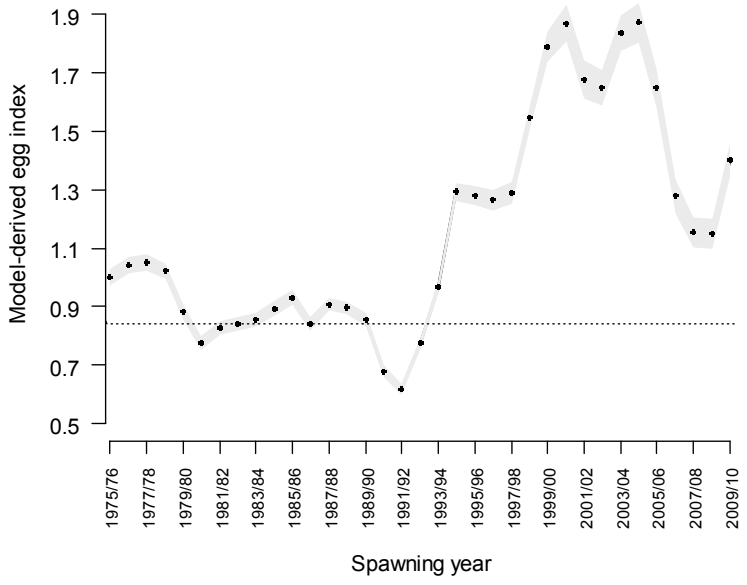
WEST COAST ROCK LOBSTER FIGURE 2

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 mid-1980's threshold. Stock Assessment Model version: Quota 2011.



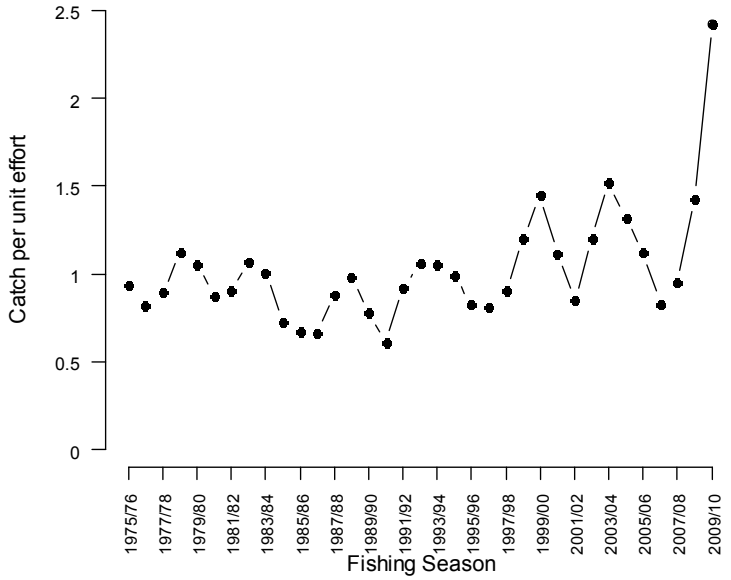
WEST COAST ROCK LOBSTER FIGURE 3

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. Stock Assessment Model version: Quota 2011.



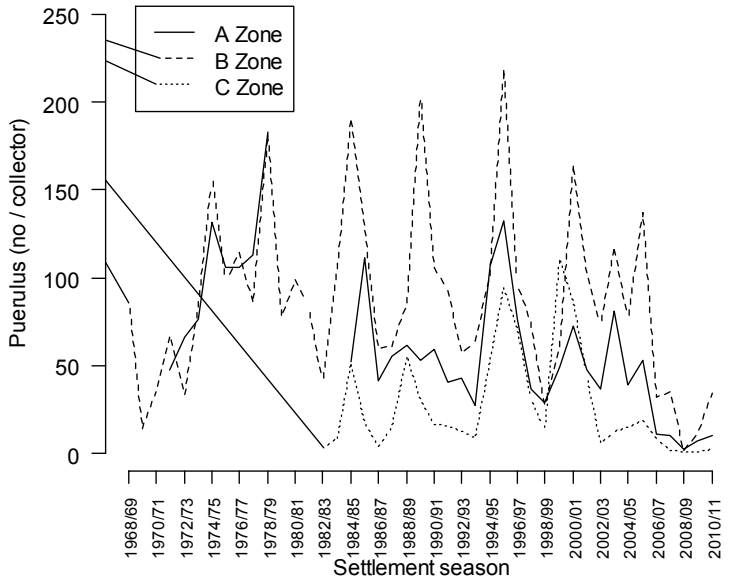
WEST COAST ROCK LOBSTER FIGURE 4

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. Stock Assessment Model version: Quota 2011.



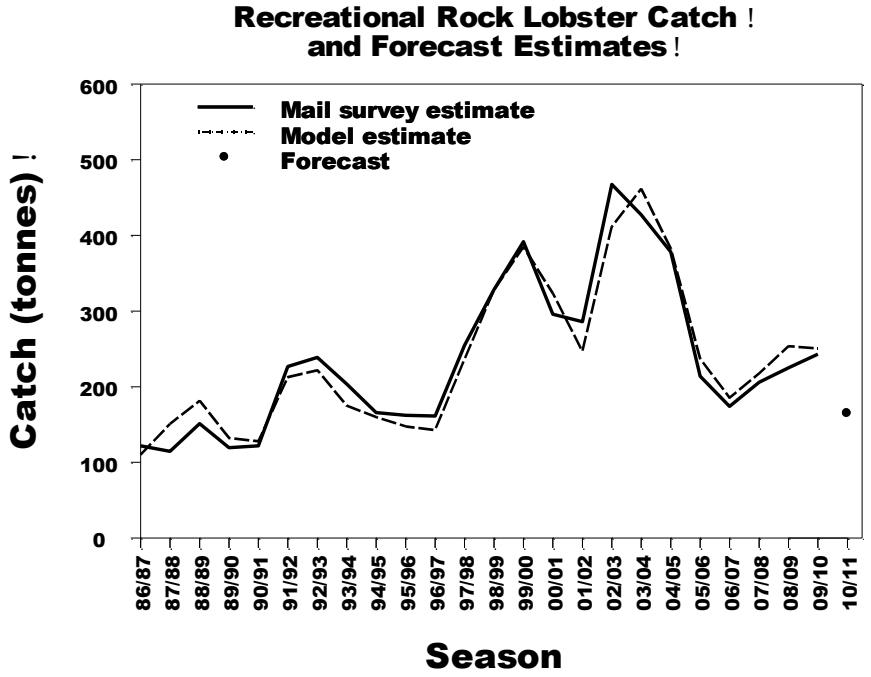
WEST COAST ROCK LOBSTER FIGURE 5

Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1975/76 to 2009/10.



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 20010/11 based on puerulus settlement 3 to 4 years earlier and expected licence usage.

Roe's Abalone Fishery Status Report

Main Features

Status		Current Landings	
		Commercial Catch	
Stock level	Acceptable	West Coast	36 t
		Other	55 t
Fishing level	Acceptable	Recreational Catch	
		West Coast	44 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 area of focus for 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 2010 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 for Area 1 (WA/South Australia border to Point Culver) and Area 7 (Cape Bouvard to Moore River)of 75 mm and 70 mm which apply.

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 as requiring ongoing management to ensure acceptable performance was the breeding stock levels of Roe's abalone. Boxed text in this status report provides the annual assessment of performance for this issue.

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. These licences are not restricted in number. The West Coast zone (Perth) of the recreational fishery is managed 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 5 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 Area (FHPA).

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 946 interviews in 2010), 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.

Research is progressing on an in-season catch prediction model based on environmental conditions, for the Perth metropolitan fishery. This model will assist the Department in managing a summer season for the fishery should this option be adopted in the future.

Retained Species

Commercial production

Season 2010: **91 tonnes whole weight**

Metro only: **36 tonnes whole weight**

The TACC for the 2010 quota year was 101.8 t whole weight for Roe's abalone. The 2010 catch of 91.4 t whole weight (Roe's Abalone Table 1) was similar to 2009 and about 90% of the TACC. The overall TACC was not caught because only 5% of the TACC of Area 1 of the fishery (Roe's Abalone Figure 1) was caught in 2010, 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 2010: **Roe's Metro Fishery 44 tonnes**

(Season 2007): **Roe's rest of state 14 tonnes**

(39% of total catch)

The recreational catch for Roe's abalone from the Perth metropolitan area in 2010 was 44 t (Roe's Abalone Table 2). This was a decrease of about 11% from 2009, but still above the TARC of 40 tonnes.

Based on the Perth recreational fishery for 2010 (44 t), and using the 2007 phone diary estimate for the rest of the state (14 t), recreational fishing represented about 39% of the total (commercial and recreational) Roe's abalone catch (149 t) across the state in 2010.

Fishing effort/access level

Commercial

Total effort for dedicated Roe's abalone divers in 2010 was 567 diver days, higher than last year's effort of 554 diver days (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 2010 season, around 22,400 licences were issued. This was a 13% decrease over the 2009 figure of 25,700 licenses (Roe's Abalone Figure 3), however is not thought to represent a reduction in effort, rather a change in the licensing structure. The umbrella type license has been discontinued. From 2011 onwards only abalone specific licenses will be available to those wishing to fish for abalone.

Effort in the Perth fishery for 2009 was 18,010 hours, a 9% reduction from 2009 effort of 19,718 hours (Roe's Abalone Table 2). This was primarily due to a decrease in the number of days fishing, from 6 in 2009, to 5 in 2010. Overall, effort increases between 2006 and 2010 reflect 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 daily season length has been reduced, with a high probability of a 4-day season in the future if no other measures are taken.

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:

Level 4 - Catch Rates / Direct Survey

Breeding stock levels: **Adequate**

CPUE and TACC assessment: The standardised CPUE (SCPUE) for the roe's abalone fishery is the main performance indicator for 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.

The SCPUE for dedicated Roe's abalone divers in 2010 was 29.5 kg/hr, which was very similar to the 2009 catch rate. 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) was 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 26 abalone/hour in 2010 was similar to the 2009 catch rate of 27 abalone per hour (Roe's Abalone Table 2).

Stock surveys: Densities of sub-legal animals (less than 60mm in size) on the platform habitat of the fished stocks in 2010 were 52 abalone m-2, similar to 2009 (Roe's Abalone Table 4). Sub-legal animals are at the highest level since surveys began in 1997, primarily due to increases in 0+ (1 - 16 mm) and 1+ (17 - 32 mm) animals due to higher settlement levels in 2009 to 2011. On the subtidal habitat, densities of sub-legal animals were similar between 2010 and 2011, and are also at their highest density since 1997.

Densities of legal-sized animals (60+ mm) on the platform habitat were significantly lower in 2011 (13 m-2), compared to 17 m-2 in 2010 (Roe's Abalone Table 4), and are at their lowest levels since 1997. This reflects a combination of the large recreational catch over the past three years (44, 49, and 44 t respectively for 2008 - 2010), and lower settlement between 2005 and 2006 (5 years prior to recruitment in to the main fished size class of 70+mm).

In the subtidal habitat, legal-sized densities were 15 abalone m-2 in 2010, similar to the three years previously (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 are about 90% higher on the platform habitat, compared with the fished stocks (Roes Abalone Table 4). However, the difference is less evident for sub-tidal stocks, particularly in recent years. Between 2008 and 2011, densities of legal-sized Roe's abalone in subtidal stocks were about 40% higher in the MPA. For sub-legal animals, densities were very similar between fished stocks and the MPA over the last three years (Roes Abalone Table 4).

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.

The main performance measure for the fishery relates to the maintenance of adequate breeding stocks in each area of the fishery.

[1] Hart AM, 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.

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 2010, 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 22,400 licences were issued that would have allowed fishers to participate in the recreational abalone fishery (Roe's Abalone Figure 3). 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 2010: **$2.3 million**

The estimated average price for Roe's abalone in 2010 was $25.00/kg. This value was similar to the value of $24.50/kg in 2009. On the basis of the average price, the fishery was worth approximately $2.3 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 $US0.6 in 2000 to >US$1.00 in 2010. 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: **530 – 640 diver days**

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 area.

The old governance range of 620 – 750 diver days (also from 1999 – 2006) does not account for changes in fishing efficiency that are now incorporated into the SCPUE calculations. Consequently, these were revised downwards by 15%, as indicated by statistical analysis1, to 530 – 640 diver days. The effort value of 567 diver days in 2010 (Roes Abalone Table 1) falls within below the expected effort range, suggesting stocks are at average levels.

Recreational (West Coast)
Target Catch range:

5 year moving average - 40 ± 2 tonnes

In 2010, 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 the 5 year moving average was developed. This range takes in the permitted maximum variations of ± 2t around the 5 year moving average of 40 t.

The 5-year (2006-2010) moving average for 2010 was 40.3 t. This was within the governance range.

New management initiatives (2010/11)

Following an examination of the Roe's abalone fishery by the Integrated Fisheries Allocation Advisory Committee (IFAAC) a Total Allowable Recreational catch (TARC) of 40 tonnes has been introduced for the West Coast Zone since 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 and

daily catch limits) to ensure the 40 t TARC is maintained.

A working group was also set up in July 2009 to examine the future management arrangements for this fishery and has recommended that a trial of a summer fishery for the West Coast Zone be undertaken for the 2011/12 season, with in-season catch prediction used to determine the eventual number of days in the fishery. The proposed season will begin on the first Sunday of November 2011 and extend till March 2012, with fishing taking place on the first Sunday of each month.

External Factors

During the summer of 2010/2011, the West Coast experienced a marine heatwave with sea surface temperatures of up to 3 degrees above average. This event has been widespread with fish kills being recorded across many fish species, however the Area 8 Roe's abalone fishery, particularly in the area around Kalbarri, appears to have been the most severely impacted. Mortalities on roe's abalone have been extensive, if not complete and no commercial or recreational catch is expected from the Area 8 fishery in the 2011 season.

Apart from that the main external factor influencing the Roe's commercial abalone fishery has been the decline in beach price and overall economic value over the last decade. 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.

Contributors

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ROE'S ABALONE TABLE 1

Roe's abalone catch and effort[1] 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	
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	132	28.5
2008	106,700	93,197	580	133	28.6
2009	101,800	92,838	554	140	29.0
2010	101,800	91,418	567	134	29.5

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.

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.

Field Survey						
Year	Effort (hours)	Catch rate	Catch per fisher	Catch (number)	Catch (tonnes)	Mean weight (g)
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
2010	18,010	26	18.7	468,000	43.9	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/m^2) 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
2011	**52**	**13**	**66**	**26**	**10.5**	**15**	**6**	**22**

ROE'S ABALONE TABLE 5

Assessment against agreed performance measures for 2010.

Performance Indicator	Performance Measure[1]	2010 Values	Assessment/Comments
Area 1			
Total catch (TACC)	5,000 kg	0	Exploratory quota – no fishing in 2010.
Effort range (Diver days)	14 – 43	0	See above.
Area 2			
Total catch (TACC)	19,800 kg	19,191	Met – 97% of quota caught.
Standardised CPUE	20 – 31	26	Met – within agreed ranges.
Area 5			
Total catch (TACC)	20,000kg	15,999	Met – 80% of quota caught.
Standardised CPUE	18 – 27	27	Met – within agreed ranges.
Area 6			
Total catch (TACC)	12,000 kg	10,994	Met – 92% of quota caught.
Standardised CPUE	18 – 26	23	Met – within agreed ranges.
Area 7			
Total catch (TACC)	36,000 kg	36,000	Met – 100% of quota caught.
Standardised CPUE	28 – 42	37	Met – within agreed ranges.
Area 8			
Total catch (TACC)	9,000 kg	8,970	Met – 99.7% of quota caught.
Standardised CPUE	16 – 24	21	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.

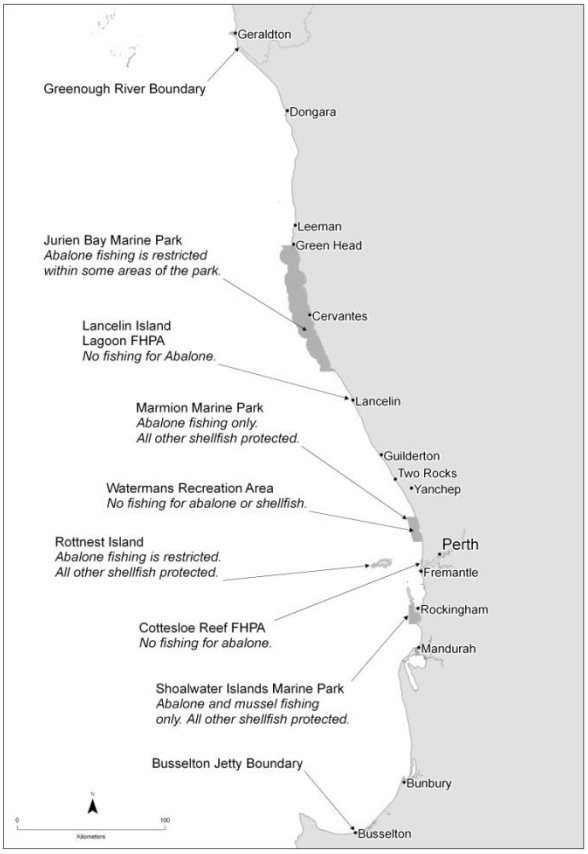


ROE'S ABALONE FIGURE 1

Map showing the management areas used to set quotas for the Roe's abalone commercial fishery in Western Australia.



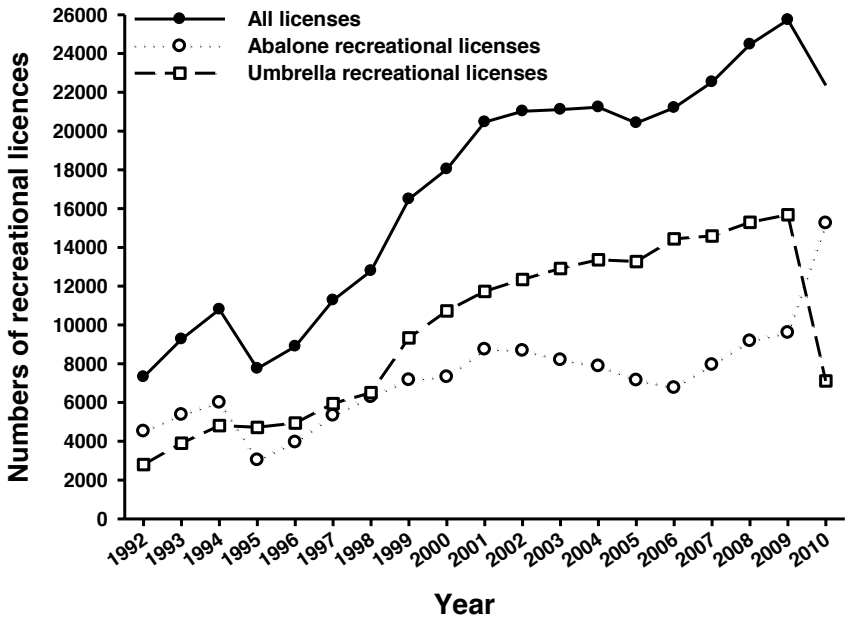
(a)



(b)

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 2010.

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

Main Features

Status		Current Landings	
Stock level	Acceptable	AIMWTMF:	Scallops 806 t (whole weight)
		SWTMF:	Scallops 217 t (whole weight)
Fishing level	Acceptable		Prawns 12 t
		SCTF:	Scallops 112 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 Managed Fishery (SWTMF) 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: Condition 73 provides for the use of demersal otter trawl nets off the south coast of Western Australia in state waters east of 115° E longitude. Condition 79 provides for the use of demersal otter 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 with 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 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.

The SWTMF is a gear based managed fishery that 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 Department's vessel monitoring system (VMS) monitors the activities of all boats including compliance with the spatial closures.

The Australian Govts. Environment Agency, currently called SEWPaC, has assessed the AIMWT fishery under the provisions of the EPBC Act 1999 and its Minister has granted a 5 year export approval for the fishery. The comprehensive ESD 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 validated by processor returns. In the AIMWTMF there is also an annual pre-season survey that provides the information required for assessing the fishery. Advice on the status of stocks and appropriate season opening and closing dates is provided to industry and management. The fishery is spatially separated into localised or traditional fishing grounds and the daily logbooks provide detailed catch and effort in each of these fish grounds. The preseason survey is undertaken in these traditional fish grounds and provides scallop abundance for each fish ground and an overall catch prediction for the fishery.

Monitoring of the scallop stocks in the SWTMF has been based on fishers' monthly return data, which is used to assess the stocks. Since 2009 daily logbooks have become mandatory providing improved spatial catch and effort information.

Retained Species

Commercial landings (season 2010)

AIMWTMF: Scallops 806 tonnes whole weight

SWTMF: Scallops 217 tonnes whole weight

Prawns 12 tonnes

SCTF: Scallops 112 tonnes whole weight

AIMWTMF

The total landings for the 2010 season were 806 t whole weight (161.3 t meat weight) of scallops. The predicted catch range for the 2010 season, based on a pre-season survey, indicated a total catch of scallops between 880 and 1320 t whole weight (176 to 264 t meat weight). The total landings were slightly below the predicted catch range. There were two main contributing factors for the lower than predicted catches. Firstly one of the areas where high abundance of scallops were evident in the survey (Wallabi area) provided small size scallop meat and therefore the area was not fished to its potential catch. Secondly, ceasing fishing at a catch rate level (250 kg/24 hours) to provide carry over of stock for spawning. (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, 217 t of scallops (whole weight), 12 t of western king prawns 1.9 t of crabs (*Portunus pelagicus*) and less than 1 tonne of squid. Since 2004 king prawns have low annual landings (3 to 14 tonnes) which, probably reflects reduced effort from zone D from where most of the prawns were taken in high catch years. However, in 2010 scallop landings were the highest they have been in the last 20 years, almost equalling the 1990 catch of 220 t whole weight Observations by fishers in 2009 indicated improved recruitment with an expected increase in catches for the 2010 season. This trawl fishery also lands a mixture of scale fish species of which the most abundant species recorded was 4.6 t of whiting spp. All other landings of scale fish byproduct species were less than 1 t each.

SCTF

The scallop catch was 112 tonnes (whole weight), which, was slightly higher than last year's catch of 71 t. There is generally low effort expended in the fishery and variable recruitment (West and South Coast Scallop Figure 2). Byproduct species landings were negligible.

Recreational catch: Nil

Fishing effort/access level

AIMWTMF

For the 2010 season, all 15 Licensed boats operated in the fishery resulting in 172 fathoms of net headrope being utilised by the boats that operated, reduced from 184 fathoms because of one boat was removed from the fishery through a Fisheries Voluntary Adjustment Scheme in 2010. The swept area for this season was a total of 112.7 square nautical miles.

A total of 2751 nominal trawl hours (2269 hours standardised effort) were recorded for the 2010 season (Abrolhos Island Scallop Figure 1). Since 1998, the aim has been to reduce ineffective fishing effort by providing annual survey catch abundance and location reports to fishers so as to reduce search time and enable fishing effort to be applied where scallop abundance is higher. Trawling activity was not extensive (approximately 5% of total fishing area) during 2010 and was confined to trawl grounds where fishable scallop abundance was indicated by the survey, rather than fishing throughout the fishery. Scallop fishing ceases at a

catch rate level to provide adequate spawning stock and all boats leave the fishery together rather than individual fishers continuing to fish to low catch rate levels.

SWTMF

A total of 203 days were fished in the SWTMF (all zones) which is an increase compared to last year (125 days) but low compared to historical fishing days. There are 14 boats licensed to fish in this fishery but not all boats actively fish. Although the low level of effort reflects the marginal fishing economics and viability of boats the slight increase in 2010 also reflects the higher scallop abundance this season.

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 2010 season three boats fished for scallops between January and October recording a total of 129 scallop fishing days a slight increase compared to 2009 fishing season.

Stock Assessment

Assessment complete:

AIMWTMF: Yes

SWTMF and SCTF: Not assessed

Assessment method:

AIMWTMF: Level 4 - Direct survey, catch rate

Breeding stock levels:

AIMWTMF: Adequate

SWTMF and SCTF: Not assessed

Projected catch range next season (2011)

AIMWTMF: Scallops 2785 tonnes

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. 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 provides a catch prediction of 2785 tonnes whole weight (557 tonnes meat weight) with a catch range 2230 to 3345 tonnes whole weight (446 to 669 tonnes meat weight) (± 20%) for the 2011 season.

The main performance measure for the 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.

The 2010 fishing season was set at three months, consistent with the yield predicted from the survey in November 2009. Also, fishing ceased at the catch rate threshold level of 250 kg/24 hrs. Hence the breeding stock indicator was met.

Non-Retained Species

Bycatch species impact: Low

The AIMWTMF 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 2010, the total permitted fishing area within the overall extent of the fishery is 2420 square nautical miles. The area fished in the 2010 season was 113 square nautical miles (4.7%). The maximum area coverage has been 11%, which, occurred during the 2003 season when the scallops were widespread and in very high abundance. Owing to the focused nature of this fishery, protocols set out when fishing and the confined area fished in 2010 and the large mesh size (100 mm), little bycatch was taken during the fishing season.

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

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. Aside from migrating humpback whales that usually avoid trawl boats, and occasional great white sharks few other protected, endangered or threatened species, are sighted in this area. For the SWTMF and SCTF whilst some protected, endangered and threatened species frequent these waters they do not occur regularly in the fishing areas. .

Ecosystem Effects

Food chain effects: Low

The total biomass taken by these fisheries is generally very small. Moreover, due to the high natural variability of scallop

[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.

stock abundance it is unlikely that any predators are highly dependent on this species.

Habitat effects: **Low**

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.

Social Effects

The estimated employment for the year 2010 was 140 in the AITMF, not including factory staff based in Perth, 12 in the SWTMF and 10 in the SCTF.

Economic Effects

Estimated annual value (to fishers) for year 2010:

AIMWTMF	**$3.3 million**
SWTMF:	**$1.2 million**
SCTF:	**$0.5 million**

For the SWTMF and the SCTF the estimated value of the scallop catch is based on wholesale price per kilogram (beach price) 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. King prawns; $15.00.

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 2010 was slightly lower than the catch range predicted (see catch section above for reasons) but within target catch range.

New management initiatives (2011)

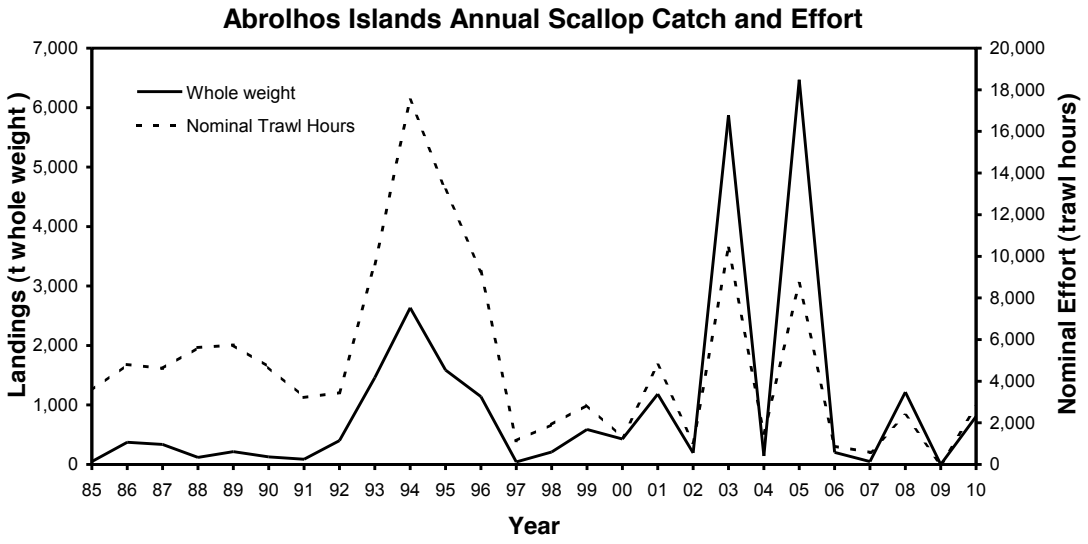
A reduction of boat numbers in the AIMWTF though a fleet restructure using the Voluntary Fishery Adjustment Scheme and the standardisation of the twin gear configuration nets with 7-fathom headrope each net as used in the Shark Bay scallop fishery.

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) are also important in the current economic climate and are factors in determining the amount of effort expended in addition to stock abundance levels

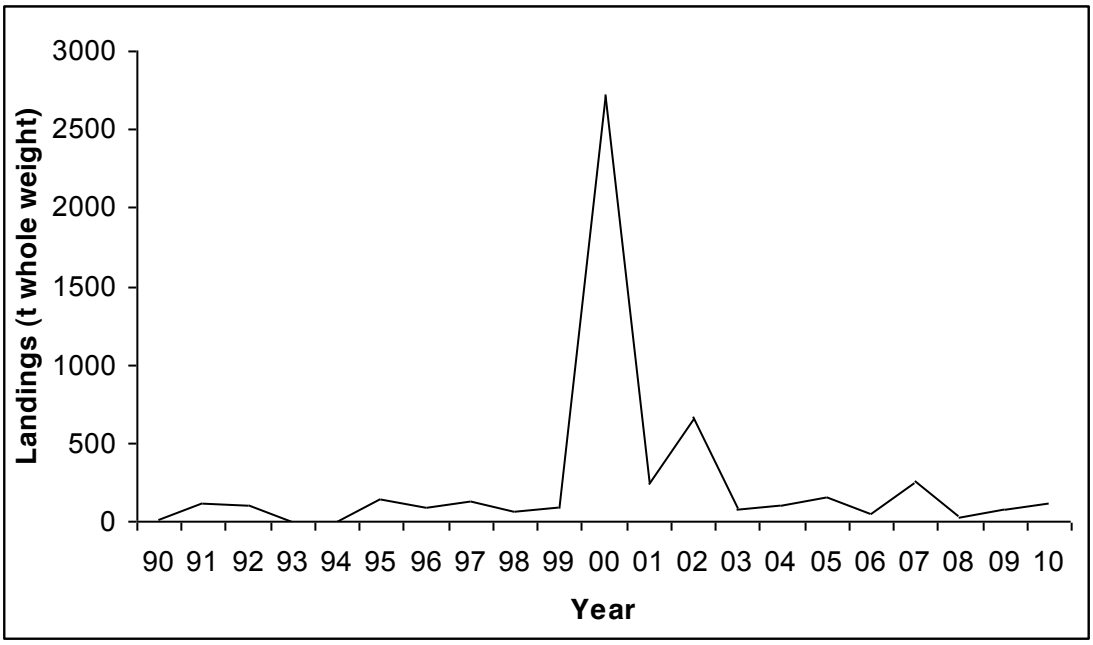
Contibutors

E. Sporer, M. Kangas, S. Brown, R. Gould and N. Chambers.



WEST AND SOUTH COAST SCALLOP FIGURE 1

Annual Scallop Landings and Nominal Effort for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985 – 2010.



WEST AND SOUTH COAST SCALLOP FIGURE 2

Annual Scallop Landings for South Coast Fishery, 1990 – 2010.



WEST AND SOUTH COAST SCALLOP FIGURE 3

Boundaries of the Abrolhos Islands and Mid West Trawl Managed Fishery,extent of fishery, Port Gregory area, Kidney patch and reef observation area's in 2010.

West Coast Blue Swimmer Crab Fishery Status Report

Main Features

Status		Current Landings	
Stock level		Total Commercial catch (09/10)	184 t
Cockburn Sound	Recovering	Cockburn Sound	56 t
Peel-Harvey Estuary	Acceptable	Peel-Harvey Estuary	65 t
		Catch by other commercial fisheries	63 t
Fishing Level			
Cockburn Sound	N/A	Recreational catch	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. Blue swimmer crabs 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 including WAFIC

Meetings between the Department of Fisheries 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 authorises crab fishing in a specified area of Comet Bay between 32°22′40″ S and 32°30 S. A single southern zone (Area 2) 120-pot exemption authorises crab fishing in the waters between Cape Bouvard and the southern

boundary of the fishery. 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. In 2007 the recreational bag limits in the West Coast bioregion were halved to 10 crabs per person and 20 crabs per boat. Further controls were introduced in March 2010 when a Recreational Fishing from Boat Licence was introduced that restricts catch to 20 crabs per powered boat when there are two or more people on-board holding Recreational Fishing from Boat Licences and 10 crabs if there is only one person on-board holding a Recreational Fishing from Boat Licence.

Restrictions also govern gear types that can be used to take blue swimmer crabs, along with localised spatial and temporal closures. Management measures were 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.

In 2006, the Cockburn Sound Crab Fishery (Fishery) was closed to protect crab stocks that were significantly depleted due to fishing pressures and environmental conditions that resulted in poor recruitment. 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 2006/07, 2007/08 and 2008/09 season.

When the Fishery was re-opened on 15 December 2009, following a rebuilding of the fishery, a precautionary management approach was adopted under the following management controls:

- a 20% reduction in commercial pot numbers;
- an increased commercial size limit of 140mm;
- a recreational size limit of 127mm and
- a limited commercial and recreational season from 15 December 2009 to 31 March 2010.

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 2010/11.

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:

a. 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, which determines the potential catch during the stock recovery;

b. maintain the Cockburn Sound commercial catch monitoring program during the fishery closure;

c. develop a commercial catch monitoring program in Warnbro Sound and the Swan River;

d. examine the genetic relationship between the Cockburn

Sound stock and those in Warnbro Sound and the Swan River;

e. 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);

f. develop a fishery-independent sampling program to assess the status of the Peel-Harvey crab stock; and

g. 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 2009/10):

Total 184 tonnes

Cockburn Sound 56 tonnes

Peel-Harvey Estuary 65 tonnes

Other west coast commercial fisheries 63 tonnes

The total commercial catch of blue swimmer crabs taken in WA waters during the 2009/10 financial year was 1071 t (West Coast Blue Swimmer Crab Figure 1) – a 27% increase on the 847 t taken in 2008/09. Total landings from the West Coast bioregion increased substantially over the same period from 74 t in 2008/09 to 184 t in 2009/10, primarily due to the re-opening of the Cockburn Sound crab fishery and increased catches from the Peel-Harvey Estuary and Mandurah to Bunbury trap fisheries.

The commercial catch from the Cockburn Sound Crab Managed Fishery for 2009/10 was 56 t. The fishery was closed for the entirety of the 2008/09 season (West Coast Blue Swimmer Crab Figure 2).

The commercial catch from the Peel-Harvey Estuary (Area II of the West Coast Estuarine Fishery) for 2009/10 was 65 t. This represents a 41% increase on the 46 t in 2008/09 (West Coast Blue Swimmer Crab Figure 3).

The Mandurah to Bunbury Inshore Experimental Crab Fishery reported an annual catch for 2009/10 of 28 t, representing a 180% increase on the 10 t reported for the 2008/09 financial year (West Coast Blue Swimmer Crab Figure 4).

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.

Within Cockburn Sound, the surveys for the 2002, 2003 and 2004 calendar years produced relatively consistent recreational catch estimates of 18 t, 23 t and 18 t 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 Leschenaulte 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

After three years of closure due to declining crab stocks, the Cockburn Sound (Crab) Managed Fishery re-opened for the 2009/10 fishing season. However, a precautionary approach to management was adopted and the season was abbreviated to three and a half months, running from December 15th 2010 to March 31st 2011 (prior to the closure, the commercial crabbing season ran from December 1st to October 30th the following year). Commercial fishers in Cockburn Sound reported 58 747 trap lifts during the 2009/10 season.

Commercial fishers in the Peel-Harvey Estuary reported 55,595 trap lifts during the 2009/10 season – a 14% increase on the 48,762 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 rose in 2009/10, with a total of 22,520 trap lifts reported compared to 17,306 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 and level:

Cockburn Sound **Level 4 - Direct survey**

Peel-Harvey **Level 4 - Direct survey**

Other West Coast fisheries **Level 2 - Catch rate**

Breeding stock levels:

Cockburn Sound **Recovering**

Peel-Harvey **Adequate**

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 10 years and in the Peel-Harvey for three years.

Cockburn Sound: 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 dependent on environmental conditions, 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.

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

Adequate protection of the breeding stock of blue swimmer crabs in Cockburn Sound had been assumed to occur if the minimum legal size was set well above the size at sexual maturity, which would allow female crabs to spawn at least once before entering the fishery. While this is a common strategy for this species, 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.

Despite an absence of fishing pressure, the recovery of the breeding stock and subsequent recruitment has been slow. Since the closure, annual recruit and residual indices provided total catch estimates of 37 t, 64 t and 111 t for the 2006/07, 2007/08 and 2008/09 seasons, respectively, had the fishery been open under the previous management arrangements. While these catch estimates reflect a slow improvement in the stocks, they are well below the historic catch range experienced. Consequently, the closure was extended to December 2009.

The experience gained from this stock collapse will add considerable value to the understanding of blue swimmer crab stock management, helping to guide future direction of the sustainable management of both the Cockburn Sound crab fishery and crab fisheries elsewhere in the State.

Fishery-independent trawl surveys conducted during 2009 indicated that the strength of both recruitment and breeding stock in Cockburn Sound had improved sufficiently to consider re-opening the crab fishery to both the commercial and recreational sectors for the 2009/10 fishing season. However, it was considered prudent to adopt a precautionary approach to the management of the fishery. Previous monitoring of commercial catches has shown that the catch at the beginning of December was predominantly female. The catch composition reversed over a discreet two week period during December such that the catch at the beginning of January was dominated by male crabs. This male dominance continued through the summer months, until the sex ratio was again reversed over a 2-4 week period in Late March/early April. Female crabs then formed the majority of the catch through the winter and spring periods to the following summer. Consequently, the commercial season in Cockburn Sound was set at three and a half months, opening on December 15th 2009 and closing on March 31st 2010, to limit the take of female crabs and provide protection to the breeding stock. In addition; 1) the minimum commercial size limit was raised from 130 mm CW to 140 mm CW; and 2) the fishers operated with a 20% trap reduction which reduced the maximum capacity for the fishery from 800 hourglass traps to 640 traps.

Peel Harvey: The mean annual catch rate for 2009/10 in the Peel-Harvey Estuary was 1.17 kg/trap lift. It follows the 2008/09 catch rate of 0.94 kg/trap lift, which was the equal lowest mean annual catch-rate since the conversion from set nets to crab traps in the late nineties (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, and so do not necessarily reflect similar declines in the overall abundance of crabs in the Peel-Harvey Estuary.

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 later than average moulting, the muscle tissue in many crabs remained under-developed and crabs were lighter than usual, possibly due to food limitation.

Although commercial fishers reported high numbers of crabs in their traps, both numbers of retained crabs and mean catch weights were down.

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.

Fishers in the Peel-Harvey Estuary continued to take crabs at a higher size than the legislated minimum for marketing purposes during 2009/10. While the practice was not universal, many fishers opted to only retain crabs larger than the minimum 127 mm CW limit. The retained catch was further reduced as some fishers returned recently moulted legal-sized crabs to the water, as they were not in prime marketing condition.

However, the fishery will continue to be monitored closely in 2010/11 in light of the lower than average retained catches in the previous two years.

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 Developing 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 2009/10 in the Mandurah to Bunbury fishery was 1.26 kg/trap lift – a marginal increase on the 2008/09 catch rate of 1.15 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 2009/10, approximately 28 people were employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast bioregion.

Blue swimmer crabs also provide a highly popular recreational fishery, particularly in the Swan River, Cockburn Sound, Warnbro Sound, the Peel-Harvey Estuary and the Geographe Bay region, where they dominate the inshore recreational catch.

Economic Effects

Estimated annual value (to fishers) for year 2009/10: **$1.12 million**

The economic value of commercial blue swimmer crab fishing to the State of Western Australia for the 2009/10 season was estimated to be $5.4 million – a 29% increase on the estimated $4.2 million generated in 2008/09.

With the re-opening of the Cockburn Sound crab fishery, and increased 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 2009/10 was valued at around $1.21 million. Despite the increased availability of product, most West Coast fishers were able to maintain an increased beach price (averaging around $6-7/kg live weight) for blue swimmer crabs sold at local markets. 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

Current fishing level

Cockburn Sound:	**Under review**
Peel Harvey:	**40 - 90 tonnes**
Other West Coast fisheries:	**Under review**

The new catch range for Cockburn Sound crabs will need to be developed once the spawning stock and recruitment levels return to normal levels or stabilise. The acceptable catch range for Peel Harvey is now determined to be within the last 10 years of catch values. The other west coast crab fisheries are yet to develop a sufficiently stable catch history or set of management arrangements to develop a definitive catch range.

New management initiatives (2010/11)

As an outcome of the review into the management arrangements for Cockburn Sound the following changes will be implemented in December 2010 for this fishery.

- Maintain the limited commercial fishing season from 15 Dec to 31 March
- Extend the limited recreational open season by one month (15 Dec to 30 April)
- A decrease in commercial size limit for blue swimmer crabs from 140mm to 135mm
- Maintain the current 20% pot reduction in the commercial fishery

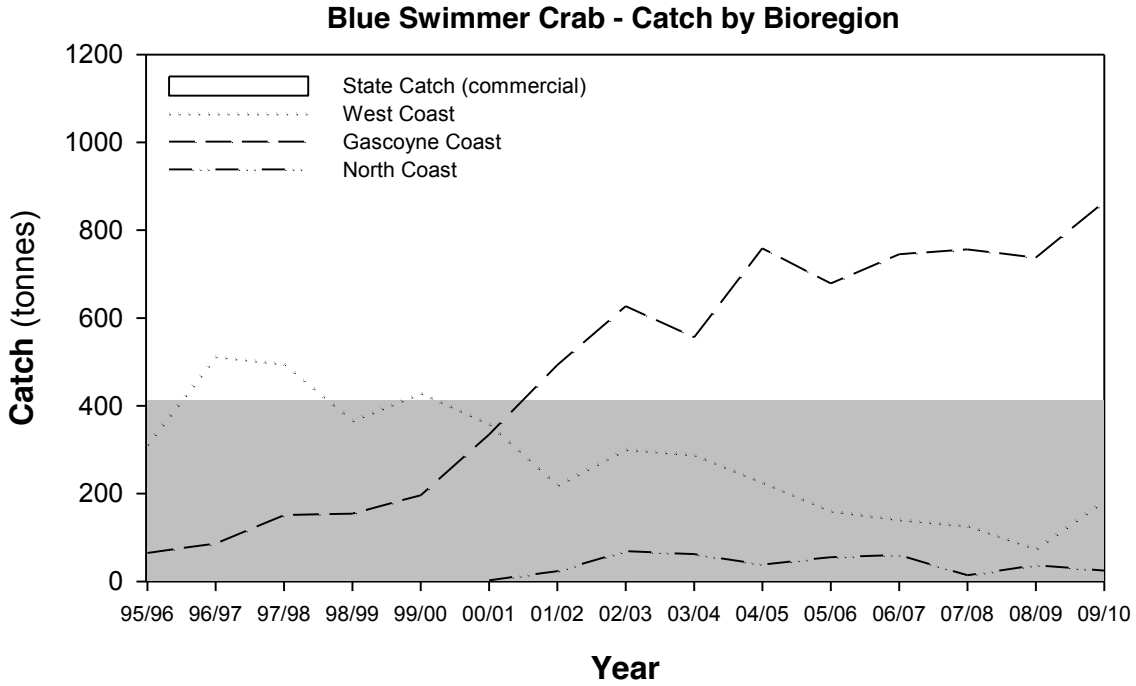
The Mandurah to Bunbury Developing Crab Fishery underwent its final review by the Developing Fisheries Assessment Committee (DFAC) in mid-2007 as part of the 'Developing New Fisheries' process. The Department of Fisheries is considering the recommendations of the DFAC.

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 (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.

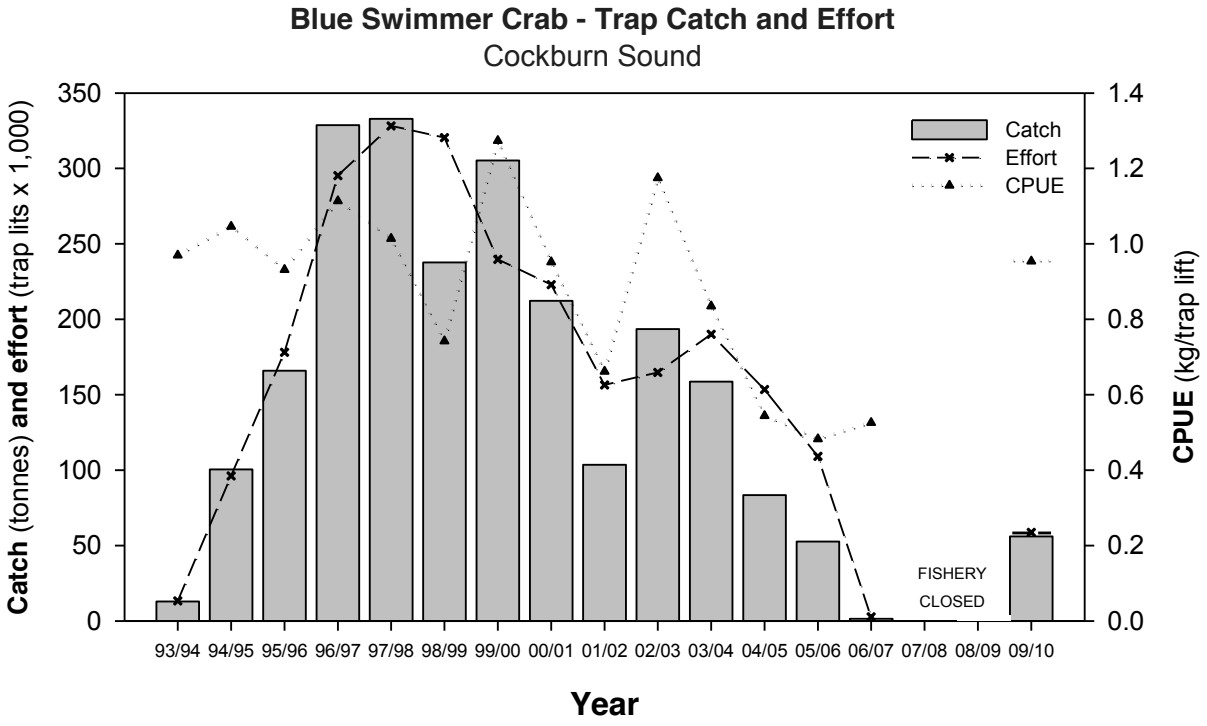
Contributors

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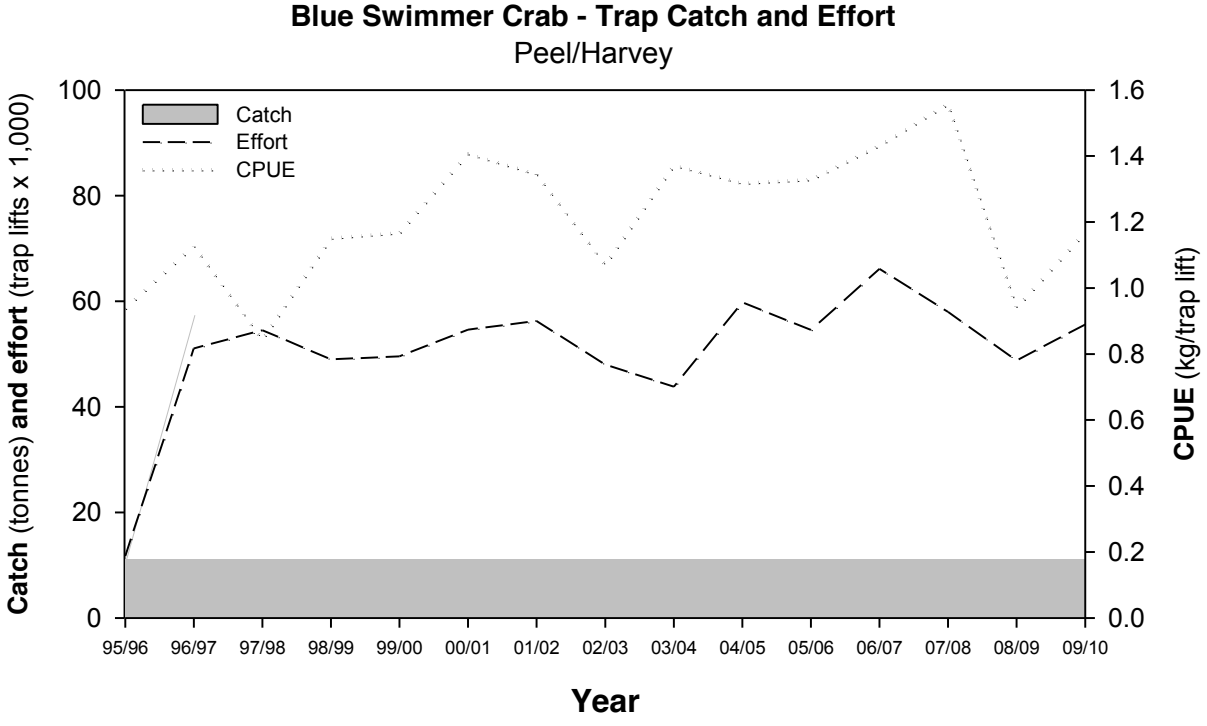
WEST COAST BLUE SWIMMER CRAB FIGURE 1

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



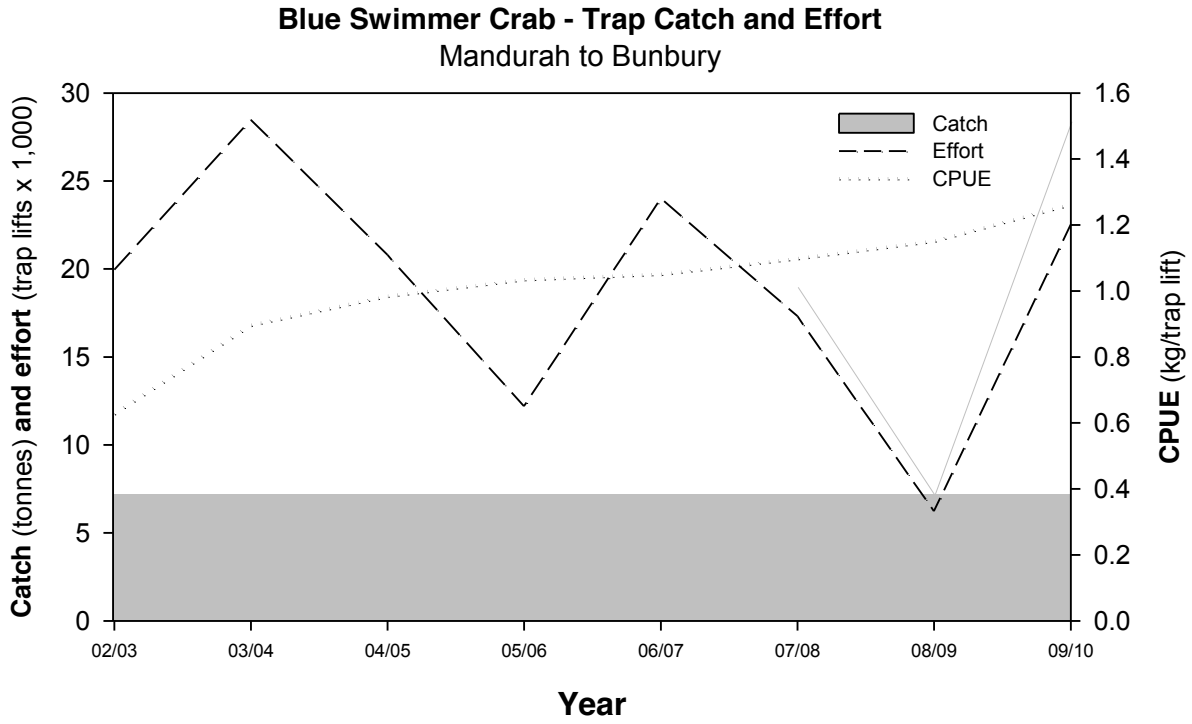
WEST COAST BLUE SWIMMER CRAB FIGURE 2

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 using traps since 1993/94.



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) using traps since 1995/96.



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 since 2002/03.

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

Main Features

Status		Current Landings	
Stock level	Acceptable	Crystal Crabs	139 t
Fishing Level	Acceptable	Champagne Crabs	6.3 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 shelf edge (>150m) 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 include 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 minimum size limits regulations to protect breeding females. A minimum carapace length of 120 mmm applies for the principal target species Crystal Crab, and 92 and 140 mm carapace minimum lengths applying respectively for the lesser targeted species- Champagne and Giant crabs.

The interim management plan came into effect on 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).

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 now need to be established.

Retained Species

Commercial landings (season 2010):

Crystal crab	**139 tonnes**
Champagne crab	**6.3 tonnes**

The catch of 139 tonnes of Crystal crab in 2010 was similar to the previous two years where catches have been just below the 140 tonne quota which was introduced in 2008 (Deep Sea Crab Figure 1). A catch of 6.3 t of Champagne crab was taken in 2010, up from the 5.2 tonnes in 2009, which was the first catch of this species since 2006. The catches are based on mandatory catch and effort returns prior to 2008, with the more accurate catch disposal records from 2008 onwards. A small quantity of Giant crab was landed in 2010, but as this was from a single fisher it has not been reported due to confidentiality issues.

Recreational catch estimate (season 2010) Nil

Fishing effort/access level

Effort decreased by17 % from an estimated 76,370 pot lifts in the 2009 season to 63,526 pot lifts in the 2010 season. The catch of the fishery (see above) is divided by the average logbook catch rates to provide an estimate of effort for the fishery.

Stock Assessment

Assessment complete **Yes**

Assessment method **Level 2 - Catch rate**

Breeding stock levels **Adequate**

Despite an increase in the nominal catch rate for Crystal crabs in 2010, the standardised catch rate for declined by 9% from 1.47 in 2009 to 1.34 kg/pot lift in 2010 (Deep Sea Crab Figure 2), continuing a gradual decline in this index since 2005. This decline is primarily due to a concentration of fishing activities within areas of high catch rate. It is not clear how the CPUE in this fishery is 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.

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. After a drop in the catch rate of ovigerous females in 2008, presumably due to a shift in effort with the removal of zone restrictions, it has remained steady from 2008 to 2010.

The original performance measure is whether the catch remains within the range 100-250 t which was met. Given that the fishery has moved to catch quota, the performance measure needs to be revised to include whether the quota has been achieved and if the effort required to achieve the quota is acceptable.

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. An approximate estimate of the amount of ground between 500–1,000 m over the distributional range of Crystal crabs is about 50,600 km^2. Assuming that all the ground is equally productive, means that at catch levels experienced in the past season about 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 six vessels operating in 2010.

Economic Effects

Estimated annual value (to fishers) for year 2010

$3.3 million

The beach value of the fishery was about $3.3 million in 2010, based on an average beach price of $21/kg for Crystal crab. The majority of the catch is exported live to SE Asia.

Fishery Governance

Target catch range **100-140 tonnes**

Preliminary Effort range **70-100,000 pot lifts**

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

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 has been generated as 70,000–100,000 pot lifts. The current effort (2010) was already below the preliminary effort range (63,526 pot lifts). This acceptable effort range will be reviewed when more data become available from this fishery whilst under quota management.

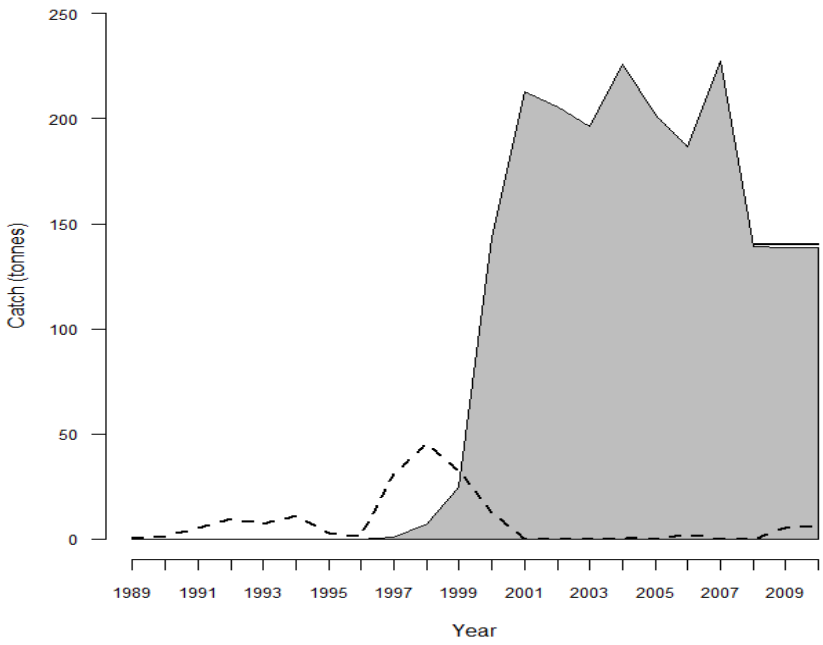
New management initiatives **Nil**

External Factors

Given a large export market, fluctuation in the Australian dollar can have impacts on the economic performance of the fishery.

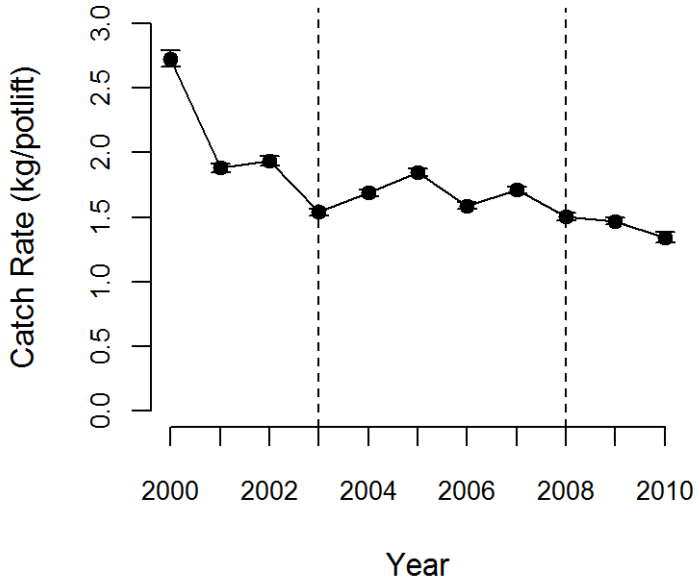
Contributors

J. How and K. Nardi



WEST COAST DEEP SEA CRAB FIGURE 1

Annual catches of Crystal (grey) and Champagne (dashed) crabs since 1989. Annual giant crab catches have always been small, and they have therefore been excluded. Dark solid line indicates the quota limit for crystal crabs which was implemented in 2008.



WEST COAST DEEP SEA CRAB FIGURE 2

Standardized catch per unit (±SE) effort since 2000 for crystal. Area between vertical dashed lines indicate period when management required fishing in all zones.

West Coast Nearshore and Estuarine Finfish Resources Status Report

Main Features

Status	
Stock levels	
Australian herring	Uncertain
Tailor	Acceptable
Southern sea garfish	Acceptable
Whiting species	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
Fishing Level	Acceptable

Current Landings (2010)	
Commercial total	389 t (finfish only)
South West Coast Salmon Fishery	69 t (salmon only)
West Coast Beach Bait & South West Beach Seine Fisheries	101 t (whitebait only)
West Coast Estuarine Fisheries	135 t (finfish only)
Recreational	not available for current year.
Most recent survey 2000/01	940 t (key species only)

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 and beach seine nets.

The Cockburn Sound (Fish Net) Managed Fishery uses gill nets in Cockburn Sound. The main target species 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 nets, to take Australian salmon (*Arripis truttaceus*).

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 to Port Geographe Bay Marina. 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 beach seine nets to target sea mullet, mulloway (*Argyrosomus hololepidotus*), Australian herring, yellow-finned whiting and southern sea garfish.

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 Bioregion estuaries are gill nets and seine nets.

A small number of operators have a condition on their Fishing Boat Licence to operate in other West Coast Bioregion estuaries (Hardy Inlet: 1 operator; Vasse/Wonnerup and Toby Inlet: 5 operators). The latter estuary system is only occasionally fished, yielding small quantities of sea mullet. These estuaries are not included in the WCEF interim management plan.

Recreational

Most finfish caught recreationally in West Coast Bioregion 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) (Sillaginidae), southern sea garfish, silver trevally (*Pseudocaranx* sp.) and black

bream (*Acanthopagrus 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 65 and 66 on a Fishing Boat Licence

Condition 68 on a Fishing Boat Licence

Condition 84 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

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 - Estuarine

WCEF: The management plan encompasses all estuaries in the West Coast Bioregion between 27º S and 33º11´ S. Complex closures exist for both the Swan/Canning and Peel/Harvey commercial fisheries (refer to management plans, related legislation and regulations).

Leschenault Estuary is closed to commercial fishing. The waters of the Vasse/Wonnerup Estuary and Toby's Inlet and all estuaries and canals located in between are open to commercial fishing.

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).

Commercial - Nearshore

Cockburn Sound (Fish Net) Managed Fishery and Cockburn Sound (Line & Pot) Managed Fishery operates within Cockburn Sound.

West Coast Beach Bait Managed Fishery covers WA waters from Moore River (north of Perth) to Tim's Thicket (south of Mandurah).

South West Beach Seine Fishery covers WA waters from Tim's Thicket south to Port Geographe Marina.

South-West Coast Salmon Managed Fishery includes all WA waters north of Cape Beaufort except Geographe 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 Bioregion 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 Bioregion nearshore and estuarine 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. A State-wide Recreational Fishing from Boat Licence (RFBL) was introduced on 2 March 2010. A RFBL is required to undertake any general fishing activity (including crabbing) conducted with the use of a powered boat anywhere in the State.

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

Indicator species

The Department of Fisheries recently selected several key species as indicators for monitoring and assessing the status of the finfish resources in the West Coast Bioregion (DoF

2011[1]) This review identified Australian herring, tailor, southern sea garfish, sea mullet and whiting species as indicators for this Bioregion's nearshore finfish suite and black bream, Perth herring (*Nematalosa vlaminghi*) and cobbler (*Cnidoglanis macrocephalus)* as indicators for the estuarine finfish suite.

Tailor, black bream and yellow-finned whiting are currently assigned to the 'medium risk' category (individual species daily bag limits of 8, 4 and 12, respectively, apply to recreational fishers). Australian herring, southern sea garfish, sea mullet and Perth herring are assigned to the 'low risk' category (mixed species daily bag limit of 30 fish). Cobbler (*Cnidoglanis macrocephalus)* is assigned to the 'medium risk' category (daily bag limit of 4), 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 Bioregion nearshore and estuarine 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 Australian 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 monthly commercial returns, recreational catch levels are estimated occasionally when recreational fishing surveys are conducted.

A 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 develop methods to monitor levels of fishing mortality for Australian herring and tailor in the West Coast Bioregion. In mid-2010 the project was extended to include other indicator species from the West Coast Bioregion nearshore and estuarine suite – whiting species and southern sea garfish. This project will be completed in 20011/12.

The NRM-funded project is also examining aspects of stock structure, including sources of recruitment to the West Coast Bioregion Australian herring and tailor stocks. The majority of West Coast Bioregion tailor landings are taken by recreational fishers in the metropolitan area. Monitoring of juvenile tailor 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 Australian herring in the West Coast Bioregion fishery that originate from nursery sites in the West Coast and South Coast Bioregions is also being examined.

[1] Department of Fisheries (DoF). 2011. Resource Assessment Framework (RAF) for Finfish Resources in Western Australia. Fisheries Occasional Publication No. 85. Department of Fisheries, Perth.

Retained Species

Total commercial finfish landings (2010):

253 tonnes in nearshore waters

135 tonnes in estuarine waters

Commercial landings by fishery (2010):

South West Coast Salmon: 69 tonnes (salmon)

WC Beach Bait + SW Beach Seine:

101 tonnes (whitebait)

West Coast Estuarine + Hardy Inlet:

135 tonnes (finfish)

Commercial catches (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 this report. Catches by all methods and all fisheries are included in the catches reported for key species and in individual stock assessments.

In 2010, the total commercial catch of finfish by estuarine and beach-based fisheries in the West Coast Bioregion included approximately 25 species. The majority of the catch consisted of whitebait (26% by weight), sea mullet (26%) and Australian Salmon (18%).

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, 56% of landings since 2000 were taken in the Geographe Bay/Bunbury area, 22% taken in Cockburn Sound and 9% taken in the Peel-Harvey Estuary. In the West Coast Bioregion, the total annual commercial catch reached an historical peak of 211 t in 1988.

Since 2000, the total state annual commercial catch of Australian herring steadily declined from 818 t in 2000 to 212 t in 2010. Annual landings in West Coast bioregions have declined from 143 t (in 2001) to 29 t in the West Coast Bioregion. The downward trend in the West Coast Bioregion mainly reflected declining catches in the Geographe Bay/Bunbury area. Landings of Australian herring in Cockburn Sound declined only slightly.

Declining herring landings in the Geographe Bay/Bunbury area are only partly attributable to declining effort levels.

Annual effort was stable/increasing prior to 2005 and then declined rapidly after 2005.

Whitebait: All commercial landings of whitebait are taken in the West Coast Bioregion. Total landings have declined 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 89% of total landings. In 2010, the total West Coast Bioregion commercial catch of whitebait was 101 t, the majority of which was landed by the South West Beach Seine Fishery. Substantial variations in whitebait landings appear to occur in response to environmental factors including El Nino -Southern Oscillation (ENSO) and Leeuwin Current fluctuations.

Southern sea garfish: There are possibly five species of garfish landed in WA waters. However, the majority of commercial garfish landings in the West Coast Bioregion are believed to be southern sea garfish (*Hemiramphus melanochir*) with small quantities of river garfish (*H. regularis*) and robust garfish (*H. robustus*) also landed. Since 2001, about 52% of total commercial landings of garfish in WA have been taken in the West Coast Bioregion, with 33% from the South Coast, 12% from the Gascoyne and 2% from the North Coast Bioregions. From 1995 to 2010, the total annual commercial catch of 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. In 2010 approximately 15 t of garfish was taken in the West Coast Bioregion.

From 1995 to 2010, 82% of total commercial landings of garfish in the West Coast Bioregion were taken in Cockburn Sound. The historical peak in garfish annual landings within Cockburn Sound was 37 t in 1980. Since 2000 annual landings of garfish in Cockburn Sound have ranged between 10 and 20 t.

Sea mullet: From 2001 to 2010, 42 % of total commercial landings of sea mullet in WA were taken in the West Coast Bioregion, with 45% from the Gascoyne, 11% 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 Bioregion has steadily declined from 179 t in 2000 to 100 t in 2010. The decline is partly due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of various Voluntary Fisheries Adjustment Schemes (VFAS) (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 2001 to 2010, 52% of total commercial landings of sea mullet in the West Coast Bioregion were taken in the Peel-Harvey Estuary.

Yellow-eye mullet: From 2001 to 2010, 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 Bioregion has steadily declined from 64 t in 2000 to 22 t in 2010. The decline is partly due to various VFAS schemes 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 2001 to 2010, 91% of total commercial landings of yellow-eye mullet in the West Coast Bioregion were taken in estuarine waters, with the Peel-Harvey Estuary landing the majority of this.

Whiting: From 2000 to 2010, 67 % of total commercial landings of whiting (all species) in WA were taken in the Gascoyne Bioregion, 23% were taken in the West Coast, 7% in the South Coast Bioregion and 3% in the North Coast Bioregion. Within the West Coast Bioregion, total landings over this period were reported to be mainly yellow-finned whiting (88%) and King George whiting (*Sillaginodes punctata*) (9%). However, with the exception of King George whiting, there may be misidentification of some commercial landings of whiting. At least three species of *Sillago*.are known to be taken in the West Coast Bioregion. The species composition of whiting landings (commercial and recreational) is currently being investigated by the Department.

The total annual commercial catch of *Sillago* spp. in the West Coast Bioregion has steadily declined from 66 t in 2001 to 23 t in 2010 due to the VFAS schemes operating since 1990. During the period 2001-2010, the Hardy Inlet and the Peel-Harvey Estuary each contributed about 25% of total commercial *Sillago* spp. landings in the West Coast Bioregion.

Australian salmon: Historically, the majority of commercial landings of Australian salmon were taken in the South Coast Bioregion. Over the 20-year period 1980-1999, approximately 80% of total commercial landings of Australian salmon in WA were taken in this Bioregion. From 2000 to 2010, only 68%, of total commercial landings of Australian salmon in WA were taken in the South Coast Bioregion. In 4 of the past 6 years, the majority share of Australian salmon landings has been taken in the West Coast Bioregion. Within the West Coast Bioregion, 55% of landings since 2000 were taken in the Geographe Bay/Bunbury area and 45% taken in the Capes/Augusta area.

Total WA landings of Australian salmon have been declining since 1995. This trend is driven by declining catches in the South Coast Bioregion, where the annual catch has steadily declined from an historical peak of 2,728 t in 1995 to 289 t in 2010. By contrast, the catch trend in the West Coast Bioregion has been non-directional over the long term, although annual landings have varied widely from <1 t (in 2000) to 1,364 t (in 1968). West Coast landings of 1,316 t in 1995 and 1,194 in 2006 were close to the historical peak reached in 1968. In 2010, total West Coast Bioregion landings of salmon were 69 t. In the South Coast Bioregion, declining landings are partly attributable to declining effort levels since 2002. South Coast salmon fishers report they have not been targeting salmon due to lack of markets in recent years.

Australian salmon landings in the West Coast Bioregion are influenced by the Leeuwin Current (a warm water current).

Low catches tend to occur during years of strong Leeuwin Current. For example, in 2000 a strong Leeuwin Current associated with la Niña conditions along the West Coast resulted in a total West Coast catch of <1 t.

(see South Coast Nearshore and Estuarine Finfish Resources status report for further information on Australian salmon)

Tailor: Since 2001, 85% of total WA commercial landings of tailor have been taken in the Gascoyne Bioregion, 13 % in the West Coast Bioregion and 1 % in the South Coast Bioregion. In 2010, the total state commercial catch of tailor was 24 t, which was mostly caught in Shark Bay. The total West Coast Bioregion catch was 5 t in 2010, with the majority reported from the Peel-Harvey Estuary. Over the past decade, tailor landings in this estuary have fluctuated between <1 t to 8 t.

Commercial estuarine species

Perth herring: Since 2000, almost all commercial landings of Perth herring in WA were taken in the West Coast Bioregion. Over this period, total annual landings have declined from 11 t in 2000 to an historical minimum of <1 t in 2010. 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 subsequent years were predominantly 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 Bioregion landings peaked at 239 t in 1978. Declining landings are partly a result of VFAS (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 2001 to 2010, 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 9 t, with over 90% of these landings caught in the Peel-Harvey Estuary. In 2010, 5 t of cobbler was caught, almost all of which was from the Peel-Harvey Estuary.

Historically, commercial catches of cobbler in West Coast Bioregion 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 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 as a result of deteriorating environmental conditions in West Coast Bioregion estuaries are believed to be the main contributing factors.

Black bream: Black bream is a true estuarine species, spending its entire life cycle in these waters. Each estuary hosts a discrete breeding stock of bream, which is genetically distinct to other estuarine populations.

From 2001 to 2010, 93% of commercial landings of black bream were caught in the South Coast Bioregion, with the remaining 7% from the West Coast Bioregion. In the West Coast Bioregion, total landings over this period were mainly caught in the Swan-Canning Estuary (61% of landings) and in Hardy Inlet (37%). Since 2000, total annual West Coast Bioregion landings of black bream have ranged from 1 to 5 t, including 2.6 t taken in 2010.

Historically, the Swan-Canning Estuary and Hardy Inlet have contributed the vast majority of commercial black 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 black 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 (2010): 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 2010. 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 2005/06[1]. 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.

Additional boat-based surveys were conducted in 2008/9 and 2009/10 (Department of Fisheries, unpub. data) and a comprehensive Statewide Recreational Boat Fishing Survey commenced in January 2011. Survey results from up to 23,000 interviews of recreational boat fishers are due in 2012.

The total landings of nearshore and estuarine species can not be estimated from the results of these boat-based surveys because shore-based fishers, who are believed to take the majority of the recreational nearshore and estuarine finfish catch, were not surveyed.

The Department of Fisheries recently conducted a pilot study of shore-based fishers in the Perth Metropolitan area from April to June 2010 in an attempt to determine the best method to quantify recreational fishing catch and effort from this sector (Smallwood *et al.* 2011[2]). During this three-month pilot study, the most frequently retained species were Australian herring, southern sea garfish and whiting (combined species).

[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).

[2] Smallwood CB, Pollock KH, Wise BS, Hall NG and Gaughan DJ. 2011. Quantifying recreational fishing catch and effort: a pilot study of shore-based fishers in the Perth Metropolitan area. Fisheries Research Report 216. Department of Fisheries, Perth.

Recreational catch share:

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.

Fishing effort/access level

Commercial

Since the early 1990s, the number of licences in nearshore and estuarine commercial fisheries has been substantially reduced via VFAS. 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, licensees, teams, 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 Bioregion 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 2,073 days fished per year between 2000 and 2010. Since 2000, 66% 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 2010. The majority of total commercial effort in 2010 and other recent years has been spent targeting blue swimmer crabs.

Hardy Inlet: The mean monthly number of fishing units declined from 3 in the 1970s to 1 in 2000 and subsequent years, including 2010. Virtually all commercial effort in recent years has been spent targeting a limited number of species of 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 VFAS. 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. All effort by this fishery is spent targeting finfish.

Moore River to Kalbarri: The total number of method days fished in this region by shore-based net fishers (gill nets, haul nets and beach seines only) in 2010 was 376. In 2010, 7 licensees 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 ranged from 26 (in 2000) to 917 (in 2002). The number of teams licenced to capture salmon in the West Coast Bioregion was reduced from 12 teams in 2009 to 8 teams in 2010 under the VFAS. Only 4 of the 8 teams reported salmon catches in 2010.

West Coast Beach Bait and South West Beach Seine Fisheries: In 2010, 9 licensees reported landings of whitebait.

Recreational

12-month surveys of boat-based fishing in the West Coast Bioregion were conducted in 1996/7, 2005/6, 2008/9 and 2009/10. These surveys estimated the total effort expended by boat-based recreational fishers in the West Coast Bioregion, including effort expended on all species. However, the proportion of boat-based effort spent targeting nearshore finfish during these surveys is unknown. The 2011 Statewide Recreational Boat Fishing Survey will provide recreational boat fishing effort data for the West Coast Bioregion in 2012.

Recent estimates of effort by shore-based recreational fishers, who are believed to capture the majority of nearshore and estuarine finfish in the West Coast Bioregion, are unavailable. Effort data from the recently conducted pilot study of shore-based fishers (Smallwood et al. 2011[1]) is not included here as this study's aim was to examine the relative benefits of different survey techniques and only investigated 3 months of metropolitan recreational fishing.

The 2000/01 National Recreational and Indigenous Fishing Survey, which included all methods and Bioregions, provided the most recent comprehensive 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:	**Level 2 - 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 assessed**
Cobbler (Peel-Harvey)	**Acceptable**
Cobbler (Leschenault)	**Not assessed**
Perth herring	**Not assessed**

Indicator 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. Australian 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. Australian 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 Australian herring in the South Coast Bioregion and in southern parts of the West Coast Bioregion (Capes, Geographe Bay and Bunbury regions) but stable 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 2010 (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, but appears to be related to environmental factors including the strength of the Leeuwin Current (weak South Coast recruitment occurs in years of weak Current). The effect of low South Coast Bioregion stock abundance on the status of the entire stock is uncertain. Research is underway to determine the current age structure and fishing mortality, and to examine the extent of connectivity of Australian 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 Bioregion fishery. Since this angler-based recruitment index began in 1996 there have been highly variable levels of annual recruitment (West Coast Nearshore and Estuarine

[1] Smallwood CB, Pollock KH, Wise BS, Hall NG and Gaughan DJ. 2011. Quantifying recreational fishing catch and effort: a pilot study of shore-based fishers in the Perth Metropolitan area. Fisheries Research Report 216. Department of Fisheries, Perth.

Figure 3). Relatively strong recruitment occurred in 1996, 2008 and 2010.

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 2010 catch was slightly above the average of annual landings over the 1996-2009 period (West Coast Nearshore and Estuarine Figure 4).

Sea mullet (Acceptable): A single breeding stock of sea mullet is believed to occur in the West Coast Bioregion. It is not known whether this is the same breeding stock that occurs in the South Coast Bioregion. Adult sea mullet typically occur in estuaries, except in winter when they migrate to ocean waters to spawn. Juveniles recruit to estuaries, where they remain until maturity. Peel-Harvey Estuary catch rates are assumed to be representative of regional availability. 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).

Whitebait (Acceptable): The 2010 total catch of 101 t of whitebait by West Coast Beach Bait and West Coast Beach Seine fisheries was within the target catch range (60-275 t). Highly variable annual catches are characteristic of this fishery. Variations in catch level are correlated with the strength of the Leeuwin Current in the previous year and with rainfall.

Anecdotal reports and fishery-independent surveys suggest a low abundance of whitebait in the metropolitan area since 2005 due to low recruitment.

Indicator 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[1]). Voluntary recreational logbook fisher catch rates suggest a stable trend in the availability of black bream in this estuary from 2005/6 to 2009/10 (West Coast Nearshore and Estuarine Figure 6). Black bream in other West Coast estuaries are not assessed.

Cobbler (Acceptable - Peel-Harvey; Not assessed - Swan-Canning and Leschnault): 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. Anecdotal information suggests ongoing low abundance of the estuarine stock. 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. A single breeding stock of Perth herring occurs in the West Coast Bioregion. Swan-Canning catch rates are assumed to be representative of regional availability. Limited evidence suggests regional 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. Low spawning success due to environmental degradation in the upper reaches of estuaries and low rainfall are believed to be the main causes of low stock 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**

Interactions with protected species by the fishing gear used in these commercial fisheries is not expected. 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 minimal.

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.

The current low abundance of whitebait in the metropolitan area is believed to be due to environmental factors and unrelated to fishing. Whitebait in Warnbro Sound is an important source of food for the local colony of little penguins (*Eudyptula minor*). Low abundance of whitebait is believed to have contributed to poor breeding success by these penguins in recent years (B. Cannell, pers. comm.).

[1] Smith 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.

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 and reefs.

Social Effects

Commercial - nearshore

In 2010, there was only 1 licensee operating in the Cockburn Sound (Fish Net) Managed Fishery employing 2 fishers per month. Landings from this fishery are used to supply restaurant and retail sectors in the Perth metropolitan area.

In 2010, there were 5 licensees involving up to 11 fishers operating within the West Coast Salmon Fishery during the Australian salmon season. There were 3-24 commercial fishers per month employed in various fisheries targeting Australian herring during 2010. Australian herring and Australian salmon fishers in the West Coast Bioregion supply local bait and human consumption markets.

Commercial - estuarine

In 2010, there was an average of 12 commercial fishers operating per month in estuaries of the West Coast Bioregion, largely supplying fresh fish to meet demand for locally-caught product.

Recreational

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

Interviews conducted during the 2011 Statewide Recreational Boat Fishing Survey will provide important data on the social aspects of the West Coast Bioregion boat-based fisheries in 2012.

Economic Effects

Estimated annual commercial value (to fishers) for 2009/10:

West Coast Estuarine + Cockburn Sound (Fish Net) + South West Salmon + West Coast Beach Bait fisheries **1,060,000 (finfish only)**

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)

This will depend on the outcomes of the research program on nearshore species currently underway.

External Factors

Climate change is expected to have impacts on nearshore and estuarine ecosystems. Changes in environmental variables such as ocean temperature, currents, winds, nutrient supply, rainfall, ocean chemistry and extreme weather conditions are expected to have major impacts on marine ecosystems (Hobday *et al.* 2008[1]). These impacts are expected to create both difficulties and opportunities for fisheries.

Many nearshore species are known to have their abundance levels affected by annual variation in coastal currents (particularly the Leeuwin and Capes Currents). These currents appear to influence the recruitment patterns of larvae of species such as whitebait, tailor, Australian herring and Australian salmon and thus their subsequent recruitment into each fishery (Lenanton *et al.* 2009[2]).

1 Hobday AJ, Poloczanska ES and Matear RJ (eds). 2008. Implications of Climate Change for Australian Fisheries and Aquaculture: a preliminary assessment. Report to the Department of Climate Change, Canberra, Australia. August 2008.

2 Lenanton RC, 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.

The abundance of nearshore and estuarine species is likely to be affected by the quantity and quality of habitats that are available for spawning, feeding and/or nursery areas. Habitat loss is ongoing due to coastal development in the West Coast Bioregion and this is likely to result in further reductions in the abundance of nearshore and estuarine species. 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 2005[1]). Juveniles of King George whiting are also strongly associated with seagrass and so may be impacted by habitat loss in Cockburn Sound.

West Coast Bioregion 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 Bioregion 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 2006[2]). Stock declines in West Coast Bioregion 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). Whilst not strictly estuarine-dependent, sea mullet and yellow-eye mullet exhibit a strong preference for estuarine habitats when available. The status of these species may also be affected by the availability and quality of estuarine habitats. A variety of barriers to fish passage occur in estuaries (e.g. weirs, dredge plumes) which can disrupt the life cycle of migratory species (e.g. mullet, Perth herring).

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

Contributors

J. Brown, K. Smith, A. Howard, N. Harrison and A. Warmbrunn

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

[2] Smith 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 NEARSHORE AND ESTUARINE TABLE 1

Total annual catches of finfish (excluding sharks and rays) from the beach-based nearshore and estuarine commercial fisheries in the West Coast Bioregion, 2006 to 2010.

Species	Scientific name	Catch (tonnes)				
		2006	2007	2008	2009	2010
Australian salmon	*Arripis truttaceus*	1193.4	622.9	333.4	494.6	69.0
Whitebait	*Hyperlophus vittatus*	231.2	99.1	57.9	139.6	100.6
Sea mullet	*Mugil cephalus*	98.4	99.6	94.8	103.0	99.6
Australian herring	*Arripis georgianus*	43.6	41.5	34.7	34.6	30.3
Yellow-eye mullet	*Aldrichetta forsteri*	26.6	37.0	26.2	26.1	22.0
Whiting species	*Sillago* spp.	34.2	28.8	24.8	24.4	23.0
Sea Garfish	*Hyporhamphus melanochir*	11.1	11.5	11.0	15.7	15.8
Blue sprat	*Spratelloides robustus*	10.3	14.5	13.7	7.1	0.1
Perth herring	*Nematalosa vlaminghi*	4.1	5.6	0.7	1.6	0.1
Cobbler	*Cnidoglanis macrocephalus*	0.7	0.8	6.9	9.2	5.4
Tailor	*Pomatomus saltatrix*	1.8	1.7	1.5	7.1	4.8
King George whiting	*Sillaginodes punctata*	2.0	0.9	5.1	2.0	5.9
Yellowtail scad	*Trachurus novaezelandiae*	1.5	2.2	2.5	1.2	0.9
Black bream	*Acanthopagrus butcheri*	2.4	0.9	1.0	1.1	2.6
Trevally	Carangidae	1.5	1.7	0.9	2.1	3.5
Other finfish	Teleostei	2.8	4.1	1.4	0.3	5.6
TOTAL		1672.4	973.6	615.1	869.0	388.7

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 2003[1]).

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

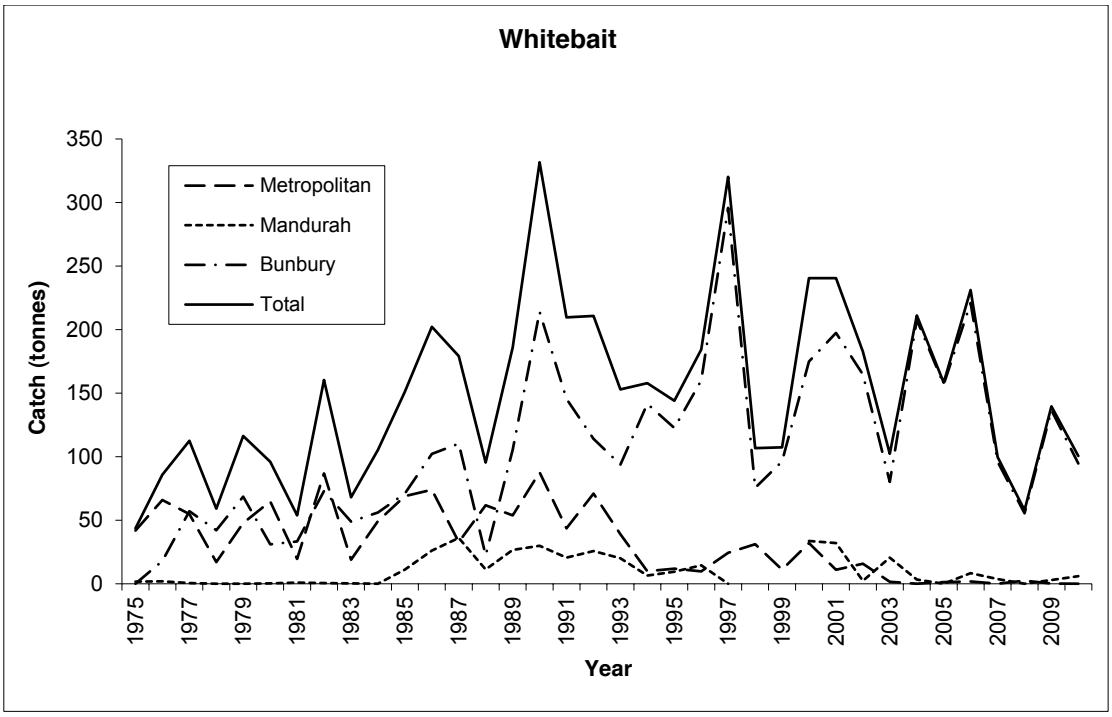
WEST COAST NEARSHORE AND ESTUARINE TABLE 3

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 [2]).

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

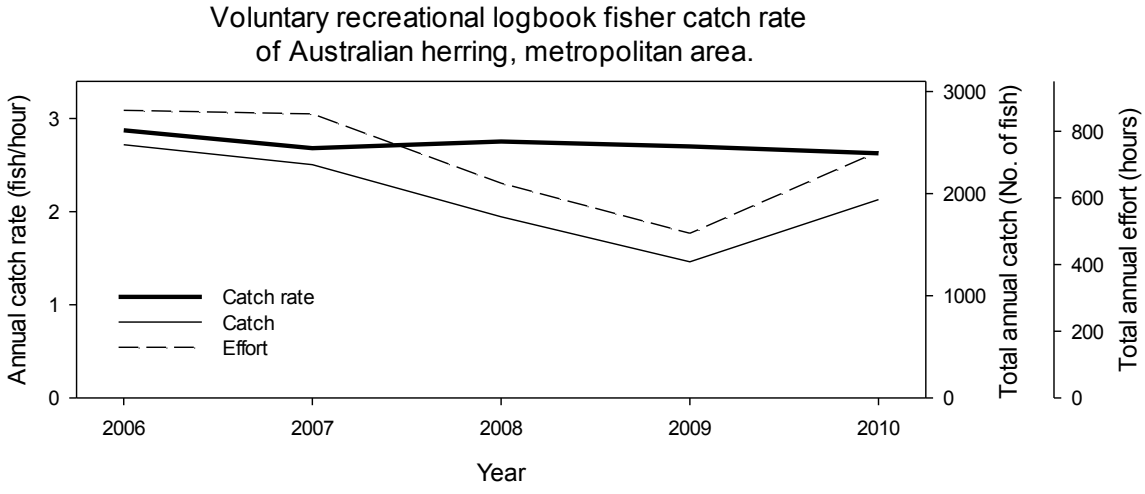
[1] Henry GW and Lyle JM. 2003. The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

[2] 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.



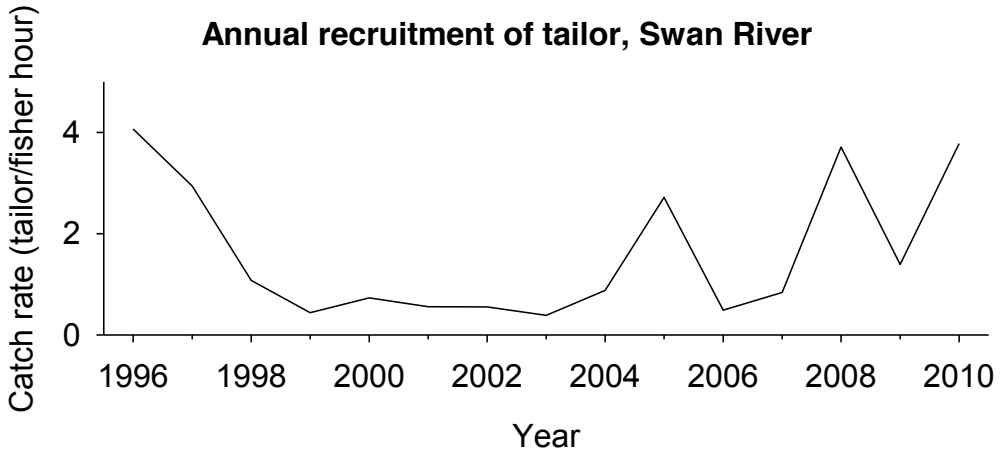
WEST COAST NEARSHORE AND ESTUARINE FIGURE 1

Annual catches of whitebait along the West Coast, by fishing region, 1975 –2010



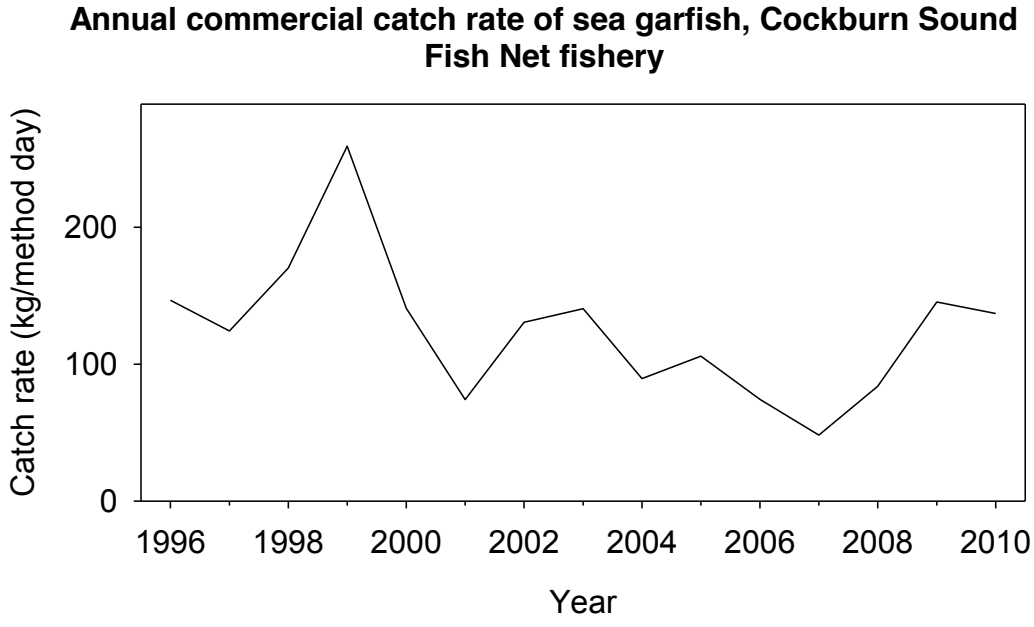
WEST COAST NEARSHORE AND ESTUARINE FIGURE 2

Total annual catch, effort and catch rate of Australian herring by voluntary recreational logbook fishers in Perth metropolitan area (shore fishing only), 2005 – 2010.



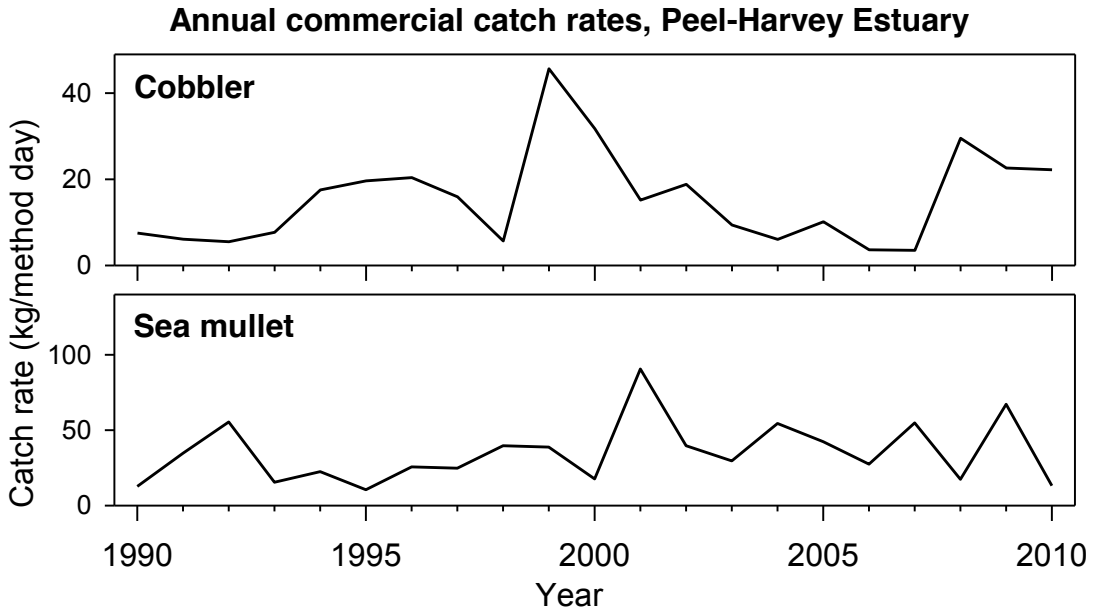
WEST COAST NEARSHORE AND ESTUARINE FIGURE 3

The annual recruitment index for the lower west coast Tailor fishery over the period 1996 – 2010, derived from volunteer angler catch rates of age 0+ juveniles in the Swan/Canning Estuary.



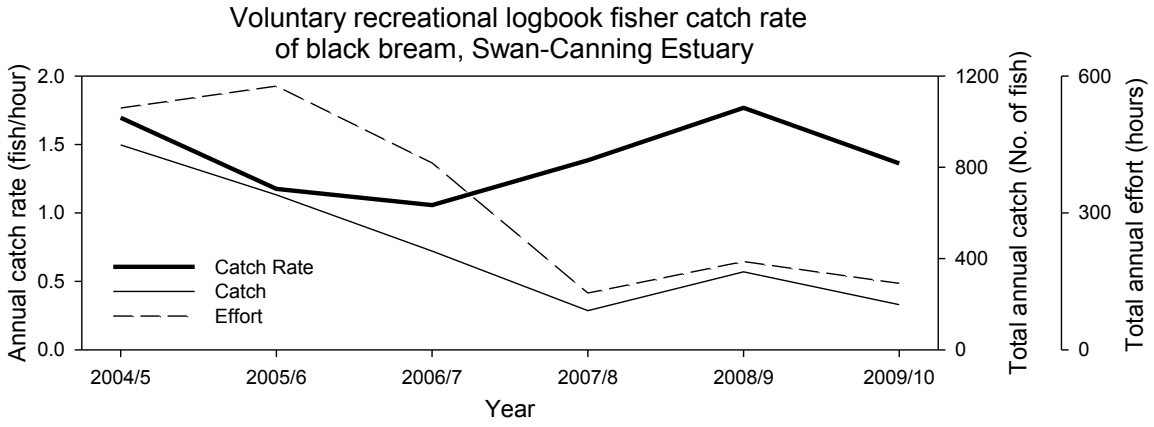
WEST COAST NEARSHORE AND ESTUARINE FIGURE 4

Standardised annual commercial catch rate of sea garfish in Cockburn Sound (Fish Net) Fishery, 1996 – 2010.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 5

Standardised annual commercial catch rates of cobbler and sea mullet in Peel-Harvey Estuary Fishery, 1990 – 2010.



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 – 2009/10.

West Coast Purse Seine Fishery Report: Statistics Only

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 (West Coast Purse Seine Figure 1). 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 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 TAC for pilchards has been in place since 2006/07, and is based on approximately 10% of the west coast pilchard stock. 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 declined further in 2010, continuing the decline from previous years. In 2010 fewer than five vessels expended a total of less than 60 days of fishing effort in this fishery. Total catches in 2010 were less than 10.2 t, the lowest on record, continuing the decline in catches in recent years (139 t in 2007, 121.3 t in 2008[1], 45.2 t in 2009) and well below the 4,000 t catches recorded in the mid to late 1990s (West Coast Purse Seine Figure 2).

Fishery Governance

Target commercial catch range: 0 – 3,000 tonnes

Current Fishing (or Effort) Level: Acceptable

Total effort and catch have declined in recent 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. Warmer oceanic conditions may influence the behaviour and distribution of schooling pelagic species, making them less available in traditional fishing grounds.

No future pilchard spawning biomass estimates are scheduled for west coast pilchard stocks. The most recent pilchard spawning biomass estimate (2004) indicated that pilchard stocks on the west coast had recovered to pre-virus levels of approximately 20,000 – 30,000 tonnes.

New management initiatives (2011/12)

The implementation of a formal quota system with tradeable, individually transferable quota (ITQ) units and a TAC has been a consideration for this fishery for the past ten years. However the implementation of quota for this fishery is

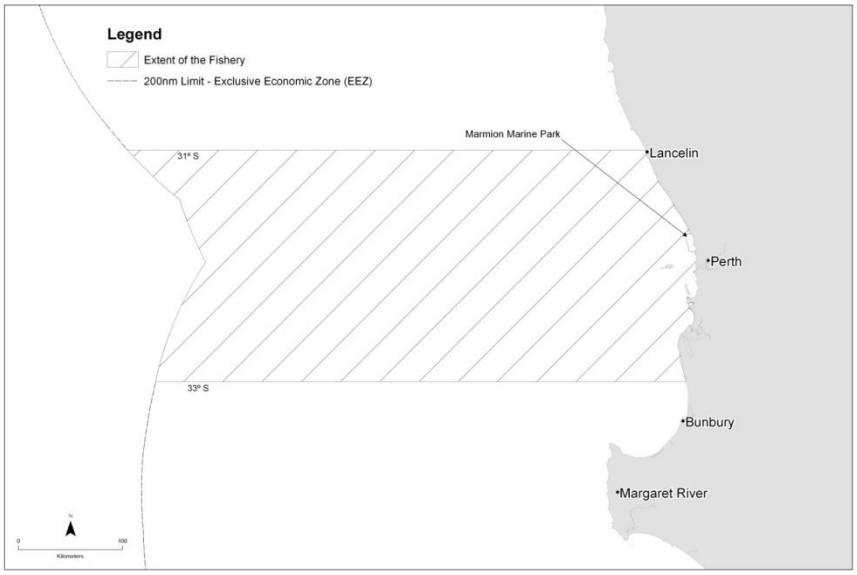
[1] The 2008 total differs from that reported in the State of the Fisheries 2008/09 Report due to the late submission of returns.

considered to be on hold indefinitely, given that catch of pilchards and the effort expended in this fishery has not returned to normal levels since the second pilchard mass mortality event in 1999.

Depending on priorities and resources, the Department may in the future 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.

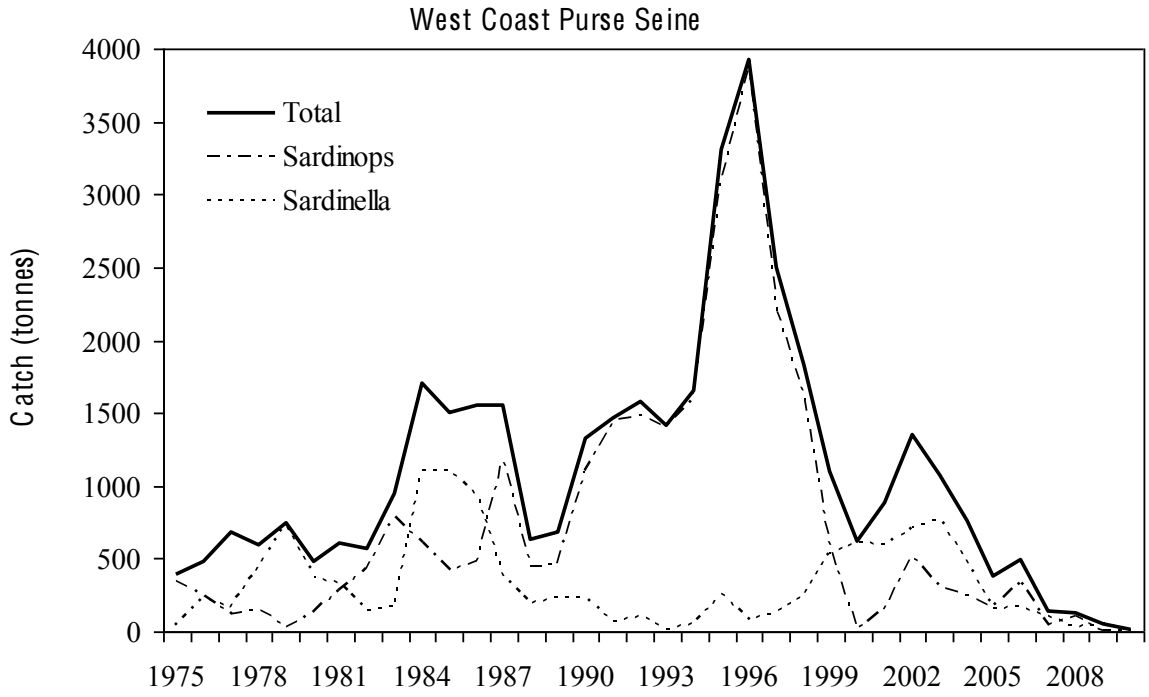
Contributors

B. Molony, E. Lai and N. Moore.



WEST COAST PURSE SEINE FIGURE 1

Map of the extent of the West Coast Purse Seine Managed Fishery.



WEST COAST PURSE SEINE FIGURE 2

Annual catches of pilchards *(Sardinops)* and sardinella in the West Coast Purse Seine Fishery, 1975 –2010.

West Coast Demersal Scalefish Resource Status Report

Main Features

Status		Current Landings		
Stock level	Recovering	Commercial sector		
		All scalefish:		
Fishing Level		WCDSIMF (2010)		365 t
Commercial:	Acceptable	Demersal suite:		
Recreational:	Acceptable	WCDSIMF (2010)		340 t
		Other (DGDLF, WCRLF, CSLPF, AIMWTMF, SWTMF; 2010 or 2009/10)		81 t
		Total demersal suite		421 t
			WCDSIMF	Other
		Indicator species	(2010)	(2010 or 2009/10)
		West Australian Dhufish	54 t	16 t
		Pink Snapper	156 t	13 t
		Baldchin Groper	12 t	5 t
		Recreational sector (2009/10)		
		Indicator species:		
		West Australian Dhufish		85 t
		Pink Snapper		24 t
		Baldchin Groper		19 t
		Charter sector (2009/10)		
		Indicator species:		
		West Australian Dhufish		10 t
		Pink Snapper		10 t
		Baldchin Groper		8 t

Fishery Description

The West Coast Inshore Demersal suite includes about 100 scalefish species which are caught by a number of different fisheries that operate in the West Coast Bioregion (WCB). The most important species of this suite are the West Australian Dhufish (*Glaucosoma hebraicum*) and Pink Snapper (*Pagrus auratus*). Substantial catches are also taken of other species from this suite, such as Red Throat Emperor (*Lethrinus miniatus*), Bight Redfish (*Centroberyx gerrardi*) and Baldchin Groper (*Choerodon rubescens*). The West Coast Offshore Demersal suite, which occurs in offshore waters (> 250 m), includes Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneios*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.

Commercial

The West Coast Demersal Scalefish (Interim) Managed Fishery (WCDSIMF) is a handline and drop line fishery and it is the main commercial fishery that targets demersal species in the WCB. The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) and Zone 1 of the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF), referred to collectively as the temperate Demersal Gillnet and Demersal Longline Fisheries (DGDLF), target sharks and rays but also retain demersal scalefish. Other commercial fisheries that take a small amount of demersal species in the WCB include the West Coast Rock Lobster Managed Fishery (WCRLF), the Cockburn Sound Line and Pot Managed Fishery (CSLPF), the Abrolhos Islands and Mid-west Trawl Managed Fishery (AIMWTMF) and the South-West Trawl

Managed Fishery (SWTMF). The Commonwealth Western Deepwater Trawl Fishery and the Great Australian Bight Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery, that operate in waters of the WCB deeper than 200 metres, also catch demersal species

Fishing and Aquatic Tour Industry (Charter)
Demersal scalefish are targeted by the fishing activities of the charter boat industry in the WCB. 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 WCB 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.

Note - The WCDSIMF and the charter and recreational sectors in the WCB are collectively referred to as the West Coast Demersal Scalefish Fishery (WCDSF).

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 Gillnet and Demersal Longline Interim Management Plan 1997

Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992

Cockburn Sound (Line and Pot) Management Plan 1995

South West Trawl Management Plan 1989

Exemption for the West Coast Rock Lobster Managed Fishery

Fishing and Aquatic Tour Industry (Charter)
Fishing Tour Operator Licence and Restricted Fishing Tour Operators Licence

Recreational
Recreational Fishing from a Boat Licence

Consultation process

Commercial
Meetings between the Department of Fisheries and permit holders in the WCDSIMF.

The Western Australian Fishing Industry Council

Fishing and Aquatic Tour Industry (Charter)
Recfishwest

Marine Tourism Western Australia (formerly the Charter Boat Owners & Operators Association)

Recreational

The consultation process is now facilitated by Recfishwest although the Department continues to undertake direct consultation with the community on specific issues.

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 areas and one offshore area. The inshore areas, i.e. Kalbarri, Mid-West, Metropolitan and South-West, extend outwards to the 250 m depth contour, while the Offshore Area extends the entire length of the fishery from the 250 m depth contour to the boundary of the AFZ (West Coast Demersal Scalefish Figure 1). The Metropolitan Inshore Area was closed to commercial operators in the WCDSIMF and WCDGDLF in November 2007 (West Coast Demersal Scalefish Figure 1).

The boundaries of each of the other fisheries that catch demersal species in the WCB are given in their separate sections of this State of the Fisheries report.

Fishing and Aquatic Tour Industry (Charter) and Recreational fishery
The boundaries applicable to the charter and recreational sectors in the WCB encompass the waters of the Indian Ocean just south of Shark Bay (at 27°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).

Management arrangements

Commercial
The WCDSIMF was established in January 2008, following the introduction of the *West Coast Demersal Scalefish (Interim) Management Plan 2007.* Permit holders are permitted to retain all scalefish other than mackerel and bluefin tuna and are not permitted to take sharks and rays.

Access to the Fishery is restricted to 60 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, with the Metropolitan Area currently allocated zero hours. 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 use acquitted accordingly. The total capacity of the Fishery restricts fishing effort at a level to ensure that catches of all scalefish and also of the suite of demersal species do not exceed catch objectives (see below). The capacity can be adjusted as required.

The primary management objective for the WCDSIMF is to maintain catches of scalefish and the suites of demersal species below 50 % of those recorded in the WCB during

2005/06. The catch in each management area should also not exceed 50 % of the 2005/06 catch in that area. 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 area in which they are an indicator. The status of the three indicator species is used to indicate the status of the entire West Coast Inshore Demersal Suite of scalefish species.

The other commercial fisheries that take demersal scalefish in the WCB (DGDLF, WCRLF, CSLPF, AIMWTMF and SWTMF) are subject to limited entry and input and/or output controls and the same management objective of maintaining catches of the suite of demersal species below 50 % of those recorded by those fisheries during 2005/06.

The detailed management arrangements of each of the other fisheries that catch demersal species in the WCB are given in their separate sections of this State of the Fisheries report.

Since 2008, fishers in the WCRLF have been permitted to retain for personal consumption only demersal species that have been caught in rock lobster pots. These fish are not permitted to be sold.

Fishing and Aquatic Tour Industry (Charter)

There are two types of fishing 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.

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 are still considered. Currently, the consideration of any Tour Operator's Licence Application is carried out in accordance with Regulation 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), however passengers onboard a fishing tour are not required to hold an individual Recreational Fishing from Boat Licence.

Recreational

The recreational fishery for demersal scalefish in the WCB is managed using input (e.g. size limits, seasonal closures and spatial closures) and output controls (e.g. daily bag limits, boat limits and possession limits).

A suite of new management arrangements was introduced during 2009/10 aimed at reducing the recreational take of demersal scalefish in the WCB by at least 50 % from 2005/06 levels. These arrangements included changes to bag, boat and size limits for demersal scalefish species, a requirement to carry a release weight (to assist in minimising the effects of barotrauma) and the implementation of a closure prohibiting fishing for "high risk" demersal scalefish for two months between 15 October and 15 December.

Since 2 March 2010, all persons fishing from a powered boat anywhere in the state have been 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 on demersal species in the WCB focuses on monitoring the status of the indicator species, West Australian Dhufish, Pink Snapper and Baldchin Groper, which indicate the status of the entire West Coast Inshore Demersal Suite (see Fisheries Occasional Publication No. 85 http://www.fish.wa.gov.au/docs/op/op085/fop85.pdf).

Fish frames of the indicator species are collected from both recreational and commercial fishers from the different areas of the WCB (West Coast Demersal Scalefish Figure 1). Otoliths are used to determine age compositions for species in each area, from which estimates of fishing mortality are calculated and stock status determined. The next stock assessment will be conducted in 2012.

Estimated catches of the demersal species/species groups that comprise the predominant 15 species[1] in 2009/10 were approximately half of those in 2005/06 (see landings of retained species below). For a list of the top 15 species/species groups, refer to Table 6a Fisheries Management Paper No. 247 (FMP 247) (http://www.fish.wa.gov.au/docs/mp/mp247/fmp247.pdf).

A new statewide survey of boat-based recreational fishing commenced in 2011, which is a collaboration between the Department of Fisheries and Edith Cowan University. Approximately 3,000 fishers were selected from the "Recreational Fishing from Boat" licence database to take part in this phone-diary survey. Data collected will be calibrated with concomitant boat-based surveys at ramps. Estimates of catch and effort will be available in late 2012.

Catch and effort data both for the commercial and charter sectors are monitored annually from fishers' daily/trip logbooks, which provide fine-scale data from 10 nm × 10 nm and 5 nm × 5 nm blocks, respectively.

Estimates of the number of individuals of demersal species caught as bycatch by the WCRLF were determined from at-sea monitoring in 2009/10. Full details are reported in the WCRLF status report. Fishes kept for personal consumption are also recorded in fishers logbooks and reported in this report.

[1] The predominant 15 demersal species are derived from the combined commercial, charter and recreational catch (by weight). The catch of each sector is typically dominated by 10 of these species (see FMP 247).

A WA Marine Science Institute-funded project to investigate the stock structure of West Australian Dhufish, Pink Snapper and Baldchin Groper in the WCB is almost complete. This is a collaboration between the Department of Fisheries, Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Murdoch University. The project used both genetic and otolith microchemistry techniques and is also examining oceanographic influences on larval dispersal. A scientific paper has been accepted on the genetics of West Australian Dhufish and another has been published on the results of otolith microchemistry work on Baldchin Groper[1].

A project to investigate site-fidelity of adult Pink Snapper to Cockburn Sound spawning aggregations commenced in 2009, using acoustic telemetry techniques. Data on the movements of tagged snapper will be collected by remotely deployed receivers until 2013. These data will be used to assess the risks associated with targeting snapper that are either migrating to or aggregating in Cockburn Sound.

Surveys of the numbers of Pink Snapper eggs in Cockburn Sound were conducted in 2010 to produce an estimate of spawning stock biomass using a daily egg production model. Results will be available as part of the 2012 stock assessment.

A State Natural Resource Management-funded project, focused on small juvenile West Australian Dhufish (< 150 mm in length), is investigating the habitat types that are important for newly-recruited juvenile dhufish and the feasibility of developing a recruitment index.

Retained Species

Commercial production

All scalefish

WCDSIMF (2010)	**365 tonnes**

Demersal suite

WCDSIMF (2010)	**340 tonnes**
DGDLF, WCRLF, CSLPF, AIMWTMF, SWTMF (2010 or 2009/10)	**81 tonnes**
Total	**421 tonnes**

Indicator species

WCDSIMF (2010)

West Australian Dhufish	**54 tonnes**
Pink Snapper	**156 tonnes**
Baldchin Groper	**12 tonnes**

DGDLF, WCRLF, CSLPF, AIMWTMF, SWTMF (2010 or 2009/10)

West Australian Dhufish	**16 tonnes**
Pink Snapper	**13 tonnes**
Baldchin Groper	**5 tonnes**

Total

West Australian Dhufish	**70 tonnes**
Pink Snapper	**169 tonnes**
Baldchin Groper	**17 tonnes**

Landings

Catches are reported from the most recent complete year of logbook data, which differ among the commercial fisheries that catch demersal species in the WCB. Thus, catches are reported for 2010 for the WCDSIMF, AIMWTMF, SWTMF and for 2009/10 for the DGDLF and WCRLF.

In 2010, 365 t of scalefish were caught by commercial fishers in the WCDSIMF, which was 62 t greater than in 2009. The suites of demersal species constituted 340 t of the total catch (327 t of inshore demersal species and 13 t of offshore demersal species), which was 59 t more than 2009. Commercial fishers caught 146 t, 122 t, 59 t and 12 t of demersal species in the Kalbarri, Mid-west, South-west and Offshore Areas, respectively, in 2010.

The WCDSIMF catch in 2010 consisted of 72 scalefish species or species groups, of which, 49 belong to the West Coast Inshore and Offshore Demersal suites and 23 are from either the West Coast Pelagic or Nearshore suites. Six species/species groups comprised 89 % of the total catch of scalefish, including the three inshore demersal indicator species, i.e. Pink Snapper (156 t, 43 %), West Australian Dhufish (54 t, 15 %) and Baldchin Groper (12 t, 3 %). The other three important species/species groups were Redthroat Emperor (45 t, 12 %), Redfish species (Centroberyx spp., 39 t, 11%) and Samson Fish (17 t, 5 %). Catches of species from the West Coast Offshore Demersal Suite, such as Eightbar Grouper and Hapuku, were each less than 4 t.

Seventy five tonnes of demersal scalefish were caught by the DGDLF in the WCB in 2009/10, 11 t more than in 2008/09, while 6 t (combined) were taken by the other commercial fisheries reported here (WCRLF, CSLPF, AIMWTMF and the SWTMF).

West Australian Dhufish: The total catch of 54 t of dhufish by the WCDSIMF in 2010 was 6 t greater than in 2009. Approximately 5 t, 31 t and 18 t were caught in the Kalbarri, Mid-West and South-west zones, respectively (West Coast Demersal Scalefish Figure 2). The DGDLF caught 16 t of dhufish in 2009/10, in comparison to 14.5 t in 2008/09, while < 1 t was taken by the other commercial fisheries.

Pink Snapper: The WCDSIMF catch of 156 t of Pink Snapper in 2010 was greater than the 110 t taken in 2009. The vast majority of the catch of Pink Snapper was from the Kalbarri (96 t) and Mid-west Areas (58 t), with only 3 t landed in the South-west Area (West Coast Demersal Scalefish Figure 3). The catch of Pink Snapper by the

[1] Fairclough, D. V., Edmonds, J. S., Lenanton, R. C. J., Jackson, G., Keay, I. S., Crisafulli, B. M., Newman, S. J. (2011). Rapid and cost-effective assessment of connectivity among assemblages of *Choerodon rubescens* (Labridae), using laser ablation ICP-MS of sagittal otoliths. *Journal of Experimental Marine Biology and Ecology* 403, 46-53.

DGDLF in the WCB increased from 9 to 11 t between 2008/09 and 2009/10, while 2 t were caught by the other fisheries.

Baldchin Groper: Approximately 12 t of Baldchin Groper were landed by the WCDSIMF in 2010, similar to the 11 t caught in 2009 (West Coast Demersal Scalefish Figure 4). Eleven tonnes were caught in the Mid-west Area and 1 t in the Kalbarri Area, with *ca* 8 t of that caught by WCDSIMF entitlement holders within the boundaries of the Abrolhos Zone A of the WCRLF (Abrolhos zone). The catch of Baldchin Groper by the DGDLF in the WCB in 2009/10 (2 t) was similar to 2008/09 (3 t). Approximately 3 t combined were taken by all other fisheries referred to here.

Charter fishing (2009/10)

Top 15 demersal scalefish species	**39 tonnes**
Indicator species	
West Australian Dhufish	**10 tonnes**
Pink Snapper	**10 tonnes**
Baldchin Groper	**8 tonnes**

In 2009/10, catches of the demersal species/species groups that comprise the top 15 by weight typically caught by the charter sector represented 91 % of the total numbers of demersal species caught by that sector and weighed 39 t (based on 96 % of logbook returns at the time of this report). This catch is less than those of previous years (West Coast Demersal Scalefish Table 1). Catches of West Australian Dhufish and Pink Snapper in 2009/10 were also lower than in previous years, but remained the highest ranked of species caught by charter fishers in the WCB. Catches of Baldchin Groper were similar to recent years but less than in 2005/06 (West Coast Demersal Scalefish Table 1). The West Coast Offshore Demersal Suite comprised less than 1 t of charter catches.

Recreational fishing (2009/10)

Top 15 demersal scalefish species	**155 tonnes**
Indicator species	
West Australian Dhufish	**85 tonnes**
Pink Snapper	**24 tonnes**
Baldchin Groper	**19 tonnes**

Surveys of boat-based fishing in the WCB in 2009/10 estimated that ca 155 t of the top 15 demersal species/species groups were caught, which is approximately half of that in 2005/06 (303 t). Estimates of catches of West Australian Dhufish (85 t), Pink Snapper (24 t) and Baldchin Groper (19 t) retained in 2009/10 were also much less than those in 2005/06, i.e. 181 t, 40 t and 26 t.

Fishing effort/access level

Commercial

In 2010, 50 vessels reported fishing in the WCDSIMF. Fifteen of those vessels fished in the Kalbarri Area, while 41, 8 and 15 fished in the Mid-west, South-west and Offshore Areas, respectively. Note that some vessels have entitlements to fish in more than one inshore area, while all can access the Offshore Area.

The total number of days fished in 2010 (1,489) is substantially lower than in financial years prior to the commencement of the WCDSIMF, e.g. 8,486 days in 2006/07. The total number of hours fished (hours searching + hours fishing) in 2010 was approximately 15,400.

Effort recorded by other fisheries that catch demersal species in the WCB is given in their separate sections of this State of the Fisheries report.

Recreational

Effort in the recreational sector has not been estimated for 2009/10.

Fishing and Aquatic Tour Industry (Charter)

During 2009/10[1], 63 charter licences reported having undertaken charter fishing operations and recorded 18,963 fisher days.

Stock Assessment

Assessment complete	**Yes**
Assessment method and level	
	Level 3 - Fishing mortality
	(Periodic - next due in 2012)
	Level 1 - Catch by sector (Annually)
Breeding stock levels	
West Australian Dhufish:	**Recovering**
Pink Snapper:	**Recovering**
Baldchin Groper:	**Recovering**

Inshore Demersal: Detailed assessments of the status of the stocks of inshore demersal species in the WCB were conducted in 2007/08 primarily based on determination of estimates of fishing mortality rates (F), using a range of estimation methods, for each of the indicator species (West Australian Dhufish, Pink Snapper and Baldchin Groper) in the different management areas. The estimates of F for these indicator species reflect the status of the entire West Coast Inshore Demersal suite of species in the WCB. This independently reviewed assessment indicated that at that time the breeding stocks for both West Australian Dhufish and Baldchin Groper were declining while that of Pink Snapper was considered to be inadequate. These results prompted the significant additional management action outlined above to achieve a 50% reduction in the catch levels on this suite across all sectors which was expected to reduce exploitation rates to acceptable levels and therefore stop declines and initiate recovery of stocks in this suite.

Annual monitoring of fishery status is achieved by comparing the overall catch and effort data (where available) for each sector of the fishery with their acceptable catch levels. If the

1 At the time of writing this report, 96 % of charter fishery logbooks had been submitted for 2009/10.

acceptable catch levels are being achieved then it is anticipated that a recovery of these stocks is occurring.

As the current overall catch levels of this suite and the indicator species are within the acceptable catch range, the stocks are currently assessed to be recovering. This assumption will be tested at appropriate intervals using more detailed analyses, with the next detailed assessment scheduled for 2012. In addition, determination of the most appropriate measure of effort and catch per unit effort (CPUE) in the WCDSIMF will be examined in 2012, as part of the next stock assessment.

Fishery-dependent samples of the three indicator species collected from 2008/09 to 2010/11 will be used to determine whether stocks are recovering at the rate that was anticipated given the reductions in catch levels that were instigated.

Preliminary age structure data for West Australian Dhufish and Pink Snapper in 2009/10 indicates strong recruitment pulses occurred in 1999 and 2007, respectively. The 1999 cohort of West Australian Dhufish has now fully recruited to the fishery, while the 2007 cohort for Pink Snapper will be recruiting to the fishery over the next few years. These observations, while encouraging, do not indicate that the stocks have recovered to acceptable levels as this may take several years.

Offshore Demersal: There is limited locally collected information for offshore demersal species (Eightbar Grouper, Bass Groper, Hapuku, Blue-eye Trevalla and Ruby Snapper). These deepwater species are particularly vulnerable 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, 2008[1]; Wakefield et al., 2010[2]). In addition, some aggregate to spawn, making them more vulnerable to fishing and most suffer barotrauma when caught due to the depths in which they are fished (> 250 m). Given the current low level of catches, risks to the biological sustainability of the stocks of these species in the WCB are considered to be medium.

Using the assessments of the indicator species as outlined above, the additional management actions have reduced the ecological risks to the suites of inshore and offshore demersal species in the WCB (see Fletcher et al., 2010[3]). The inshore suite still has high risks associated with meeting social and economic objectives for the community. This combination of factors means that this suite of species still has a high priority for the Department with the inshore demersal suite requiring continued close monitoring and assessment. The offshore demersal 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[4]. Other demersal species that are caught but not normally retained during demersal fishing activities (including inedible species, e.g. Silver Toadfish, and small species, such as wrasses) are often susceptible to the effects of barotrauma and may not survive. Note that while they are not bycatch species, post-release survival of target species, such as West Australian dhufish and Pink Snapper decreases substantially when caught in waters > about 30 m deep[5], but this is likely to be indicative of many species caught but not retained in this fishery.

Protected species interaction — Negligible

As line fishing is highly selective, interactions with protected species by commercial, charter and recreational fishers in the WCDSF are low. Commercial WCDSIMF and charter fishers are required to record protected species interactions in their logbooks. During 2010, one grey nurse shark and five seabirds (albatrosses, muttonbirds) were caught and released alive by commercial vessels. In 2009/10, charter vessels interacted on four occasions with grey nurse sharks and six times with albatrosses, each animal being released alive.

Ecosystem Effects

Food chain effects — Low

An FRDC study[6] examined the last 30 years of catch data by commercial wetline, gillnet and longline fisheries in the WCB and found that while the species composition in catches had changed over time, which may be a function of changes in targeting or differences in reporting methods, there was no evidence of a decline in the trophic level or mean size in catches.

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.

[1] 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. Cybium, 32, 321-324.

[2] 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.

[3] 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

[4] Bycatch interactions of the gillnet and longline sector are presented in the relevant report.

[5] see Fisheries Research Report No. 191 http://www.fish.wa.gov.au/docs/frr/frr191/frr191.pdf

[6] Hall, N.G. and Wise, B.S. (2011). Development of an ecosystem approach to the monitoring and management of Western Australian fisheries. FRDC Report – Project 2005/063. Fisheries Research Report No. 215. Department of Fisheries, Western Australia. 112pp.

Social Effects

Commercial

The 50 permitted vessels that fished in the WCDSIMF in 2010 employed up to three crew members, with the vast majority employing one crew member per trip.

Fishing and Aquatic Tour Industry (Charter)

In 2009/10, 125 charter operators were licensed to operate in the WCB via a Fishing Tour Operators Licence, six less than in 2008/09. Also, 23 held a Restricted Fishing Tour Operators Licence, which is two more than in 2008/09. The number of people employed in the charter industry has not been estimated.

Recreational Fishing

Over 115,000 Recreational Fishing from Boat Licenses were issued across the state in the 12 months to 2nd March 2011.

Economic Effects

Estimated annual value (to commercial fishers) for year 2010 **$3.54 million**

The estimated value of the WCDSIMF in 2010 ($3.54 million) was greater than in 2009 ($2.94 m). West Australian Dhufish and Pink Snapper contributed $909,000 ($16.81/kg) and $1,485,600 ($9.53/kg), respectively, to the fishery, while Redthroat Emperor contributed $405,700 ($9.01/kg), Redfishes (*Centroberyx* spp.) $233,300 ($5.78-8.54/kg) and Baldchin Groper $146,500 ($12.30/kg). Together, catches of those species/species groups comprised 90 % of the value of catches by the WCDSIMF. Prices per kg vary with supply and demand and are based on average 'beach prices' to the fisher in 2010.

Fishery Governance

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

Catch (or effort) limit range (acceptable catch levels):

All scalefish

WCDSIMF **449-469 tonnes**

Demersal suite

WCDSIMF **408 tonnes**

All fisheries combined (WCDSIMF, DGDLF, WCRLF, CSLPF, AIMWTMF, SWTMF)

< 450 tonnes

The primary management objectives for the WCDSIMF are to reduce catches of all scalefish, of the demersal suites and of each of the indicator species, i.e. West Australian Dhufish, Pink Snapper and Baldchin Groper, by at least 50 % of those caught by wetline fishers in the WCB during 2005/06. In addition, catches of the demersal suites in the WCB by other fisheries, i.e. DGDLF, WCRLF, CSLPF, AIMWTMF and the SWTMF, should remain at or below 50 % of those in 2005/06.

In 2010, the catches of all scalefish (365 t) and of the suite of demersal species (340 t) by the WCDSIMF were below 50 % of those of 2005/06. While catches of West Australian Dhufish (54 t) and Baldchin Groper (12 t) by the WCDSIMF were below 50 % of those in 2005/06, those of Pink Snapper were greater (156 t) (West Coast Demersal Scalefish Table 2).

Total catches of the demersal suites (421 t) in a full year of fishing (either 2009/10 or 2010) by the WCDSIMF, DGDLF, WCRLF, CSLPF, AIMWTMF and the SWTMF were below 450 t.

Charter/recreational
Current Fishing level

Demersal suite **Acceptable**

Catch (or effort) limit range (acceptable catch level 2009/10): **< ca. 200 tonnes**

Catches of the suite of demersal species (represented by the top 15 species/species groups) and of the indicator species by the charter and recreational sectors in the WCB should also remain below 50 % of 2005/06 catches, i.e. < ca 200 t. In 2009/10, the combined estimated catch of the top 15 species/species groups by the charter and recreational sectors was 194 t. Total estimated catches by the charter and recreational sectors of West Australian Dhufish (95 t), Pink Snapper (34 t) and Baldchin Groper (27 t) were less than 50 % of those in 2005/06 for dhufish (109 t) and greater for those of snapper (33 t) and baldchin (19.5 t).

New management initiatives

Commercial

Formal catch management guidelines are being developed to determine how the various target catch adjustments by the different commercial sectors that take demersal species will be most efficiently achieved.

A new management plan for the WCDSIMF is to be progressed during 2013, which will include a review of the fishery's management arrangements and the management objectives for the demersal scalefish resource in the WCB following the stock assessment of key indicator species in 2012. This review will also include an evaluation of the management arrangements of the other relevant commercial fisheries (DGDLF, WCRLF, CSLPF, AIMWTMF and SWTMF) as they relate to those fisheries' take of demersal species in the WCB.

Recreational/Charter

The Department of Fisheries is undertaking a Statewide Recreational Boat Fishing Survey, which started in January 2011. For the first time, the Department will be able to estimate the quantity of fish retained and released for each WA fisheries bioregion. This information will assist the Department in managing the State's fisheries and aquatic ecosystem resources to help to ensure there are *fish for the future*.

A review of the effectiveness of the recreational fishing arrangements implemented in the WCB to achieve the 50 % reduction in catch from 05/06 levels will be made during 2013, following the results of the Statewide Recreational

Boat Fishing Survey.

Integrated Fisheries Management

The Integrated Fisheries Management (IFM) policy process is formally underway for the demersal scalefish resource in the WCB. IFM is a policy aimed at making sure that Western Australia's fisheries continue to be managed in a sustainable way in the future. Two Fisheries Management Papers relevant to the implementation of IFM for the demersal scalefish resource in the WCB were released in July 2010 (see Fisheries Management Papers 237 and 247 http://www.fish.wa.gov.au/docs/mp). It is expected that the final decisions regarding the sectoral allocations for the West Coast Demersal Scalefish Resource will be made in the second half of 2011.

External Factors

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

Cockburn Sound is the only known spawning aggregation location for Pink Snapper in the WCB. 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 WCB.

The Commonwealth Western Deepwater Trawl Fishery and Great Australian Bight Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery fish in waters of the WCB from the 200 m isobath to the boundary of the AFZ. These fisheries target species such as Deepwater Flathead *Platycephalus conatus* and Bight Redfish *Centroberyx gerrardi*. The geographical overlap of these fisheries with the WCDSF indicates that they are likely to be fishing the same stocks and will be discussed with the Australian Fisheries Management Authority in 2011/12.

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

The changing climate may lead to increased average water temperatures or acidification from absorption by the ocean of increased atmospheric CO_2, which in turn could influence aspects of the biology of demersal species, such as spawning success and thus recruitment patterns. Extreme events, such as the marine heatwave recently reported, may have severe negative effects, including increased mortalities (http://www.fish.wa.gov.au/docs/pub/Highlights/marine-heatwave.php).

Contributors

D. Fairclough, E. Lai, C. Bruce, N. Moore and C. Syers

WEST COAST DEMERSAL SCALEFISH TABLE 1.

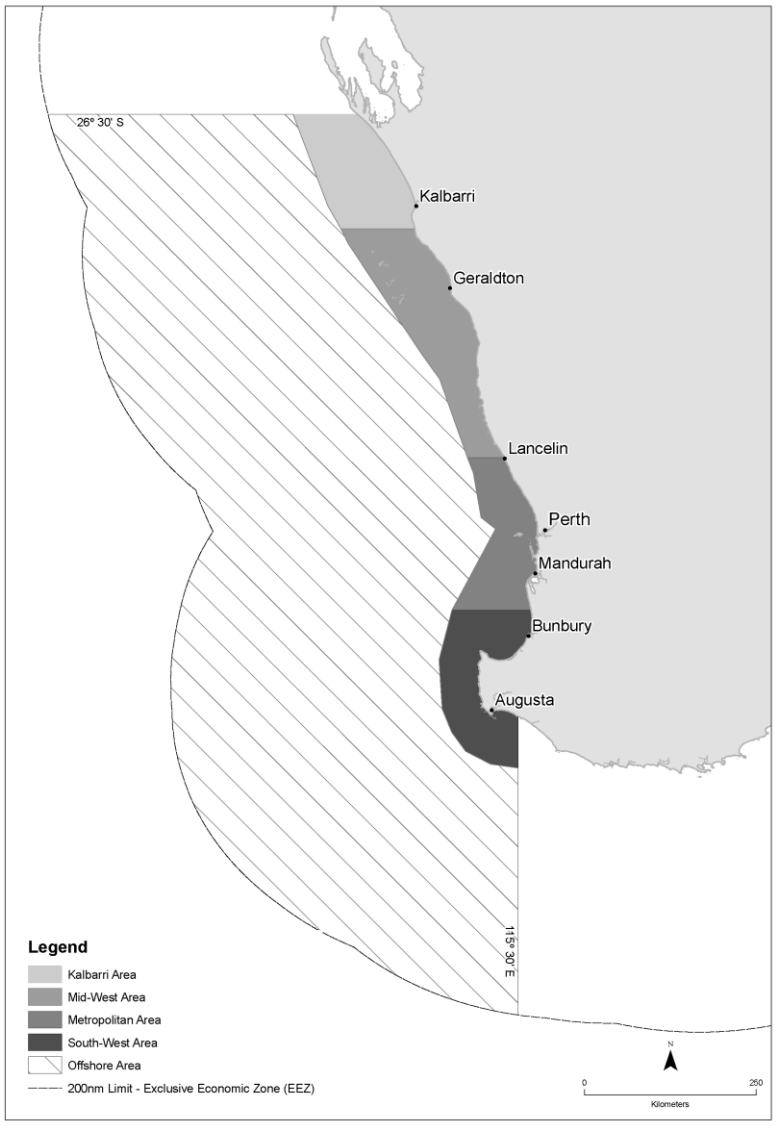
Catches of the top 15 demersal species, West Australian Dhufish, Pink Snapper and Baldchin Groper by the charter and recreational sectors in the West Coast Bioregion between 2005/06 and 2009/10. Estimates of catches are not available for 2006/07 and 2007/08 for the recreational sector.

	Charter sector					Recreational sector		
	2005/06	2006/07	2007/08	2008/09	2009/10	2005/06	2008/09	2009/10
Top 15	72	73	62	46	39	303	250	155
West Australian Dhufish	19	16	15	12	10	181	144	85
Pink Snapper	17	23	20	12	10	40	31	24
Baldchin Groper	10	12	8	7	8	26	32	19

WEST COAST DEMERSAL SCALEFISH TABLE 2.

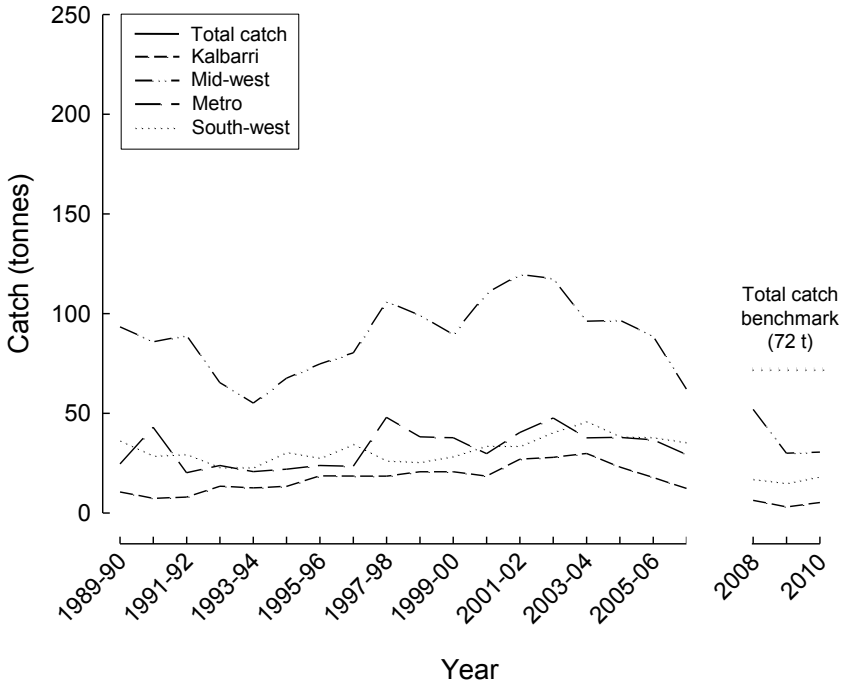
Acceptable catch levels (tonnes) of all scalefish in each area of the WCDSIMF.

	Area				
	Kalbarri	Mid-west	South-west	Offshore	
All scalefish	150	197	82	20-40	449-469



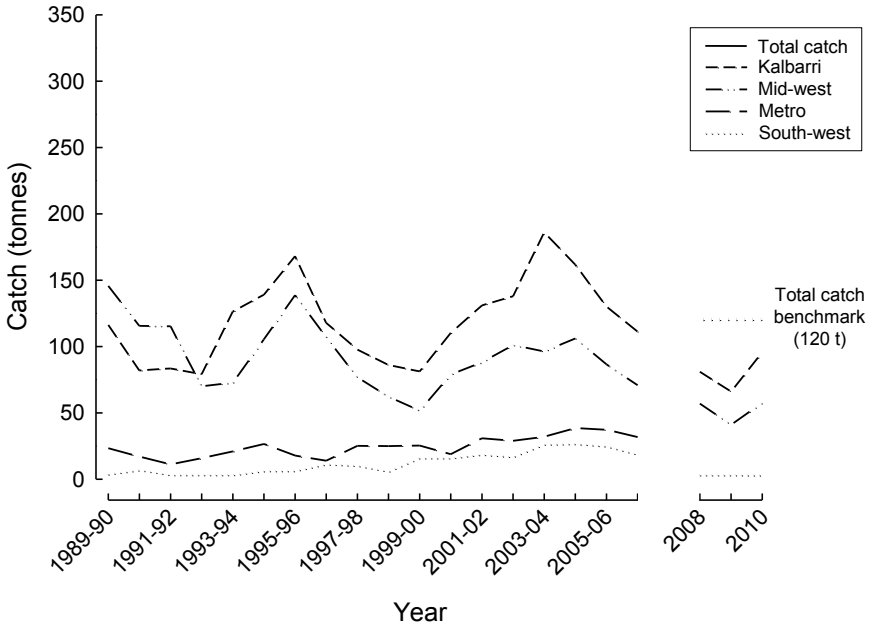
WEST COAST DEMERSAL SCALEFISH FIGURE 1

Map of the boundaries of the West Coast Demersal Scalefish Fishery extending from 26°30’ S to 115°30’ E. The northern boundary shown applies to the West Coast Demersal Scalefish (Interim) Managed Fishery (WCDSIMF) and is the proposed future boundary for the charter and recreational fishery. The Kalbarri, Mid-west, Metropolitan and South-west areas apply only to the WCDSIMF and extend from the coast to the 250 m depth contour, while the offshore area encompasses the waters from the 250 m depth contour outwards to the boundary of the 200 nm Australian Fishing Zone boundary (AFZ) and from 26°30’ S to 115°30’ E. Note the Metropolitan Area is currently closed to fishing by the WCDSIMF.



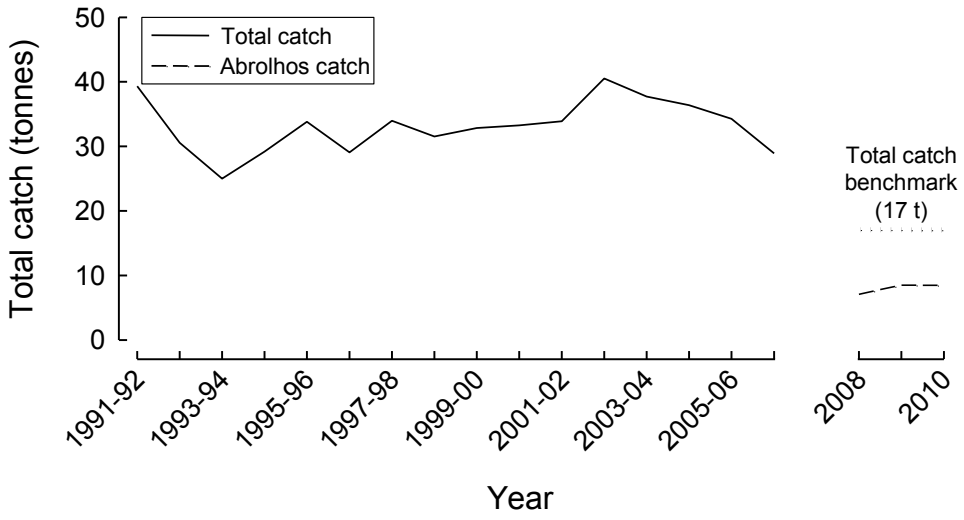
WEST COAST DEMERSAL SCALEFISH FIGURE 2

Total catch and catch by area of West Australian Dhufish *Glaucosoma hebraicum* by commercial wetline fishers in the West Coast Bioregion between 1989/90 and 2006/07 and in the West Coast Demersal Scalefish (Interim) Managed Fishery between 2008 and 2010.



WEST COAST DEMERSAL SCALEFISH FIGURE 3

Total catch and catch by area of Pink Snapper *Pagrus auratus* by commercial wetline fishers in the West Coast Bioregion between 1989/90 and 2006/07 and in the West Coast Demersal Scalefish (Interim) Managed Fishery between 2008 and 2010.



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 2006/07 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 between 2008 and 2010.

Octopus Fishery Status Report

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial – Statewide	174 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 historically accounted for the majority of total octopus landings, although the Developing Octopus Fishery (DOF) is now the major octopus fishery. The Cockburn Sound (Line and Pot) Managed Fishery (CSLPF), uses unbaited or passive (shelter) octopus pots; the 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 has been managed though input controls in the form of limited entry and boat size restrictions. Two larger vessels operate in the fishery by means of exemption, with a maximum number of octopus pots allowable under the exemption conditions as well as spatial restrictions. Management deliberations regarding the use of nominal TACs, explicit pot allocations, and other changes to the management plan are underway and expected to be incorporated into the plan in 2012.

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 spatially controlled, with each exemption holder allocated a specific area of coast. Sustainable harvest levels and pot allocations in the DOF are currently being examined through a combination of exploration of new areas, and associated biological and stock assessment research.

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. No minimum size currently applies to octopus as the animals are not amenable to management by this method.

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 obtained a research grant from the Fisheries Research and Development Corporation (FRDC) 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 potential for any expansion of the DOF.

Retained Species

Commercial landings (season 2010):

174 tonnes (live weight)

Recreational catch estimate (season 2001):

17 tonnes (live weight)

Landings

Commercial: In 2010 the total commercial octopus catch was a record 174 t live weight, an increase of 112% over last year's catch of 82 t, mainly due to the expansion and increased in effort in the DOF (Octopus Figure 1).

On a sector-specific level, octopus catch from the WCRLF declined slightly from 32 to 27 tonnes, catch from the CSLP increased 47%, from 17 to 25 t, while the catch from the DOF increased significantly from 33 tonnes to 119 tonnes or 260 % (Octopus Figure 1).

The developing octopus fishery (DOF) has steadily risen from 4% of the total catch in 2001 to 69% in 2010 (Octopus Table 1). At the same time, share of catch from the lobster fishery has declined from 86% to 16%, 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 survey[1] 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 (days on which octopus were landed) in the WCRLF in 2010 was 8,071 days, a 140% reduction from 19,299 days in 2009 (Octopus Table 1). Days fished in the CSLP and DOF were 271 and 639 respectively, an increase of 6% and 158% from 2009 (Octopus Table 1).

Stock Assessment

Assessment complete: **Preliminary**

Assessment method and level:

Level 2 - Catch rate

Breeding stock levels: **Adequate**

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

The CPUE for octopus from the WCRLF was 3.4 kg/day, which was an increase from the 2009 estimate of 1.7 kg/day (Octopus Figure 2). Otherwise it has been fairly stable between 2001 and 2009, varying between 2.3 and 2.9 kg/day.

The CPUE for octopus in the CSLPF and DOF sectors was 92 and 187 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, and the move to more efficient trigger traps.

A standardised CPUE (SCPUE) analysis for the CSLPF 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 (Octopus Figure 3). SCPUE for trigger pots is only available between 2008 and 2010, but also shows a slightly increasing trend, from 0.9 to 1.1 kg/pot.

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 bycatch. The selective method of fishing used for the CSLPF 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.

[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.

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 CSLPF 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 dedicated octopus fishing vessel employs between 2 and 3 people. In 2010, 189 vessels caught octopus, although the vast majority of these landings were small (< 100 kg), as they were by-catch in the WCRLF. Only 19 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 2010: **$1.2 Million**

The estimated annual value for 2010 was $1.2 million based on an average product price of $10/kg (head off) or $7/kg live weight. This is a beach price value and supports a substantial processing and value-adding sector. A substantial increase in octopus catch in 2010 caused an over supply in the market and forced a price drop of ~ $3 kg compared to 2009.

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 174 tonnes is within the target range.

New management initiatives (2010/11)

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.

The CSLP management plan is currently under review and discussions being held between Industry and the Department of Fisheries. It is likely that changes to this plan will be made in 2011/2012.

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. In particular, a "marine heatwave" experienced on the West Coast in the summer of 2010/11, where water temperatures reached 3 degrees above average, may prove to have a significant effect on the fishery.

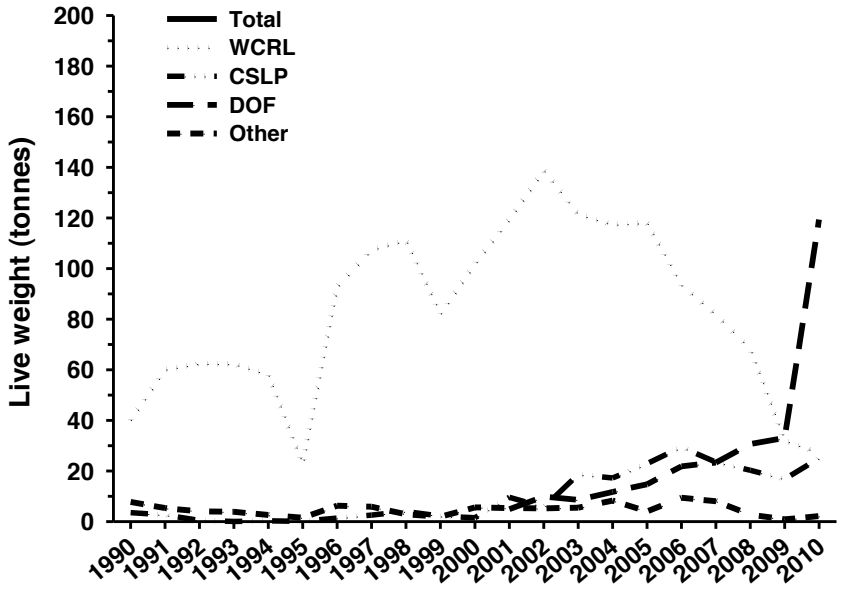
Contibutors

A. Hart, D. Murphy, R. Gould, A. Warmbrunn and M. Coloper

OCTOPUS TABLE 1

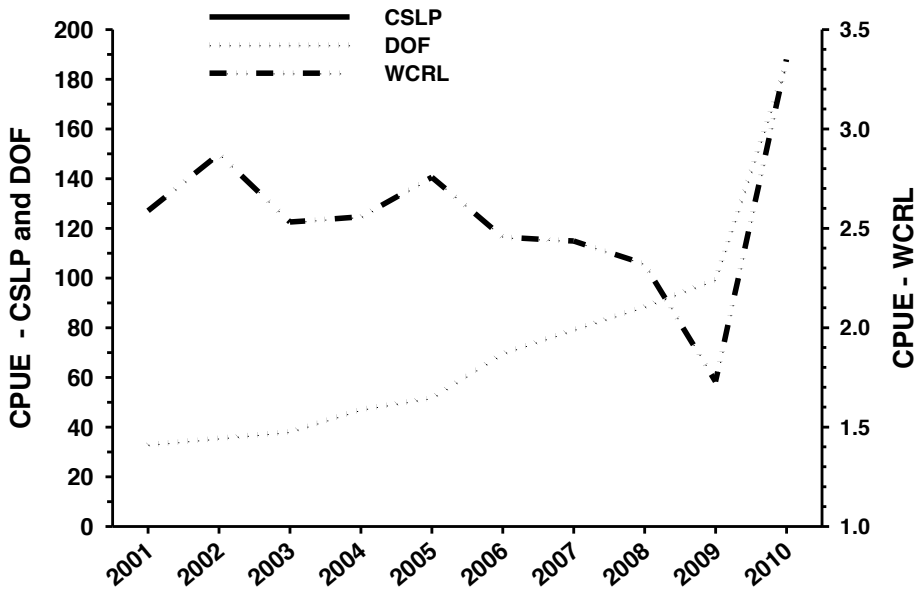
Percentage of octopus catch and total days fished from different sectors of the fishery. – WCRLF (West Coast Rock Lobster Fishery), CSLPF (Cockburn Sound Line and Pot), DOF (Developing Octopus Fishery) and Other, which is by-catch from trawl and miscellaneous pot fisheries

Year	WCRLF	CSLPF	DOF	Other	WCRLF	CSLPF	DOF
	Percentage of total catch				Effort (total days fished)		
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	39	20.3	40.0	1.0	19,299	256	248
2010	16	14.4	68.7	1.2	8,071	271	639



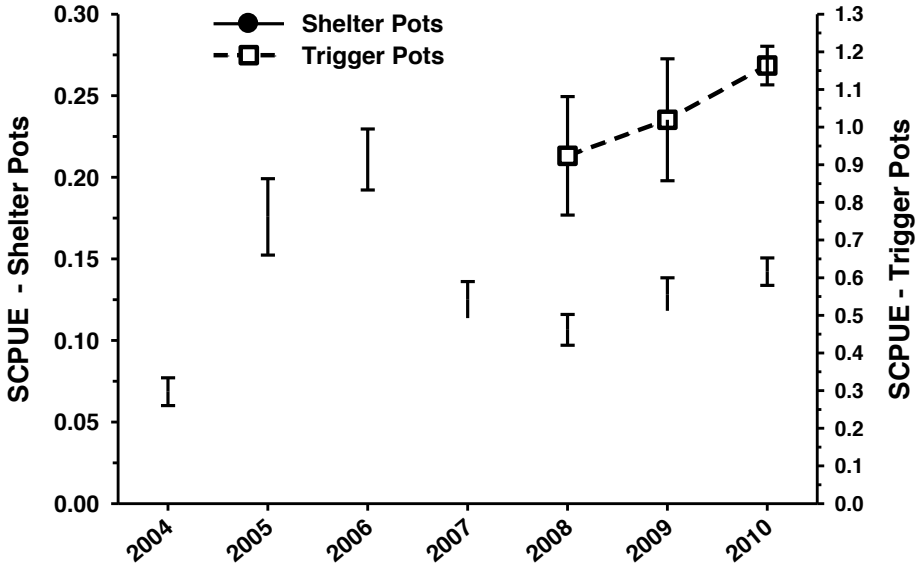
OCTOPUS FIGURE 1

Commercial catch (t) of octopus in Western Australia since 1990. Catch is divided between the main sectors – WCRLF (West Coast Rock Lobster Fishery), CSLPF (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 – WCRLF (West Coast Rock Lobster Fishery), CSLPF (Cockburn Sound Line and Pot), DOF (Developing Octopus Fishery).



OCTOPUS FIGURE 3

Standardised catch per unit effort (SCPUE) (±95% CL) in kg / pot (kg in landed weight) of Octopus in all 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.

The Department's review of aquaculture licence conditions has been delayed as a result of limited staff resources; the process is now scheduled to start early in the 2010/11 year. The outcome of the review will deliver higher levels of consistency, transparency and certainty in licensing and compliance arrangements across all aquaculture industry sectors.

Progress continues to be made on the development of a new framework for the environmental arrangement for large- and small-scale aquaculture applications. A Memorandum of Understanding to formalise new arrangements has been executed with the Department of Environment and Conservation. Under the terms of the agreement, the Department of Fisheries is now responsible for the environmental management of aquaculture in WA waters. Environmental management will be effected principally through a requirement for licensees (with some exceptions) to develop and operate according to a Management and Environmental Monitoring Plan. The Department is writing a set of Guidance Statements to assist licensees in the preparation of the Management and Environmental Monitoring Plans.

The *Fish Resources Management Amendment Bill 2011*, which was introduced into Parliament in May 2011, includes several new and amended provisions for aquaculture, mainly in relation to the environmental management of the industry and the establishment of offshore zones for aquaculture development.

Two leases have been issued under section 97 of the *Fish Resources Management Act 1994*. The Department anticipates receiving additional lease applications from aquaculture proponents as the offshore sector continues to develop.

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. 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.* The project won the 2010 Premiers Award in the "Developing the economy" category.

A focus of the Department of Fisheries in the Abrolhos region is the regulation of the pearling industry, based on species such as the blacklip oyster *Pinctada margaritifera*. The production of pearls from several other species such as *Pinctada albina* and *Pteria penguin* is also increasing in importance.

Aquaculture licences authorising the production of coral and live rock at sites at the Abrolhos Islands have been issued and are being assessed. Given the increasing interest in aquaculture in the vicinity of the Abrolhos Islands, the Department has started the development of a policy for aquaculture in that area. The policy development process will involve substantial communication and consultation with stakeholders.

As well, the FRDC project developed in collaboration with a commercial octopus fishing and processing company continued with research on ranching wild-caught juvenile octopus and seeking to close the life cycle through larvae rearing.

The Department, through the fish health unit, worked closely with the Marine Fishfarmers Association and the Mid West Development Corporation on a successful project to test the feasibility of farming yellowtail kingfish in sea cages at Geraldton.

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 *P.V's Mc Laughlin*, *Hamelin* 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 (where available) of Fisheries Volunteers based in some regional centres within the bioregion. 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.

The Department also delivers at-sea marine safety compliance services on behalf of the Department of Transport 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 2009/10

During 2009/10, Fisheries and Marine Officers delivered a total of 19,329 hours of compliance and community education services in the field (West Coast 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 Armatus" was a welcome addition in undertaking compliance operations and research projects in the Metropolitan Region. The "PV Armatus" 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 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 and the introduction of new management arrangements. Routine compliance operations targeted a number of significant risks including over potting, fishers interfering with other fishing gear and black market operations.

Within the West Coast Rock Lobster Managed Fishery, 259 vessels had their catch inspected by FMOs on at least one occasion, with an average of 3 checks per vessel throughout the fishery (West Coast Compliance Table 2). On average 11.4 baskets were inspected per vessel, a decrease on the number of 18.5 baskets per vessel in 2008/09. The percentage of total catch inspected was 1.1 - 1.4% of the catch inspected (compared to 2.6 - 3.3% in 2008/09). The observed per-animal non-compliance rate for the catch was the same as the previous season with an estimated range of 0.0007 - 0.0011. This range has been used to estimate that between 4.1 and 6.3 tonnes of illegal rock lobster were consigned during 2009/10.

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 by commercial fishers was similar to previous years, although there was a decrease in the number of prosecutions from 73 to 34 returning to levels recorded in 2007/08. The number of infringements decreased from the previous year, with a total of 43 infringement notices being issued. Infringement warnings decreased from 193 to 134.

Considerable compliance activity was directed towards recreational fisheries within the bioregion, with FMOs achieving 51,154 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 amount of illegal crabbing occurring in the Peel-Harvey Estuary. A strong compliance presence during 2008/09 appears to be responsible for a slight reduction in the number of prosecutions for illegal crabbing, in the recreational sector, from 222 in 2008/09 to 190 in 2009/10. A total of 1,119 infringement warnings and 590 infringement notices were instigated for less serious recreational offences during 2009/10.

The Department continues to work collaboratively with the Department of Environment and Conservation (DEC) 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 compliance service delivery, the Department continued its commitment to training officers from DEC, Water Corporation and the Rottnest Island Authority.

Throughout the year FMOs undertook joint patrols with other agencies including Department of Transport, Australian Customs Service and WA Police Service. The Department

also continued to provide at sea resources to assist the Department of Environment and Conservation in the disentanglement of whales in the West Coast Bio Region. This assistance led to the successful disentanglement of a number of humpback whales entangled with primarily rock lobster fishing gear.

Initiatives in 2010/11

With the West Coast Rock Lobster fishery moving to quota management arrangements a full review of the WCRL Compliance program will be undertaken with the focus being on educating fishers on the new arrangements and catch recording regime and on landing and processor inspections to ensure that the relevant catch entitlement details are being recorded. There will also be a significant effort in the gathering of intelligence and dealing with black market operations as the catch limits reduce the number of lobster available in the domestic market. Compliance focus will be on ensuring the catch limits, both individually and collectively, are not exceeded.

Ensuring that only licensed wetline fishers are taking fish for a commercial purpose in the West Coast Demersal Scalefish Interim Managed Fishery will remain a compliance priority throughout the bioregion.

The increased focus on recreational fishing compliance will continue, particularly with the implementation of new mobile patrols operating within the Bio Region. Five dedicated recreational fishing mobile patrols will be operating within the bioregion based at Geraldton, Hillarys, Fremantle, Mandurah and Busselton will deliver fisheries compliance and education services to the recreational fishing community. They will be supported by one of the state-wide recreational mobiles during the period of peak activity. 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.

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 2009/10 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	19,329 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	296
Infringement warnings	134
Infringement notices	43
Prosecutions	34
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	51,154
Infringement warnings	1,119
Infringement notices	590
Prosecutions	190
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field Contacts by Fisheries & Marine Officers	4,040
Fishwatch reports**	531
VMS (Vessel Days)****	22,099

*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 PV McLaughlin 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.

**** VMS (Vessel Days) represents the number of vessel days recorded in this bioregion. That is, a count for each day that each vessel was polled within the bioregion.

WEST COAST COMPLIANCE TABLE 2

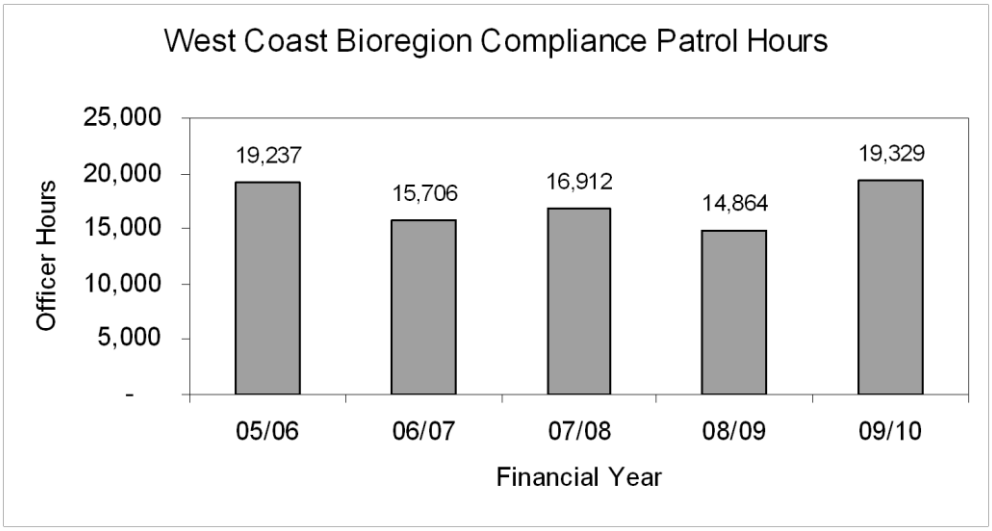
Summary statistics for Commercial West Coast Rock Lobster compliance in all bioregions in the 2009/10 fishing season.

TOTAL COMPLIANCE HOURS*	17,220 Officer Hours
Field Contacts by Fisheries & Marine Officers	979
FACTORY INSPECTIONS OF CONSIGNMENTS	
Number of unique vessels checked	259
Average number of inspections per vessel	3
Average number of baskets checked per vessel **	11.4
Proportion of total commercial catch inspected	1.1-1.4%
Non-compliance rate (per-animal basis) ***	0.0007 - 0.0011
Total consigned commercial catch ('000 kg)	5,899
Estimated total illegal catch consigned ('000 kg)	4.1-6.3

*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 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 09/10 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 1,848 "on-patrol" hours delivered in 2009/010 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 McLaughlin* and *PV Hamelin* in West Coast.

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 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 three 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 trawl based 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 has an offshore pink snapper fishery and the Denham-based beach seine fishery since the 1960s, which respectively provide most of the pink snapper and whiting catch for the state. A fishery for blue swimmer crabs, based primarily in Carnarvon but operating throughout the waters of Shark Bay, has grown in the last decade to currently be the largest Western Australian crab fishery. The line fishery that originally targeted pink snapper has also been developed over the past decade into a broader fishing sector taking other demersal finfish species including emperors, cods and deeper water species such as goldband snapper (jobfish). These are all managed as the Gascoyne Demersal Scalefish Fishery. 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, tropical 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.

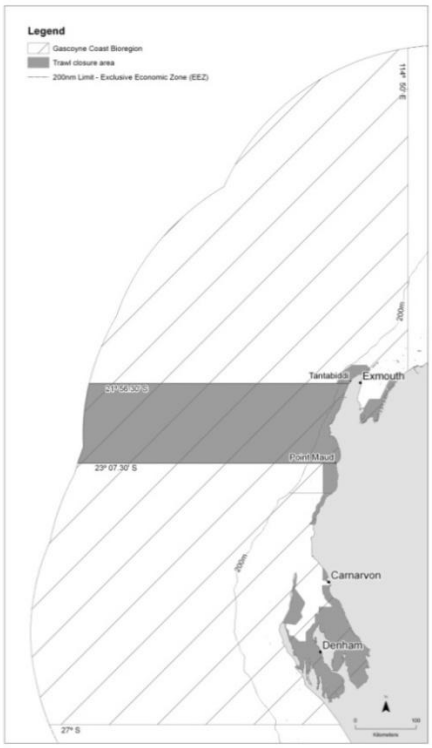
ECOSYSTEM MANAGEMENT

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 Ecosystem Management Figure 1). The extent of these areas means that 35% of the entire shelf region (< 200 m) of the Gascoyne Coast Bioregion could be classified as a marine protected area with an IUCN category of IV (as per Dudley, 2008[1]; 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 Murion Islands Marine Management Area, and the Quobba and Miaboolya Beach Fish Habitat Protection Areas.

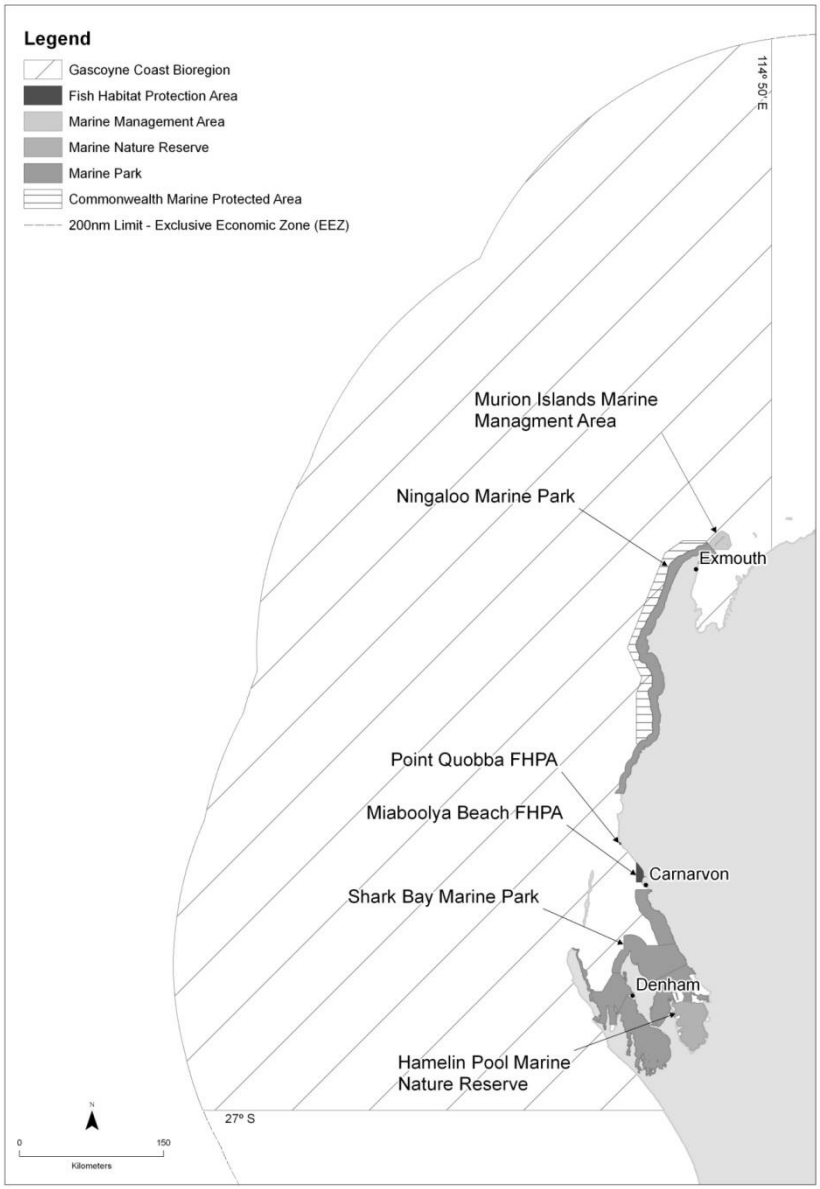
The Australian Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) is also undertaking a process of identifying additional protected areas for Commonwealth waters between Shark Bay and the Northern Territory border. The Draft Plan is expected to include proposed marine protected areas, and has been 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 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 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 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)[1] 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

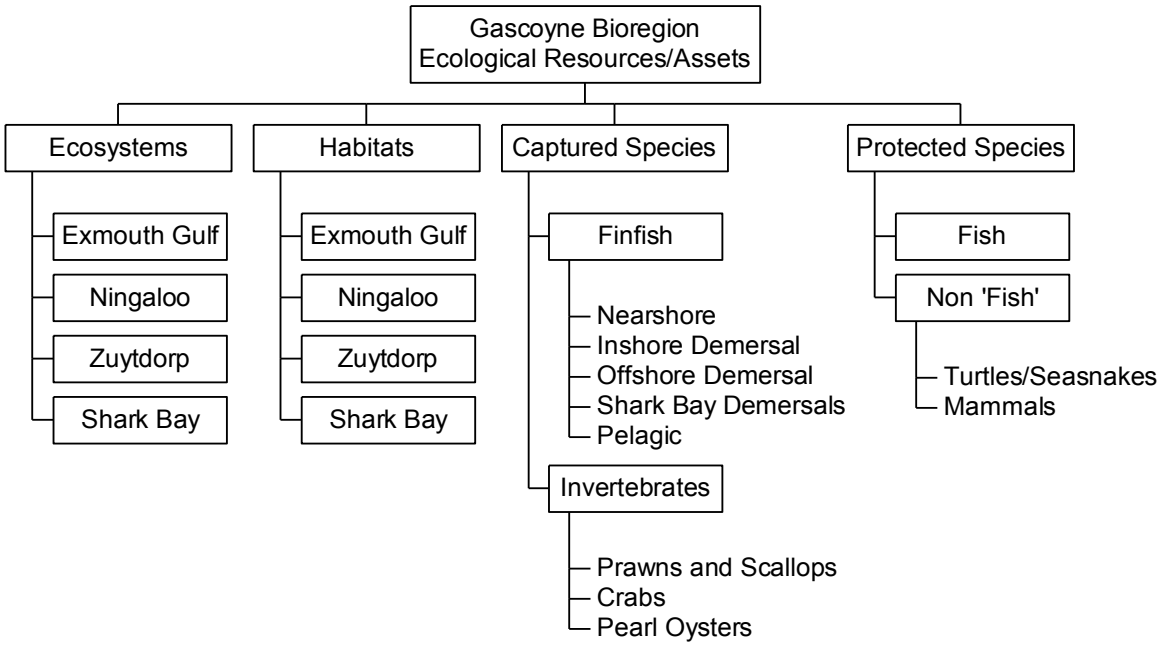
Protected species (direct impact – capture or interaction);

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 Coast Bioregion.

[1] 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

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 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

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 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	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.

Captured Species	Aquatic zone	Ecological Risk	Status and Current Activities
	Inshore demersal (20-250m depth)	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	Concerns around deeper-water species (e.g. ruby snapper, various cods) are largely due to uncertainty in the stock status of these species and their long-lived, slow growing life histories. The main risk to these stocks comes from potential increases in fishing by Commonwealth licensed trawlers who operate outside of 200 m depth and the current discussions about altering this line.
	Pelagic	MODERATE	The stock status and fishing levels on these species (e.g. Spanish mackerel) are both at acceptable levels
	Shark Bay Gulf Demersals	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 size 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	MODERATE	The recent stock levels of pearl oysters in this region have been low. Recovery management arrangements have already been implemented and minimal catches have been taken in recent years.

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	LOW	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.
	Seagrass	NEGLIGIBLE	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	NEGLIGIBLE	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 HIGH in medium 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

Summary of Monitoring and Assessment of Ecosystem Assets

The Department is a contributor and supporter of the extensive ecological research and monitoring that has been undertaken in the Ningaloo Marine Park, much of which was funded by the recently completed 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 (2010) 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. This study found no high or unacceptable risks (Evans and Molony, 2010)[1].

1 Evans, R. and Molony, B. W. 2010. Ranked Risk Assessment for Bycatch in Multiple Fisheries: a Bioregional Risk Assessment Method. Fisheries Research Report No. 212. Department of Fisheries, Western Australia. 88pp.

FISHERIES
Shark Bay Prawn and Scallop Managed Fisheries Status Report

Main Features

Status		Current Landings	
Stock level		King Prawns	1122 t
Prawn	Acceptable	Tiger Prawns	423 t
Scallop	Acceptable	Endeavour Prawns	<1 t
Fishing level		Scallops	1592 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 and real time management to maximise economic efficiency and ensure sustainability.

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). These diagrams outline the boundaries of the two fisheries plus all the closures (both temporary and permanent) and the areas trawled in the 2010 season.

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. The prawn 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, B class boats in the scallop fishery, is 432 fathoms (790 metres). The total headrope net capacity for the scallop fleet is 196 fathoms (358.4 metres). The scallop 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 because they fish with small size mesh codends. Scallop boats have larger 100 mm mesh codends resulting in only a small amount of bycatch being taken during trawl operations and therefore do not require the secondary devices.

The Australian Government's Environment Agency, currently called SEWPaC,has assessed the fisheries under the provisions of the EPBC 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 ESD assessment of these fisheries found that the only potential sustainability risks requiring direct management actions to ensure acceptable performance 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 the major real time component 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.

Determining 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 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* (see also New management initiatives section). A separate review of the catch share was completed by an independent working group in November 2010 that recommended that from 2011 the Department adopt a formal objective of sharing the annual scallop catch between Class A and Class B.

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 catch large, good quality prawns to optimise market value 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 2010, the prawn season opened on 10 March and closed on 21 October providing a total of 180 nights fishing. During the season the fishing strategy involved flexible 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, in some years there may be a need to assess meat size and condition before the season commences to meet these criteria. To ensure that sufficient stock remains for spawning, the fishing arrangements provide a threshold catch rate for the cessation of scallop fishing.

The 2010 scallop season officially opened on 10 March with fishing beginning in the northern part of Shark Bay for A and B class boats. Scallop fishing ceased in the northern part of Shark Bay and both the A and B class boats moving to Denham Sound on 20 March and remaining there until 0800 hrs 6 April, when scallop fishing ceased in Shark Bay for the spawning period. The B class scallop boats continued to retain scallops from August after the key spawning period and scallop fishing ceased late August for the 2010 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 catch rate 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.

Shark Bay is separated into two sectors, northern Shark Bay (Red Cliff and North West Peron) and Denham Sound for both prawn and scallops. Logbook catch and effort data and survey data is analysed separately for each sector of the fishery because the stocks within these sectors appear to have little connectivity.

A 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 2011.

Retained Species

Commercial production (season 2010)

Prawns	**1,545 tonnes**
Scallops	**1,592 tonnes (whole weight)**

Landings

Prawns

The total (whole weight) landings of major prawn species for this fishery was 1545 tonnes, comprising 1122 tonnes of king prawns, 423 tonnes of tiger prawns, less than 1 tonne of endeavour prawns (Shark Bay Prawn and Scallop Figure 3). In addition, 106 t of coral prawns (various species, but mainly *Metapenaeopsiscrassissima*) were landed. These total landings were significantly higher than the previous three seasons, higher than the interim range set in 2009 (950 – 1450 t) but within the historical target catch range (1501 to 2330 tonnes).

King prawn landings (1122 t) were within the target catch range (1100 to 1600 tonnes). The more recent 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 2010, there was an effort increase and an associated increase in total catch compared to the 2006 to 2009 fishing seasons.

Tiger prawn landings were within the target catch range (400-700 tonnes) with the average catch over the last 15 years (1995-2009) being 540 tonnes. The total landings for 2010 season were within the current target level mainly because of the increased abundance of both king and tiger prawns (higher recruitment indices) and increased effort on king prawns. The target total catch levels are still being reviewed to reflect current fishing/targeting strategies and effort levels.

Scallops

The total scallop landings for this fishery, which includes the catch from both A and B class scallop boats, was 1592 t (whole weight) (Shark Bay Prawn and Scallop Figure 4). A class boats landed 1116 t (70%) and the B class boats landed 476 t. The 2009 scallop survey provided a catch prediction of 1495 t of scallop (whole weight) for the entire Shark Bay scallop fishery. The total scallops taken from northern Shark Bay (Red Cliff and North West Peron areas) were 666 t. The Denham Sound area provided the majority of scallop catch in Shark Bay for the 2010 season. The total scallop taken from Denham Sound was 926 t. Denham Sound has provided consistent catches since 2002. No fishing was undertaken in "the Leads" area this season.

By-product

By-product landings from the prawn fishery included 338 t of blue swimmer crab (*Portunus pelagicus*), 2 t of coral crabs (*Charybdis feriata*), 45 t of squid, 29 t of cuttlefish, 13 t of bugs (*Thenus orientalis*), < 1 t of octopus, 1t of mulloway (*Argyrosomus hololepidotus*), and < 1 t of other finfish species.

The retention of blue swimmer crabs by the prawn boats increased compared to the 2009 season (255t) and is the highest total catch recorded. The blue swimmer crab resource provides valuable cash flow in response to declining profit in this prawn fishery. The prawn sector has developed a market for crabmeat, which is a value added component for by-product.

By-product landings for the A class boats in the scallop fishery included 2 t of blue swimmer crabs (*P. pelagicus*), and < 1 tonne of bugs (*T. 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 2010, towing quad gear (4 x 5.5-fathom nets). This was accompanied by a reduction of total headrope length used of approximately 8% from 432 fathoms to 396 fathoms.

The mean annual total effort recorded historically by 27 prawn boats between 1990 and 2004 inclusive is 44,864 hours (prior to 1990, the fleet consisted of 35 boats). 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 18 quad boats with the 2010 adjusted effort being 40,828 hours (twin-gear equivalent effort). This adjusted effort is slightly higher than last year and the highest in five years but well below the mean effort between 1990 and 2004. The fleet fished 174 nights of the allocated 180 nights during the 2010 season.

For the scallop fishery, the nominal effort recorded by the 14 A Class boats in 2010 was 4,785 hours with 2,393 hours in northern Shark Bay and 2392 hours in Denham Sound (Table 4). Fishing effort in the main fishing grounds was lower in 2010 compared to 2009 (9,871 hours). The effort is standardised as all boats tow 7 fathom headrope nets. The A class fleet fished 11 days in northern Shark Bay and 17 days in Denham Sound for a total of 28 days.

Recreational component: Nil

Stock Assessment

Assessment complete: **Yes**

Assessment method and level:

Level 4 - 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 catch rate levels of tiger prawn spawning stock levels from logbook data. The conservative tiger prawn threshold catch rate levels are in place to maintain spawning 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 to obtain information regarding abundance and size structure of prawns. Historically, fishing occurred in these grounds from 1 March and commercial catch rate information provided information on recruitment trends, however since late 1990s, no fishing occurs in these areas early in the season so fishery-independent surveys are required to measure recruitment strength The information is also used to determine the extent of areas to be 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. . Additional surveys were carried out in May and June 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 27.5 kg/hr (for adjusted effort equivalent to twin gear units) for king prawns observed in 2010 was higher than last year's rate of 23.7 kg/hr. This indicates that the fishery is healthy and fished efficiently as there are only four years above this catch rate since the mid 1970's. The 2010 tiger prawn overall catch rate of 10.3 kg/hr was a significant increase compared to 2009 (7.7 kg/hr) and within 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. The catch rate was difficult to assess due to the sporadic fishing effort by boats in the TPSA. Although there is a need to monitor the tiger prawn spawning area prior to the closure for catch rate and its subsequent closure, an understanding of the harvesting strategy i.e. timing of the opening of this area and fishing effort directed onto tiger prawns in the southern part of the eastern fishery and the recruitment strength is also considered for the closure date of the TPSA. The tiger prawn catch rates in the fishing area directly south of the TPSA were deemed adequate to allow fishing to continue into June. Some of the king prawn breeding stock is also protected by this closure and their catch rates are also recorded during the surveys.

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.

Two standard spawning stock surveys are generally undertaken around the third moon phase in July and August, in the Tiger Prawn Spawning Area (TPSA). However, because the survey is based on the lunar phase, the months in which the survey is undertaken can be vary from late June or July to early July or August.

An additional survey was undertaken in May and the mean tiger prawn catch rate was 36.7 kg/hr and the king prawn catch rate 15.9 kg/hr. The tiger prawn catch rate obtained from the May survey was higher than the threshold and therefore it was deemed appropriate to close the TPSA when the moon closure commenced on 24 June. The 2010 TPSA assessment surveys were undertaken in July and August and showed that the mean tiger prawn catch rate (27.1 kg/hr with 22.3 in July and 32.0 kg/hr in August) was within the threshold range.

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 occurs in July/August each year, which gives protection to these smaller prawns early in the season allowing a higher spawning biomass in this region.

The survey results showed that catch rates for both tiger and king prawns increased from July to August indicating migration into the area in the latter part of the season. In consultation with prawn licensees, it was decided to re-open the TPSA during October (the last fishing period for the season) and limited fishing in this area to three nights. The mean catch rates of tiger and king prawns were 16 and 8 kg/hr respectively for the three nights, well below the catch rates observed during the spawning closure. This suggests that the spawning stock migrates though the area during the key spawning period and, therefore, it is important that the area is closed at the required threshold catch rate and should remain closed for the remainder of the fishing season.

Fishery-independent recruitment survey 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 and was reflected in the improved catches in 2010. The recruitment of tiger prawns increased in 2010 even though the tiger prawn overall catch rate in 2009 (7.7 kg/hr) was

below target highlights the conservative nature of the current threshold. 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 low market prices received 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 2010, the breeding stock indicator for tiger prawns was met showing adequate breeding stock levels. The surveys in July and August indicated a mean catch rate in the TPSA that was within the target range. The king prawn annual landings were within the target range.

Scallops

Shark Bay is separated into two sectors, northern Shark Bay and Denham Sound, and can have different 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 the forthcoming seasons recruits.

The catch rate of 46.6 kg/hr from A class boats (based on scallop meat weight which is 20% of the whole scallop weight) indicates maintenance of a catch rate similar to 2009. For the last four years the fishing regime has focussed on fishing pre-spawning scallops and fishing to a threshold catch rate. This was done in consultation with industry to enhance 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 for an adequate spawning stock.

The scallop survey is undertaken for the main fishing grounds, northern Shark Bay and Denham Sound. The survey design and analysis of the data provides a catch forecast for 2010.The survey showed low residual scallop abundance remaining at the end of the 2009 season (the lowest observed in since 2003). Therefore, provided little carry over of residual stock into the 2010 season although there appeared to be a moderately successful spawning during 2009 because of the number of recruits in the fishery and due to the low numbers of residual scallops they will only contribute a low proportion of the catch in 2010 and will likely provide even less breeding stock.

Fishing for scallops ceased at the appropriate catch rate level in May leaving adequate breeding stock. However, the take of scallops in the latter part of the season (post spawning) appears to have depleted the residual stock to a low level. Fishing for scallops in Denham Sound was undertaken during night- time, 1700 hrs to 0800 hrs the following day, for both fleets and was a direct contrast to previous seasons when fishing operations were undertaken during day-time by the scallop boats only.

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 2010 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 northern Shark Bay and in 450 kg boat /night in Denham Sound 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 current levels are deemed adequate to provide recruitment in the acceptable range given 'normal' environmental conditions. It is considered that these cut-off catch rates be trialled for a further two years to determine if this level ensures an adequate breeding stock. Also the fishing strategy has aimed at 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.

Projected scallop catch next season (2011):

1340 tonnes (whole weight)

The catch projection for the 2011 season is based on the 2010 survey results. In northern Shark Bay, recruitment was slightly higher than the previous season but lower than the previous three years, but with a low abundance of residuals. This resulted in a catch forecast for this area of approximately 1340 t whole weight, a reduction compared to last year's forecast of 1735 t. In Denham Sound residual scallops were extremely low with recruitment being moderate. The survey index provided a prediction of 31 t whole weight. Because of the low catch prediction in this part of the fishery it was advised by Research Division that no commercial fishing be undertaken in 2011 so that the spawning stock is protected. The prediction for the 2011 season is based on the scallops in northern Shark Bay and most of the catch will be derived from recruits. The catch projection for the fishery as a whole is therefore 1340 t whole weight with a range of 1070 -1600 t whole weight. The size of the recruits were smaller than usual indicating a late recruitment and this will influence the timing of the opening of the scallop fishery in 2011.

These predictions are based on catch trends involving 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 2011 which, provides a total of five years of data with the new fishing strategies, the minimum needed for such an analysis and will also incorporate a spatial catch, catch rate 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 crustacean species are also taken in significant quantities but are generally returned to the seas alive. Overall bycatch taken in trawl nets are moderate relative to other subtropical trawl fisheries at about 4–8 times the prawn catch. 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. A comprehensive research survey found no significant difference in invertebrate or finfish abundance or diversity between trawled and untrawled areas.

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.

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 and other fauna is minimal.

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 2010 season, 2 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, 1 turtle was reported as being taken in scallop nets and was reported as released 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. The total area inside Shark Bay, is 4652 nm2 and represents 38% of the total 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 boundaries. The permitted trawl area inside Shark Bay is 1768 nm2 and represents 38% of inner Shark Bay (excluding the closed areas) but trawling does not occur across this whole region. 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) but actual trawling occurs in a much smaller area than this. 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 2010 the performance measure was met as the total area trawled within inner Shark Bay by the prawn fleet was approximately 856 square nautical miles or 18% of inner Shark Bay and the scallop area trawled was approximately 314 square nautical miles or 7% of the inner Shark Bay.

Social Effects

These industries are a major contributor to regional employment During 2010, approximately 150 skippers and other crew were employed in the prawn fishery. There are also approximately 100 processing and support staff directly employed at Carnarvon. Nor West Seafood is based in Carnarvon with administration, wharf and engineering staff based at the small boat harbour and a processing factory at Babbage Island. Approximately 70% of their work force is permanent. The prawn sector also utilises, wherever possible, Western Australian service companies providing engineering supplies, packaging, transport logistics, ship stores and fuel. For the scallop sector approximately 100 sippers and other crew are employed for the relatively short period in the region with support staff in Geraldton and Fremantle.

Economic Effects

Estimated annual value of major prawn and scallop for year 2010:

Prawns	**$16.8 million**
Scallops	**$6.5 million**

Estimated value of the fishery to the prawn sector

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: The value of the fishery including crabs, coral prawns, scallops, squid and bugs to the prawn sector is $20.5 million.

The estimated value of the scallop only sector is $4.5 million

King prawns	$10.36/kg
Tiger prawns	$12.33/kg
Coral prawns	$3.00/kg
Scallops	4.05/kg
Crabs	$4.50/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.

The focus by industry is now to target larger size prawns, the resulting effort shift has reduced expected total landings to around the 950 to 1450 t under normal environmental conditions compared to historical catch ranges. In 2010 the catch has returned to be with the historical overall catch range so the interim range will be reviewed over the next two–three years and a new target catch range developed for the combined prawn catch and the target species.

The scallop target catch range 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 4), apparently created by an unprecedented four years of El Niño conditions.

The projected catch for next season (1340 t) whole weight, based on a pre-season survey, is within the target catch range.

New management initiatives (2011)

Implementation of a fixed 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 higher catch rate periods) and to target larger prawns and to shift the emphasis on domestic markets rather than the export market. The reduction in prawn boat numbers has added cost to licensees because of the repayment of the Voluntary Fisheries Adjustment Scheme for the B Class operators but should result in higher catches and catch rates for the boats remaining.

The catches of prawns in Shark Bay are relatively stable compared with other Penaeid prawn 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. There have been two significant flooding events in Shark Bay, December 2010 and February 2011, that are probably associated with the strong La Niña event in late 2010 and early 2011 that could have a significant effect on the prawn fishery. The La Niña is also associated with a strong Leeuwin Current and warm water temperatures.

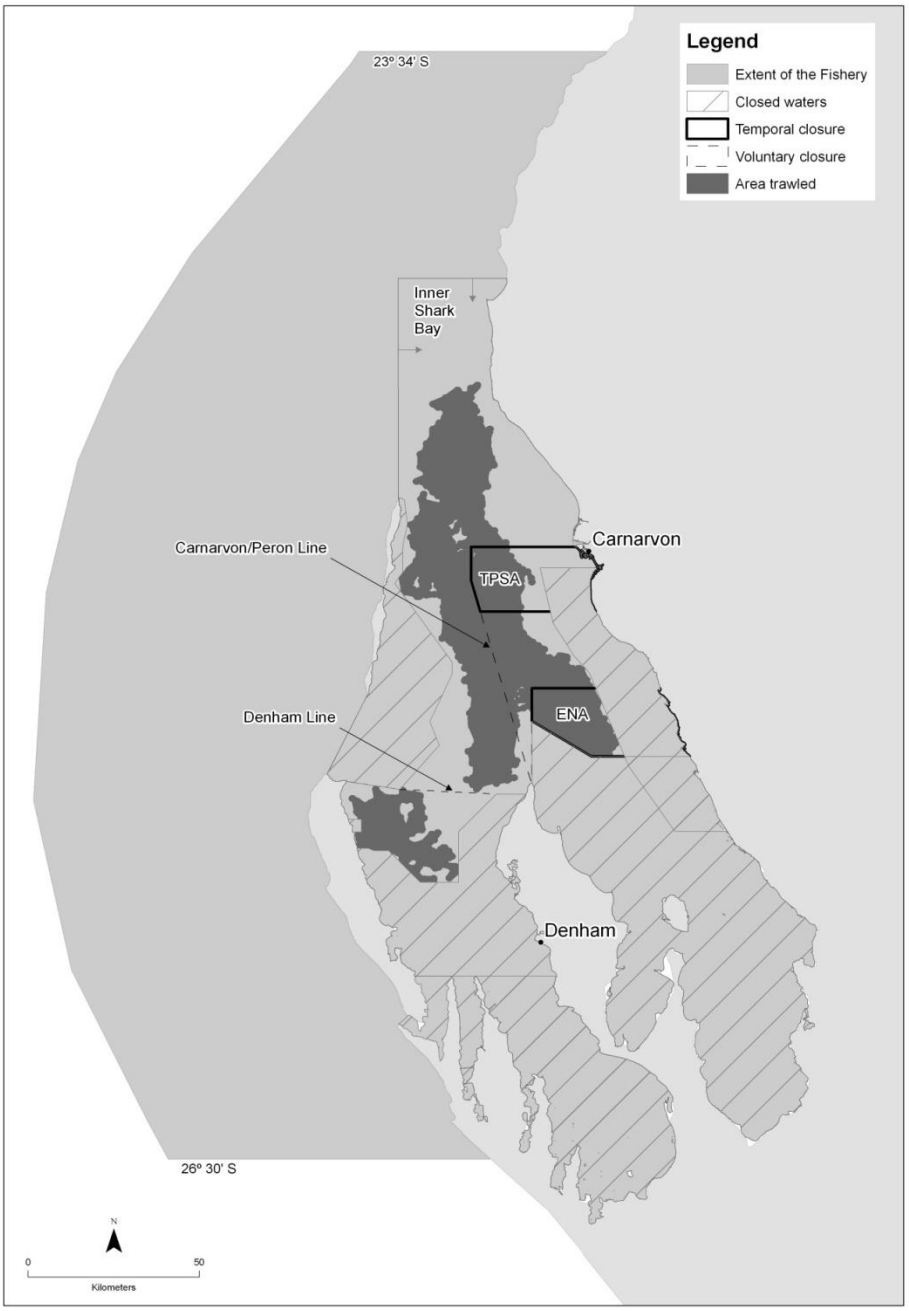
A relationship exists between sea level (at Fremantle) and the

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 strong La Niña conditions have generally resulted in below-average scallop recruitment.

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.

Contributors

E. Sporer, M. Kangas, S. Brown and R. Gould.



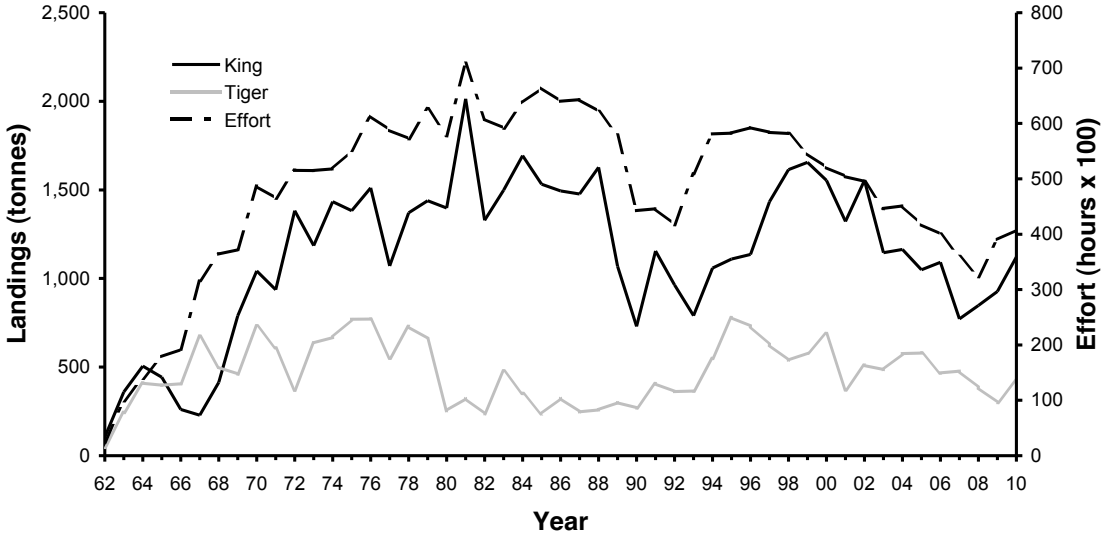
SHARK BAY PRAWN AND SCALLOP FIGURE 1

The main boundaries of the Shark Bay Prawn Fishery, Inner Shark Bay, TPSA, ENA, trawl closures, permitted trawl area (extends out to the 200m isobath) and area trawled in 2010.



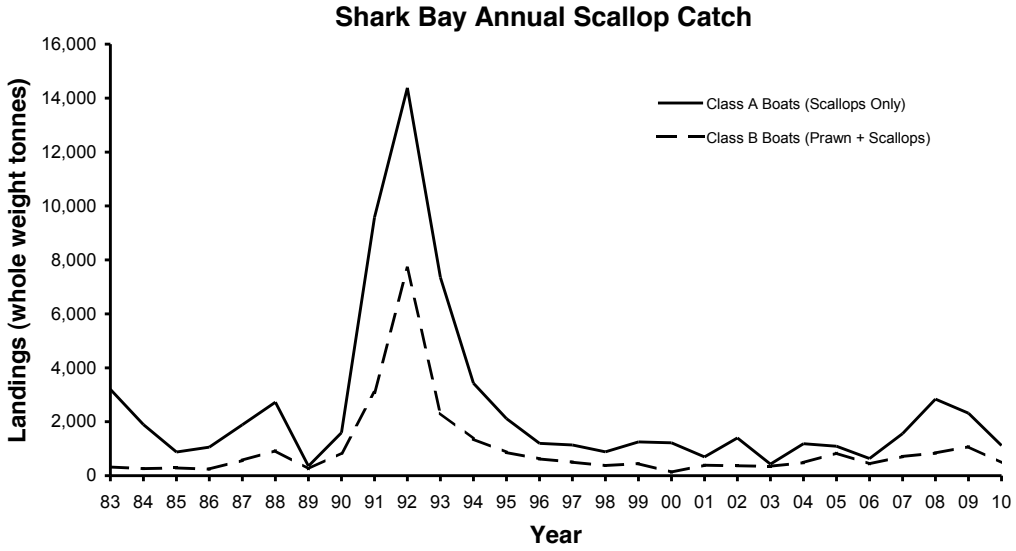
SHARK BAY PRAWN AND SCALLOP FIGURE 2

The main boundaries of the Shark Bay Scallop Fishery, permitted trawl area (extends out to the 200m isobath) and area trawled in 2010.



SHARK BAY PRAWN AND SCALLOP FIGURE 3

Shark Bay Prawn Managed Fishery annual landings and effort (adjusted to twin gear units) 1962 – 2010.



SHARK BAY PRAWN AND SCALLOP FIGURE 4

Shark Bay Scallop Managed Fishery annual landings 1983 – 2010.

Exmouth Gulf Prawn Managed Fishery Status Report

Main Features

Status		Current prawn Landings	
Stock level	Acceptable	Tiger	388 t
		Kings	254 t
Fishing level	Acceptable	Endeavours	138 t

Fishery Description

The Exmouth Gulf Prawn Managed Fishery uses low opening, otter prawn trawl systems within the sheltered waters of Exmouth Gulf to target western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*). This limited entry fishery uses sophisticated real time management to maximise the economic efficiency and ensure ecological sustainability.

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 who jointly decide on the timing and extent of areas to be fished or closed, according to size and abundance of prawns.

Boundaries

The main boundaries for the Exmouth Gulf Prawn Managed Fishery are shown in Exmouth Gulf Figure 1. This diagram outlines the extent of fishery boundaries, the areas where trawling is permitted, the areas actually trawled in 2010, the Tiger Prawn Spawning Area (TPSA) which is closed for part of the season, and the areas always closed to trawling.

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. This sophisticated set of management arrangements is designed to keep fishing effort at levels that will maintain a 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.

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 boats currently operating under an exemption 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 while still maintaining overall catch and ensuring ongoing stock sustainability.

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 2010 season, official opening and closing dates were formally set at 22 March and 20 November respectively, providing a maximum of 211 nights for fishing. The season actually commenced on 20 April, based on results from pre-season surveys and it closed at 0800 hrs on 17 November. 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 for tiger prawns 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. Together with these 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 lowered from 25 kg/hr to 19 kg/hr and fishing ceases in the southern part of the gulf on the tiger prawn stock at this catch rate level. Furthermore, fishing ceases in the northern part of the gulf according to the size of king prawns and/or an agreed catch rate threshold. When this occurs the fishing season is closed.

Bycatch reduction devices (BRDs) are utilised in this fishery, with all boats required, by a condition on the managed fishery licences, to fish with a 'grid' and a secondary, fish escapement device (FED) fitted in each net. Industry, in association with the Department, successfully gained certification from the US Department of State in 2008 of its BRD-compliancy, in for potential turtle captures. This certification allows licensees to export product to the US market. Since 2002 industry has also used 'hopper' in-water sorting systems, which, provide an improved quality of prawns and reduced mortality for some bycatch species.

The Australian Govt. Department, currently called SEWPaC, assessed the fishery in 2008 as being sustainable under the provisions of the EPBC Act 1999. This has provided the export accreditation the fishery for a period of five years. The comprehensive ESD assessment of this fishery identified the only risks that required specific management actions to ensure adequate performance were the breeding stock levels of target prawn species, bycatch species impacts, habitat and provisioning effects. 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). An annual catch prediction for tiger prawns is also provided using an index derived from the recruitment survey data. Monitoring of fishing activity is undertaken in real time and using threshold catch rates to determine the specific timing of the closure of the tiger prawn spawning area. All boats complete detailed daily logbooks, which, together with survey data and factory catch unload records, provide a major source of information 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 2010):

779 tonnes

Landings

The total landings of major penaeids for the 2010 season were 779 t, comprising 254 t of king prawns, 388 t of tiger prawns and 138 t of endeavour prawns and less than 1 t of banana prawns. This was lower than the previous year's catch of 828 t, mainly due to a slight reduction in tiger prawns and continued low king prawn landings. 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 again under the target catch range of 350–500 t.

Recorded landings of by-product included 18 t of coral prawns, 17 t of squid, 2 t of octopus, 16 t of blue swimmer crab (Portunus pelagicus) and 2 t of Moreton Bay bugs (Thenus orientalis).

The size of crabs retained by the prawn trawl boats is standardised by the use of a gauge that measures the body of the crab at 115 mm. This measurement is approximately 137 mm spine to spine, 10mm above the recreational legal size limit.

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 2010 towing a total of 206 fathoms of net headrope. There were two differing net headrope sizes used (5.5, and 6 fathoms) as 5 boats, although entitled to use them, are not suitable to tow 6-fathom headrope nets.

Total nominal fishing effort for the 2010 season was 16,605 hours. The adjusted effort was 25,787 hours, which has remained relatively constant since the fleet boat numbers was reduced from 12 to 9 boats in 2007. The fleet fished 169 nights during the 2010 season. The annual landings were relatively low, effort focused on tiger prawns to ensure that this species was exploited to their potential this season. The king prawn abundance was low and fishing for this species ceased when catches were too low to provide adequate returns. Therefore, the overall effort for the 2010 season was at the level expected for the total catch taken.

Stock Assessment

Assessment complete: **Yes**

Assessment method and Level:

Level 4 - Direct survey/catch rate

Breeding stock levels: **Adequate**

Projected catch next season (2011):

600 (480-720) tonnes tiger prawns

The standardised catch per unit effort data from the fishery is an indicator of abundance, and 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 recruitment and breeding stock surveys.

Catch assessment

The adjusted catch rate 9.8 per kg/hr, for king prawns is slightly below the reference catch rate level of 11.7 kg/hr. The lower king prawn catches may in part be due to lower overall effort on king prawns at the start of the season. The season commenced later than normal and the effort was focused on tiger prawns in the early part of the season and areas of small prawns were closed to fishing, for both king and tiger prawns, in the early part of the season to ensure that size and quality was maintained.

The season ceased according to the agreed minimum king prawn size protocol. The assessment used to initiate closure of the fishery includes the king prawns size composition and catch rates. When the daily size composition is approximately 23 to 25 per pound, or if more than 50% of the daily catches are between 21-30 and greater than 31 count per pound, and particularly if the king prawn catch rate is low(between 15 and 25 kg/hr), the fishery is closed. For the 2010 season the king prawn catch rates were very low (between 5 and 10 kg/hr) in November and this may be an indication that fishing the spawning stock to less than desirable level occurred during the key spawning period. In view of this it has been agreed that the king prawn stock in the northern part of the fishery should be monitored more vigilantly in the latter part of the season and fishing should cease on these prawns at a higher catch rate (between 15 and 25 kg/hr) than in 2010. The catch rate of 15 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 5.3 kg/hr, similar to the reference point catch rate of 5.6 kg/hr. This catch rate may not represent the endeavour prawns abundance as they are not targeted because of the low value compared the king and tiger prawns.

Survey assessment

For tiger prawns, the assessment 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 2010 season the total landings were above the catch prediction but within the prediction range, based on recruitment survey indices (335 t with a range of 268t to 402 t). 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 2010, tiger prawn catch rates were monitored from May to August and the tiger prawn grounds closed on 25 July. Three standardised tiger prawn breeding stock surveys carried out from August to October with an average CPUE of 36.6 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 26.3 kg/hr, 44.0 kg/hr and 39.6 kg/hr respectively. The tiger prawn spawning area (Area B) was re-opened for fishing on 18 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 (38.5 kg/hr) than in Q1.

King prawn breeding stock levels in the fishery appear to be 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. However, in eight of the years since 2000, king prawn catches have been below the target catch range and therefore it is considered that a review of spawning stock levels is required. The variability in the abundance of the king prawn stock has been assessed since 2002 by a pre-season recruitment survey, However, no spawning stock abundance estimate is derived as there are currently no independent fisheries surveys to monitor the spawning stock. It is considered there needs to be a review of the number of surveys needed to provide indices of recruitment, and to obtain the catch rate levels (including spawning stock abundance), used for the cease fishing protocol applied in the latter part of the season.

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 considered to be more resilient to fishing pressure due to their smaller size and lower catchability, which is similar to king prawns.

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 2011 is 480 to 720 tonnes.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2010 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. An assessment for the cessation of fishing at a threshold level to be established. 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 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 2010 was slightly lower than 2009.

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.

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 in all nets in 2005. Five green turtles were reported as being caught in nets and returned alive during 2010.

Ecosystem Effects

Food chain effects: **Low**

Although the prawn species are managed so 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 2010 the performance measure was met as the total area trawled, at approximately 340 square nautical miles (30%) per cent of Exmouth Gulf, was below the 40% level.

Social Effects

The estimated employment in the fishery for the year 2010 was 27 including skippers and other 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 contributing to the economic viability of the Exmouth township.

Economic Effects

Estimated annual value of major prawns for year 2010: **$8.0 million**

Ex-vessel prices for prawns vary, depending on the type and quality 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 company which, own the boats undertaking direct marketing of the product into overseas markets. For this reason, the product prices quoted for prawns can only be estimates, however prices are likely to be similar to those received for product from Shark Bay Prawn Managed Fishery. The estimated value of the fishery includes byproduct ($8.3 million). Estimated prices for prawns were as follows:

King prawns	$11.00/kg
Tiger prawns	$11.50/kg
Endeavour prawns	$5.50/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 2010 season. The catch range for king prawns

may need to be reviewed and adjusted for the lower effort applied in this fishery in recent years.

New management initiatives (2011): Nil

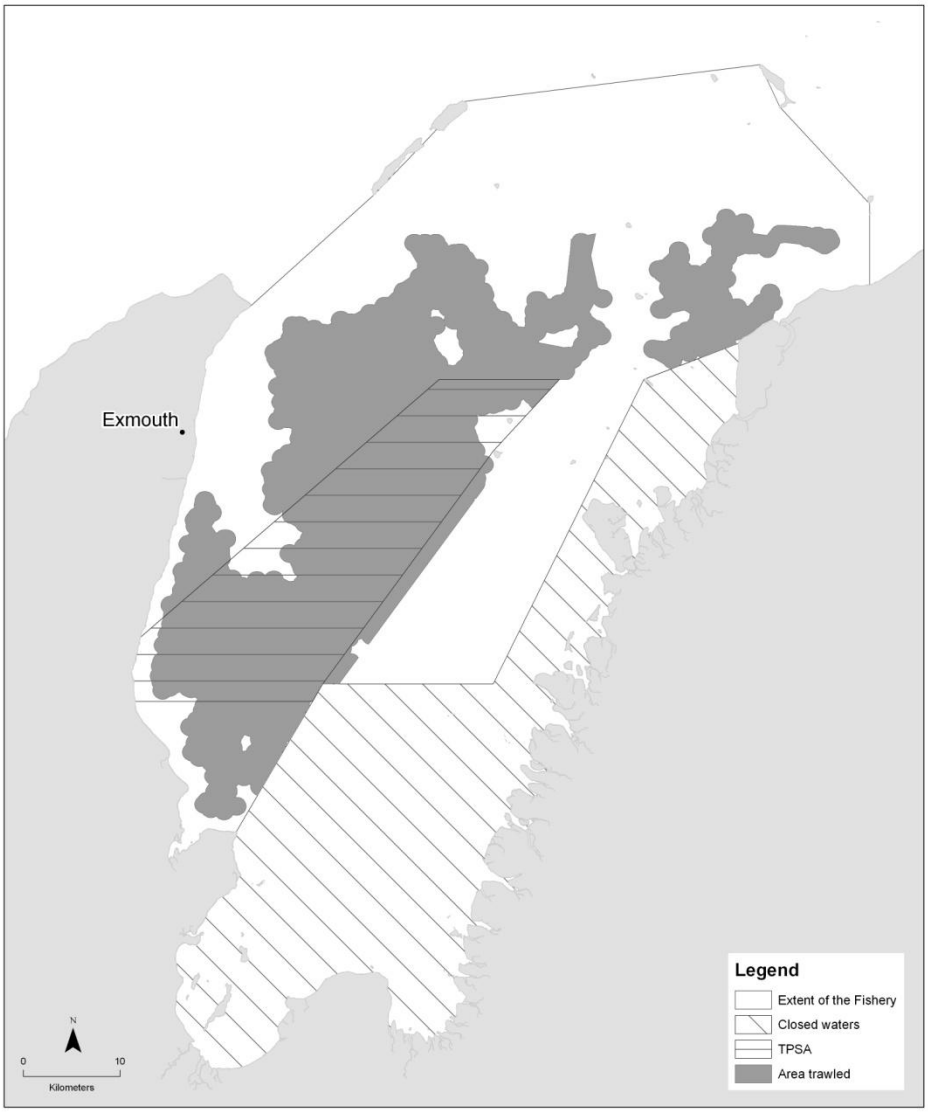
External Factors

High costs of fishing and lower returns, due to the current economic climate and competition from imported and locally aquacultured small prawns, has required focussing management and harvesting practices on reducing costs (i.e. only fish efficient catch periods),to targeting larger prawns and shifting the emphasis to domestic markets rather than previous 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 January) cyclones can have a negative impact (high mortality) on small size prawns in the shallow nursery areas. The positive effect is that the water becomes turbid and prawn mortality reduces and prawns are triggered to move out into the trawl grounds. It is considered likely that there will be other environmental factors, yet to be fully investigated, that will affect the spawning stock – recruitment relationship.

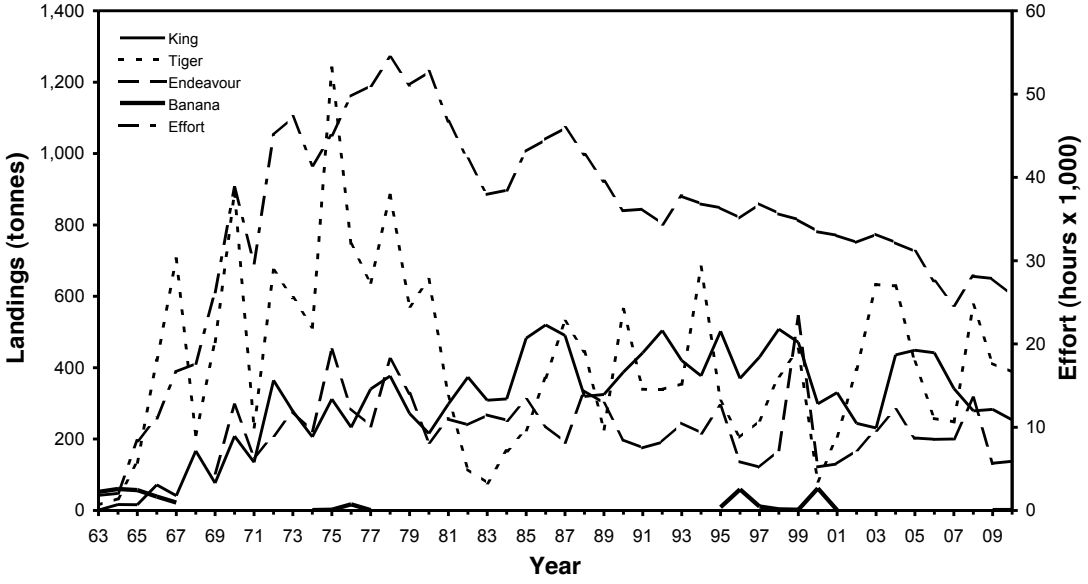
Contributors

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EXMOUTH GULF PRAWN FIGURE 1

The main boundaries of the Exmouth Gulf Prawn Fishery, extent of fishery closed waters, TPSA (Q1 and Q2), and area trawled in 2010.



EXMOUTH GULF PRAWN FIGURE 2

Exmouth Gulf Prawn Managed Fishery annual landings and adjusted effort (twin-gear), 1963 – 2010.

Gascoyne Demersal Scalefish Fishery Status Report

Main Features

Status		Current Landings (2010)	
Stock level		Pink snapper:	
Pink snapper	Recovering	Commercial	263 t
Goldband snapper	Adequate	Recreational	ca. 50 t
Spangled emperor	Adequate	Charter	13 t
Fishing Level		Goldband snapper:	
Pink snapper	Acceptable	Commercial	105 t
Goldband snapper	Acceptable	Recreational	ca. 15 t
Spangled emperor		Charter	7 t
North Gascoyne	Unacceptable		
South Gascoyne	Acceptable	Spangled emperor:	
		Commercial	4 t
		Recreational	ca. 50 t
		Charter	5 t

Fishery Description

The Gascoyne Demersal Scalefish Fishery encompasses commercial and recreational (line) fishing for demersal scalefish in the continental shelf waters of the Gascoyne Coast Bioregion (Gascoyne Demersal Scalefish Fishery Figure 1).

Since November 2010, the Gascoyne Demersal Scalefish Managed Fishery (GDSF) now incorporates vessels that previously operated as the Shark Bay Snapper Managed Fishery (SBSF) plus a limited number of open-access wetline vessels, along with recreational fishing from both licensed charter and private vessels.

Commercial vessels in these waters historically focussed on the oceanic stock of pink snapper (*Pagrus auratus*) during the winter months. The GDSF licensed vessels fish throughout the year with mechanised handlines and, in addition to pink snapper, catch a range of other demersal species including goldband snapper (*Pristipomoides* spp., mainly *P. multidens*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, includes spangled emperor, *Lethrinus nebulosus*, and redthroat emperor, *L. miniatus*), cods (Serranidae), ruby snapper (*Etelis carbunculus*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicus*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).

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) to catch a similar range of demersal species.

Governing legislation/fishing authority

Commercial

Gascoyne Demersal Scalefish Management Plan 2010

Gascoyne Demersal Scalefish Managed Fishery Licence

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

Recreational Fishing from a Boat Licence

Consultation process

Commercial

Department–industry meetings

Recreational

The consultation process is now facilitated by Recfishwest although the Department continues to undertake direct consultation with the community on specific issues.

Boundaries

Commercial

The GDSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°07'30"S and 26°30'S (Gascoyne Demersal Scalefish Fishery Figure 1). GSDF vessels are not permitted to fish in inner Shark Bay. No state-licensed commercial vessels are permitted to fish between 21°56' and 23°07'30"S ('Point Maud-Tantabiddi Well' closure). Management arrangements for the West Coast Demersal Scalefish Fishery (WCDSF) permit a limited number of commercial vessels to operate in waters up to the southern boundary of the GDSF (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

The Gascoyne Demersal Scalefish Management Plan 2010 (the Plan) was implemented on 1 November 2010. The Plan superseded the Shark Bay Snapper Management Plan 1994 and provides a more effective management framework for the sustainable use of demersal scalefish stocks in the Gascoyne Coast Bioregion.

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 onwards, the SBSF was quota-managed (pink snapper only) 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 5,102 units (previously was 5,125) in the fishery (value of one quota unit = total allowable pink snapper commercial catch [TACC] ÷ 5,102).

In response to stock assessment advice there have been a number of significant reductions in pink snapper TACC in recent years. The TACC was reduced from 563,750 kg to 338,250 kg in 2004, was further reduced to 297,250 kg in April 2007, and most recently reduced to 276,750kg, in September 2007. An EPBC assessment for the SBSF fishery was completed in 2003 and was re-assessed in 2009.

'Open-access' wetline fishing operations that were previously able to be undertaken in waters between 23°34'S and 23°07'30"S (Gascoyne Demersal Scalefish Fishery Figure 1) are now incorporated within the GDSF 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 lengths apply to many of the commercial target species (e.g. pink snapper, red emperor and emperors).

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. Since 2 March 2010, all persons fishing from a powered boat anywhere in the state have been required to hold a Recreational Fishing from Boat Licence or fish in the company of a licence holder.

Research summary

Catch and effort monitoring for this fishery includes analyses of commercial (daily/trip returns for GDSF licensed vessels; monthly returns for 'open access' vessels) and charter catch and effort (monthly) returns and catch-disposal records (SBSF, apply to 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. Noting that the GDSF did not come into operation until 1st Nov 2010, commercial catches here are those reported for the period of the (final) SBSF quota-year, i.e. September 1 2009 - August 31 2010 (referred to hereon as the 'season 2010'). Charter catches are reported for the period January – December 2010. The most recent survey of boat-based recreational fishing within the Gascoyne Coast Bioregion was undertaken between April 2007 and March 2008 (this equates to the commercial 'season 2007').

Research undertaken by the Department of Fisheries on scalefish in each Bioregion is now focussed on selected indicator species. These indicators are taken to be representative of the inshore demersal (20-250 m) and offshore demersal suites (>250 m) and were identified using a risk-based approach based on the vulnerability of the species/stock to fishing (Anon 2011[1]).

In the Gascoyne Coast Bioregion, pink snapper, goldband snapper and spangled emperor (*Lethrinus nebulosus*) were selected as the indicator species for the inshore demersal suite.

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; this project is now being completed and results will be available in late 2011.

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 externally reviewed. Monitoring of commercial catches and age structure is continuing and further research is planned to

1 Anon 2011 Resource Assessment Framework (RAF) for Finfish Resources in Western Australia. Fisheries Ocassional Publication No. 85, Department of Fisheries, Perth.

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 externally reviewed. Limited monitoring of recreational catches landed at fishing tournaments in the bioregion is on-going.

Retained Species

Commercial landings (season 2010):

	Total 477 tonnes
Pink snapper	**263 tonnes**
Goldband snapper	**105 tonnes**
Spangled emperor	**4 tonnes**
Other species	**105 tonnes**

The total commercial catch of 477 t taken in the Gascoyne Coast Bioregion in 2010 included 263 t of pink snapper (oceanic stock), plus 213 t of other species including 105 t of goldband snapper, 4 t of spangled emperor and 105 t of other scalefish species (Gascoyne Demersal Scalefish Table 1). This is similar to the total of 478 t taken by this fishery last season and it is also similar to that for the previous two seasons.

Of the total commercial catch, SBSF licensed vessels caught 257 t of pink snapper (TACC = 277 t) plus 123 t of other species including 53 t of goldband snapper, 4 t of spangled emperor and 66 t of other scalefish species.

Recreational catch estimate (2007/08, includes charter sector):

Pink snapper	**ca. 70 tonnes**
Goldband snapper	**ca. 20 tonnes**
Spangled emperor	**ca. 50 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 2010 was 13 t (15 t in 2009, 22 t 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 2010 was 5 t (similar to 2009 and 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 2010 was 7 t (8 t in 2009, 9 t in 2008).

Fishing effort/access level

Commercial

SBSF licensed vessels landed 80% of the total commercial catch of demersal scalefish species in the Gascoyne Coast Bioregion (includes pink snapper) in the 2010 season. At the start of the season there were 55 licences in the SBSF with a total of 19 vessels actively participating in fishing (14 in 2009).

These vessels fished for a total of 831 days in waters between 23°34'S and 26°30'S in the period September 2009-August 2010.

The level of effort targeted at pink snapper by SBSF vessels varies on a seasonal basis, historically peaking in June–July, when the oceanic stock aggregates 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 283 boat days during June-July in 2010.

Recreational

Total recreational boat fishing effort (fisher days) across the entire Gascoyne in 2010 was assumed 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 and level:

Pink snapper

Level 5 - Composite Assessment (2009)

Level 2 - Catch Rates (annual)

Goldband snapper

Level 3 - Fishing Mortality (2010)

Spangled emperor

Level 3 - Fishing Mortality (2010)

Breeding stock levels:

Pink snapper	**Recovering**
Goldband snapper	**Adequate**
Spangled emperor	**Adequate**

Pink snapper: An integrated stock assessment model was developed for this stock in 2003 which indicated that the spawning biomass of the oceanic stock was at a depleted level (< target level in 2002-2003). The most recent assessment using this method (2009) indicated that the spawning biomass in 2008 was now 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 around 2014. The next assessment is currently 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 stock during the winter spawning period.

This indicator was used in the original EPBC Act assessment of the SBSF with an inaugural trigger level set at a minimum of 500 kg pink snapper/standard boat day. The pink snapper catch rate in 2010 (SBSF licensed vessels fishing in June–July only) increased significantly to 595 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 had a slight downwards trend through the 1990s but the early 2000s saw a clear decline reaching a low of 450 kg pink snapper/standard boat day in 2004. Since that time (TACC was reduced significantly in 2004 and reduced again in 2007), catch rates have increased to an average value of about 550 kg/day with yearly fluctuations. In 2010 the catch rate was 595 kg pink snapper/standard boat day, above the minimum trigger level (500 kg pink snapper/standard boat day).

Goldband snapper: Historical catch rate data from the SBSF were found to be uninformative for use as an index of relative abundance for this species. Several more years of daily trip logbook data (implemented in January 2008) will provide the basis of an improved time series of catch rates for examining 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. 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 so breeding stock levels and fishing level are currently assessed as adequate.

The completed 'weight of evidence' assessment has now been externally reviewed and will be made available as a Fisheries Research Report in late 2011.

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, was used based on data collected primarily in 2007. Estimates of fishing mortality (F) indicated that in the South Gascoyne, F was close to the target level while in the North Gascoyne, F was above the limit level, suggesting that localised over-fishing was 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 the available evidence, that the current level of fishing on the spangled emperor population in the North Gascoyne exceeds sustainable levels. The spangled emperor breeding stock is estimated to be at an acceptable level for the bioregion overall noting significant reductions in the relative numbers of older (breeding age) spangled emperor in the North Gascoyne due to localised depletions. The completed 'weight of evidence' assessment has now been externally reviewed and will be made available as a Fisheries Research Report in late 2011.

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 components of the stock are likely subject to large, mostly-environmentally driven fluctuations in abundance even in the absence of fishing, resulting in significant variability in annual recruitment strength. A recent study (Hall and Wise, 2011)[1] of finfish community structure in this bioregion found no evidence of material changes.

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 benthic habitats.

Social Effects

The pattern of fishing by SBSF vessels in 2010 was similar to previous years and reflects the focus on pink snapper during the peak season and fishing for deeper water species (e.g. goldband snapper, ruby snapper) throughout the rest of the year.

[1] Hall, N.G. & Wise, B.S. (2011) Development of an ecosystem approach to the monitoring and managmetnnof Western Australian fisheries FRDC Report 2005/063. Fisheries Research Report 215 Department of Fisheries, Western Australia. 112pp.

In 2010, 13 vessels fished for more than 10 days during the peak season with average crew of 2-3.

Fishing and associated fish processing are important sources of local employment in Denham and Carnarvon.

Shark Bay and Ningaloo are popular recreational fishing destinations and both locations are major tourist attractions especially during the winter months and school holidays.

Economic Effects

Estimated annual value (commercial sector)

(season 2010) $ 3.6 million

The overall value of the commercial component of the Gascoyne Demersal Scalefish Fishery (catch taken by SBSF and limited number of 'open-access' wetline vessels combined) was around $ 3.6 million in 2010 with $2.0 million from pink snapper and $1.6 million from all other scalefish species. 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 recreational fishing-based tourism industry and generates significant income for the regional economy.

Fishery Governance

Commercial:
Current effort level (season 2010): Acceptable

Target catch (and effort) range:

Pink snapper 277 tonnes/380-540 days

In 2010, SBSF vessels required 432 boat days to catch 257 t of pink snapper (oceanic stock, TACC = 277 t).

The average catch rate at 595 kg pink snapper/boat day for the 2010 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, likely 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 (based on data from 2007/08) indicate localised depletion of spangled emperor is occurring north of Point Maud.

New management initiatives (2010/11)

As noted previously, the GDSF Management Plan 2010 was implemented on 1 November 2010, superseding the Shark Bay Snapper Management Plan 1994. The key advantages of the Plan are that it provides the Department with the ability to better manage all demersal scalefish stocks, whereas the Shark Bay Snapper Management Plan 1994 had the legal capacity to regulate only the take of pink snapper. The Plan also incorporated the last unregulated 'open access' waters off Coral Bay resulting in all commercial line fishers in the southern Gascoyne operating under a consistent set of management arrangements.

While the first phase of the Plan has been implemented, it still only includes a formal pink snapper entitlement system (in the form of individual transferable quota) and requires a second form of entitlement to be introduced to regulate the take of other demersal scalefish. The second form of entitlement proposed is fishing effort in the form of individually transferable 'effort days'. Effort entitlement would regulate the catches of other scalefish, primarily the targeted deepwater snappers, such as goldband snapper. The two entitlements would work in combination to regulate scalefish catches, with the ability to exercise a licence being subject to holding both unexhausted pink snapper quota and unexhausted scalefish effort entitlement on the licence.

As an interim measure to protect species other than pink snapper, licence holders initiated an effort day cap to control fishing effort. 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. However, as a licence condition does not allow for temporary or permanent transfers of effort entitlement (which would provide greater flexibility for operators) a new effort entitlement system needs to be incorporated into the GDSF Management Plan.

The first "Operators' Guide to the Management Arrangements for the Gascoyne Demersal Scalefish Managed Fishery"[1] was produced. The key purpose of the document is to enhance the understanding of, and generate voluntary compliance by, commercial operators with the legislation pertaining to the GDSF. The concept behind the guide is an easy-to-read 'one stop shop' for operators to find out what the rules for the new GDSF are and where they can find specific legislation to obtain more detail. The document has been well received by industry and will likely be reviewed and re-produced annually with any updates on management arrangements included for operators.

The most recent pink snapper stock assessment indicated that the spawning biomass of the oceanic 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

1 Fisheries Occasional Paper #83, see http://www.fish.wa.gov.au/docs/op/op083/index.php?0706

arrangements in early 2012 ahead of commencement of the 2012/13 season.

A state-wide recreational boat fishing license was in introduced in March 2010. An statewide integrated survey based on the database of licensed boat fishers is now underway (commenced in January 2011) and will provide estimates of recreational catches in late 2012.

A report on the stock status of the three demersal indicator species - pink snapper, goldband snapper and spangled emperor - will be made publicly available in late 2011. The information contained in this document will used as the basis for management recommendations, to be developed in conjunction with stakeholders in 2012 onwards, as part of the IFM process in the Gascoyne.

External Factors

Under the Offshore Constitutional Settlement, commercial vessels licensed by the Commonwealth may operate in state waters outside the 200 m isobath as part of the Western Deepwater Trawl Fishery (WDWTF). In the 2008/09 season total effort in this fishery was 482 hours of trawling with ruby snapper making up the majority (28 t) of the scalefish catch (Wilson et al. [eds] 2010)[1]. Recent information on catches of pink snapper taken or returned by WDWTF vessels fishing in waters >200 m off the Gascoyne coast 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, with temperate species such as pink snapper, affecting spawning patterns and influencing their geographic distribution (latitude shift). A review of the impacts and responses to marine climate change in Australia has been undertaken by CSIRO[2].

A 3-year FRDC-funded project has recently commenced that will assess the effects of climate change on key fisheries in Western Australia. A recent collaborative study with CSIRO on management strategy evaluation for the take of spangled emperor in the Ningaloo Marine Park has modelled the potential influence of long-term increases in water temperatures and cyclone activity on the effectiveness of alternative management strategies for consideration.

Contributors

G. Jackson, R. Marriott, E. Lai and M. Stadler.

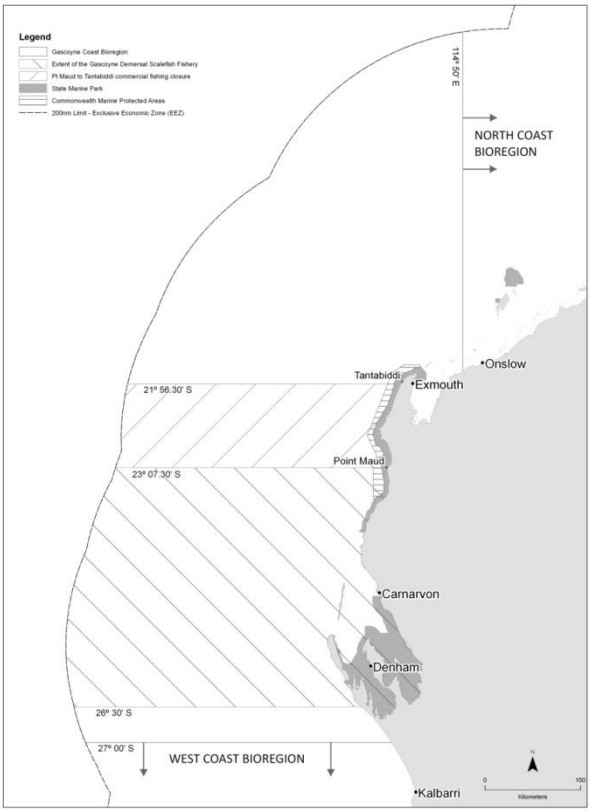
GASCOYNE DEMERSAL SCALEFISH FISHERY TABLE 1

Total commercial catches of demersal scalefish species other than pink snapper taken in Gascoyne waters between 20001/02 and 2009/10 (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	2009/10
Goldband snapper	41.6	110.0	310.7	250.4	239.8	105.8	107.2	121.1	143.8	104.6
Red emperor	24.4	21.3	18.6	21.3	18.5	19.4	17.0	12.8	11.7	9.8
Spangled emperor	40.3	23.1	20.4	15.2	13.5	18.1	7.0	7.0	3.3	3.8
other emperors	35.6	25.7	25.8	37.4	31.8	29.2	34.3	26.8	13.8	9.2
Cods	27.2	29.7	38.0	39.2	27.9	21.9	21.5	15.0	9.5	13.4
Other	89.9	85.9	90.5	95.4	82.0	78.1	77.1	65.8	64.8	72.9
Total	259.0	295.7	504.0	458.9	413.5	272.5	264.1	248.5	246.9	213.7

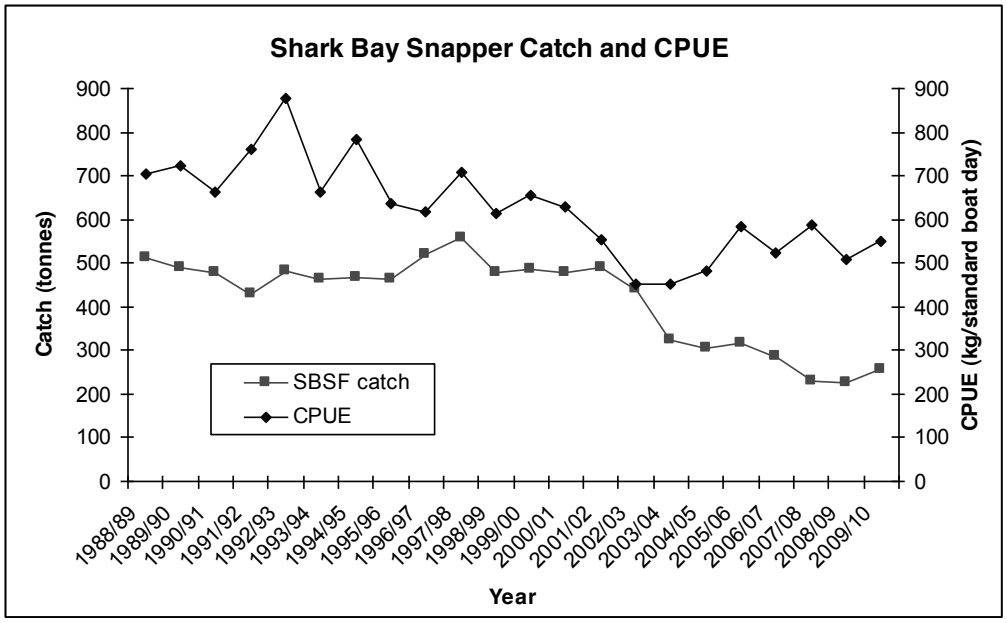
[1] Wilson DT, Curtotti R and Begg GA (eds) (2010) Fishery status reports 2009: status of fish stocks and fisheries managed by the Australian Government, Australian Bureau of Agricultural and Resource Economics - Bureau of Rural Sciences, Canberra.

[2] see www.oceanclimatechange.org.au



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 1

Waters of Gascoyne Coast Bioregion including Gascoyne Demersal Scalefish Fishery and 'Point Maud to Tantabiddi Well' fishing closure. Commercial line fishing in waters between 26°30'S and 27 °00'S has been managed as part of West Coast Demersal Scalefish Fishery since January 2008.



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 2

Catch and catch per unit effort by season from 1988/89 to 2009/10 for the SBSF. Units are kg whole weight of pink snapper per standard boat day. The CPUE for vessels line fishing for pink snapper 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

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 (2010)	
Whiting	116 t
Mullet	95 t
Tailor	16 t
Yellowfin bream	10 t
Pink snapper	<0.5 t
Recreational (2010, Pink snapper only)	
Eastern Gulf	4 t
Charter	<0.5 t
Denham Sound	6 t
Charter	1 t
Freycinet	1 t
Charter	nil

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 pink snapper *(Pagrus auratus)*, black snapper (grass or blue-lined emperor, *Lethrinus laticaudis*), western butterfish *(Pentapodus vitta)*, whiting (*Sillago* spp.), Queensland school mackerel *(Scomberomorus queenslandicus)*, tailor, blackspot tuskfish (bluebone, *Choerodon schoenleinii*) and estuary cod (slimy cod or gold spotted rockcod, *Epinephelus coioides*). 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

The consultation process is now facilitated by Recfishwest although the Department continues to undertake direct consultation with the community on specific issues (e.g. Shark Bay Inner Gulf Pink Snapper Working Group, convenes every 3 years)

Boundaries

The areas covered by this report are shown in Inner Shark Bay Fishery Figure 1. Fishing is not permitted in the Hamelin Pool 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 2010, 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

The stocks of pink snapper within the inner gulfs have been the focus of a comprehensive research program since 1996/97. Since 2002, integrated 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. These assessments are updated every 3 years.

Estimates of recreational catch and effort have been derived from 'on-site' recreational fishing surveys involving interviews with boat crews returning to the Monkey Mia, Denham, and Nanga boat ramps. Surveys were undertaken each year between 1998 and 2010 (no surveys were conducted in 1999 and 2009).

Catches of pink snapper taken by licensed commercial and charter vessels are derived from compulsory monthly catch returns. The status of the four SBBSMNMF target species (whiting, sea mullet, tailor, 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 SBBSMNMF 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 limited to a monitoring level and involves using daily egg production method [DEPM] surveys to estimate spawning biomass 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 the next scheduled meeting in 2011.

Retained Species

Commercial landings (season 2010):

Whiting	**116 tonnes**
Mullet	**95 tonnes**
Tailor	**16 tonnes**
Yellowfin bream	**10 tonnes**
Pink snapper	**<0.5 tonne**

The total commercial catch taken by SBBSMNF licensed vessels in 2010 was 249 t (was 251 t in 2009). This comprised 116 t of whiting, 95 t of sea mullet, 16 t of tailor, 10 t of yellowfin bream and 12 t of other mixed scalefish species that included <0.5 t of pink snapper taken as bycatch (net fishing gears only).

Recreational catch estimates (including charter, 2010)

Pink snapper	**Eastern Gulf ca. 4 tonnes**
	Denham Sound ca. 7 tonnes
	Freycinet Estuary ca. 1 tonne
Black snapper	**ca. 10 tonnes**

As a direct result of management intervention, including the introduction of TAC-based management in 2003, recreational catches of pink snapper have decreased significantly since 1998.

Based on results of the most recent recreational fishing survey in 2010, the estimated recreational catch of pink snapper was approximately 4 tonnes in the Eastern Gulf, approximately 6 tonnes in Denham Sound and approximately 1 tonne in the Freycinet Estuary. The estimated recreational catch of black snapper in 2010 was approximately 10 tonnes (all areas combined).

In 2010, approximately 1 t of pink snapper was taken in Denham Sound and <0.5 t in the Eastern Gulf by licensed charter vessels; no charter boat catches were reported from the Freycinet Estuary. A total catch of <0.5 t of black snapper (all three areas combined) was reported by charter vessels in 2010.

Fishing effort/access level

Commercial

In 2010, of the 12 SBBSMNF licenses, as in 2009, seven vessels were actively involved in fishing.

Fishing effort in the SBBSMNF declined slightly in 2010 (1,041 boat days) compared with 2009 (1,118 boat days).

Recreational

In 2010, boat-based recreational fishing effort in the inner gulfs was estimated at approximately 37,000 boat fisher hours (was estimated at 33,000 fisher hours in 2007).

Stock Assessment

Assessment complete

Whiting	**Yes**
Mullet	**Yes**
Tailor	**Yes**
Yellowfin bream	**Yes**
Pink snapper	**Yes**
Black snapper	**Yes**

Assessment method and level:

Whiting/Mullet/Tailor/YF Bream

Level 2 - Catch, Catch Rate

Pink snapper

Level 5 - Composite Assessment (2011)

Black snapper

Level 3 - Fishing Mortality (2005)

Level 1 - Catch (2010)

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 249 tonnes in 2010 and was within the target range (235–335 tonnes). The overall CPUE of 240 kg/boat day (all species) was similar to the long-term average since 1990 (230 kg/boat day). The catch and CPUE for whiting (116 tonnes, 112 kg/boat day), mullet (95 tonnes, 92 kg/boat day) and yellowfin bream (10 tonnes, 10 kg/boat day) were all within the respective target (catch) ranges and above the minimum (CPUE) trigger levels in 2010 (Inner Shark Bay Fishery Table 1). The tailor catch (15 tonnes) was again below the target range and the CPUE (15 kg/boat day) again below the minimum trigger level. However, while some reduction in natural abundance cannot be discounted, low tailor catches again are mostly attributable 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. Most recently, DEPM surveys were conducted in Eastern Gulf in 2009 and in Denham Sound and Freycinet Estuary in 2010. Research trawl surveys, to monitor variation in juvenile recruitment, have been conducted each year since 1996. Integrated 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. The most recent assessments (2011) estimated the spawning biomass of pink snapper was above the target level (40%) in both the Eastern Gulf and Denham Sound but while improving, was still below the threshold level (30%) in the Freycinet Estuary.

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 but there is no information from recent catch data that would suggest the situation has changed.

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 seven managed fishery licenses actually operating. Fishing and associated fish processing is an important source of local employment - the fishery, although relatively small-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)

(2010) $1.1 million

Commercial

The overall value of the SBBSMNMF in 2010 was estimated at $1.13 million and includes catch values of $706,000 for whiting, $274,000 for sea mullet, $47,000 for yellowfin bream and $53,000 for tailor. 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 (2010): Acceptable

Target catch range (2010):

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 to 1,041 boat days in 2010 (was 1,118 in 2009).

The total commercial catch (ex. pink snapper) in 2010 at 249 t was within the acceptable target range (235–335 t). At this time, this fishery is considered to have a low risk in terms of sustainability, and as a consequence is a low research/management priority.

Commercial catches of pink snapper taken as bycatch by SBBSMNMF vessels in 2010 were either nil or significantly below their allocation within the respective pink snapper TACs (<0.5 tonne in Denham Sound, nil catch in Eastern Gulf and Freycinet Estuary).

Recreational

Target catch range (2010):

Pink snapper Eastern Gulf 12 tonnes

Denham Sound 12 tonnes

Freycinet Estuary 3.8 tonnes

Estimated recreational catches of pink snapper were well below the allocation within the respective TACs in each area in 2010 (ca. 4 tonnes in the Eastern Gulf, ca. 7 tonnes in Denham Sound and ca. 1 tonne in Freycinet Estuary).

In 2010, a total of 937 Freycinet Estuary management quota tags (total available 1,050) were allocated to recreational fishers in 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 SBBSMNF, 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 in introduced in March 2010. A statewide integrated survey based on the database of licensed boat fishers is now underway (commenced in January 2011) and will provide estimates of recreational catches at a bioregional level in late 2012.

Integrated Fisheries Management (IFM) in the Gascoyne is likely to begin in 2012 and will include consideration of the inner Shark Bay Fishery and other scalefish fisheries in the Bioregion.

External Factors

The inner Shark Bay environment is particularly stable as a result of its typically low-rainfall, arid environment. The impacts of the flood events (e.g. Gascoyne and Wooramel Rivers) in late 2010 and again in early 2011 remain to be determined. 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.

Climate change has the potential to impact fish stocks in range of ways including, with temperate species such as pink snapper, affecting spawning patterns and influencing their geographic distribution (latitude shift). A review of the impacts and responses to marine climate change in Australia has been undertaken by CSIRO (see www.oceanclimatechange.org.au). A 3-year FRDC-funded project has recently commenced that will assess the effects of climate change on key fisheries in Western Australia.

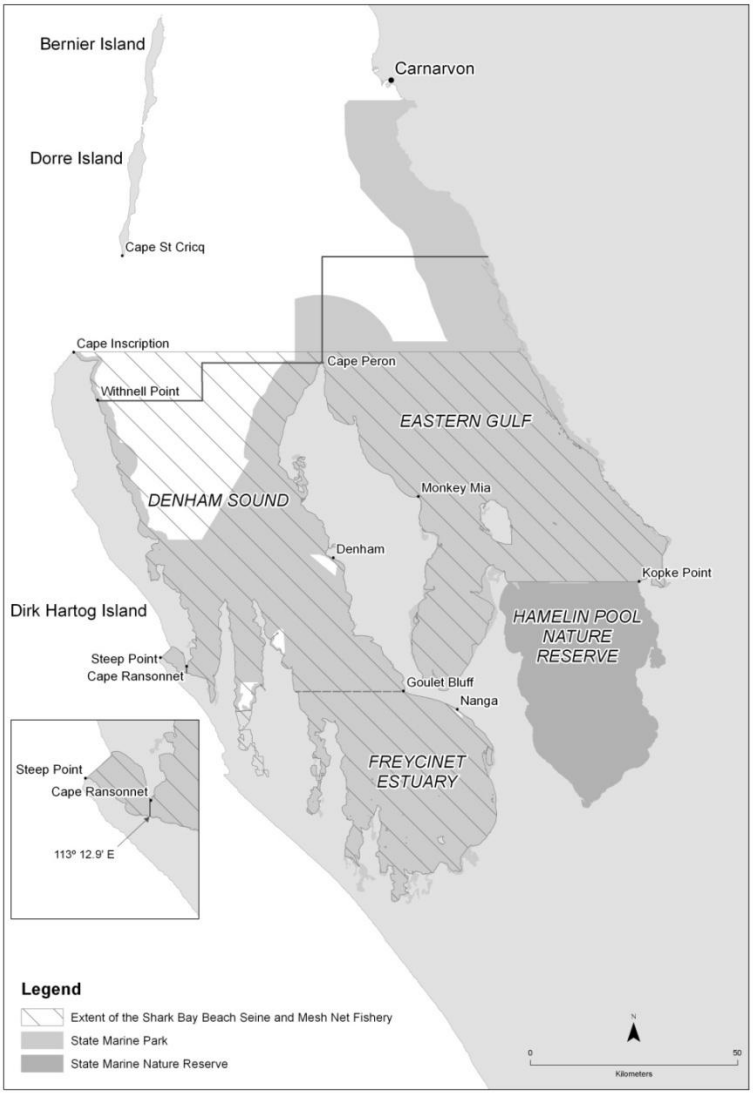
Contributors

G. Jackson, J. Norriss and M. Stadler

INNER SHARK BAY SCALEFISH FISHERY TABLE 1

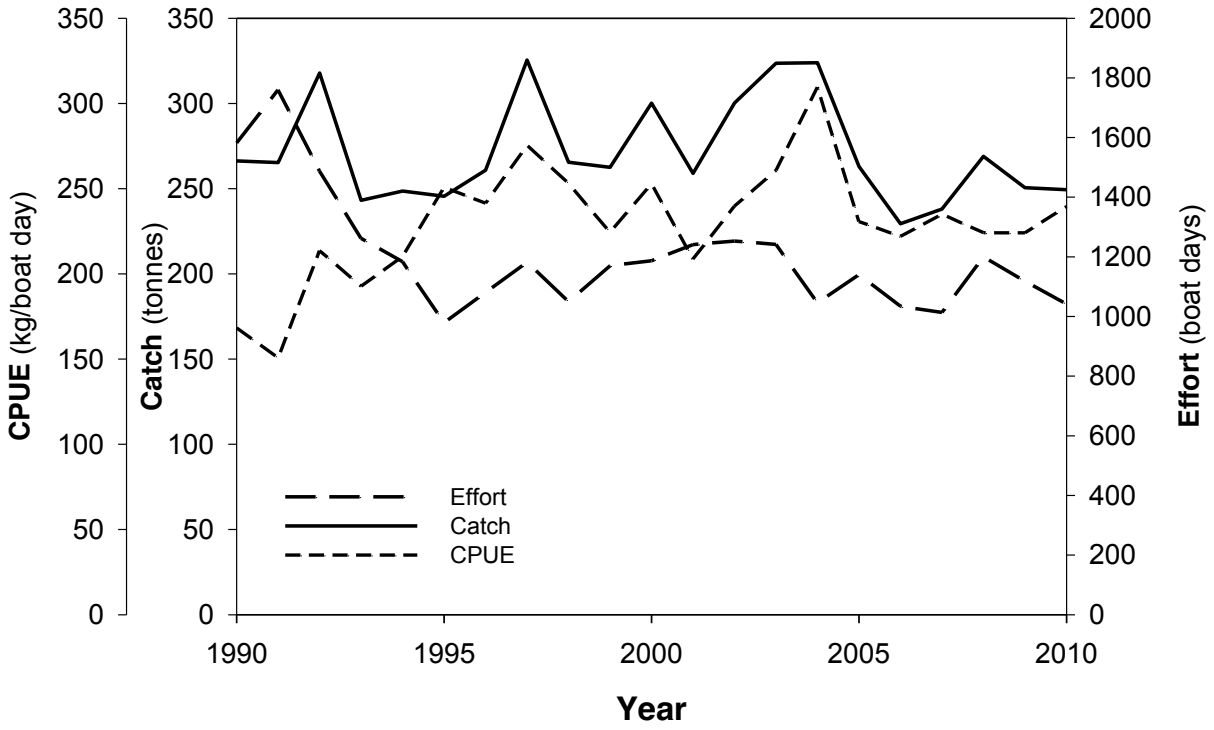
Annual catch per unit effort (kg/boat day) and minimum CPUE trigger levels for key species taken by Shark Bay Beach Seine and Mesh Net Managed Fishery vessels for the period 2001-2010.

Species	Trigger Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Whiting	75	92	79	86	114	102	110	100	98	100	116
Mullet	62	93	80	120	137	74	60	90	89	93	95
Tailor	20	21	21	22	23	17	20	22	19	15	16
Bream	5	6.2	13	19	26	23	22	14	6	7	10



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 1990–2010.

Gascoyne and North Coast Blue Swimmer Crab Fishery Status Report

Main Features

Status		Current Landings	
Stock level		Commercial catch	888 t
Shark Bay	Acceptable	Shark Bay trap fleet	529 t
Exmouth	Acceptable	Shark Bay trawl fleet	323 t
Pilbara	Acceptable	Exmouth Gulf	11 t
		Pilbara	24 t
Fishing Level			
Shark Bay	Under Development	Recreational catch	Minimal
Pilbara	Acceptable		

Fishery Description

The blue swimmer crab (*Portunus pelagicus*) is found along the entire Western Australian (WA) 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.

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, and Pilbara Developing Crab Fisheries are only permitted to use 'hourglass' traps. Each of the State's prawn and scallop trawl fisheries that operate in this region also retain crabs as a by-product.

Crabbing activity in the Gascoyne Coast bioregion is centered in the embayments of Shark Bay and Exmouth Gulf. The Shark Bay Crab (Interim) Managed Fishery has developed into the largest crab fishery in WA.

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 (FRMA). The exemptions were issued to allow for the sustainable exploration of the commercial viability of fishing crab stocks along the Pilbara coastline.

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)

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 fishers with long-standing histories of trapping crabs in Shark Bay are permitted to fish in the waters of Shark Bay south of Cape Inscription.

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 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 licences 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 Shark Bay Crab Interim Managed Fishery [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 Pilbara Developing Crab Fishery are set by conditions on the exemption 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 Shark Bay, Exmouth Gulf, Onslow and Nickol Bay Prawn Managed Fisheries are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices (grids). The fleet is composed of trawlers up to 23 metres in length; operating twin- or quad-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m). The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all trawlers in these fleets.

A second comprehensive ESD assessment of the Shark Bay fishery was completed in 2007. SEWPaC 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.

Research summary

Data for the assessment of blue swimmer crab stocks in the Gascoyne and North Coast bioregions are obtained from trap fishers' compulsory catch and effort returns and voluntary daily log books and trawl fishers daily logbooks. Department of Fisheries' research staff also conduct quarterly catch monitoring surveys aboard commercial crab trap vessels in Shark Bay and a fishery independent trawl survey over some of the crab distributional area is conducted annually.

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 2009/10):

	888 tonnes (total)
Shark Bay trap fleet	**529 tonnes**
Shark Bay trawl fleet	**323 tonnes**
Exmouth Gulf	**11 tonnes**
Pilbara	**24 tonnes**

The total combined catch for the Gascoyne and North Coast bioregions during 2009/10 was 888t, representing a 12% increase on the 2008/09 catch of 774 t. This catch accounted for 81% of the state commercial blue swimmer crab catch for 2009/10.

The annual catch from the Shark Bay crab trap fishery for 2009/10 was 529 t, marginally higher than the 2008/09 catch of 493 t (Gascoyne Coast Blue Swimmer Crab Figure 2, 3). Landings from the Shark Bay trawl fleet were 323 t in 2009/10, a 42% increase on the 2008/09 catch of 227 t.

A total of 11 t of blue swimmer crabs was landed in the Exmouth Gulf region during 2009/10, down on the previous year's catch of 17 t (Gascoyne Coast Blue Swimmer Crab Figure 2). All of the crab catch was landed as by-product from trawlers, with no commercial trap fishing undertaken in Exmouth Gulf during 2009/10 as the trap fishery was formally closed in June 2009.

The combined commercial catch of blue swimmer crabs from trap based crab fishers and prawn trawlers operating along

the Pilbara coast during 2009/10 was 28 t, a 24% decrease on the 2008/09 catch of 37 t (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 derived from recreational surveys targeting pink snapper conducted in 2000/01, 2001/02, 2005/06, 2006/07 and 2007/08. While the surveys were restricted to boat fishers only who used boat ramps in Monkey Mia, Denham and Nanga, the limited data that was collected also suggested that the recreational crab catch in the lower gulfs was minimal compared with the take by commercial fishers operating in the same area. The surveys provided recreational catch estimates of between 0.3-1.9 t of blue swimmer crabs for the gulf regions.

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 Interim Managed Fishery increased slightly during 2009/10, as operators continued to maximize profitability by capitalizing on peak catch periods. Shark Bay crab trap fishers reported a total of 352,550 traplifts for 2009/10 (Gascoyne Coast Blue Swimmer Crab Figure 3) – an 11% increase on the 317,416 traplifts reported for the previous year.

No effort was expended in the Exmouth Gulf crab trap fishery during 2009/10. The fishery was officially closed in June 2009.

Crab trap fishers along the Pilbara coast reported 32,700 traplifts during 2009/10, a 29% decrease on the 46,220 traplifts reported for 2008/09.

Stock Assessment

Assessment complete:

Shark Bay: **Yes**

Pilbara: **Yes**

Assessment method and level:

Level 2 - Catch rate/Size Distributions

Breeding stock levels:

Shark Bay: **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 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 development 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 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 2009/10 the mean catch rate was 1.50 kg/traps lift (Gascoyne Coast Blue Swimmer Crab Figure 3), a slight decrease on the 2008/09 catch rate of 1.55 kg/trap lift. A review of the interim management plan is planned for 2010/11.

Over the past decade there has been a substantial increase in the quantity of blue swimmer crabs retained as by-product by the Shark Bay prawn trawl fleet, and to much less extent the Shark Bay scallop trawl fleet. The prawn Licensees have developed new crab markets and an increased capacity onboard boats to process prawns, scallops and byproduct. Blue swimmer crabs are now forming an important economic component of their fishing enterprise

Exmouth Gulf: Catch and effort levels on blue swimmer crabs in the Exmouth Gulf trawl fishery have been relatively

stable and the stocks 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 2009/10 of 0.7 kg/trap lift – the same catch rate as the previous 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, than, whereas spawning is restricted to the late spring and early summer months on the lower West Coast

The performance measure for the Shark Bay fishery requires that the breeding stocks be maintained. The breeding stock is measured as adult crab abundance (catch per unit effort - CPUE). The CPUE in the Shark Bay fishery for 2009/10 was 1.50 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 ongoing recruitment to the fishery.

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 2009/10, approximately 15 people were employed as skippers and crew on vessels fishing for blue swimmer crabs in the Gascoyne Coast bioregion and a further 2 people along the Pilbara coast. Additional employment for some 30-35 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 2009/10 **$4.2 million**

Blue swimmer crab landings from the Gascoyne Coast and North Coast bioregions during 2009/10 were worth $4.2 million, up markedly on the $3.5 million generated during 2008/09. This increase was largely due to a significant increase in the catch of blue swimmer crabs by the Shark Bay trawl fleet. The catch from the Pilbara region for 2009/10 was valued at approximately $120,000, a substantial decrease on the $170,000 from 2008/09.

Beach prices for blue swimmer crabs from the major trap fisheries in Western Australia throughout 2009/10 ranged from $5-$15/kg live weight, with the average price in the Gascoyne fisheries for the year around $4.50-$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 Asia. The crab catch from the Pilbara region was sold through local and interstate markets.

Fishery Governance

Target catch (or effort) range:

Shark Bay: Under Development

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 - N/A

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 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 low annual retention of crabs 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 considered 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, one licensee has not renewed their exemption since the 2007/08 fishing season. Consequently, the number of traps in the Pilbara trap fishery has reduced from 600 down to 400.

New management initiatives (2010/11)

The Shark Bay Crab Interim Management Plan was extended to 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 further extension to this Plan may be considered given the complex nature of these issues. 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 exemptions permitting trapping 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 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 DFAC. On this basis, in June 2009, the CEO of the Department decided to close the Exmouth Gulf Developing Crab Fishery.

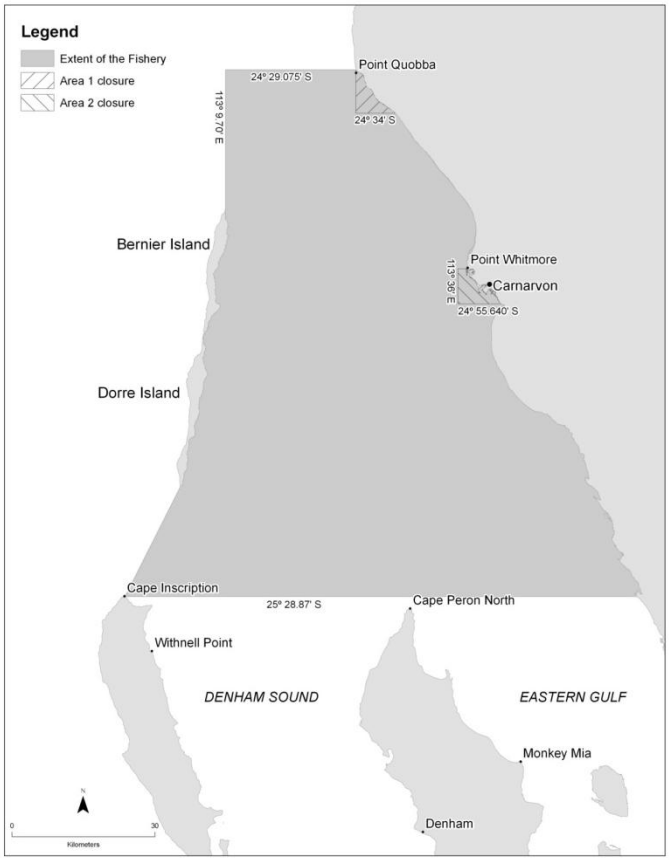
The Department proposes to bring the Pilbara Crab DNF under formal management arrangements during 2010/11.

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.

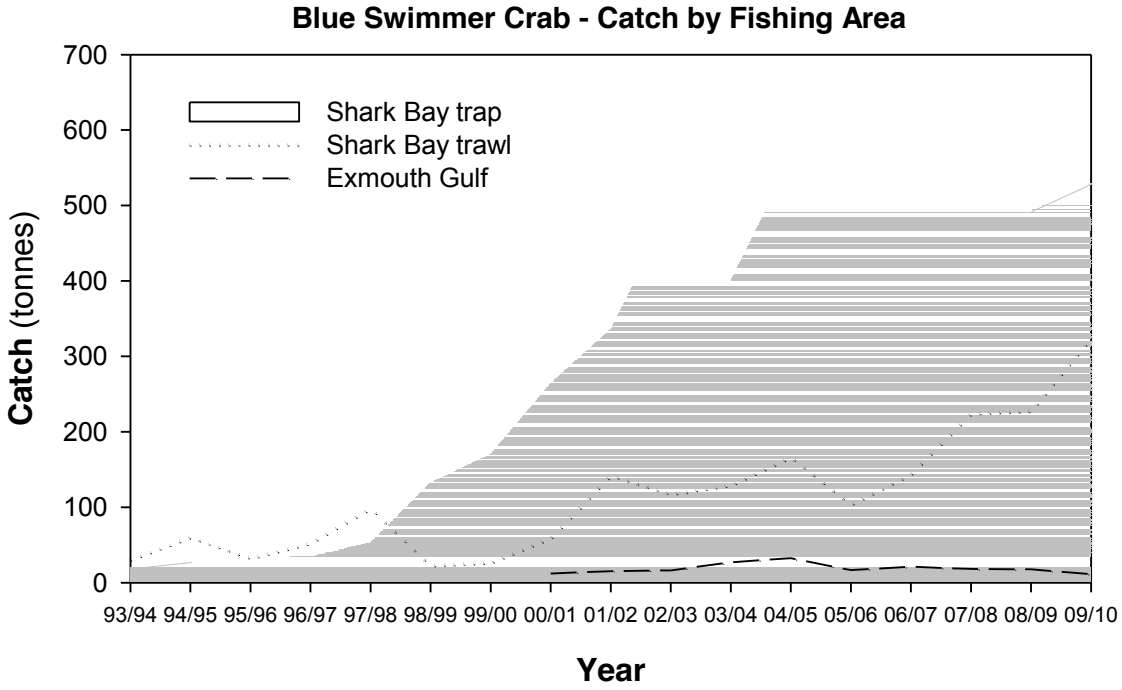
Contributors

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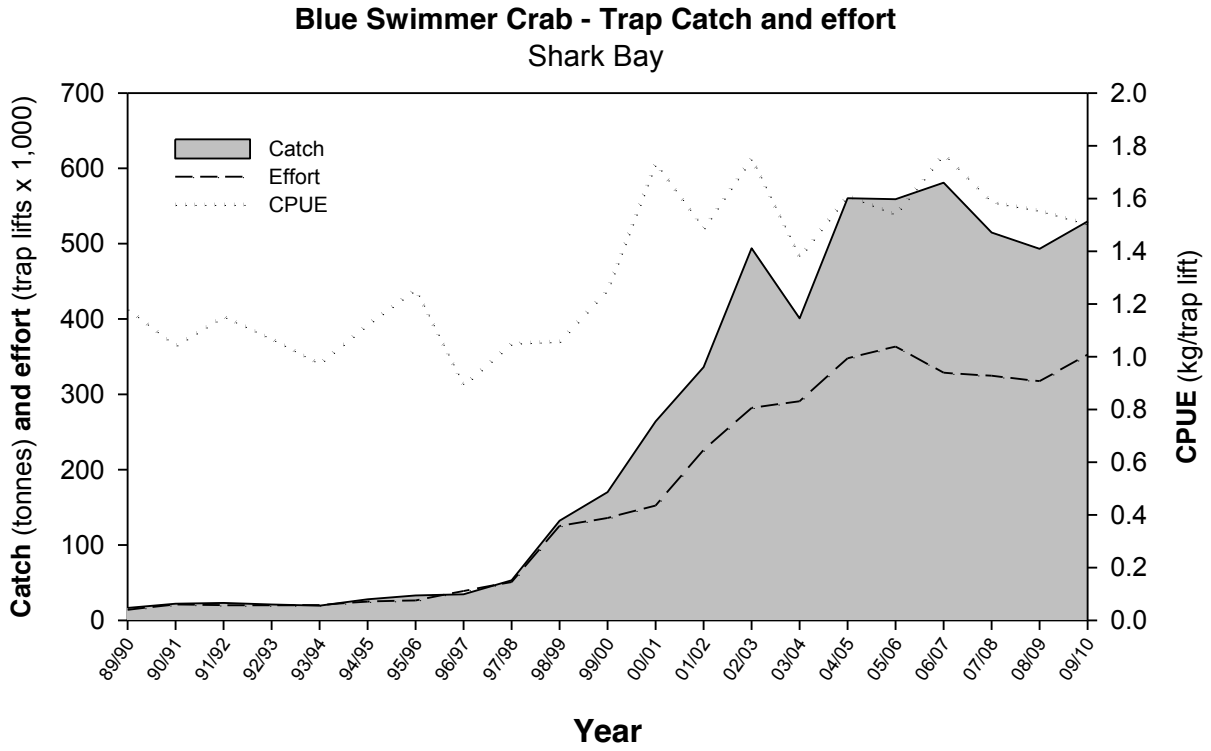
GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 1

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.



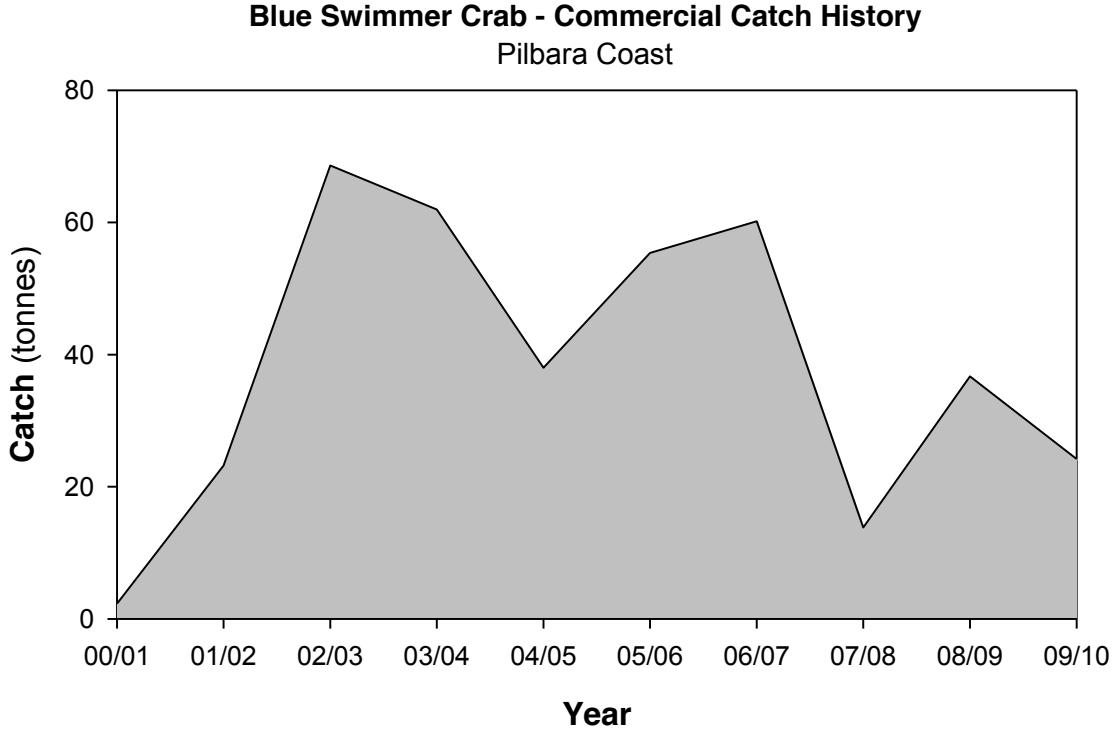
GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 2

Commercial catch history for the blue swimmer crab (*Portunus pelagicus*) fisheries in the Gascoyne Coast bioregion of Western Australia since 1993/94.



GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab trap catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in Shark Bay since 1989/90.



GASCOYNE BLUE SWIMMER CRAB FIGURE 4

Commercial catch history for the blue swimmer crab (*Portunus pelagicus*) in the North Coast bioregion between since 2000/01.

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, including the blacklip oyster *Pinctada margaritifera*, which now complements the major state industry built on silverlip pearls (*Pinctada maxima*).

Key development tasks continue to involve supporting the emergence of a local sector producing aquarium species, including coral and live rock. This developing sector is regulated according to the relevant policy entitled *The Aquaculture of Coral, Live Rocks and Associated Products*.

Research and development is continuing on the aquaculture of tropical rock lobster species, in particular the development and up-scaling of hatchery production methods.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services in the Gascoyne Coast Bioregion are delivered by Fisheries and Marine Officers (FMOs), Community Education Officers (CEOs) and associated management and administrative support staff based at District Offices in Denham, Carnarvon and Exmouth. During 2009/10 the three district offices supported a total of eleven 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 kilometres 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), FMOs 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. Recently, a high visibility Recreational Fishing Mobile Patrol has been added to the Gascoyne pool of recourses. This dedicated education and enforcement unit patrols the coast from Onslow through to Kalbarri.

FMOs at Exmouth make extensive use of the 13-metre Patrol Vessel (PV) the PV *Edwards* to conduct compliance activities throughout the Gascoyne bioregion. FMOs in Denham use an 8 metre PV and in Carnarvon a 7.3-metre rigid inflatable boat is used to conduct at-sea inspections in Shark Bay and within the Southern aspects of the Ningaloo Marine Park and Commonwealth Marine Park. In all 3 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 2009/10. 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, which has become the Gascoyne Demersal Scalefish 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 CDRs. 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 the Gascoyne Management team 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 the coordination of educational and interpretive activities during peak periods utilising CEOs 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 and CEOs. 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 monitored 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 Gascoyne Demersal Scalefish and mackerel fisheries has ensured that a higher and more effective rate of compliance is achieved.

Activities during 2009/10

During 2009/10 FMOs delivered a total of 5,891 hours of "in-field" compliance activity (Gascoyne Coast Compliance Table 1 which excludes Gascoyne pearling compliance activities which are reported in the North Coast Bioregion), (Gascoyne Coast Compliance Patrol Hours Figure 1). The total budgeted hours for compliance were not delivered by FMOs in the region during 2009/10. This was due again to staff shortages for significant periods of time during the 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 2009/10 year using this model. Several other OCPs were completed, including the Gascoyne Demersal Scalefish and Recreational Fishing plans. 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.

OCPs have been operating for several years now in the Exmouth Gulf Prawn Fishery, Shark Bay Prawn Fishery, Shark Bay Scallop Fishery, Shark Bay Crab Interim 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 remained at a moderately high level in 2009/10. 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 3 infringement warnings and 5 infringement notices were issued and 3 prosecutions were instigated from a total of 293 field contacts with commercial fishers. Field contacts were lower than 2008/09 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 (102) was significantly higher, as was infringement notices issued (134). No prosecutions were instigated. This was achieved from a total of 9,446 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 13.5% lower in 2009/10.

Three Recreational Fishing Mobile Patrols from outside the region were active in the Gascoyne in 2009/10. "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 Gnarrloo Bay area. Two Mobile Patrols from the Metro Region patrolled the Gascoyne Region increasing the effective contact rate at the peak of the season.

The bioregion's Fisheries Volunteer program continued to find it difficult to attract volunteers during 2009/10. 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 continues a partnership arrangement with DEC in the Coral Bay area that has returned very positive outcomes. Utilising 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 2010/11

For the 2010/11-year a number of initiatives across the Gascoyne Bioregion have been planned. These include: -

Manage the compliance aspects associated with the Gascoyne Demersal Scalefish Fishery;

Introduce a more Intelligence based and Tactical approach to compliance delivery, especially in marine parks and recreational fishing;

Improve the level of FMOs investigation and prosecution skills and experience;

Increase effort in terms of education and enforcement in the Onslow and Eastern Exmouth Gulf area;

Improve recruitment and retention practises to attract and retain staff in the Gascoyne;

Refine compliance practises associated with the Ningaloo Marine Park (Commonwealth);

Resolve issues associated with the allocation of Blue Manna Crab between the Gascoyne Crab Fishery and other commercial fisheries;

Commence construction of new Denham Fisheries and DEC building;

GASCOYNE COAST COMPLIANCE TABLE 1

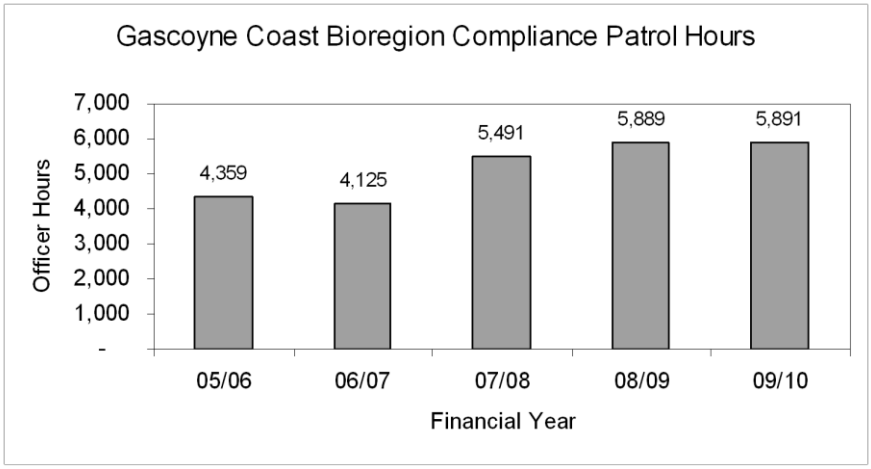
Summary of compliance and educative contacts and detected offences within the Gascoyne coast bioregion during the 2009/10 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	5,891 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	293
Infringement warnings	3
Infringement notices	5
Prosecutions	3
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	9,446
Infringement warnings	102
Infringement notices	134
Prosecutions	0
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	590
Fishwatch reports**	10
VMS (Vessel Days)****	12,987

*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.

**** VMS (Vessel Days) represents the number of vessel days recorded in this bioregion. That is, a count for each day that each vessel was polled within the bioregion.



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 09/10 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

The oceanography of the North Coast bioregion includes Pacific Ocean waters that enter 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 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.

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 is obtained from wild stocks and 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, 2008[1]; 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 the marine conservation reserve planning process in this region. This has resulted in the proposal to establish the Camden Sound Marine Park which is likely to be gazetted in 2011/2012. The Department has recently received funding to establish baseline and ongoing monitoring and research to underpin ecosystem management of this area. There is considerable interest in developing further marine protected areas within the Kimberley area, and the State Government has announced funding of a further marine protected area at Eighty Mile Beach. 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 Sustainability, Environment, Water, Population and Communities (SEWPaC) is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border, with the aim of releasing a draft North Marine Bioregional Plan for public consultation in 2011/12

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.

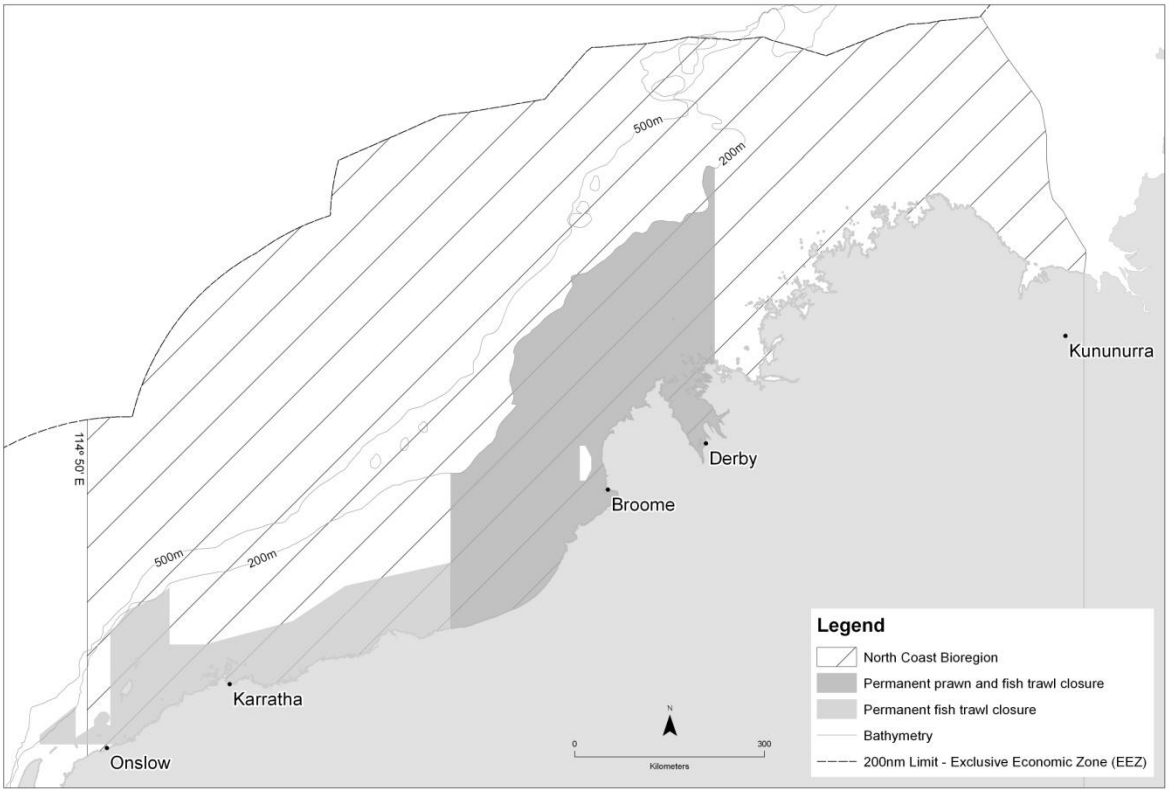
The recent Montara oil spill that occurred in this region highlights the potential risks to this area from oil and gas production. The outcome of this incident on fishery resources and assets may not be known for some time.

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

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

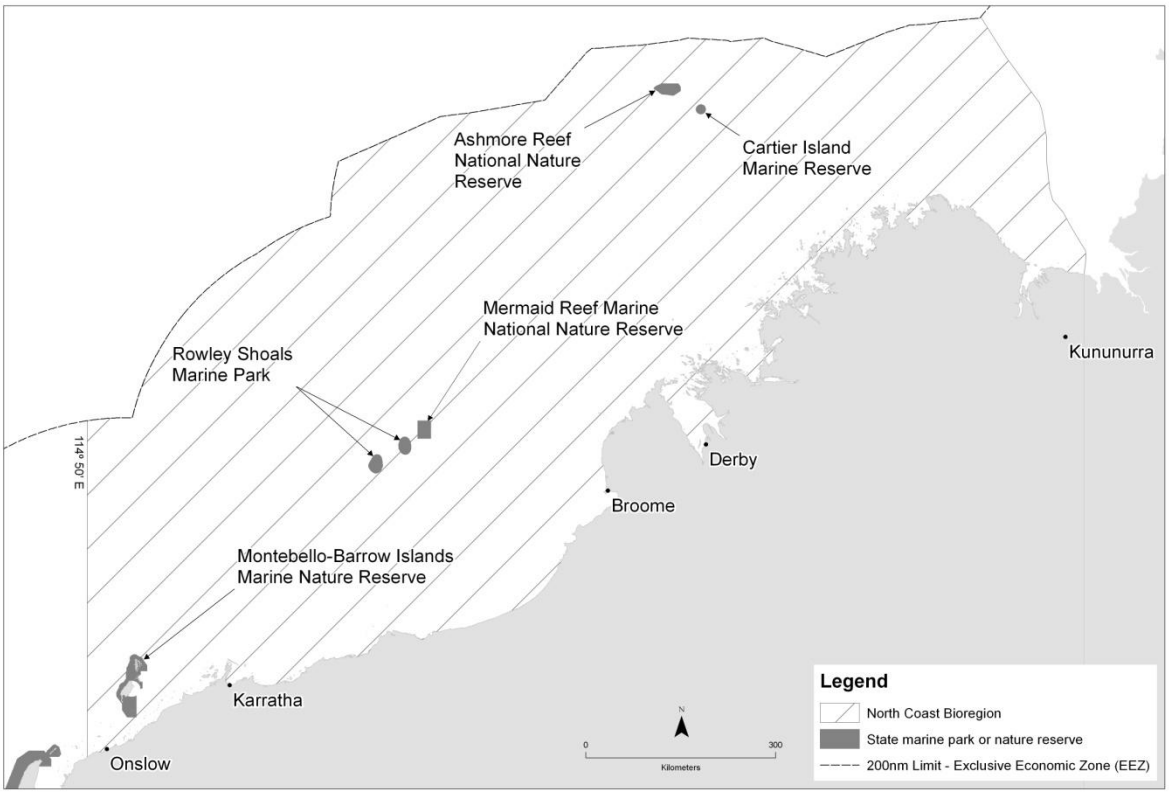
The areas and proportions of the North Coast Bioregion making up State Waters and continental shelf waters where habitats are protected from the physical disturbance of trawl fishing. The areas, 200 m depth which are formally closed to trawling would be equivalent to meet category IV of the IUCN criteria 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

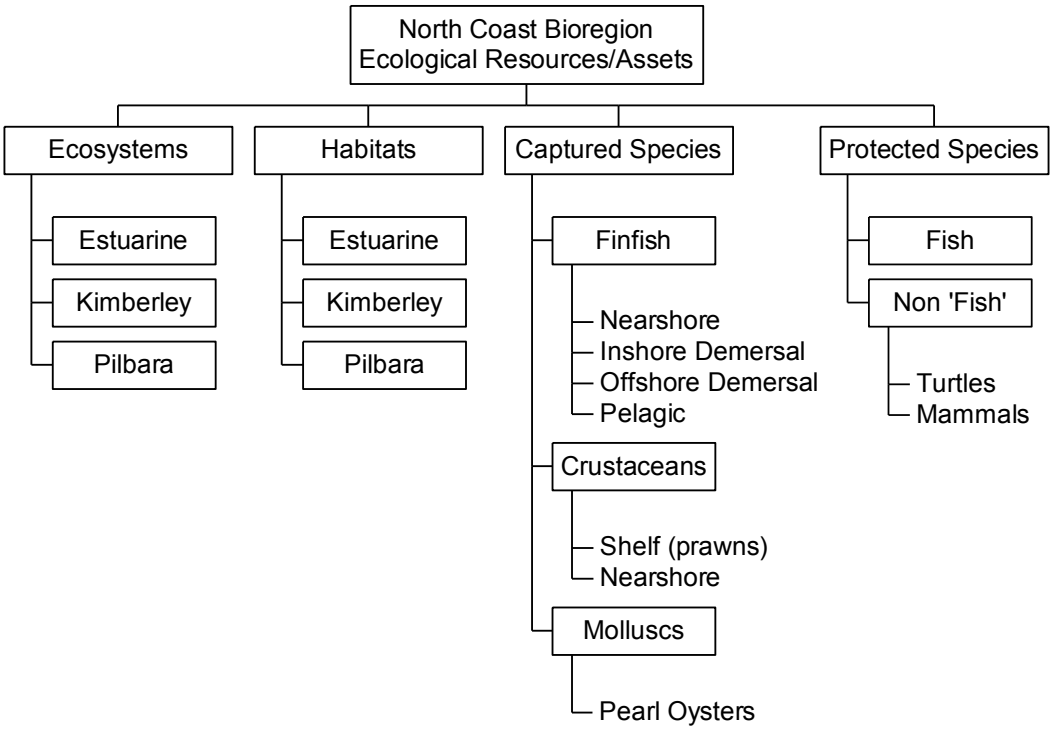
Identification of Ecological Assets using the EBFM framework

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 at a regional level to an unacceptable level. A recent study by Hall and Wise (2010) 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 (2010) 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 the Kimberley Science Plan.

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	MODERATE	The current status of demersal finfish stocks captured by the Pilbara trawl fishery requires a review. 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	The Spanish mackerel stock in this region is at acceptable levels and there are few other pelagic fish that are impacted.
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.

	Aquatic zone	Risk	
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	NEGLIGIBLE	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 but further refinements in net design are underway.
Protected 'Fish' Species	Fish	LOW	The sawfish (Pristidae), speartooth shark (Glyphis glyphis) or the northern river shark (Glyphis garricki), 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 in closed to trawling. These activities may 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 for an ongoing monitoring program in the Camden Sound Marine Park. Further initiatives are being developed as part of the broader Kimberly Science and Conservation strategy and in the progression of the recently established WAMSI 2 project.

The Biodiversity and Biosecurity branch have implemented a series of biosecurity related projects during 2010 – 2011. All projects aim to detect the presence of introduced marine pests (IMPs) using a suite of tools including ongoing background monitoring and large-scale Port monitoring. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. Two large-scale, nationally approved, surveys have been implemented for the Port s of Dampier and Port Hedland that will inform the Department of the status of IMPs in those Ports. Background monitoring programs are also continuing within Dampier and Port Hedland Port s waters with assistance from the Dampier Port Authority and Port Hedland Port Authority.

FISHERIES
North Coast Prawn Managed Fisheries Status Report

Main Features

Status		Current Landings	
Stock level	Acceptable	Onslow:	29 t
		Nickol Bay:	40 t
Fishing level	Acceptable	Broome:	3 t
		Kimberley:	256 t

Fishery Description

There are four small prawn fisheries that operate in the north coast 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 merguiensis*).

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 merguiensis*) 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 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.

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 114º39.9' 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 north coast 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.

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 during 2010 for the various areas in the OPMF were as follows:

Area 1	6 May – 22 October
Area 2	6 May – 22 October
Area 3	6 May – 22 October
Fortescue SMFG	5 June – 12 September
Ashburton SMFG	5 June – 25 July
Weld Island SFMG	5 June– 24 August
Mangrove Island SFMG	1 April – 22 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 2010 season opened on 8 March with a closure on 14 November. The major fishing areas opened during these periods:

Nickol Bay	20 May – 1 August
	(Day fishing only 20 May – 3 June)
Extended Nickol Bay SMFG	20May –14 November
Depuch SMFG	20May – 1 August
	(Day fishing only 20 May – 3 June)
De Grey SMFG	20May – 14 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 2010 season arrangements opened the Fishery on 17 May and it officially closed at 0800 hrs 17 August, providing 72 fishing nights. Only one boat entered the BPMF fishery in June and it fished for 13 nights before leaving to fish in the Northern Prawn Fishery (NPF) where the expected catch rates were much higher. Because there were indications that the prawn catch rates might have improved beyond the set season end date, operators requested that the fishing season be extended. Subsequently, the season was extended for one month and closed 17 September.

KPMF: The KPMF Management Plan permit the use of two otter trawl nets where the total headrope length 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. Of the 126 licensees in the KPMF, as at 30 June 2010, 31 also held an NPF licence. Opening and closing dates are aligned to prevent large shifts of fishing effort into the KPMF. Consequently, the 2010 season opened on 1 April and closed mid-season closure on 27 May. The fishery re-opened on 1 August, with a promulgated final season closure on 30 November. 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. The SEWPaC (formerly DEWHA) have recently completed the reassessment of the NBPMF, OPMF, KPFM and BPMF trawl fisheries and export approval has been granted until 20 August 2015 for all fisheries under the one approval. DoF has also agreed to prepare a comprehensive Bycatch Action Plan for the invertebrate trawl fisheries indentifying best practice for bycatch reduction and a plan for moving all of these fisheries to best practice. As a first step, in 2010 the Department initiated a review of gear and BRDs used in all the Western Australian prawn and scallop trawl fisheries.

Research summary

Research programs are focused to underpin the sustainable management of these small fisheries involving 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 normally 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, and not fish small size prawns. For 2010 this did not occur because only one boat fished and the late opening date and market prices mitigated the risk of taking small size prawns. For the BPMF a De Lury depletion analysis is undertaken when sufficient fishing activity occurs (insufficient effort in 2010) which assists in the assessment of the king prawn stocks within the permitted fishing area.

Retained Species

Commercial production (season 2010):

Onslow:	**29 tonnes**
Nickol Bay:	**40 tonnes**
Broome:	**3 tonnes**
Kimberley:	**256 tonnes**

Landings

OPMF: The total landings of major penaeids for the 2010 season were 29 t, comprising 1 t of king prawns, 27 t of tiger prawns, <1 t of endeavour prawns and <1 t of banana prawns. Tiger prawn landings in 2010 were low but within the target catch range and at the expected level given the low effort in this fishery. King and endeavour prawn landings were extremely low and below the target catch range (Northern Prawn Figure 5). 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 2010 season were 40 t comprised only of banana prawns with no recorded landings of king, tiger or endeavour prawns (Northern Prawn Figure 6). The recorded landings of banana prawns in 2010 were low but within the projected catch range (30 to 60 t) and at the lower end of the target catch range. Recorded byproduct landings for 2010 were extremely low with < 1 tonne of blue swimmer crabs as the only species recorded.

BPMF: Recorded landings for target species were very low at 3 t, in the BPMF and no byproduct species was recorded (Northern Prawn Figure 7).

KPMF: The total recorded landings in the KPMF were 256 t, comprising 241 t of banana prawns, 11 t of tiger prawns, 4 t of endeavour prawns (Northern Prawn Figure 8). Banana prawn landings were within their target catch range (200-450 t) and the projected catch range (230 to 350 t) 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 2010 but 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: One boat fished in 2010 with a total of 97 boat days, a decrease compared to 265 boat days (two boats fished) in 2009. It is understood the other two boats did not fish in 2010 because of depressed product prices and high operating costs. This effort is extremely low compared to the days fished between 2000 and 2005 inclusive (mean of 1136 days) and the second lowest effort ever recorded in this fishery. 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 18 fathoms for fuel efficiency. There is also competition for boat crew with the oil and gas resource sector.

NBPMF: Three boats fished during the 2010 season for an aggregated total of 69 boat days, a very low level of effort.

BPMF: Only thirteen nights of fishing effort was expended by one boat in this fishery in 2010.

KPMF: Thirteen boats operated in the fishery during 2010. The total number of days fished was 365 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:	**Level 1 - 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 (2011):

NBPMF:	**250 t banana prawns**
KPMF:	**390 t banana prawns**

For the northern prawn fishery stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from depleting breeding biomass to unacceptable 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.

The low landings of prawns in general cannot be completely explained in these northern fisheries but any stock abundance issues that may have existed, were exacerbated by very low effort caused by the current economic conditions including; high fuel prices and purchasing fishing equipment, increased time to sell prawns into markets (longer term cold storage of product) and low market prices. These variable market conditions mean that operators only fish when they consider it profitable to do so. In addition, increased fuel and labour costs, direct competition from both higher prawn production from other Australian fisheries and the increase in the volume of low priced domestic and imported aquacultured prawns are generally squeezing profit margins. In summary, it is considered the low catches and resultant falling GVP in these fisheries may indicate under exploitation in response to increased competition and declining profit opportunities rather than a lack of abundance.

OPMF: The 2010 season tiger prawn landings (27 t) were lower compared to 2009.The effort in this fishery since 2006 has been very low with a maximum number of boats fishing in any one year being three but in most of these years only 1 boat fished. The low overall landings is in part is a reflection

of low effort. The abundance of tiger prawns could only maintain fishing over 4 months (May to August inclusive) mainly because of the absence of other species to increase overall catch rates to fish profitably. Although the landings were below the average landings (the mean reference landings range for 1985 to 2009 inclusive is 49 t) these tiger prawn catches were taken at efficient catch rates. The total catch of tiger prawns taken with level of effort indicates adequate breeding stock

King prawn catch (1 t) remains low compared to the mean catch of 33 t for 1985 to 2009. Since the early 2000's, there has been a decline in king prawn abundance in this fishery. Since 2006, the decline in effort may also be contributing to the low catches. There were no recorded landings of banana prawns this season. 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 low landings since 2002 and low rainfall there was no expectation of banana prawn abundance.

NBPMF: The landings of banana prawns (40 t) in 2010 were lower than in 2009 but within the target catch range and expected catch range for this species. There were no king and tiger prawn landings therefore the target ranges for these species was not met.

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 2010 and March 2011 (at Roebourne) was 411 mm and the predicted catch for 2011 is around 250 t with a range of 205 –310 t of banana prawns.

BPMF: Very low fishing effort (and resultant catch) occurred in this fishery during 2010 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 and the tiger and endeavour prawn landings are likely to be effort related as in the 2009 season.

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 for 2011, based on the rainfall in Kalumburu and Derby in January and February 2011, is 390 tonnes with a range of 310-460 t.

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 2010 the breeding stock indicators in the OPMF (catches within specified ranges, as set out in the 'Fishery Governance' section) for tiger prawns were met whereas king, banana and endeavour prawns were below the target catch range due to low effort. Environmental conditions i.e. low summer rainfall did not benefit banana prawn production this year, therefore, prawn abundance was expected to be low.

The breeding stock indicator for banana prawns in the NBPMF was met and the landings was within the projected catch range (at the low end of the range). There were no recorded king or tiger prawn landings, therefore, they were below the target ranges. This is likely to be a result of the very 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 has reduced this risk even further. The NBPMF and KPMF fishery operates predominantly by specifically targeting schools of banana prawns. This targeting 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. All trawl nets have grids to exclude large fish and protected species.

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. One turtle and sixteen sea snakes were reported as caught but released alive in the OPMF. There were no reported interaction with protected species in the NBPMF, BPMF or the KPMF.

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 effort and 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.

Habitat effects:

BPMF: **Negligible**

OPMF, NBPMF, KPMF: **Low**

In 2010 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 2010 was 70 to 80 including skippers and other crew with additional people involved in local processing.

Economic Effects

Estimated annual value (to fishers) for year 2010:

OPMF/NBPF/BPMF: **$0.6 million**

KPMF: **$2.2 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. Effort is now a considered a factor when reviewing target catch ranges in these northern fisheries.

New management initiatives (2011):

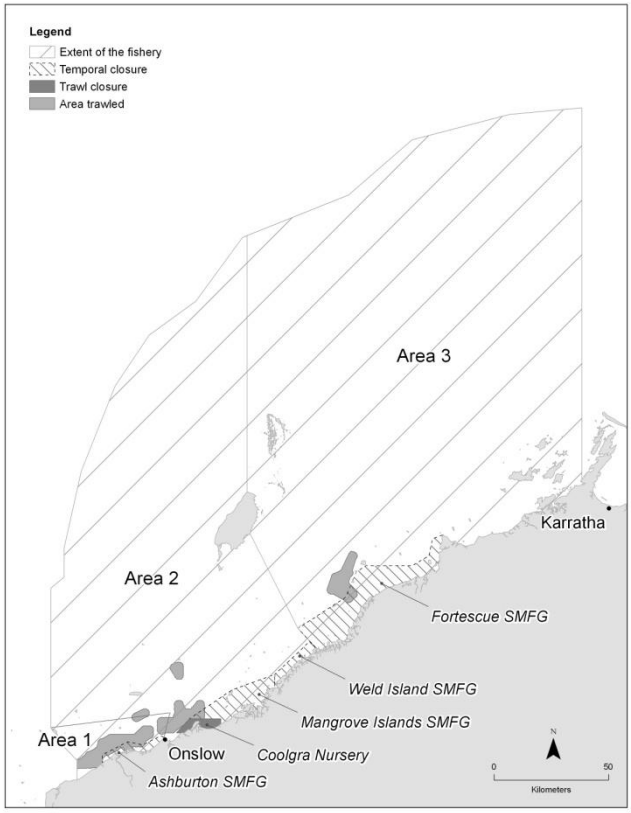
The Department will consider an application for an exemption from licensees holding both NPF and KPMF licenses to allow boats to use the quad net gear configuration used in the NPF within the KPMF.

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.

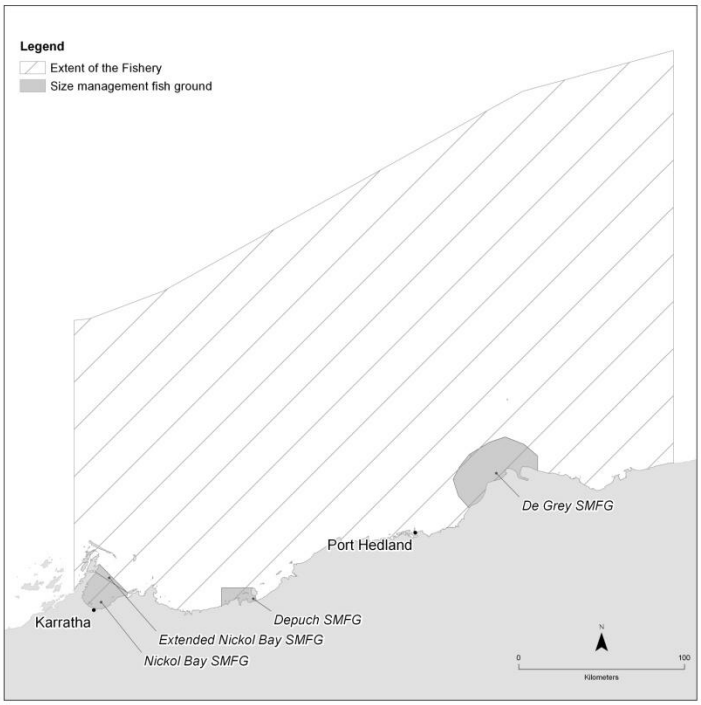
Contributors

E. Sporer, M. Kangas, S. Brown and R. Gould.



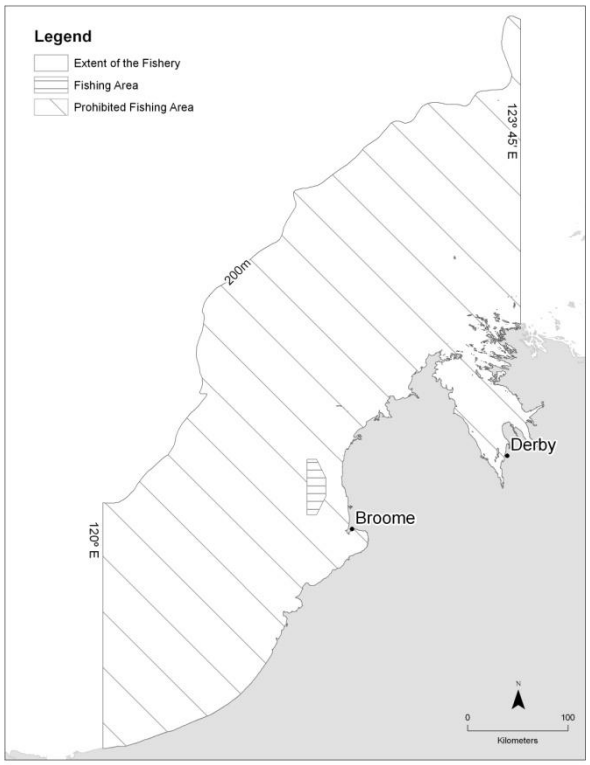
NORTHEN PRAWN FIGURE 1

Boundaries of the Onslow Prawn Managed Fishery indicating trawl closures and size management fish grounds and area trawled in 2010.



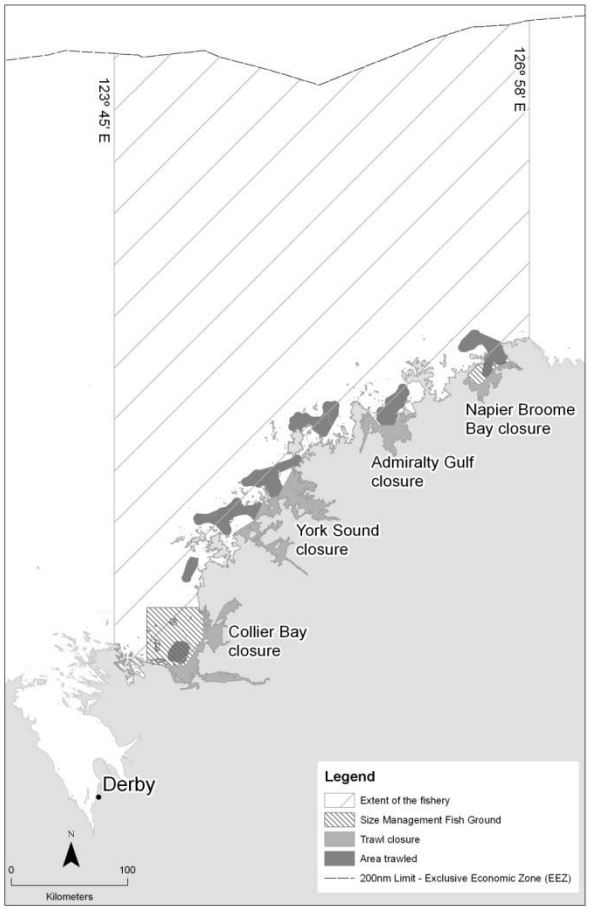
NORTHERN PRAWN FIGURE 2

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2010.



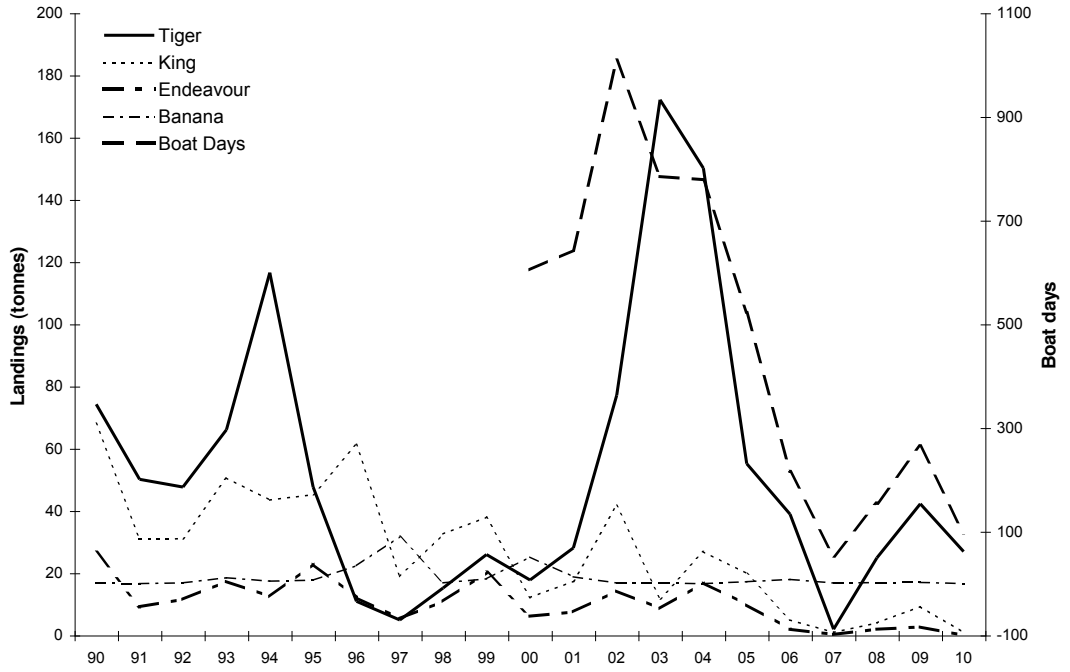
NORTHERN PRAWN FIGURE 3

Boundaries of the Broome Prawn Managed Fishery. Negligible area was trawled in 2010.



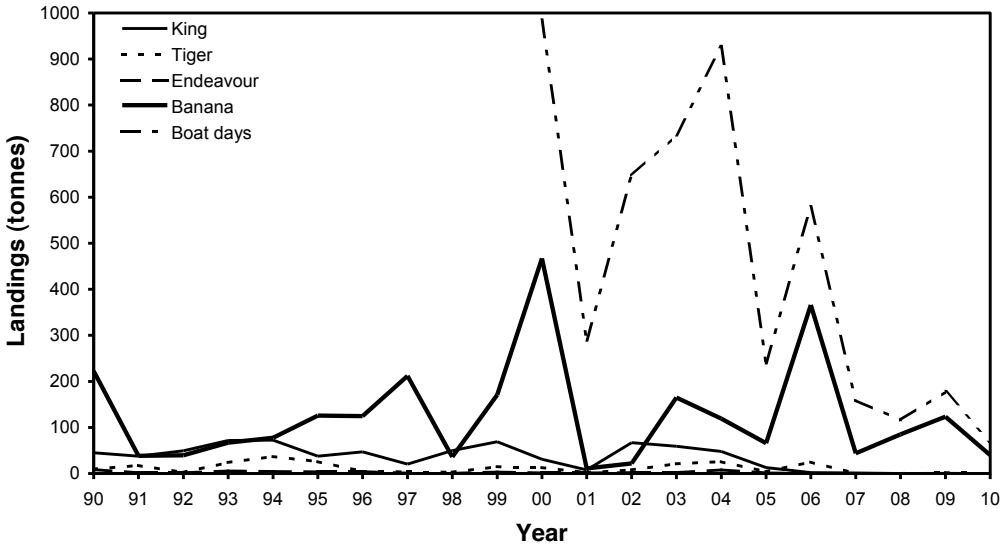
NORTHERN PRAWN FIGURE 4

Areas fished in the Kimberley Prawn Managed Fishery in 2010, Size Management Fish Grounds and the inshore trawl closures.



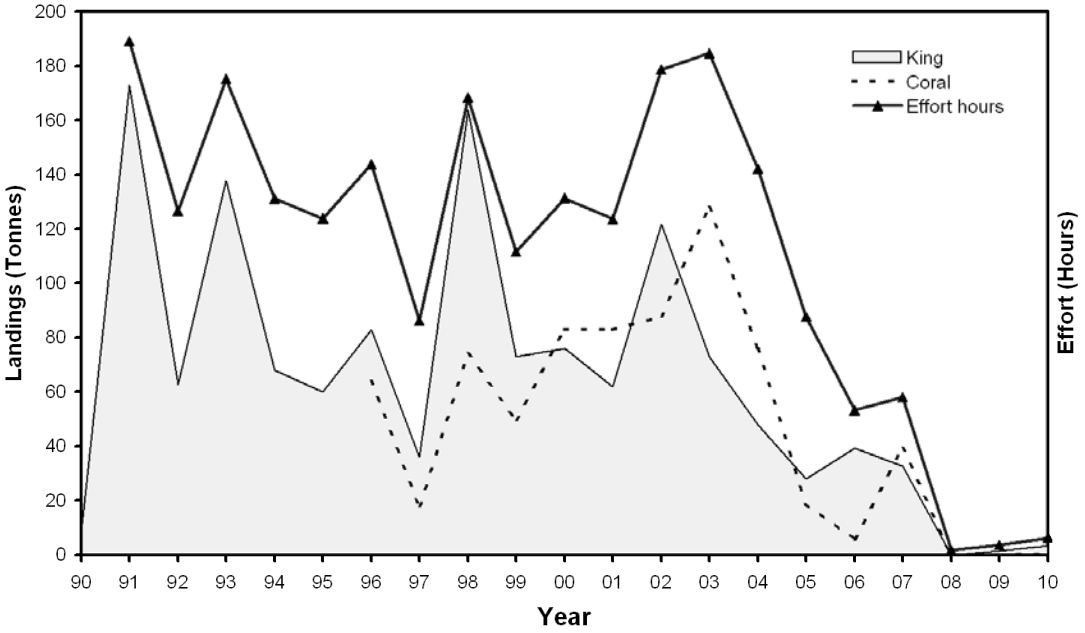
NORTHERN PRAWN FIGURE 5

Annual landings and number of boat days (from 2000) for the Onslow Prawn Managed Fishery, 1990 – 2010.



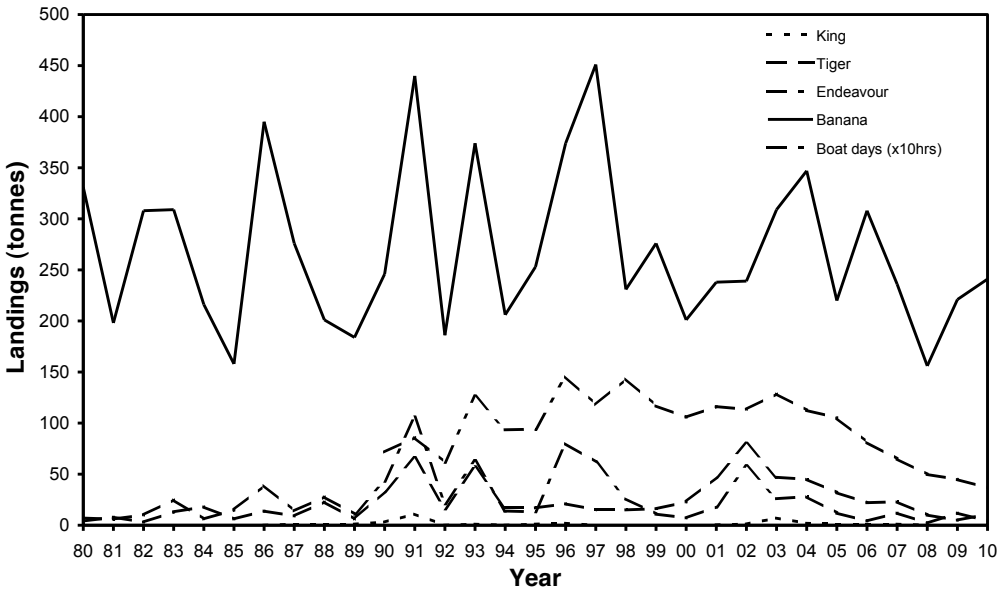
NORTHERN PRAWN FIGURE 6

Annual landings and boat days (from 2000) for the Nickol Bay Prawn Managed Fishery, 1990 – 2010.



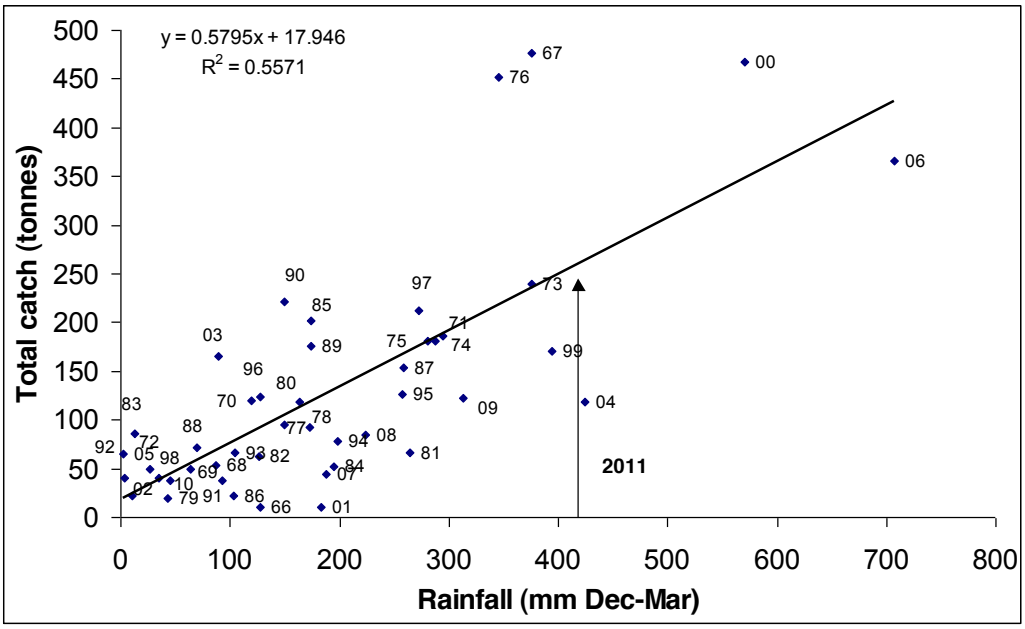
NORTHERN PRAWN FIGURE 7

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990 – 2010.



NORTHERN PRAWN FIGURE 8

Annual landings and number of boat days (from 1990) for the Kimberley Prawn Managed Fishery, 1980 – 2010-.



NORTHERN PRAWN FIGURE 9

Relationship between banana prawn landings in Nickol Bay and rainfall between December and March for 1966 – 2010 with rainfall level for 2011 indicated.

North Coast Nearshore and Estuarine Fishery Status Report

Main Features

Status		Current Landings	
Stock levels	Acceptable	Total	150.9 t
		Barramundi	57.1 t
Fishing Levels	Not Acceptable	Threadfin	83.3 t
		Recreational	2-10% of total (last estimate 2000)
		Charter	< 5 t (barramundi and threadfin)

Fishery Description

Commercial

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) operates in the nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129ºE) to the top of Eighty Mile Beach, south of Broome (19ºS). 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 19ºS.

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

Recfishwest

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´south 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 21º46'S latitude and east of 114º50'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 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, 123º08.23´ 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.

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).

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 17º27′ S and the lower Ord River upstream of Adolphus Island.

In March 2007, representatives from the commercial, recreational and charter fishing sectors negotiated 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, sustainable harvesting and sectoral shares of barramundi and threadfin stocks in the Kimberley region.

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, maximum size limit of 800mm); Broome area (bag limit of 1 fish, possession limit of 2 fish); and the Ord River area (bag and possession limit of 1 fish, maximum size limit of 800mm). 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 (e.g. Barramundi) or species group specific (e.g. mullet). 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 and threadfin populations 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 was defined in FRDC Project 2007/032 (Welch et al. 2010).

Retained Species

Commercial landings (season 2010):

All species	**150.9 tonnes**
Barramundi	**57.1 tonnes**
Threadfin	**83.3 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) became totally protected under the *Fish Resources Management Regulations 1995* in December 2005 and may no longer be retained by this fishery, and are released alive wherever possible.

The total reported catch of all species in the KGBF in 2010 was 151t (Kimberley Gillnet Figure 2). The total landings of barramundi from all four prescribed fishing areas within the KGBF were 57.1 t for 2010 (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 3), a slight decrease on the reported catch of 59.6 t in 2009, which is the highest recorded catch since 1987. The 2010 landings of threadfin from the KGBF were 83.3 t (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 4). Although slightly lower than in 2009, this is still a relatively high level of catch. The composition of the KGBF catch in 2010 is summarised in Kimberley Gillnet Table 2.

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[1]). 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 2010 was estimated to be approximately 3.3 t of barramundi and less than 1.0 t of threadfin. The total charter vessel catches in 2010 are estimated at less than 5 t of barramundi and threadfin.

Fishing effort/access level

Commercial

Procedures to validate and standardise reported fishing effort in the KGBF were developed by McAuley et al. (2005)[2].

[1] 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

[2] McAuley, R., Lenanton, R. Chidlow, J., Allison, R. and Heist, E. 2005. Biology and Stock Assessment of the Thickskin

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 2010, the total effective effort across the four prescribed fishing areas 2059.5 km gn.hr-1, which is a significant increase on the 2009 effort figure of 1542.6 km gn.hr-1 (Kimberley Gillnet Figure 2), and the highest level of effort reported since 1992. There may be considerable latent effort in the KGBF.

Recreational
Not assessed this season.

Stock Assessment

Assessment complete:

Barramundi **Yes**

Threadfin **Yes**

Assessment method and level:

Level 2 - Catch Rate

Breeding stock levels:

Barramundi **Acceptable**

Threadfin **Acceptable**

The overall increased levels of catch of both barramundi and threadfin in the KGBF during the last 3 years is predominantly due to a marked increase in fishing effort in the Cambridge Gulf and Kimberley Coast (62% increase from 2009 to 2010) regions, and to a lesser extent King Sound. Fishing effort in the Broome Coast region (Roebuck Bay) has remained stable during the past three years by comparison. The increased level of effort in the other regions appears to be the result of new operators in the fishery.

The catch rates for both barramundi and threadfin in the KGBF decreased in 2010. The catch rate for barramundi in 2010 fell to 27.7 kg/km gn.hr-1 (35.5 kg km/gn.hr-1 in 2008, 38.8 kg km/gn.hr-1 in 2009) (Kimberley Gillnet Figure 3), while the catch rate for threadfin fell to 40.4 kg/km gn.hr-1 (65.5 kg km/gn.hr-1 in 2008, 58.6 kg km/gn.hr-1 in 2009) (Kimberley Gillnet Figure 4).

Continuing high levels of catch and effort will need to be monitored closely for both these species across all regions, particularly given the decreased catch rates for barramundi and threadfin in 2010. The 2010 catch and effort data highlight the 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. The re-evaluation of targeted effort, and factors such as species – specific targeting by fishers on catch rates need to be investigated and incorporated into any such assessment. There is the potential for localised depletion risks to threadfin populations given their fine scale spatial stock structure.

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 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 speartooth 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 overall 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. Any increase in effort levels inside freshwater drainages will need to be monitored.

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.

(Sandbar) Shark, *Carcharhinus plumbeus*, in Western Australia and Further Refinement of the Dusky Shark, *Carcharhinus obscurus*, Stock Assessment. Final Report to the Fisheries Research & Development Corporation for FRDC project no. 2000/134. Fisheries Research Report no. 151. Department of Fisheries, Government of Western Australia. Perth.

Social Effects

Commercial

During 2010, seven vessels fished in the KGBF with an average crew level of approximately 2.3 people, with an estimate of at least 16 people 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 2010: $1.1 Million

The KGBF landed a total of 151 t of fish in 2010, for a catch value of approximately $1.1 million. This estimate is based on the landed weight of each species recorded in the CAES system and the most recent data available on average prices per kilogram of whole weight of each species as supplied by fish processors.

Fishery Governance

Target commercial catch range:

Barramundi 25-40 tonnes

Current Fishing (or Effort) Level Not Acceptable

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 suggesting higher abundance levels than during the 1980s and 1990s. The barramundi catch in 2010 was above the target range for the third successive year. The catch rate for this species is now declining and the overall catch rates for the fishery are also declining. Therefore a review of the fishery is recommended. This review should include the status of the barramundi stock, the current fishing and effort levels, the target catch range for barramundi along with the development of a target catch range for threadfin.

New management initiatives (2011/12)

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 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. the amount of rainfall). These stocks will be 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.

In addition, the introduction of marine parks across the Kimberley region has the potential to concentrate fishing effort from multiple sectors into those areas that are easily accessible, further increasing sustainability risks to barramundi and threadfin stocks.

Contributors

S.J. Newman, C. Skepper, G. Mitsopoulos, R. McAuley and R. Green.

KIMBERLEY GILLNET TABLE 1

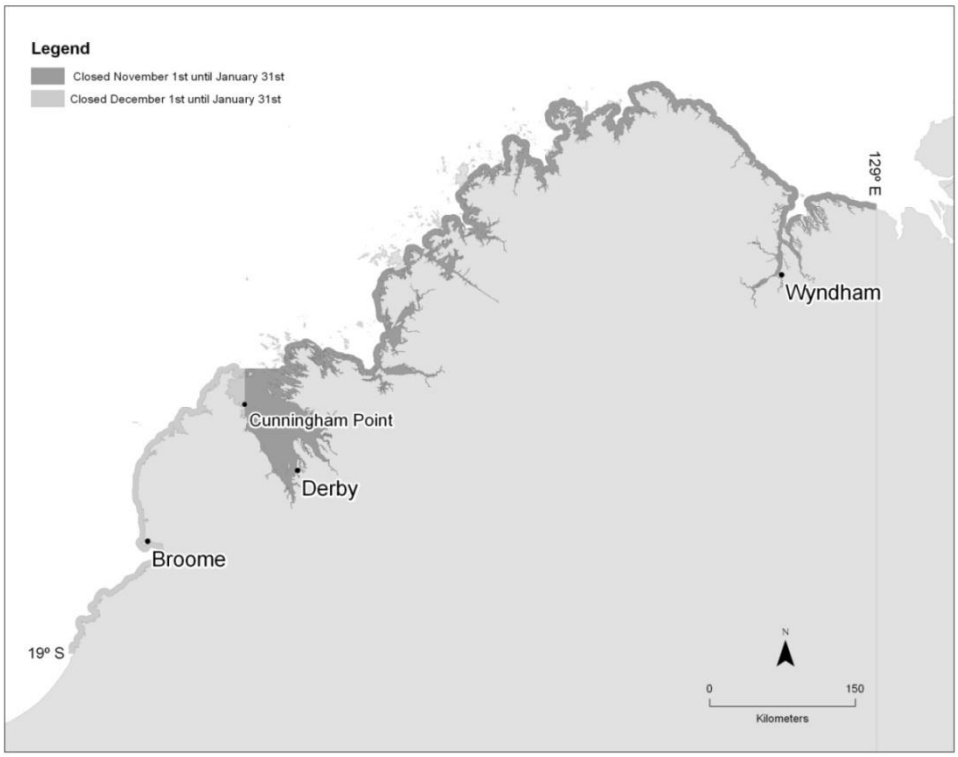
Annual catches of the major target species by the KGBF from 1999-2010.

Species	Kimberley Gillnet Annual Catch (tonnes)											
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Barramundi	41.2	42.9	38.8	39.5	45.0	53.5	35.6	36.3	27.2	54.8	59.6	57.1
Threadfin	109.8	66.7	50.9	76.4	94.1	75.8	70.6	67.7	78.5	101.2	89.9	83.3
Total	160.4	120.7	100.5	124.4	148.0	136.1	117.8	109.9	111.4	165.6	167.3	150.9

KIMBERLEY GILLNET TABLE 2

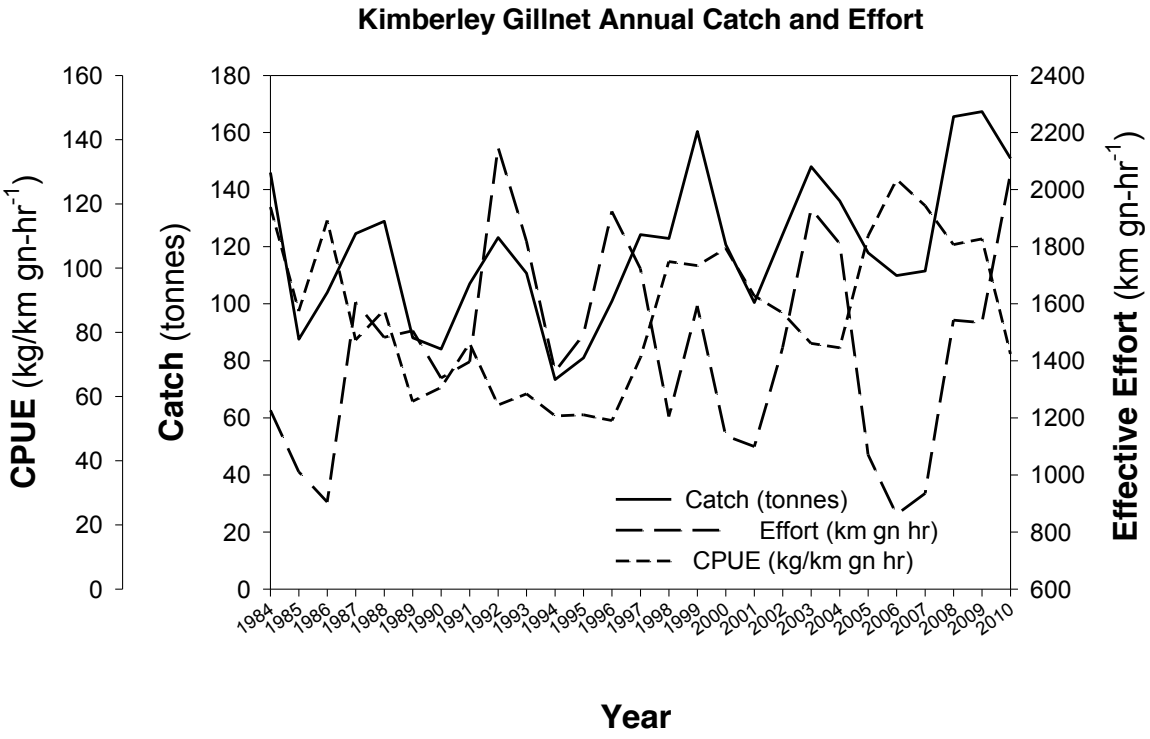
Summary of the reported catch (t) in the KGBF in 2010 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin	83.3	55.2
Barramundi	57.1	37.8
Tripletail	3.4	2.2
Black jewfish	4.3	2.9
Sharks and rays	1.3	.9
Other fish	1.5	1.0
Total	150.9	100



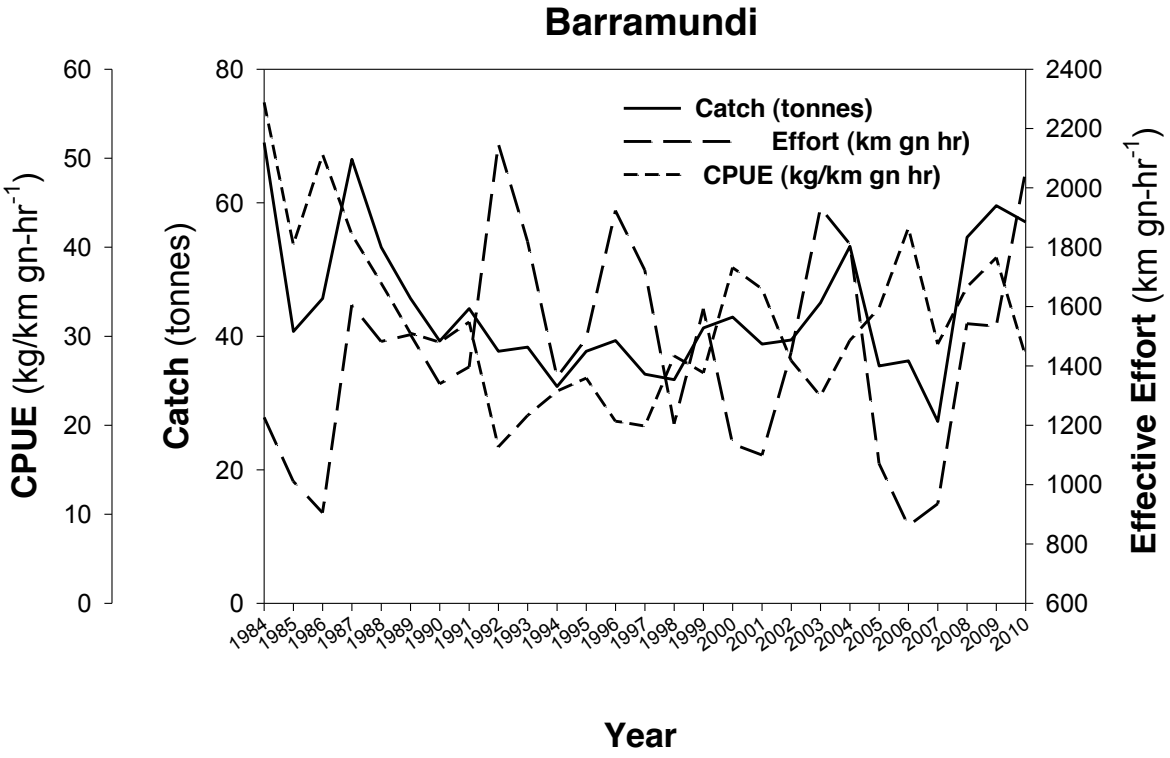
KIMBERLEY GILLNET FIGURE 1

Location and extent of the KGBF within the Kimberley region of Western Australia. Note: this map is indicative only



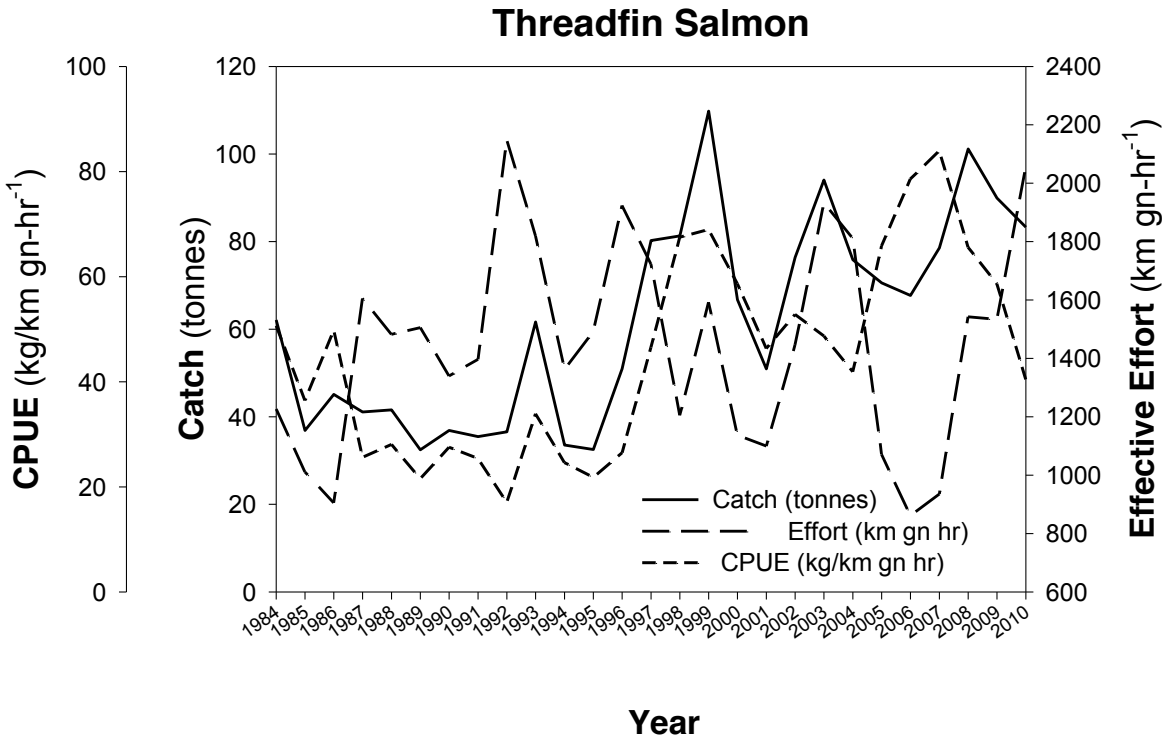
KIMBERLEY GILLNET FIGURE 2

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 2010.



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 2010.



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 2010.

North Coast Demersal Fisheries Status Report

Main Features

Status

Pilbara:

Stock level	Acceptable
Fishing Level	
Trawl Fishery	Not Acceptable
Trap Fishery	Acceptable
Line Fishery	Acceptable

Kimberley:

Stock level	Acceptable
Fishing Level	Acceptable

Current Landings

Total North Coast Demersal landings	2,981 t
Pilbara:	
Total	1,865 t
Red emperor	167 t
Rankin cod	68 t
Bluespotted emperor	254 t
Pilbara Fish Trawl Fishery	1,259 t
Pilbara Fish Trap	489 t
Pilbara Line	117 t
Charter (Recreational)	< 25 t (2.5% of total)
Kimberley (NDSF):	
Total	1,116 t
Red emperor	142 t
Goldband snapper	523 t
Charter (Recreational)	< 5 t (1.5% of total)

Fishery Description

There are a number of commercial and recreational fisheries that operate in this region which target, to varying degrees, the following tropical, demersal fish species (in order of gross tonnage); goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), saddletail snapper (*Lutjanus malabaricus*), crimson snapper (*Lutjanus erythropterus*), rosy threadfin bream (*Nemipterus furcosus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), spangled emperor (*Lethrinus nebulosus*) and frypan snapper (*Argyrops spinifer*). Each of these fisheries is outlined below.

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, which collectively use a combination of vessels, time, gear limits plus spatial zones (including extensive trawl closures) as management measures. The Trawl Fishery lands the largest component of the catch of demersal finfish in the Pilbara (and North Coast Bioregion) targeting all the main demersal species, with smaller subsets of species taken by the Trap and fewer still by the Line Fishery.

Kimberley

The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the northwest 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, but since 2002 it has essentially been a trap based fishery which uses gear time access and spatial zones as the main management measures. The main species landed by this fishery are red emperor and goldband snapper.

Recreational

Recreational fishing activities on these species are mostly line based fishing from boats which are concentrated in inshore areas around key population centres, with a peak in activity during the dry season (winter months, April/May to September/October).

Governing legislation/fishing authority

Commercial

Pilbara

Pilbara Trap Managed Fishery Management Plan 1992

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:

Western Australian Fishing Industry Council (WAFIC); and

Licensee meetings for the Fish Trawl, Trap and Line Fisheries

Kimberley

WAFIC

Department – industry meeting for the NDSF and the annual Broome Consultative Forum.

Recreational

Department - in liaison with:

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 in Zone 2 is 14,980 square nautical miles, however, only 6,900 square nautical miles are currently open (~46% of Zone 2 is currently open to trawling). This represents less than 5% of the total area available in the North Coast Bioregion. 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 120E. 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) 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 (now formalised under an Exemption), the offshore sector (Area 2) has been further divided into 3 zones; A, B and C. Zone B comprises the area of most 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 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 21º46'S latitude and east of 114º50'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 (1998). 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 Interim 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 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 ports).

There are 11 permits for the Fishery, with the combined effort allocations being consolidated over time onto 3 full 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 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 5,456 trap days. However, the Management Plan allows the Chief Executive Officer to alter the value of these units. There are 6 licences in the Fishery, with the allocation consolidated onto 3 vessels.

The Line Fishery is managed under 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 ESD assessments were submitted to the Australian Govt. agency now called SEWPaC 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 is an approved Wildlife Trade Operation until June 2013.

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 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 waters of the NDSF.

The notional target TAC for Zone B is a recommended level of catch for the entire demersal species suite 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 2010, Zone B effort allocation was 1,038.4 standard fishing days.

The areas that encompass Zone A and Zone C are likely to have a lower sustainable catch compared with Zone B, and thus exploratory TACs are set for Zone A and Zone C. These will need to be revised as effort and catches in these zones increase. In 2010, 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 2010, 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 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

The recreational fishery for demersal fish in the North Coast Bioregion is managed in a similar manner to other Bioregions across the State through the use of input controls (e.g. size limits) and output controls (e.g. limits on the numbers of fish that can be taken by individuals and boats – these are assigned based on a number of risk categories).

From 2 March 2010 all persons fishing from a powered boat anywhere in the state have been 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 in 2012.

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 11 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 (red emperor, Rankin cod, bluespotted emperor, brownstripe snapper and goldband snapper) using various assessment methods constituting a weight-of-evidence approach. These methods include trend analysis of trawl catch rates using two measures of effort (time spent trawling reported in logbooks and time spent in each management area derived from VMS) for five indicator species and the total catch in each of the trawl-managed

areas. In addition, ages are determined from otolith sections for the indicator species in each of the trawl-managed areas and the Trap Fishery, and for ruby snapper from the Line Fishery.

Estimates of fishing mortality are derived from age structures and compared to internationally recognised benchmarks or reference points (see Stock Assessment section). Approximately every 4-5 years the spawning biomass of two indicator species, red emperor and Rankin cod, are assessed using the age-composition and catch rate data in an integrated age-structured model. In 2010, a fishery independent research survey was conducted which was aimed at describing the demersal fish assemblages associated with trawl, trap and closed management areas.

Kimberley

Assessment of the status of the demersal fish stocks in Zone B of the NDSF is determined annually using catch and catch rates of the major species or species groups, and every 4-5 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 previous years. Ongoing monitoring of this fishery is being undertaken using both catch and effort logbook and VMS data.

The catch from the NDSF also includes components from Zone A of the fishery. This zone has a somewhat similar catch composition to Zone B of the fishery. The level of catch from Zone A will be monitored as this area of the fishery is developed.

The catch from the NDSF also includes at times 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 productivity of these longer-lived, deeper-slope reef fish, the sustainable catch from this zone is likely to be lower than for Zone B.

Retained Species

Commercial landings (season 2010):

Pilbara Fish Trawl	**1,259 tonnes**
Pilbara Fish Trap	**489 tonnes**
Pilbara Line	**117 tonnes**
Kimberley (NDSF)	**1,116 tonnes**

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 2010 are summarised in North Coast Table 9. The relative contribution of the Kimberley sector has been increasing as the catch from the Pilbara sector has been declining.

Pilbara

The fish trawl catch increased slightly in 2010 but remained below the target catch range (North Coast Tables 1 and 2). The increase in catch is thought to be a result of improving catch rates following substantial reductions in effort since 2007, which have allowed stocks to rebuild. The major target species landed by the trawl fishery in 2010 (2009 catch in brackets) were rosy threadfin bream 187 t (165 t), bluespotted emperor 164 t (108 t), crimson snapper 93 t (92 t), goldband snapper 63 t (69 t), red emperor 76 t (66 t), brownstripe snapper 76 t (62 t), saddletail snapper 50 t (51 t), Rankin cod 14 t (13 t) and spangled emperor 15 t (10 t). The total retained by-product was 32 t (37 t) including bugs, cuttlefish, and squid (North Coast Table 2).

The Trap Fishery catch increased from 455 t in 2009 to 489 t in 2010, but remained within the 400-500 t target catch range (North Coast Tables 1 and 2). Major species taken by the trap fishery in 2010 (2009 figures in brackets) were red emperor 89 t (92 t), crimson snapper 48 t (71 t), bluespotted emperor 90 t (65 t), Rankin cod 52 t (60 t), goldband snapper 37 t (31 t) and spangled emperor 20 t (15 t).

Demersal scalefish catches taken by line fishing in 2010 were slightly less than that reported in 2009 (North Coast Tables 1 and 2). Catches of goldband snapper in 2010 were similar to 2009, 17 t and 15 t, respectively (North Coast Table 1). The catch of ruby snapper by the Pilbara Line Fishery continue to increase, rising from 12 t in 2008, 37 t in 2009 to 56 t in 2010. This fishery and the Commonwealth's North West Slope Trawl Fishery are likely to be targeting the same stock (management unit) of ruby snapper, so catches from both commercial fisheries will need to be considered in any future assessment or harvest strategy.

Kimberley

After the initial development period from 1990 to 1992, the catch of the NDSF reached the first peak in catch (> 900t) in 1996 before declining to levels of about 500 t in 2003 (North Coast Figure 4). The total catch began to increase again in 2003 and the 2010 catch of 1,116 t is the highest recorded, mainly to increased levels of catch from Zone A of the fishery (North Coast Tables 6 and 7).

The NDSF principally targets red emperor and goldband snapper, with a number of species of snappers (Lutjanidae), cods (Epinephelidae) and emperors (Lethrinidae) comprising the majority of the remainder of the catch (North Coast Table 6). The species composition of the landed catch in 2010 is similar to that reported in 2009. In 2010 the total catch of red emperor was 141 t, down from the reported catch of 156 t and 173 t in 2009 and 2008 respectively. There was an increase in the landed catch of goldband snapper up from 485 t in 2009 to 523 t in 2010 (457 t in 2008), as well as a slight increase in the cods/groupers catch, up from 142 t in 2009 to 153 t in 2010 (148 t in 2008). Rankin cod dominates the composition of the cod/grouper catch complex. The catch of Rankin cod increased from 45 t in 2009 to 49 t in 2010 (North Coast Table 7).

The catch rates of red emperor in Zone B from 2005 to 2010 have been relatively stable, however, there has been a slight declining trend in catch rates from 2007 to 2010 (North Coast Figure 5). In contrast, the catch rates for goldband snapper in Zone B have increased steadily from 2006 to 2009 (North Coast Figure 6) and have been stable from 2009 to 2010. Similarly, the catch rates of the cod/grouper complex in Zone B have been increasing since 2002 (North Coast Figure 7).

The 2010 catch of red emperor and cods/groupers were within acceptable levels as defined in the Export exemption for this fishery (see 'Fishery Governance' section), while the catch of goldband snapper exceeded the trigger point (20% increase in average catch of the previous 4 years).

Recreational catch estimate (season 2010):

Pilbara	**2.5%**
Kimberley	**<1.5%**

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 demersal scalefish fisheries. The reported charter vessel catch of demersal scalefish in the offshore waters of the Pilbara (depth > 30 m) in 2010 is estimated to be ~1.6% (~29 t) of the commercial catch. Due to the increasing population in the Pilbara from mining developments, catches are likely to increase in the future.

Kimberley
Historically, there has been little recreational or charter boat fishing effort directed towards the demersal fishes in Area 2 of the NDSF, the species that are targeted by commercial fishers. However, this is now changing with charter vessels moving into the inshore demersal waters of the NDSF. The reported charter vessel catch of demersal scalefish in the inshore demersal waters of the NDSF (depth > 30 m) in 2010 is estimated to be less than 1% (~8.2 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 people associated with oil and gas developments in the Kimberley region has the capacity to significantly increase the level of recreational catch taken from nearshore and inshore demersal 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, along with the time spent in each management area derived from VMS data.

The trawl fleet had the equivalent of three full-time vessels. The percentage of allocated hours used by the trawl fleet during the 2009/10 season were 79.0% in Area 1, 94.2% in Area 2, 100.6% in Area 4 and 85.2% 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 (North Coast Figure 1).

In 2010, trap fishers were allocated 5,457 trap days (capacity is set in trap days with a value per unit of 1 unit = 1 trap day), with 93% of the units used as calculated from the VMS.

In 2010, line fishers reported operating for 366 days, compared with 282 days in 2009.

Kimberley
The seven fish trap vessels that fished in the NDSF in 2010 reported using between 19 and 35 fish traps per day. Line fishing has not been reported since 2002 and no line fishing was undertaken in Zone B of the NDSF in 2010. Effort increased in 2010 to 1,178 days, the highest since 2007 (North Coast Table 8).

The total effort allocated in Zone B in 2010 was 1,038.4 standard fishing days (i.e. using 20 traps) (North Coast Table 8). The number of standard fishing days (SFDs) recorded in Zone B using VMS data was 936 SFD's (90%). That is, 10% of effort allocated to Zone B in 2010 was not used. A total of 616 standard fishing days was allocated to Zone A in 2010. The number of SFDs recorded using VMS data was 237 SFD's (38%), indicating that 62% remained unutilised in Zone A at the end of the season. Thus, some latent effort exists in this fishery.

Stock Assessment

Assessment complete:

Pilbara	**Yes**
Kimberley	**Yes**

Assessment method and level:

Pilbara

Level 1 - Catch and effort statistics (Annual)
Level 2 - Catch rates (Annual)
Level 3 - Fishing mortality (Periodic - 2007)
Level 5 - Age Structured model (Periodic - 2007)

Kimberley

Level 1 - Catch and effort statistics (Annual)
Level 2 - Catch rates (Annual)
Level 5 - Age Structured Model (Periodic -2007)

Breeding stock levels:

Pilbara

Trawl Fishery	**Acceptable**
Trap Fishery	**Acceptable**
Line Fishery	**Acceptable**
Kimberley	**Acceptable**

Pilbara
There are four tiers of assessment used in the Pilbara, that when combined constitute a weight-of-evidence approach to determine overall stock status based on the performance of indicator species that represent the entire demersal suite of species. Four different tiers of assessment (see How to Use This Volume for more details) are applied to the indicator species of this suite. Catch rate analyses are used to assess five indicator species and the total combined retained catch on an annual basis. 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 with natural mortality[1] on a periodic basis with the last analysis completed using 2008 data. An age-structured model incorporating catch rates, catch history and age structure data is used to assess spawning biomass levels for red emperor and Rankin cod also on a periodic basis (5 year) with the last assessment completed in 2007.

Catch Rates: Catch rates are derived from logbook catch data and adjusted according to the unload data, so that catches match reported unloads with the area component obtained from 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 derived from VMS data. VMS data have only been available since 2000. Catch rates were calculated using the adjusted catch divided by effort (separately for both methods) by area for each trip. A moderate efficiency increase (0-4% per year) is applied to nominal catch rates based on trawl-time as this level of efficiency increase is typical for many trawl fisheries internationally.

Mean trawl catch rates of the indicator species and the total catches decreased annually from 2004 to 2008 (North Coast Figures 3). Over the last one to two years (2009 and 2010) the catch rates of the indicator species (with the exception of goldband snapper) and total catch have increased to some degree but are still below the catch rate values observed prior to 2004. The increases were most evident for the two relatively shorter-lived indicator species (bluespotted emperor and brownstripe snapper) and red emperor in Area 1 and 2 (North Coast Figures 3). The catch rates of Rankin cod have had only slight increases in some Areas 1, 4 and 5 while those for goldband snapper have remained relatively constant in all management areas.

Fishing Mortality: The high rate of fishing mortality of red emperor (> ERP Limit level) in the western areas (Areas 1 and 2) of the trawl fishery (North Coast Table 4), and the declining catch rates of several species including the indicator species of 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.

Age Structured Model: The integrated age-structured model outputs for 2007 indicated the following: red emperor spawning biomass was greater than 40% of virgin biomass overall with a stable trend forecast for future years, with a declining trend in some management areas; and Rankin cod spawning biomass was greater than 40% of virgin biomass overall with a declining trend forecast for future years, with a declining trend across most management areas. This 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.

Current Assessment: The catch rates of all indicator species (except goldband snapper) and those of the total catch in 2010 are displaying signs of improvement since 2008/09, and for some indicator species this constitutes two consecutive years of increasing catch rates. This recent turn around in catch rate trends is likely to be a response from the reduced fishing effort in Areas 1, 2 and 4 since 2007. These recent increases in annual catch rates may also provide an early indication of recovery of the red emperor stocks in the western areas (Areas 1 and 2). Otoliths of the indicator species, red emperor, rankin cod, bluespotted emperor and brownstripe snapper are being collected in 2010/11 from the trawl and trap fisheries, and for ruby snapper from the line fishery. The age structures derived from these otolith collections will be used to evaluate changes in fishing mortality since the levels estimated in 2007/08 and therefore the sustainability of current exploitation levels.

Pilbara: The major performance measures for the fish stocks in the Pilbara demersal fisheries relate to breeding stock levels of the long-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 (spawning biomass was greater than 40% of virgin biomass) in 2007 by synthesising the available data in an age-structured model.

Kimberley

Assessment of the indicator species in the NDSF is also undertaken using a multitier approach. Catch and catch rates are assessed annually and an age structured stock assessment model is applied using relevant data on a periodic (5 year) basis with the last assessment completed in 2007.

Catch Rates: 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 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. In 2010, all NDSF vessels reported catch and effort using daily logbook returns. Catch per unit of effort was determined by calculating the mean CPUE from the analysis of catch and effort for every fishing trip undertaken in 2010. During 2010, Zone B catch rates for the indicator species were 132 kg/std day for red emperor, 577 kg/std day for goldband snapper and 167 kg/std day for cods/groupers. Catch rates for goldband snapper and red emperor were slightly lower than those reported in 2009 (141 kg/std day for red emperor, 582 kg/std day for goldband snapper), while catch rates for cods/groupers increased from 145 kg/std day in 2009 to 164 kg/std day in 2010.

The 2010 catch of goldband snapper continued the trend of increased catches for this species in recent years, and exceeded the ESD trigger point of a 20% increase in catch above the average of the past four years. While the increased cods/grouper catch in 2010 was above the average of the past

[1] The ERPs for long-lived (> 20 years) species include (1) the Target level, where F ≤ 2/3 the ratio of natural mortality (M), for which fishing mortality is sustainable; (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.

4 years, it remained below the trigger point. The catch of red emperor was well below the average of the previous 4 years.

Increases in catch levels are, by themselves, not very sensitive indicators of stock status but combined with the previous estimates of fishing mortality of goldband snapper being close to the upper acceptable limit, further material increase in their catch would represent an unacceptable risk given the information currently available. While several scenarios may explain the increased catches of goldband snapper in recent years, their validity should be resolved following the next collection and analysis of the representative age samples.

Age Structured Model: The spawning biomass of the key target species in the NDSF was last estimated by an age-structured stock assessment model in 2007, which indicated the spawning biomass was above the international reference point of 40% of virgin biomass but with a slight declining trend for both red emperor and goldband snapper. These model outputs were reviewed by Prescott and Bentley in 2009, they concluded that the model was appropriate for use but would benefit from modifications including the better determination of levels of model uncertainty. Improvements have been made to the model in 2009 and 2010.

Current Assessment: The most recent model based assessment estimates indicated that there was a high probability that the spawning stocks of the indicator species were both above their respective threshold levels at that time. The overall catch levels and the species based catches were all within the acceptable ranges for the fishery, noting significant increases in goldband catches since 2007. The catch rates for the indicator species were all stable or increasing and the F based assessments indicated that the fishing level on the indicator species were either lower than the target level or between target and threshold levels. Consequently the stocks for the suite of species targeted by this fishery are effectively fished and currently considered to be at acceptable levels. If catches in Zone B are maintained at current levels, there is a low likelihood that the spawning stocks of any species within this suite declining to unacceptable levels. The current risk to sustainability for this suite is therefore moderate. Zone A of the fishery continues to receive low levels of effort and catch. Therefore, there is currently a low risk to the sustainability of the fishery resources in this zone. Zone C of the fishery received very low levels of effort in 2009. Therefore, there is currently a very low risk to the sustainability of the fishery resources in this zone.

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 2010, the catches of goldband increased from 2009, and exceeded the performance indicator of a 20% increase in catch above the average catch of the preceding four years. The 2010 level of catch of cods/groupers was above that taken in 2009, and although also above the average of the previous four years, did not exceed the trigger point.

The 2010 red emperor catch was below the average of the preceding four years. The spawning biomass was greater than 40% of virgin biomass in 2007 with a slight declining trend for both red emperor and goldband snapper. All three species/groups are thus considered to currently have adequate breeding stock levels.

Non-Retained Species

Bycatch species impact:

Pilbara	**Moderate**
Kimberley	**Low**

Pilbara

An independent observer program designed to monitor bycatch and interactions with protected species 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 has recently been developed by industry and is scheduled for scientific trials in 2011/12. 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.

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 (North Coast Table 5). 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 SEWPaC. The bycatch of dolphins and turtles has remained 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 2010, the dolphin mortality rate was 4.9 per 1,000 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 2.3 per 1,000 shots (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 (shorter lived) 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. In addition, Hall and Wise (2011) demonstrated that there has been no reduction in either mean trophic level or mean maximum length in the finfish catches recorded within the Pilbara (i.e. no fishing down of the food web).

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. Furthermore, Hall and Wise (2011) demonstrated that there has been no reduction in either mean trophic level or mean maximum length in the finfish catches recorded within the Kimberley (i.e. no fishing down of the food web).

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.

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.

Pilbara: The performance measure for the fish trawl impact on the North West Shelf habitat 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.

Social Effects

Pilbara
It is estimated that 14 fishers on 3 vessels were directly employed during 2010 in the Pilbara Fish Trawl Fishery, and 8 fishers on 3 vessels in the Trap Fishery, and at least 21 fishers on 7 vessels in the line fishery. At least 41 people were directly employed in the Pilbara Demersal Scalefish Fisheries.

This fishery supplies significant amounts of fish to Perth with catches from the Pilbara fisheries dominating the Perth metropolitan markets and supporting 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
Seven vessels fished in the 2010 fishing season, with generally three crew per vessel, indicating that at least 21 people were directly employed in the NDSF. Approximately half the fish from this fishery are supplied to Perth metropolitan markets, while the other half are supplied to east coast metropolitan markets.

Economic Effects

Estimated annual commercial value (to fishers)

for year 2010:	**$20.1 Million**
Pilbara	**$10.9 Million**
Kimberley	**$9.2 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 2010 calendar year, not necessarily the individual fishery entitlement year.

Pilbara
This estimate is based on the landed weight of each species recorded in catch returns the average price per kilogram of whole weight 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 2010 was estimated to be $6.5 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 $3.6 million (fish trap) and $0.78 million (line).

Kimberley
The NDSF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery landed a total of 1,116 t of demersal scalefish in 2010, for a catch value of approximately $9.2 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	
Trawl Fishery	**Not Acceptable (review required)**
Trap Fishery	**Acceptable**
Line Fishery	**Acceptable**
Kimberley	**Acceptable**

Pilbara
In the Fish Trawl Fishery, the total catch was still well below the target catch range continuing a trend of the last three seasons which is classed as not acceptable. Given that it is unclear if this reduction is due to changed net designs or from reduced abundances in the trawled areas a formal examination is required. This may involve a revision to the target catch range for the trawl fishery 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 in 2010. The line catch was at the upper limit of the acceptable catch range in 2010.

Kimberley
For the 2010 calendar year, the total allowable effort was set at 1,038.4 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. The 2010 catches were above the reported range, given the fishing activities in Zone A and C of the fishery there is a need to review the target catch range for this fishery.

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. Of the key target species/groups, the goldband snapper catch exceeded ESD performance measures in 2010, the cods/groupers catch was above the average of the previous four years but did not exceed the ESD performance measure, while the red emperor catch remained significantly below the trigger level. Several different scenarios could explain the increased catches of goldband snapper in recent years and the validity of each of these scenarios should be resolved with the collection of the next representative age sample.

New management initiatives (2011/12)

Pilbara
The Pilbara Fish Trawl Interim Managed Fishery Management Plan cessation date was recently extended to 30 June 2013. The extension was provided to allow for the implementation of the Fisheries Research and Development Corporation (FRDC) Project 2008/048 *Reducing dolphin bycatch in the Pilbara finfish trawl fishery* recommendations, being, 1) the need for further net modifications, i.e. the installation of top opening escape hatches, to potentially further reduce dolphin capture rates; and 2) observer coverage combined with deployment of net-mounted video cameras in underwater housings for the trials, to be assessed. Following this, assessment regarding the long-term future of the Pilbara Fish Trawl Interim Managed Fishery, including consideration of moving the Fishery to "managed" Fishery status will be carried out.

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

The Commonwealth's North-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 North Coast Bioregion to all sectors, i.e. commercial, recreational and charter.

Under the Offshore Constitutional Settlement, commercial trawl vessels licensed by the Commonwealth may operate in waters outside of a line that is meant to represent the 200 m isobath as part of the North West Slope Trawl Fishery (NWSTF). However, as this line encompasses waters in Zone

B of the NDSF, any future catches by Commonwealth trawl vessels in the these waters that are shallower than 200 m will impact on the demersal fish resources of the NDSF.

Climate change and climate variability has the potential to impact fish stocks in a range of ways including influencing their geographic distribution (e.g. latitudinal shifts in distribution). However, it is unclear how climate change may affect the sustainability risk to North Coast demersal fisheries.

Pilbara

The available fishing area has decreased slightly 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 is expected to significantly affect fish catches as these closures and operations occur over a limited area.

Kimberley

The impacts of environmental variation on the fishery are not considered to be large as the target species are long-lived. Some commercial fishers within the fishery have raised concerns 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. 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.

Contributors

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NORTH COAST TABLE 1

Commercial catches (tonnes) and the percentages of each major species taken by trawl, trap and line in the Pilbara in 2010 (estimates rounded to the nearest tonne).

Species		Trawl catch		Trap catch		Line catch		Total catch
		tonnes	%	tonnes	%	tonnes	%	tonnes
Bluespotted emperor	*Lethrinus punctulatus*	164	65%	90	35%	–	–	254
Crimson snapper	*Lutjanus erythropterus*	93	64%	48	33%	5	3%	146
Rosy threadfin bream	*Nemipterus furcosus*	187	99%	2	1%	–	–	189
Brownstripe emperor	*Lutjanus vitta*	76	84%	14	16%	–	–	90
Goldband snapper	*Pristipomoides multidens*	63	54%	37	32%	17	15%	117
Red emperor	*Lutjanus sebae*	76	46%	89	53%	2	1%	167
Saddletail snapper	*Lutjanus malabaricus*	50	69%	16	22%	6	8%	72
Spangled emperor	*Lethrinus nebulosus*	15	41%	20	54%	2	5%	37
Frypan snapper	*Argyrops spinifer*	37	95%	2	5%	–	–	39
Rankin cod	*Epinephelus multinotatus*	14	21%	52	76%	2	3%	68
Ruby snapper	*Etelis carbunculus*	–	–	–	–	56	100%	56
Other demersal scalefish		484	77%	119	19%	27	4%	630
All demersal scalefish		**1,259**	**68%**	**489**	**26%**	**117**	**6%**	**1,865**

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.

	Demersal Scalefish				By-product*
Year	Line	Trap	Trawl	Total	Trawl
1985	180	168		348	
1986	65	113		178	
1987	67	192	3	262	
1988	136	243	3	382	
1989	104	457	124	685	
1990	157	407	421	985	4
1991	107	119	754	980	14
1992	63	148	1,413	1,624	21
1993	67	178	1,724	1,969	42
1994	79	207	2,506	2,792	102
1995	95	222	2,821	3,138	77
1996	136	302	3,201	3,639	102
1997	109	234	2,630	2,973	133
1998	78	250	2,512	2,840	119
1999	50	371	2,136	2,419	69
2000	59	257	1,995	2,314	80
2001	99	266	2,221	2,592	150
2002	90	306	2,310	2,706	180
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	37
2010	**117**	**489**	**1,259**	**1,865**	**32**

* By-product in 2010 consists of cuttlefish, squid, bugs, and tropical lobster.

NORTH COAST TABLE 3

Summary of the fishing effort in the Pilbara Demersal Scalefish Fisheries, 1985 to 2010. The trap, line and trawl effort (days) are derived 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	1,014	14,663
2004	816	418	953	15,372
2005	993	425	886	14,721
2006	418	467	914	15,792
2007	344	429	841	14,197
2008	278	428	831	11,966
2009	282	483	713	10,605
2010	**366**	**472**	**659**	**9,723**

NORTH COAST TABLE 4

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 5

Reported by-catch of protected species by skippers in the Pilbara trawl fishery in 2010.

	Number Alive	Number Dead*	Total Reported
bottlenosed dolphins	4	13	17
pipefish	29	88	117
sawfish, green	17	2	19
sawfish, narrow	10	3	13
seahorses	3	0	3
sea-snakes	97	7	104
Turtles	8	0	8

*Where the condition was not reported, the animal was considered deceased.

NORTH COAST TABLE 6

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)					
	2005	2006	2007	2008	2009	2010
Goldband snapper *(Pristipomoides spp.)*	429	336	393	457	485	523
Red emperor *(Lutjanus sebae)*	192	166	176	173	156	141
Saddletail snapper *(Lutjanus malabaricus)*	92	79	96	104	108	125
Spangled emperor *(Lethrinus nebulosus)*	21	28	14	18	23	30
Cod/grouper (Epinephelidae)	110	129	121	148	142	153
Other species	78	63	108	110	132	144
Total demersal scalefish catch	**922**	**801**	**908**	**1010**	**1046**	**1116**

NORTH COAST TABLE 7

Catches of major target and by-product species or species groups by zone in the NDSF in 2009 and 2010.

Species	NDSF annual catch (tonnes)			
	2009		2010	
	Zone A & C	Zone B	Zone A & C	Zone B
Goldband snapper (*Pristipomoides* spp.)	22.2	462.3	29.5	493.1
Red emperor (*Lutjanus sebae*)	34.0	121.9	41.1	100.4
Saddletail snapper (*Lutjanus malabaricus*)	14.4	93.7	21.0	104.6
Spangled emperor (*Lethrinus nebulosus*)	2.8	20.5	3.5	26.4
Rankin cod (*Epinephelus multinotatus*)	10.0	34.9	16.0	33.0
Other Cods/groupers (Epinephelidae)	14.9	82.6	23.2	80.7
Other species	38.7	93.0	65.0	78.7
Total demersal scalefish catch	**137**	**909**	**199**	**917**

NORTH COAST TABLE 8

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.

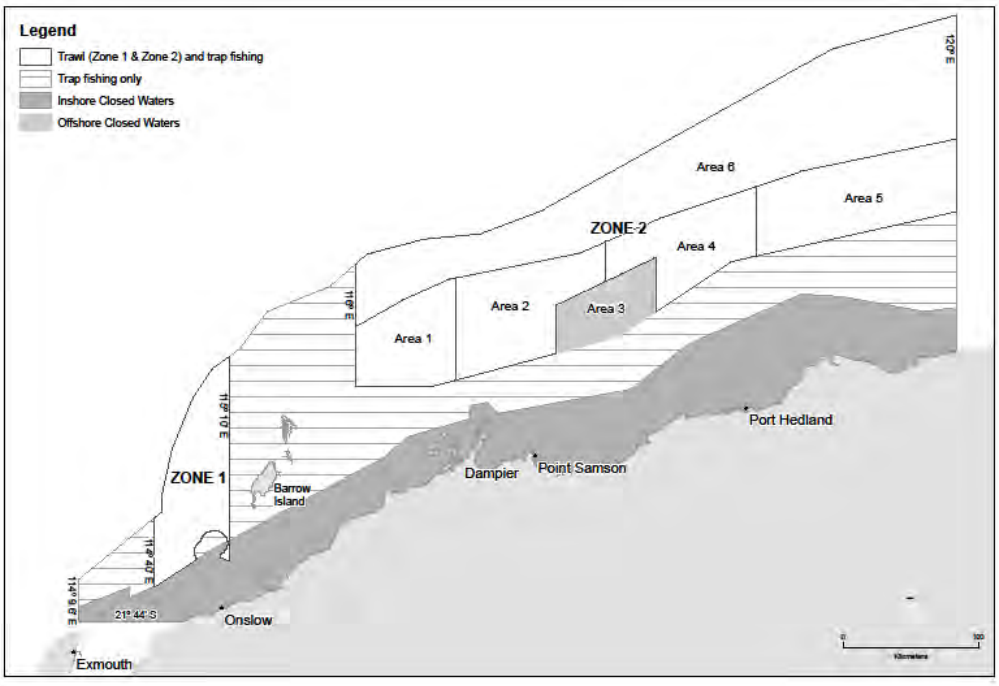
Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
1998	1,684	45	78	497	916	542
1999	1,716	91	228	486	992	577
2000	1,562	67	155	409	890	476
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	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
2010	**1038.4**	**0**	**0**	**1,116**	**1,178**	**1,116**

(2010 Estimated Catch: Zone A = 199 t, Zone B = 917 t; 2010 Estimated Effort: Zone A = 237 SFDs, Zone B = 936 SFDs)

NORTH COAST TABLE 9

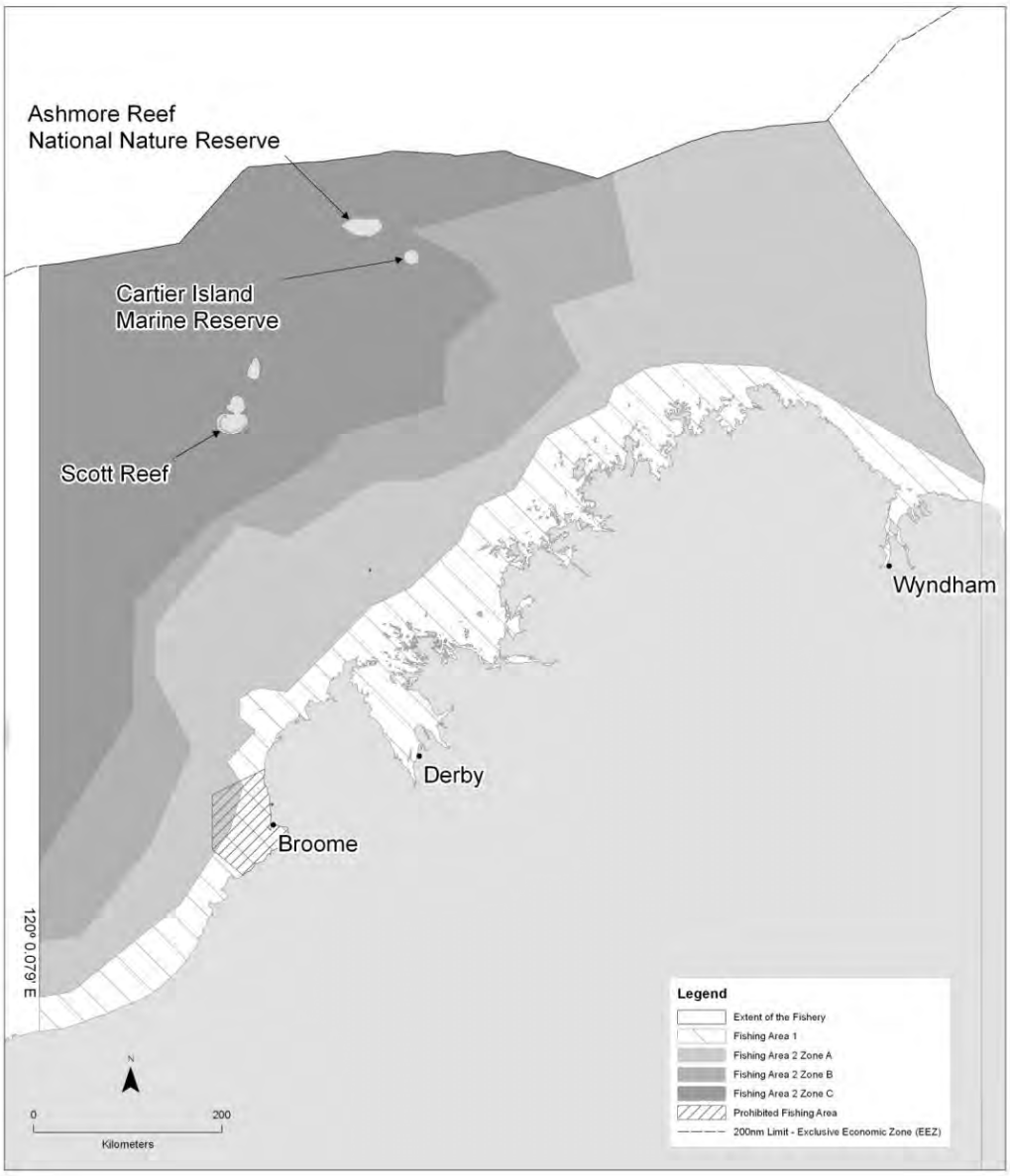
Summary of the commercial catches and the relative contribution (% composition) of each of the major species taken within the Pilbara and Kimberley sectors of the North Coast bioregion in 2010.

Species	Pilbara catch		Kimberley (NDSF) catch		Total catch
	tonnes	%	tonnes	%	tonnes
Red emperor	167	54%	141	46%	308
Saddletail snapper	72	37%	125	63%	197
Crimson snapper	146	77%	43	23%	189
Brownstripe snapper	90	93%	7	7%	97
Goldband snapper	117	18%	523	82%	640
Spangled emperor	37	55%	30	45%	67
Bluespotted emperor	254	90%	27	10%	281
Rankin cod	68	58%	49	42%	117
Frypan snapper	39	100%	<1	0%	39
Rosy threadfin bream	189	100%	<1	0%	189
Other demersal scalefish	686	80%	171	20%	857
Total all demersal scalefish	**1,865**	**63%**	**1,116**	**37%**	**2981**



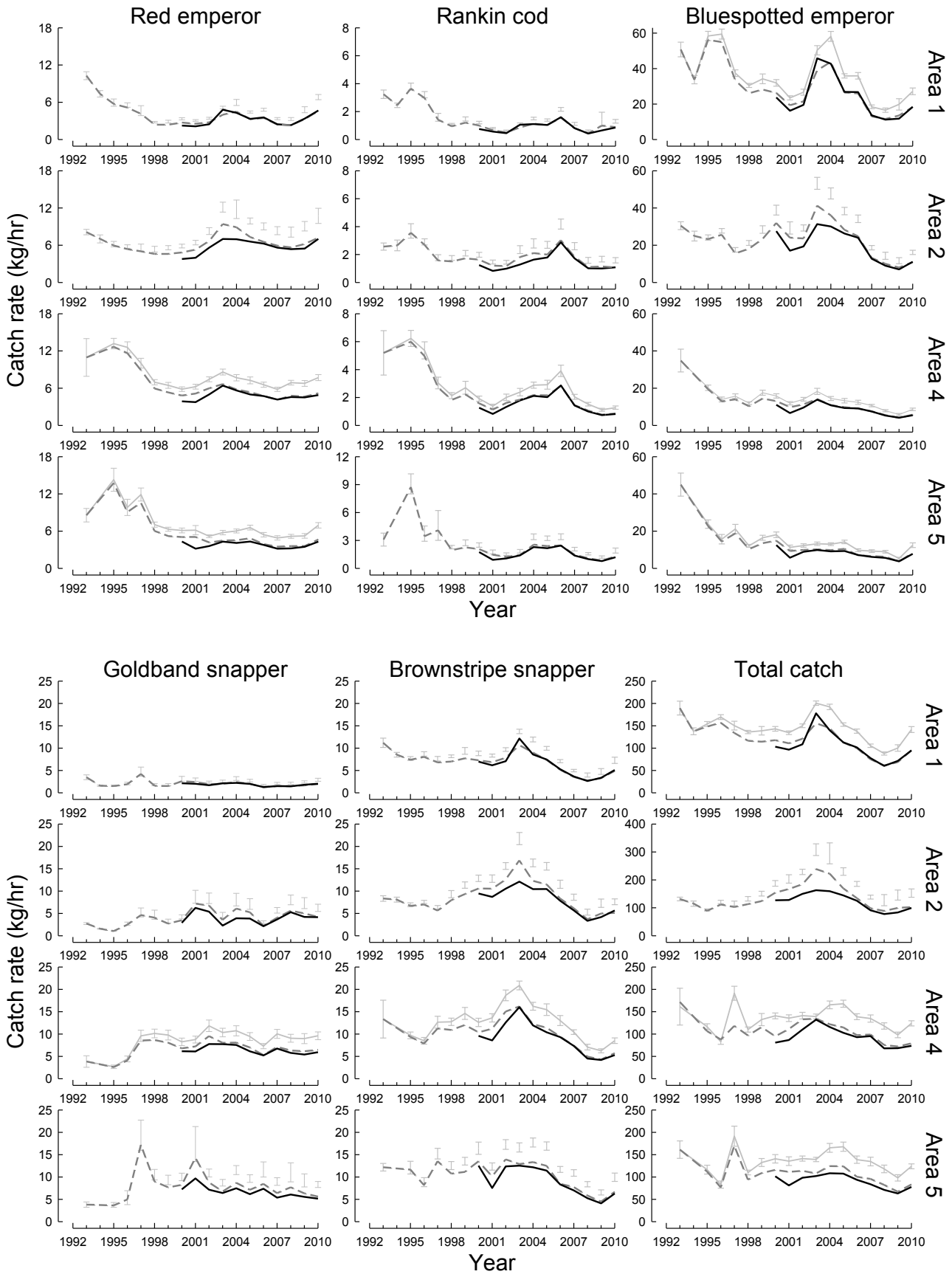
NORTH COAST FIGURE 1

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.



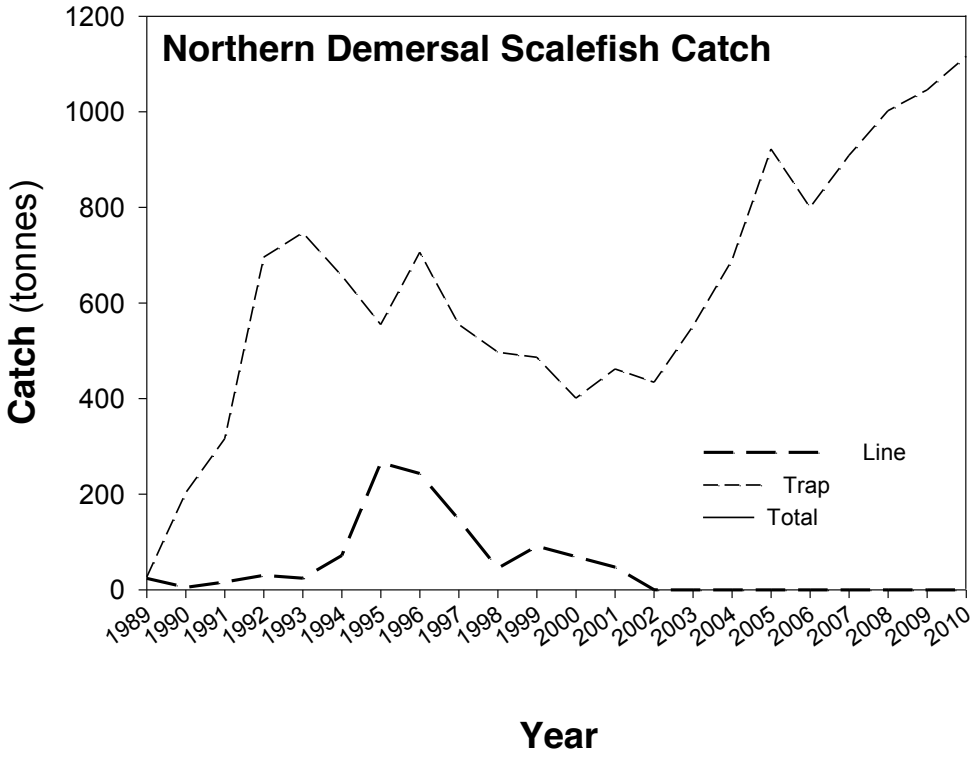
NORTH COAST FIGURE 2

Location of the Northern Demersal Scalefish Managed Fishery in the Kimberley region of Western Australia. Access areas and boundaries within the fishery are shown.



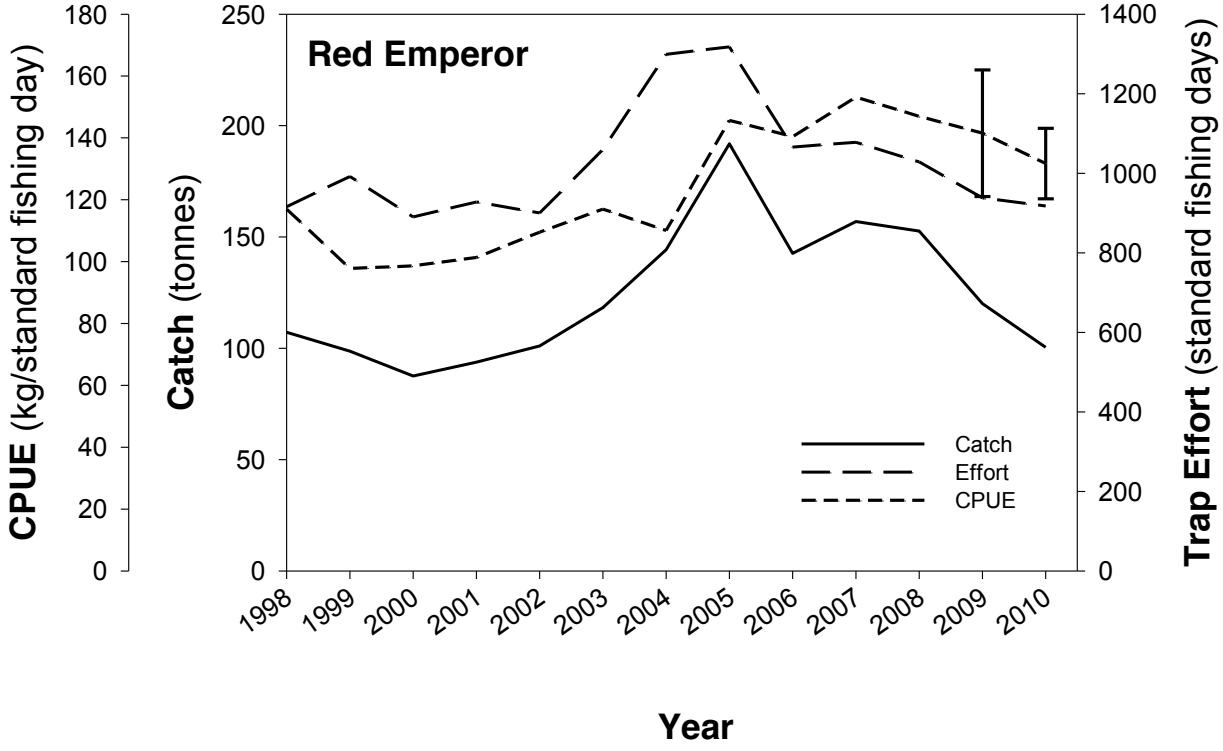
NORTH COAST FIGURE 3

Annual mean Catch Per Unit Effort (CPUE, kg/hour) for five indicator species and the total catch in Areas 1, 2, 4 and 5 of the Pilbara Trawl Fishery from 1993–2010. 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).



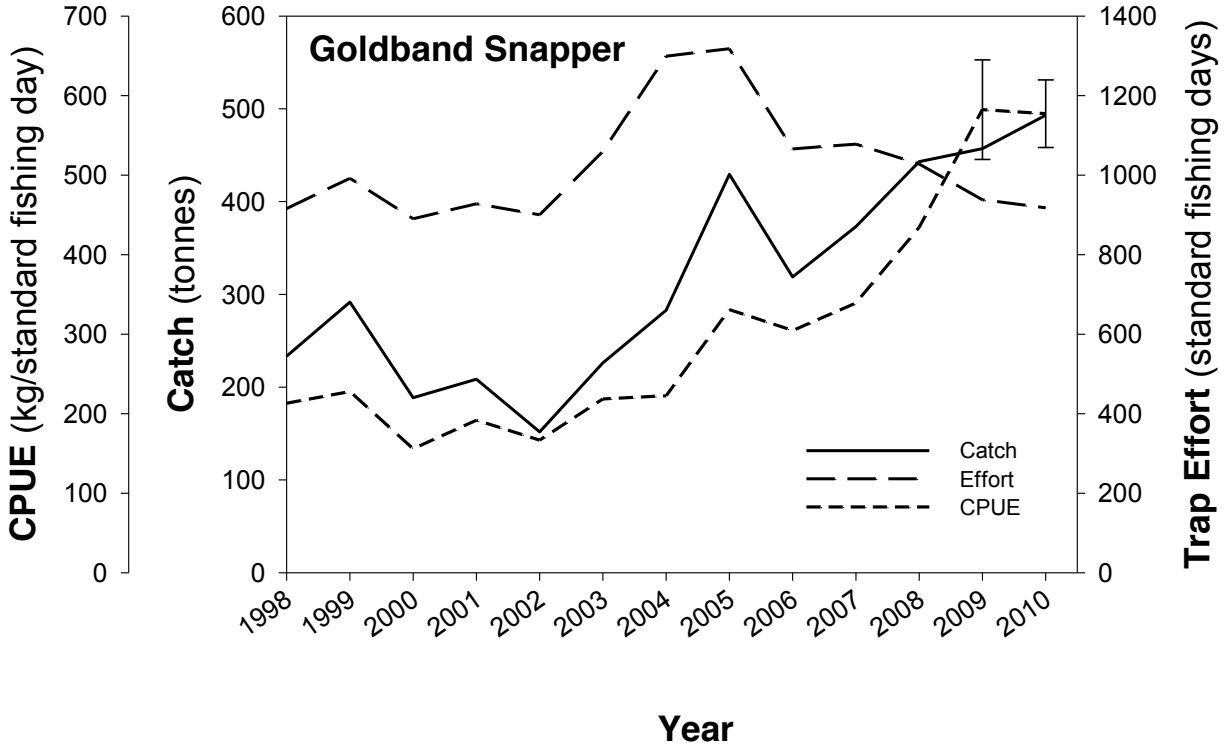
NORTH COAST FIGURE 4

Catch levels of demersal finfish in the NDSF by line and trap, 1989–2010 (All Zones).



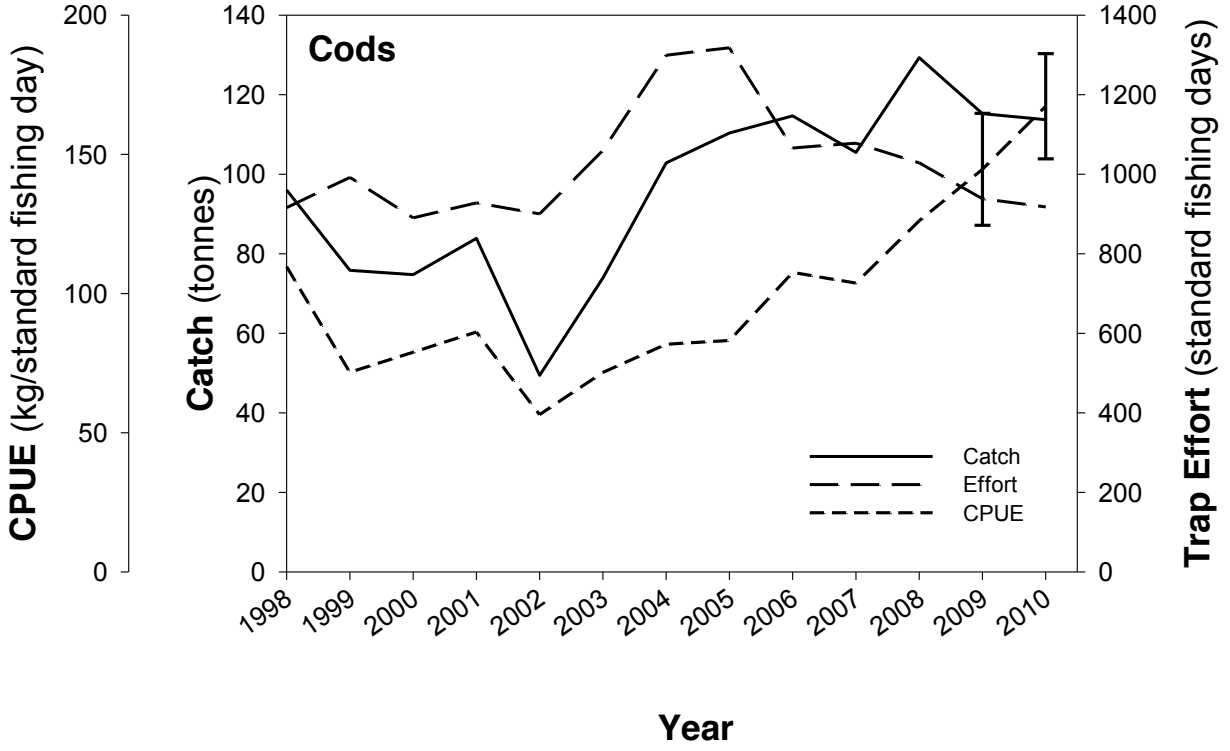
NORTH COAST FIGURE 5

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2010 (2006-2010 for Zone B only). Standard error bars 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, 1998–2010 (2006-2010 for Zone B only). Standard error bars 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, 1998–2010 (2006-2010 for Zone B only). Standard error bars illustrate variability in CPUE from two sources of catch returns (daily and monthly).

Mackerel Managed Fishery Report: Statistics Only

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 spear guns.

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 separately for three Areas: Area 1 - Kimberley (121º E to WA/NT border); Area 2 - Pilbara (114º E to 121º E); Area 3 - Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S) (Spanish Mackerel Figure 1).

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 (ITQ) 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 determined by the Chief Executive Officer. The 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.

Permit holders may only fish for mackerel by trolling or handline. There are currently 65 permits in the Fishery with 23, 21 and 21 in Areas 1, 2 and 3 (respectively), with the combined quota allocations being consolidated onto 3, 4 and 7 boats operating within Areas 1, 2 and 3 (respectively).

A comprehensive 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. 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.

Landings and Effort (Season 2010)

Spanish mackerel	**283.6 tonnes**
Grey mackerel	**9.6 tonnes**
Other mackerel	**0.9 tonnes**

Commercial

The majority of the catch is taken in the Kimberly Area, reflecting the tropical distribution of mackerel species (Spanish Mackerel Figure 2). Estimates of catches are monitored through mandatory logbook systems with the total catch of Spanish mackerel in the 2010 season estimated at 283.6 t, similar to the total Spanish mackerel catch taken in 2009 (284.2 t) but lower than the peak catches in the early 2000s. Reductions in total catches since the early 2000s reflects reductions in fishing effort across all Areas (approximately 10 – 15% reduction compared to 2010 levels) with the highest effort reductions occurring in the Gascoyne Coast Bioregion.

A total of 10.5 tonnes of other mackerel were landed in the 2010 season, including 9.6 t of grey mackerel. The catch of grey mackerel has remained at similar levels since 2001 which is well below the TAC and historical high catches of 'other mackerel' recorded in the late 1980s and 1990s.

All estimates reported do not include fish caught and released or lost to sharks.

Recreational

Catch estimates and resource sharing by this sector are currently only available through creel surveys which have occurred periodically (Spanish Mackerel Table 1). Reported annual catches of Spanish mackerel by recreational charter boats are relatively minor. New estimates of recreational catches will be available in 2012.

Fishery Governance

Target commercial catch range: 246 – 410 tonnes

The total catch in 2010 of 283.6 t was within the acceptable catch range. The reported catch from the Kimberley Area of 154.0 t was within the Area's acceptable catch range (110 – 205 t), albeit lower than in previous years. Catches in the Pilbara Area have been relatively stable since 2006 and the 2010 catch of 80.3 t is within the acceptable range (80 – 126t). Catches from the Gascoyne/West Coast Area in 2010 were 49.3 t, below the acceptable range of 56 – 79 t but similar to the range of catches from this Area since 2004 suggesting a change in this range is required.

Current Fishing (or Effort) Level: Acceptable

Fishing effort throughout the Fishery has broadly stabilised since 2006 following reductions due to management changes. This is reflected by stable (Kimberley, Area 1) or increasing (Pilbara Area 2 and Gascoyne/West Coast Area 3) catch rates in the Fishery (Spanish Mackerel Figure 2). The decline in catch rates in Area 1 (Kimberley) in 2009 and 2010 have been due to equipment issues on some vessels, as discussed by licence holders in the Annual Management Meetings.

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.

Additionally, the total catches of Spanish mackerel remain within the target range. The total catch for this Fishery has remained within the acceptable catch range since 1991.

New management initiatives (2011/12)

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 a Draft Mackerel Management Plan has recently been developed and is currently out for statutory public consultation (until end of August 2011) as required under the Fish Resources Management Act 1994. It is anticipated that the new Mackerel Management Plan will be gazetted by 31 October 2011 and will come into effect on 1 January 2012.

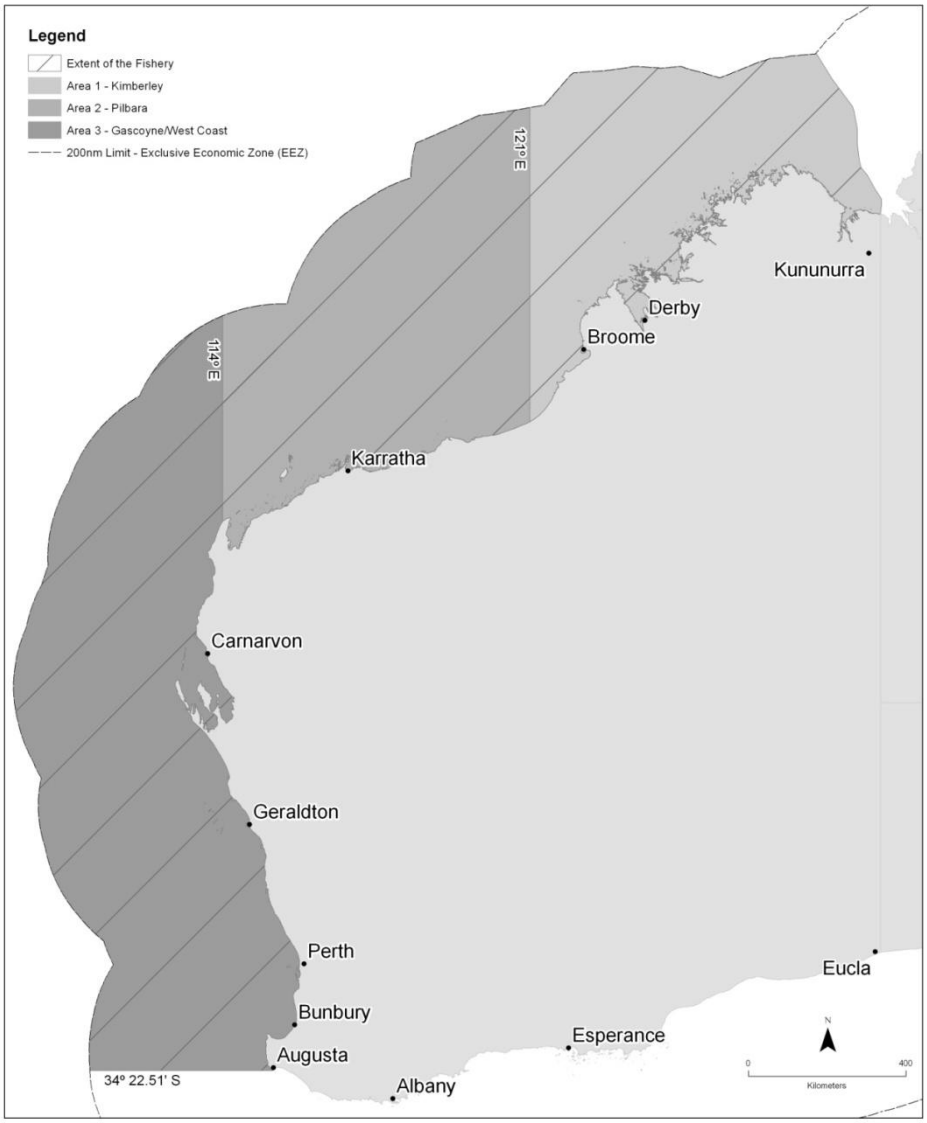
Contributors

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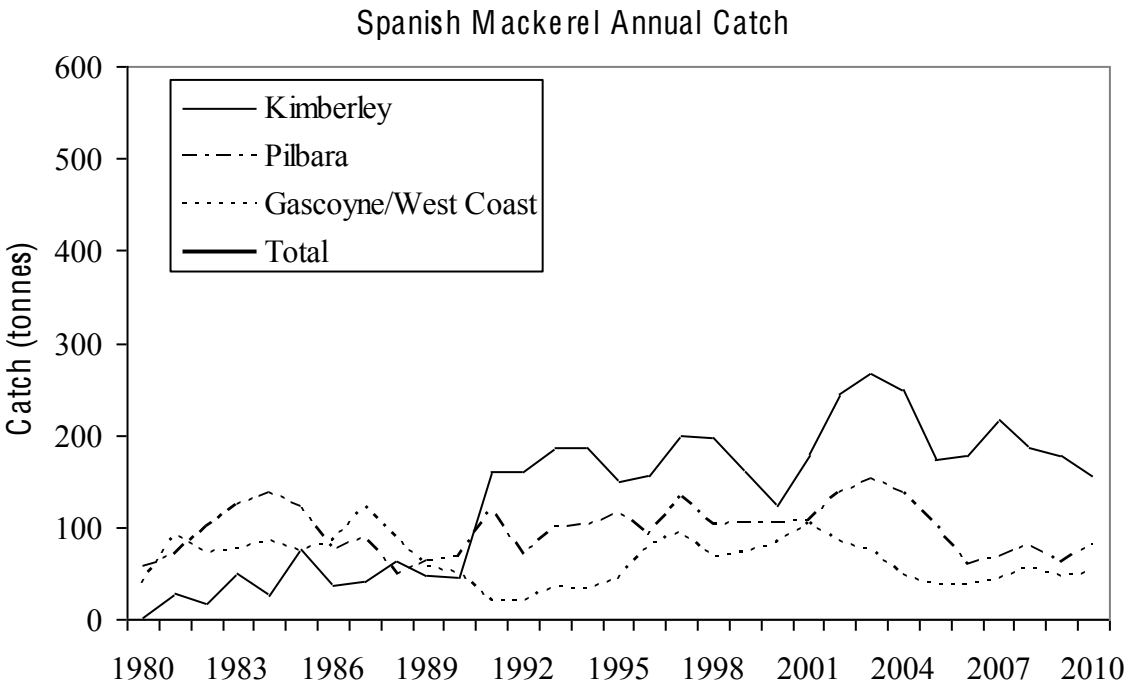
SPANISH MACKEREL TABLE 1

Recreational catch estimates of Spanish mackerel in Western Australia

Bioregion	Year	Retained catch	Share	Source
Pilbara (including Broome)	1999/2000	Spanish: 28 t Other: 11 t	21 % 15 %	Williamson et al. (2006)
Gascoyne	1998/1999	Spanish: 48 t Other: 8 t	42 % 10 %	Sumner et al. (2002)
West Coast	2005/2006	Spanish: 7 t Other: <1 t	45 % < 3 %	Sumner et al. (2008)

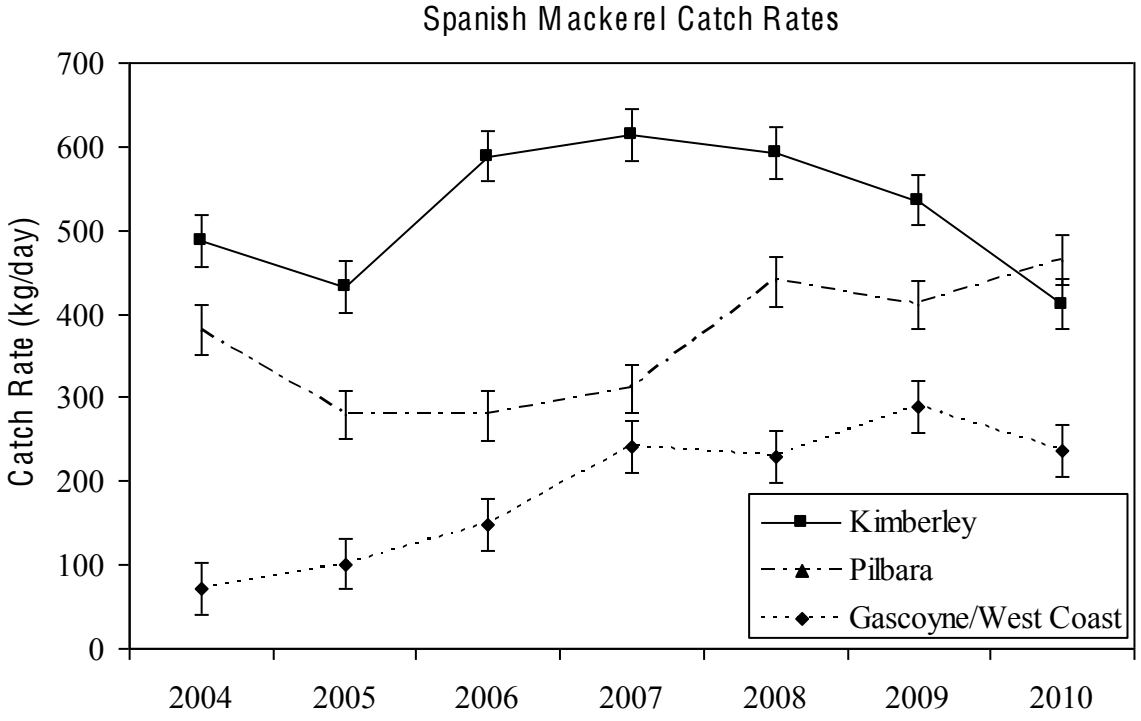


MACKEREL MANAGED FISHERY FIGURE 1
Map of the extent of the Mackerel Managed Fishery.



SPANISH MACKEREL FIGURE 2

Annual catches of Spanish mackerel in Western Australia, 1979–2010. Note:new management arrangements began in 2005 and quotas were introduced in 2006.



SPANISH MACKEREL FIGURE 3

Annualised catch rates of Spanish mackerel in Western Australia derived from daily logbooks, 2004–2010.

Northern Shark Fisheries Status Report

Main Features

Status		Current Landings	
Stock level		Total sharks (2009/10)	0 t
Sandbar shark	Unacceptable	Total scalefish (2009/10)	0 t
Blacktip sharks	Uncertain	Shark catches by other commercial Fisheries (2009/10)	4t
Fishing Level (2009/10)	Acceptable	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 was historically demersal longline with a relatively small amount of pelagic gillnetting in the JANSF. The northern shark fisheries have targeted a variety of species through their history, including sandbar *(Carcharhinus plumbeus)*, blacktip (various *Carcharhinus* spp.), tiger *(Galeocerdo cuvier)*, hammerhead (Sphyrnidae) and lemon sharks *(Negaprion acutidens)*. Due to the small number of vessels authorised to fish in the northern shark fisheries and the commonality of gear-types and target species, data from the two fisheries are combined and they are considered as a single fishery for reporting purposes. As there was no reported fishing activity in the northern shark fisheries during 2009/10, much of the following report is based on assessment of fishing returns submitted between 2006/07 and 2008/09. However, as only a few vessels reported fishing during those three years, annual catch and effort statistics cannot be reported separately and 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 and Recfishwest

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 demersal longlines and gillnets.

The solely Western Australian-managed sector of the northern shark fishery was closed by a Section 43 order under 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 entitles 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 required to report fishing activities via the 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 formal management arrangements and concerns about the fishery's ecological sustainability. In February 2009 the Wildlife Trade Operation approval that allowed the export of products from the WANCSF expired and therefore, no product from either fishery can currently 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 is currently reviewing 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 Demersal Gillnet and Demersal Longline fisheries operating in the South and West Coast Bioregions due to their targeting of the same stocks of dusky and sandbar sharks. A three-year FRDC-funded project that concluded in 2005 provided an age-structured demographic assessment of the status of the northern shark fisheries' then principal target species, the sandbar shark (*Carcharhinus plumbeus*) and an improved understanding of the fisheries and of northern shark stocks more generally. That research also confirmed that sandbar sharks taken in the Northern Shark Fisheries were the same unit stock as was being targeted in the West Coast Bioregion of the Temperate Demersal Gillnet and Demersal Longline Fisheries (TDGDLF). Additional information on these fisheries and others that take sharks as bycatch in the North Coast Bioregion was collected during a series of SEWPaC 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 and concluded that numerous species were at high risk of unsustainable exploitation by the WA northern shark fisheries.

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 sharks, sandbar shark and mackerel sustainability, as well as Threatened, Endangered and Protected (TEP) species interactions with pelagic gillnets require evaluation. Further research to estimate key biological parameters and fishing mortality rates for these and other species is required before any robust assessment of the fisheries' ecological sustainability can be undertaken.

To support the fishery management arrangements introduced in 2005, improve assessments of key stocks and facilitate the more detailed reporting requirements of the fisheries' export accreditation under the EPBC Act, a new daily/trip catch and effort reporting system was introduced in 2006/07.

Retained Species

Commercial landings (season 2009/10)

Northern Shark Fisheries:	**0 tonnes**
Other Commercial Fisheries:	**0 tonnes**

Average Commercial landings (season 2006/07-2008/09 combined):

Northern Shark Fisheries:

Total sharks	**78 tonnes**
Sandbar shark	**63 tonnes**
Blacktip sharks	**67 tonnes**
Scalefish	**3 tonnes**

The total shark catch by the northern shark fisheries decreased substantially from its peak of 1,294 t in 2004/05 as a result of the management arrangements 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 northern shark fisheries' mean annual sandbar shark catch of 63 t over those 3 years was more than 3 times the level determined to be sustainable (see Stock Assessment section of Demersal Gillnet and Longline Fisheries Status Report). The mean annual blacktip shark catch of 67 t was similar to previous year's catches.

Sharks are also incidentally caught by other commercial fisheries operating in the Northern Bioregion. However, since sharks and rays were commercially protected in 2006, only two non-target shark fisheries are now authorised to retain shark catches in the North Coast Bioregion (Northern Demersal Scalefish[1] and Marine Aquarium Fish). In 2009/10, vessels licensed in those fisheries reported total landings of 4 t of sharks and rays from the area between North West Cape and the WA/NT border. It is expected that those fisheries' landings will remain at low levels in the future due to the limited marketability of sharks from those fisheries.

The northern shark fisheries have a small scalefish catch that is generally retained for sale. Most of the reported scalefish landings 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. Additional measures to manage this byproduct will need to be developed if fishing resumes and pelagic gillnet effort escalates.

[1] Within a 2 shark per trip limit.

Recreational catch estimate: **Not assessed**

Commercial Fishing effort/access level

There was no reported fishing effort in the northern shark fisheries in 2009/10. Two or three vessels reported sporadic activity in the fisheries between 2006/07 and 2008/09, which amounted to approximately 47% of the fisheries' permitted longline effort and 3% of their permitted gillnet effort.

Stock Assessment

Assessment complete: **Yes**

Assessment method and level:

Sandbar shark: **Level 3 - Catch (relative to previous direct survey)**

Blacktip sharks: **Level 1 - Catch**

Breeding stock levels:

Sandbar shark: **Unacceptable**

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 various Australian and Taiwanese-operated fisheries that have targeted them since the 1970s. However, that assessment did not provide specific advice on the status of Western Australian stock components and the reliability of the 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 a 2,000 tonne per year maximum sustainable yield are considered unreliable for assessment of the Western Australian blacktip stock.

Assessing the status of other North Coast Bioregion shark stocks is also complicated by poor species identification in catch returns prior to 2000 and a general lack of biological information. Thus, monitoring the status of other northern shark stocks will rely on analyses of reported catches and catch rates from the target commercial fisheries and, increasingly from a ten-year time series of fishery-independent survey data. Although between 2006/07 and 2008/09 the nominal commercial fisheries CPUE of tiger and hammerhead sharks were at their highest levels since the late 1990s, these rates were derived from relatively small catches and limited effort. Thus, previous declines of 78% and 84% in their respective CPUE between the late 1990s and mid 2000s, remain of concern.

Non-Retained Species

Bycatch species impact: **Low**

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 low to negligible during the ESD risk assessment process, these assessments would require revaluation if levels of pelagic gillnet fishing effort escalate above historical levels.

Protected species interactions

(Longline only) **Low**

The northern shark fisheries were rated as having a generally low risk of interacting with 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 levels of pelagic gillnet fishing effort escalate above historical levels. 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 speartooth 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 sub-tropical distributions. Whale sharks (*Rhincodon typus*) are extremely unlikely to be caught by demersal longlines.
Turtles: No turtle captures have either been observed or reported in the northern shark fisheries.
Billfish: The small observed bycatch of billfish by demersal longlines in the northern shark fisheries was assessed as being insufficient to impact breeding stocks. This level of bycatch is unlikely to increase given the restrictions on longline 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.

Ecosystem Effects

Food chain effects: **Negligible**

Given the small 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 sharks (and possibly other species, eg. tiger and hammerhead sharks), unassessed residual trophic 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. Fishing is now constrained to a smaller area than in 2005 and the concurrent 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 in 2008/09. However, as only two or three fishing vessels have operated for a few months each year, these fisheries 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 recreationally prized 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 2006/07 - 2008/09	**$2.2 million**
Shark and scalefish	**$1.1 million**
Shark fin*	**$1.1 million**
For year 2009/10	**$0**

*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 km gillnet days)

< 300 longline days (300,000 hook days)

Target catch range:

Sandbar sharks: < 20 tonnes

Current fishing (or effort) level:

Effort: Acceptable (2009/10)

Sandbar shark catch: Acceptable (2009/10)

There was no reported fishing effort in the northern shark fisheries in 2009/10 and total fishing effort was significantly lower and more sporadic between 2006/07 and 2008/09 than prior to 2005/06 (Northern Shark Figure 2). The few vessels that have been active since 2005/06 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 annual sandbar shark catch of 63 tonnes between 2006/07 and 2008/09 far exceeded the upper target limit of 20 tonnes (Northern Shark Figure 2 and 3). As breeding biomass of the sandbar stock is likely to be at the minimal acceptable limit reference point (at least 40% of unfished biomass) and possibly continuing to decline (see Demersal Gillnet and Longline Fisheries Status Report), recent excessive catches of this species in the northern shark fisheries were unacceptable.

New management initiatives (2010/11)

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 gillnet data in the North Coast Bioregion and other factors beyond the WA fisheries' control including: Illegal, Unregulated and Unreported (IUU) shark catches; cross-jurisdictional catches of target and byproduct stocks and long-term impacts on the breeding stock of sandbar sharks, the latter being critical to the sustainability of West Coast Demersal Gillnet and Demersal Longline Fishery catches (see Demersal Gillnet and Longline Fisheries Status Report).

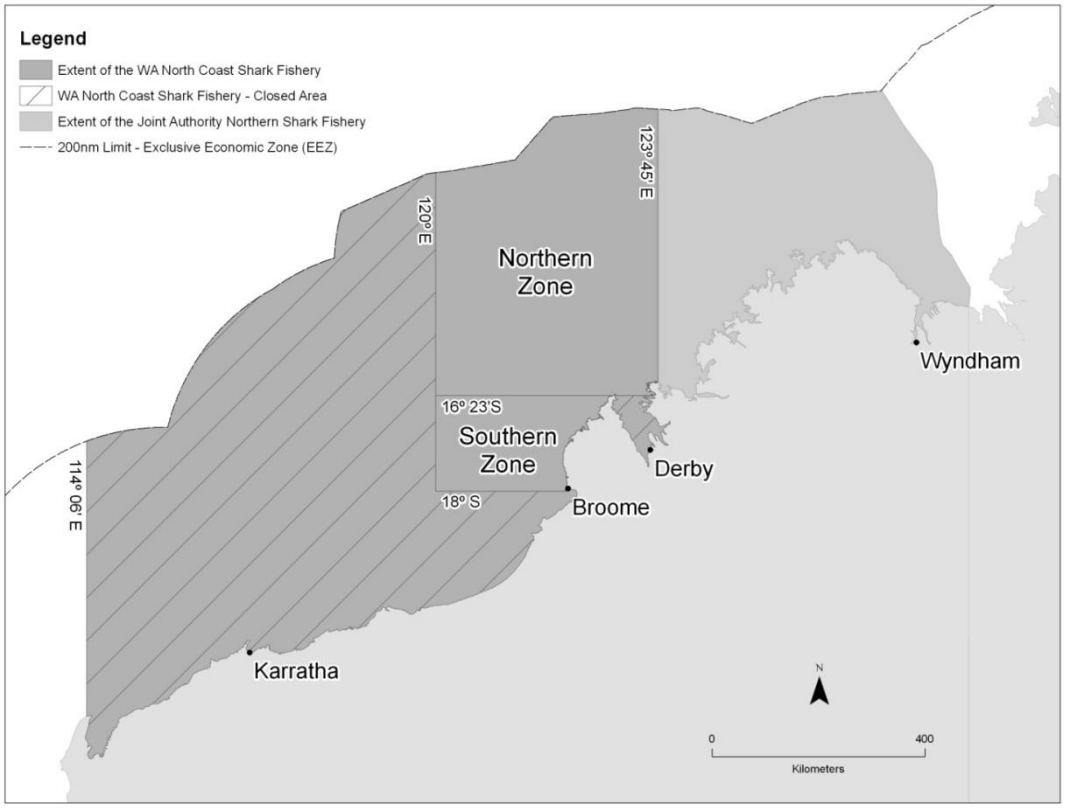
Contributors

R. McAuley and N. Sarginson.

NORTHERN SHARK TABLE 1

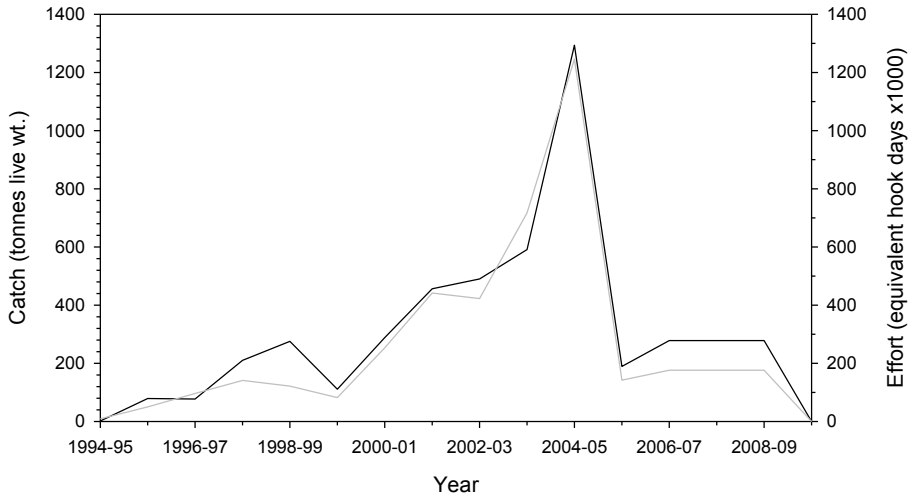
Northern shark fisheries' (WANCSF and JANSF) elasmobranch catch from 2006/07 to 2008/09. Data are amalgamated across these three years due to the confidentiality of records from the small number of vessels that were active in the fisheries in those years.

Name	Species or taxon	2006/07 - 2008/09 catch (tonnes)	
		Total	Mean annual
Blacktip shark	*Carcharhinus* spp.	202.0	67.3
Sandbar shark	*Carcharhinus plumbeus*	188.5	62.8
Pigeye shark	*Carcharhinus amboinensis*	138.4	46.1
Tiger shark	*Galeocerdo cuvier*	103.1	34.4
Hammerhead sharks	Sphyrnidae	82.9	27.6
Lemon shark	*Negaprion acutidens*	45.4	15.1
Spot-tail shark	*Carcharhinus sorrah*	36.2	12.1
Dusky shark	*Carcharhinus obscurus*	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	Scomberomorus	6.2	2.1
Cod	Serranidae	1.3	0.4
Spanish mackerel	*Scomberomorus commerson*	0.6	0.2
Mackerel, other	Scombridae	0.3	0.1
Other scalefish	Teleostii	0.7	0.2
Total scalefish		**9.1**	**3.0**



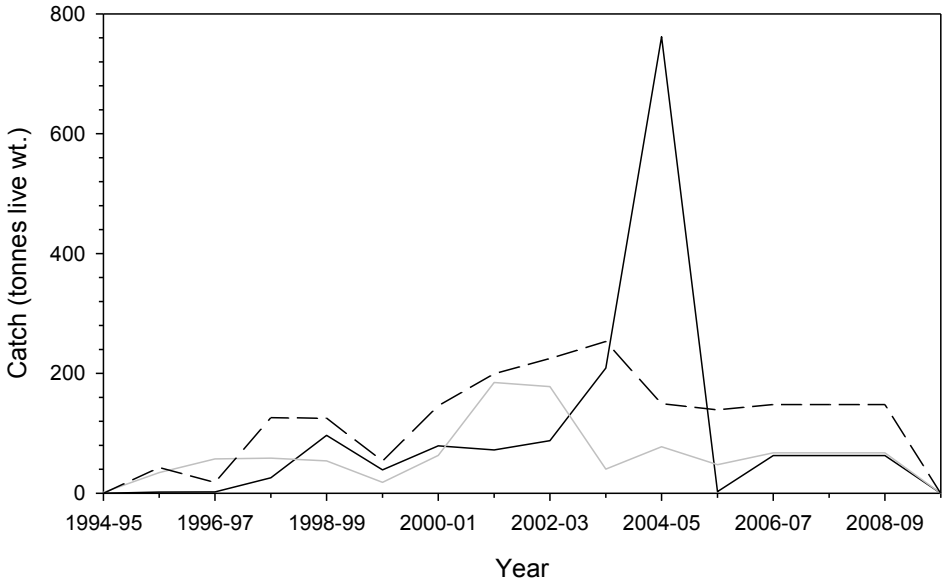
NORTHERN SHARK FIGURE 1

Management boundaries of the WA northern shark fisheries



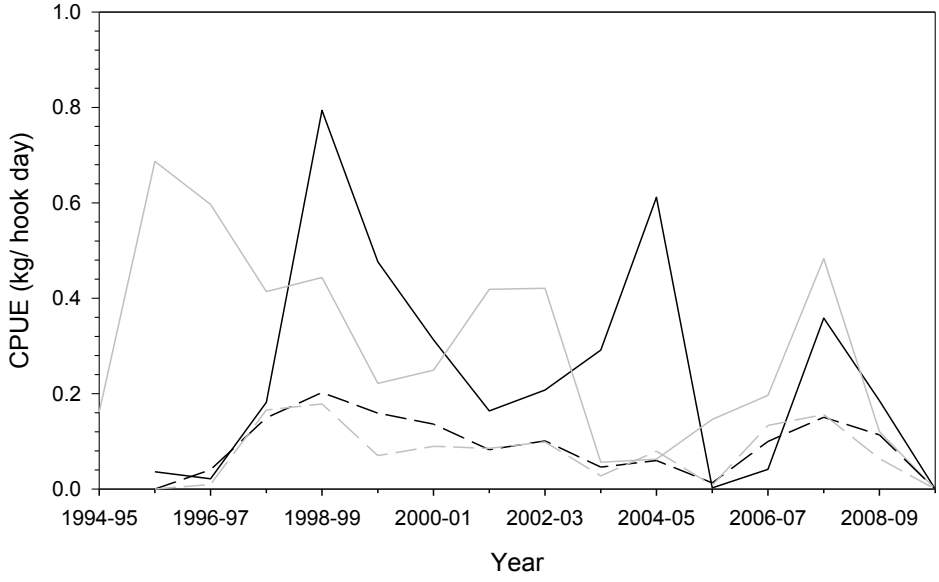
NORTHERN SHARK FIGURE 2

Total annual elasmobranch landings and standardised fishing effort (WANCSF and JANSF), 1994/95 – 2009/10. Black line is catch (tonnes estimated live weight) and grey line is standardised total fishing effort (thousand hooks). Data from 2006/07 – 2008/09 have been averaged due to the confidentiality of records from the small number of vessels that were active in the fisheries in those years.



NORTHERN SHARK FIGURE 3

Annual catches (tonnes estimated live weight) of indicator and other shark species by the northern shark fisheries (WANCSF and JANSF), 1994/95 – 2009/10. Solid black line is for sandbar shark, grey line is blacktip sharks and dashed black line is other sharks. Data from 2006/07 – 2008/09 have been averaged due to the confidentiality of records from the small number of vessels that were active in the fisheries in those years.



NORTHERN SHARK FIGURE 4

Nominal Catch Per Unit Effort (CPUE) of indicator and secondary target shark species in the northern shark fisheries, 1994/95 – 2009/10. 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

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial Pearl Oyster Catch	
Fishing level	Acceptable	Shell numbers (All Zones) -	394,947 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*) which are collected mainly for use in the culture of pearls.

Governing legislation/fishing authority

Pearling Act 1990

Pearling (General) Regulations 1991

Commonwealth 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. Hatchery bred oysters are now a major component of pearl production in Western Australia.

The pearl oyster fishery is managed primarily through output controls in the form of a total allowable catch (TAC) divided up into individual 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 14 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 ESD 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.

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 4 – 6 years ahead 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 oedema disease (OOD) in Pinctada maxima, to assist in mitigating the impacts and understand pathways to disease and disease response in pearl oysters;

Retained Species

Commercial landings (season 2010):

397,947 oysters

In 2010, the number of wild-caught pearl oysters was 397,947 (Pearl Tables 1 and 2). The TAC for the pearl oyster fishery was 1,500,000, thus only 26% of the TAC was caught, as this was the quantity required under current market conditions. This represents an increase on the 260,002 oysters caught in 2009 and reflects the improved economic conditions and return of buyers in the market after the Global Financial Crisis (GFC).

As for 2009, Zone 2 was the only area fished, for a total of 397,947 oysters (Pearl Table 1). From this total, Mother of Pearl (MOP) was fished for the first time since 1986 with a total of 12,677 shells. MOP were generally fished offshore in deeper waters at an average depth of 30m, thus increasing the overall average depth fished (Pearl Table 1). There has been no fishing in Zone 1 or Zone 3 since 2008 (Pearl Table 2).

Fishing effort/access level

Total effort was 4,447 dive hours (Pearl Tables 1 and 2), an increase of 26% from the 2009 effort of 3,285 hours. Of this, 117 hours was applied to MOP diving.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Acceptable**

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2010 fishing season based on catch and effort statistics, settlement analysis (28,871 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (8,602 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 2010, CPUE was 89 shells per dive hour which was the highest since this times series began in 1979 and a 11% increase from the 2009 catch rate (79 shells/hour – Pearl Table 1). While the reduced effort would contribute to the high CPUE, it indicates that stock levels are at an all time high.

Catch Prediction: Recruitment to the fishery is predicted by the piggyback spat abundance index at 4 to 6 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 between 2009 and 2011 resulting in the highest CPUE for over 30 years.

The 2011 stock abundance in Zone 2 was predicted to be lower than 2010, but with an additional large residual stock left over from uncaught TAC in 2009 and 2010. To account for this, the 2011 TAC in Zone 2/3 was increased slightly to 1,600,000 (3,500 shell per unit). This is 250 % above the baseline level of 1,000 shell per unit (Pearl Table 1).

Zone 1: The Zone 1 fishery has not been fished for three 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, 2009 and 2010 (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 2010. 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 89 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 GFC on the industry, only two vessels fished. Number of vessels fishing increased to 4 in 2010, with the GFC abating.

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)

2010 (Total Industry value): **$99 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 2010 was considered to be approximately $99 million, which is $14 million more than 2009.

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 1,555,000 oysters in 2010 (1,500,00 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 4,447 dive hours of effort (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 2010 (Pearl Table 2).

Current effort level: **Acceptable**

Overall fishery effort level is acceptable, but current levels reflect market issues and not stock abundance.

New management initiatives (2011)

The Department is working with industry to rationalise the legislation that is currently used to regulate the pearl oyster wildstock fishery and incorporate it into the broader managed fishery 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 between 2009 and 2011 are a direct result of companies opting not to fish because of this. Future signs for 2012 suggest a recovery and overall catches are expected to be higher. 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.

Contributors

A. Hart and D. Murphy.

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	3,285	79.2	11.4	79.2
2010	1,500,000	397,947	12,677	385,270	4,447	89.0	14.9	89.4
2011	**1,600,000**							

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

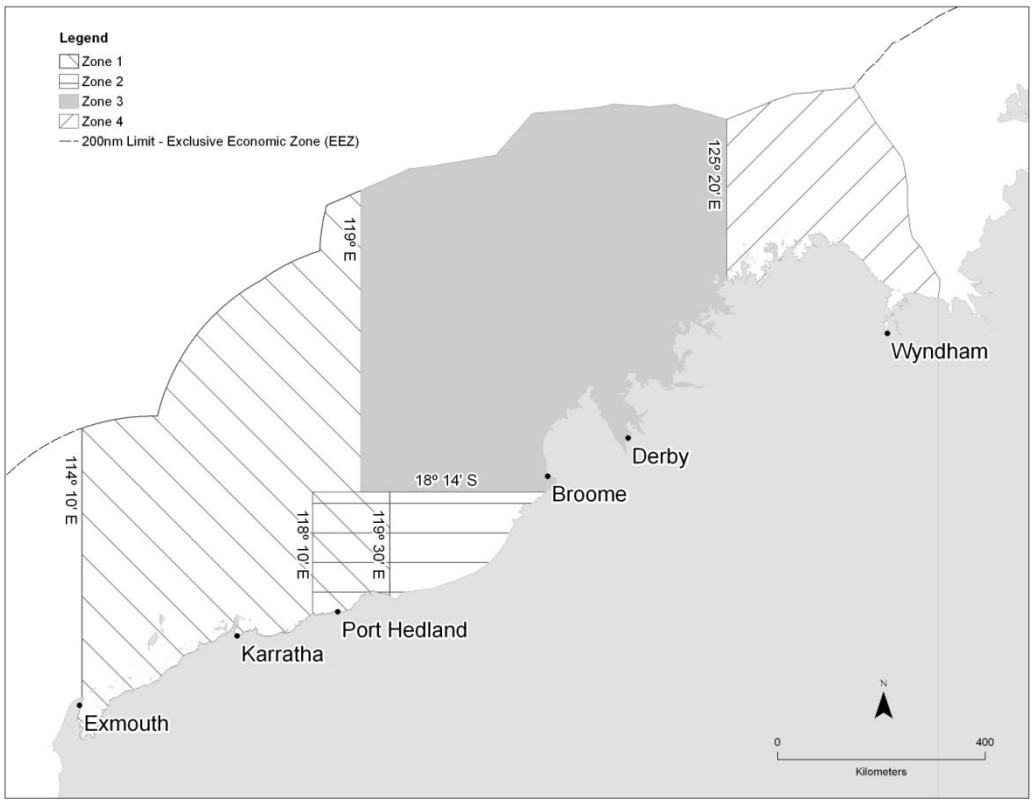
PEARL TABLE 2

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	0	0	
2011	55,000			

Notes next page:

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

Main Features

Status		Current Landings	
Stock level	Acceptable	Total Catch	121 t
Fishing level	Acceptable	*Actinopyga echinites* – Redfish	86 t
		Holothuria scabra – Sandfish	35 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 on the seafloor or buried in sand or mud bottoms.

The Western Australian beche-de-mer fishery is based in the northern half of the State, from Exmouth Gulf to the Northern Territory border. 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 it was essentially a single species fishery, with 99% of the catch being sandfish (*Holothuria scabra*). Since then, an additional species (deepwater redfish - *Actinopyga echinites*) has been targeted and the fishery is now a two species fishery.

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)

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 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 ESD 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):

121 tonnes (live weight)

Landings

In 2010 the total beche-de-mer catch was 121 t live weight (Beche-de-mer Table 1), a decrease of 6% over last years catch of 129 t, mainly due to less catch from the newly developing redfish fishery, although catch increased in the traditional sandfish fishery.

On a species-specific level, the 121 t catch was made up of 35 t (29%) *Holothuria scabra* and 86 t (71%) *Actinopyga echinites* (Beche-de-Mer Figure 1). This is the fourth year that *A. echinites* has been caught in high numbers and represents a continued new target species within the fishery.

Fishing effort/access level

Similar to the last three seasons (2007-09), only 2 licensed vessels fished for beche-de-mer in 2010. This represents 33% of the potential number of vessels that have an endorsement to fish.

Total effort was 1053 hours fished – about 25% lower than in 2009 and approximately 40% below the average of the last 6 years (Beche-de-mer Table 1). A total of 754 hours was spent on sandfish, and 299 hours on Redfish (Beche-de-mer Table 1). The effort is spatially separate as these species occupy different habitats.

Stock Assessment

Assessment complete: **Yes**

Assessment method and level:

Level 2 - Catch rate

Breeding stock levels: **Adequate**

The overall catch rate for beche-de-mer (diving only in 2010) was 115 kg/hour, which is the highest in the history of the fishery. The principal reason for this was the continued development of a new target species (deepwater redfish), which had a CPUE of 289 kg/hour. There was also a higher catch rate in the existing sandfish fishery (46 kg/hour), 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.

Species specific performance indicators that relate to breeding stock maintenance were developed for the first time in 2010. These replaced the old performance indicators for the entire fishery. The old indicators were catches remaining in the range 50 – 150 t and catch rate remaining above 80 kg/crew day. In 2010, both the total catch (121 t) and catch rate (378 kg/crew day) measures were met.
The species performance measure for the Sandfish fishery are catches remaining in the range 20 – 100 t and catch rate remaining above 25 kg/hour. In 2010, both the catch (35 t) and catch rate (44 kg/hr) measures were met.
The species performance measure for the Redfish fishery are catches remaining in the range 40 – 150 t and catch rate remaining above 60 kg/hour. In 2010, both the catch (86 t) and catch rate (289 kg/hr) measures were met.

Non-Retained Species

Bycatch species impact: **Negligible**

Given the selective method of fishing used (diving or wading, collection by hand only), no bycatch species are known to be taken in this fishery.

Protected species interaction: **Negligible**

There are currently no protected species known to be impacted by 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 2010, 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 2010: **$330,000**

The estimated annual value for 2010 was $333,000 based on an average product price of $10.00/kg for sandfish (gutted and boiled) or $3.33/kg live weight, and $7.50 for redfish ($2.50/kg live weight). This is only a farm gate value and the

catch from the fishery supports a substantial processing and value-adding sector.

Fishery Governance

Sandfish catch range: **20 – 100 tonnes**

Redfish catch range: **40 – 150 tonnes**

Current fishing level of 86 tonnes for Redfish and 35 tonnes for Sandfish are both within the target ranges.

New management initiatives (2010/11)

The species-specific information on catch and effort from the daily logbook, implemented in 2007, has facilitated the development of species-specific management response and performance indicators in 2010 and these will be refined in 2011.

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.

Contributors

A. Hart, D. Murphy and R. Green.

BECHE-DE-MER TABLE 1

Catch and effort of Beche-de-mer in Western Australia since 1995.

Year	Live Wt (t) (all species)	Hours fished (all methods)	Live Wt (t) (Sandfish)	Hours fished (Sandfish)	Live Wt (t) (Redfish)	Hours fished (Redfish)	Live Wt (t) (Teatfish)
1995	93	2,972	93	2,972	0		0
1996	257	3,938	257	3,938	0		0
1997	382	7,493	371	7,403	9	90	2.8
1998	310	9,030	310	9,030	0		0
1999	176	5,470	176	5,470	0		0
2000	83	2,255	83	2,255	0		0
2001	90	2,434	88	2,414	2	20	0.2
2002	87	3,235	87	3,235	0		0
2003	122	4,877	121	4,867	1	10	0
2004	81	2,117	81	2,117	0		0.2
2005	78	1,876	75	1,876	0		0
2006	58	2,662	55	2,632	3	30	0.3
2007	113	1,804	26	976	87	828	0
2008^	196	1,544	27	448	169	1096	0
2009	129	1,423	31	701	98	722	0
2010	**121**	**1,053**	**35**	**754**	**86**	**299**	**0**

^ Diving only method used in recent years

BECHE-DE-MER TABLE 2

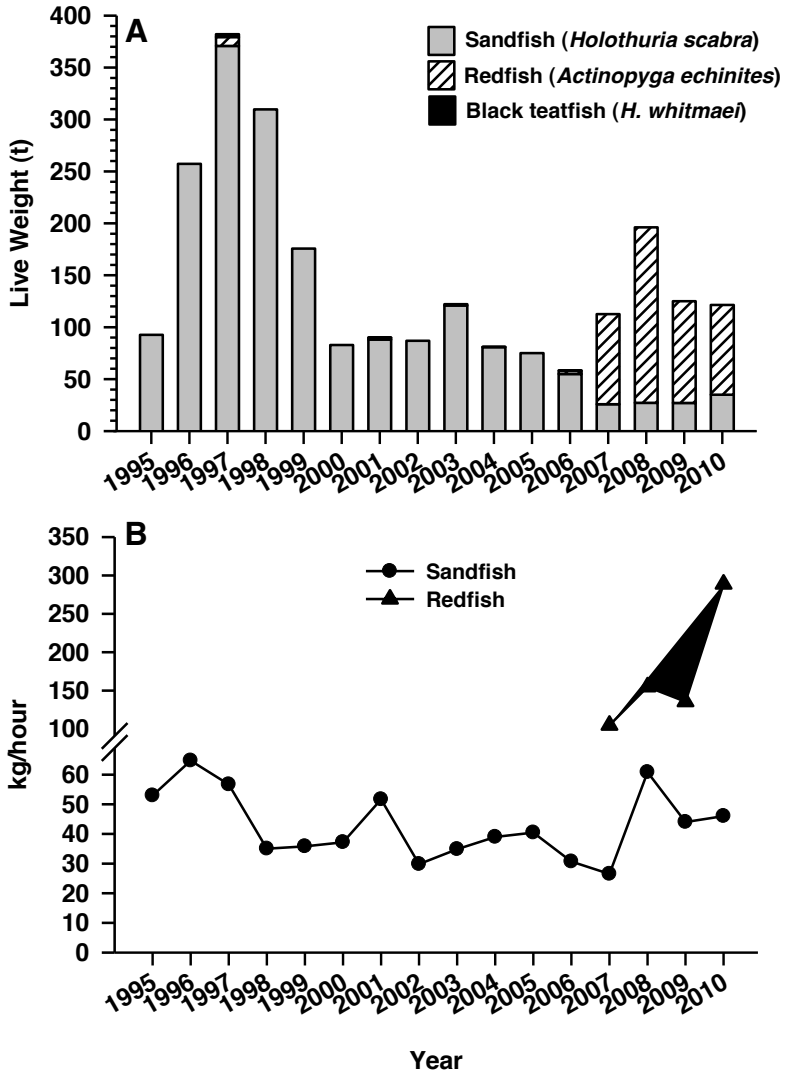
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

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 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 operator is planning to gradually increase its production capability to 5,000 tonnes per annum, subject to receiving the requisite environmental approvals.

A demonstration project culturing marine microalgae for the production of bio-fuels, omega-3 lipid and protein biomass has recently started near Karratha. The company is planning for significant increases in scale and production capability in the future.

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 including coral and live rock.

COMPLIANCE AND 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.

Three district offices located in Kununurra, Broome and Karratha provide compliance and education across the region with eleven permanent Fisheries and Marine Officers and one Community Education officer. During the peak season from May to October additional two officer mobile patrols also operate 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 undertaken 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 are conducted a 23 metre vessel is utilised.

A range of compliance duties are carried out in the bioregion including investigations, catch, licence, gear, processor, retail and transport inspections. These are carried out through roadside checks, 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.

The community education officer coordinates and manages the Fisheries Volunteer program for the Northern Region and is heavily involved in the education of school-aged children and the community. In-school and school holiday programs are the main method of reaching students in both the Pilbara and Kimberley, while attendance at shows and local events target the broader community.

Fisheries Volunteers are trained community members who educate the public on bag and size limits and a variety of other fishing rules.

Activities during 2009/10

During 2009/10, the North Coast bioregion's FMOs delivered a total of 2,575 officer hours of active compliance patrol time (North Coast Compliance Table 1). - a small decrease from the previous year (North Coast Compliance Figure 1). FMOs also achieved 8,533 personal compliance contacts with the fishers and non-fishers across the recreational and commercial sectors.

In the commercial sector FMOs undertook prosecution action as a result of compliance operations in 2009/10. This resulted in 10 infringements notices being issued and 3 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 138 infringement warnings were issued, 61 infringement notices and 8 matters resulted in prosecution action.

Fisheries Volunteers from across the Karratha District were provided with training and support.

Initiatives in 2010/11

The Department will open an office in Kununurra Staffed by one FMO who will carry out Patrols with staff from other agencies such as Department of Environment and Conservation and the Department of Transport. This will greatly enhance the ability of the Department to conduct education and compliance activities in the East Kimberley.

The Department will establish a Northern Region Mobile Patrol, the patrol comprising of two FMO's who will focus entirely on recreational fisheries compliance and education throughout the Northern Region.

A newly established Fremantle based Statewide Mobile Patrol Unit will be based in the Pilbara District from July to September and will focus on recreational fishers operating in the area.

The Departments other Statewide Mobile Patrol, will continue to provide recreational compliance patrols across the Northern Region during peak fishing periods.

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.

FMOs will continue to assist with ongoing checks of bio-security of vessels entering the states' waters for introduced marine pests.

Improved engagement with short and long term visitors to the Kimberley through a targeted education program.

Increase communication with and introduce an education campaign targeted at recreational fishers on international ships that enter Northern Ports.

NORTH COAST BIOREGION

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 2009/10 financial year

PATROL HOURS DELIVERED TO THE BIOREGION	2,575 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	47
Infringement warnings	0
Infringement notices	10
Prosecutions	3
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	7,621
Infringement warnings	138
Infringement notices	61
Prosecutions	8
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	865
Fishwatch reports***	19
VMS (Vessel Days)****	7,494

* 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.

**** VMS (Vessel Days) represents the number of vessel days recorded in this bioregion. That is, a count for each day that each vessel was polled within the bioregion.

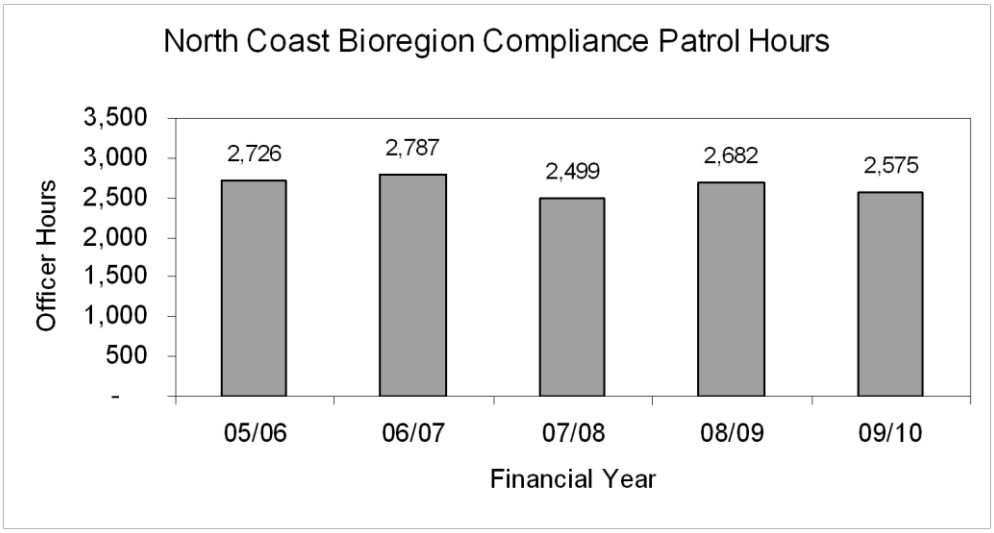
NORTH COAST COMPLIANCE TABLE 2

This table gives summary statistics for pearling compliance in all bioregions in the 2009/10 fishing season.

Total compliance hours*	2,132 Officer Hours
Field contacts by Pearling Officers	17
Letters of Warning issued**	1
Prosecutions	0

* 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 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 2009/10 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 2009/10).

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

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 Sustainability, Environment, Water, Population and Communities (SEWPaC) is also undertaking a Marine Bioregional Planning process for Commonwealth waters from Kangaroo Island, South Australia to Shark Bay in Western Australia., The draft South West Marine Bioregional Plan was released for a three month public consultation period in June 2011.

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

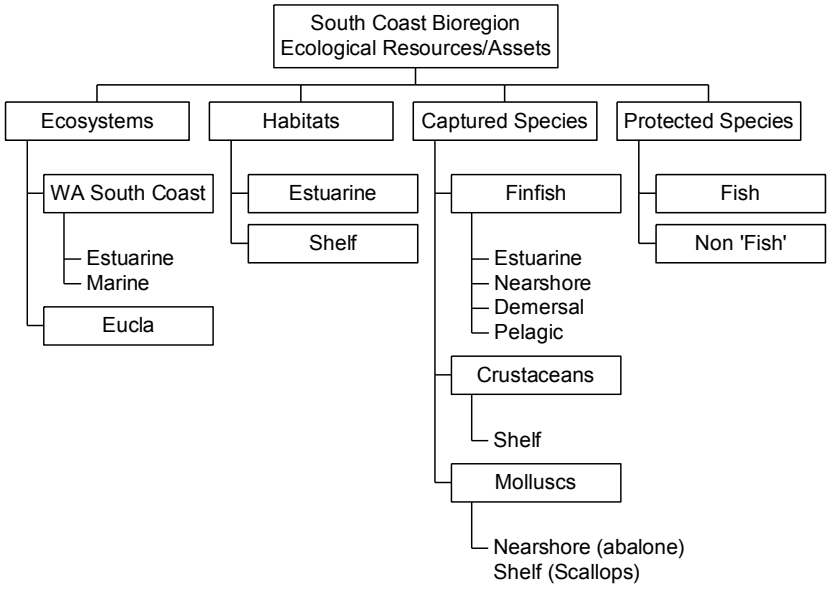
Identification of Ecological Assets using the EBFM framework

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 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 (2010) 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.
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 some concern that there could be an increase in targeting of demersal fishing on the south coast in the near future and the stock status may therefore 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.

Fish species	Aquatic zone	Risk	Status and Current Activities
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 only occurs 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 are currently being 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 *Codium fragile* 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

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 2009/10, 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 previous West Coast Rock Lobster Managed Fishery season (prior to the 2010/11 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	**47.4 tonnes**
Deep-sea crab	**25.3 tonnes**

The 2009/10 season total catch of southern rock lobsters was 47.4 t, an increase of 22.8% from the 2008/09 season (South Coast Crustacean Table 1). A catch of 23.8 t of southern rock lobsters was taken in the ERLF in 2009/10 – an increase of 34.5% on the catch taken in the 2008/09 season (17.7 t).

The combined catch for the GAB and Albany southern rock lobster fishery zones in 2009/10 was 23.6 t, a 12.9% increase of the catch taken in 2008/09 (Table 1). The catch in the Albany zone was 6.1 t, an increase of 117.9% compared to the 2008/09 season, however, the catch in the GAB zone decreased by 3.3% to 17.5 t.

As a secondary target of the rock lobster fishery, a total of 25.3 t of deep sea crabs was caught (South Coast Crustacean Table 1). In the Albany zone this included 3.5 t of giant crabs (an increase of 2.7 t over the 2008/09 season), 4.2 t of champagne crabs (a decrease of 1.4 t over 2008/09 season) and 14.6 t of crystal crabs (an increase of 2.2 t over the 2008/09 season). In the ERLF, 2.5 t of giant crabs were landed (an increase of 0.4 t over the 2008/09).

The fishing effort in the Esperance fishery (ERLF) had an increase in effort of 57.1% when compared to that in 2008/09 (South Coast Crustacean Table 1). Conversely, the effort decreased by 59.2% 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 2009/10, the south coast catch of 47.4t 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 (2011/12)

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.

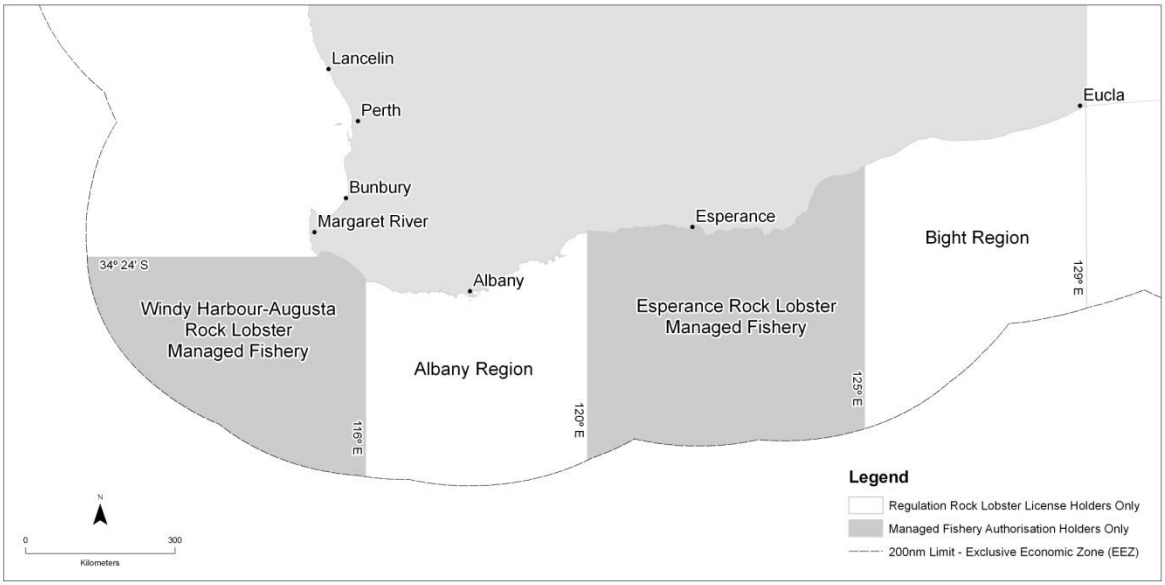
Contributors

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SOUTH COAST CRUSTACEAN TABLE 1

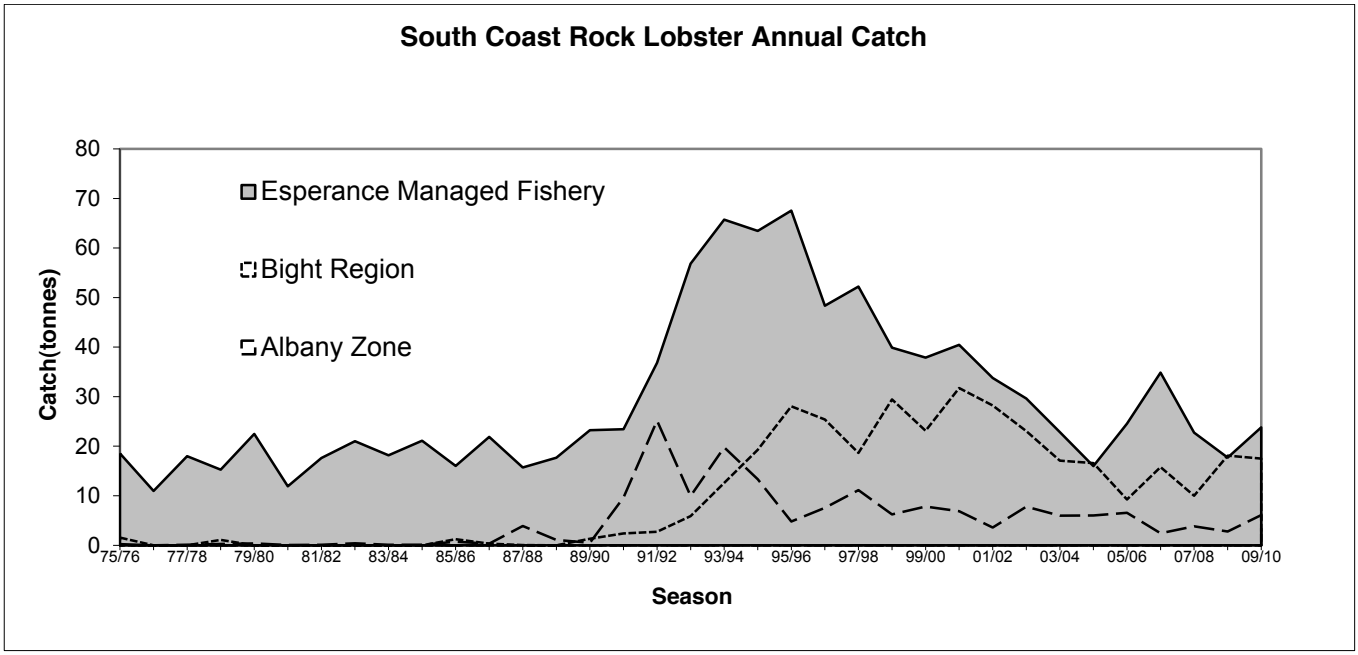
Comparisons of fishing effort and southern rock lobster and crab catch in 2008/09 and 2009/10 in the south coast crustacean fisheries.

Management zone	Season	Pot lifts	Southern rock lobster catch (tonnes)	Deep-sea crabs catch (tonnes)
ERLF	2008/09	28,000	17.7	3.3
	2009/10	44,000	23.8	3.0
	difference	57.1%	34.5%	-9.1%
Albany	2008/09	38,000	2.8	18.8
	2009/10	15,500	6.1	22.3
	difference	-59.2%	117.9%	18.6%
Great Australian Bight	2008/09	43,000	18.1	2.0
	2009/10	54,500	17.5	0
	difference	26.7%	-3.3%	-100%



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

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial	
Fishing level	Acceptable	Total	205 t
		Greenlip	166 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 2010 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. 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 ESD 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 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 continued in 2010, under the externally funded Seafood CRC 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 2010): 205 tonnes

In 2010 the greenlip/brownlip catch was 205 t whole weight (Greenlip Brownlip Abalone Table 1), which was 3% higher than the 2009 catch of 199 t. The Area 1 (Nullarbor fishery) exploratory quota remained at 1.2 t but was not fished in 2010.

The greenlip catch of 165.6 t whole weight from a total quota of 171.2 t, was 3% higher than the catch in 2009. The brownlip catch of 39 t whole weight for the 2010 season was the same as last year and represents 93% 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 2010.

Fishing effort/access level

Commercial

Total fishing effort on the main stocks in 2010 was 1,196 days. This was slightly lower than 2009 (1,205 days).

Recreational

For the 2010 season, around 22,400 licences were issued allowing abalone fishing, a 13% decrease over the 2009 figure of 25,700 licenses (Greenlip Brownlip Abalone Figure 2). This is not thought to represent a real reduction in effort but rather a change in the licensing structure as the umbrella type of license has been discontinued. From 2011only abalone specific licenses will be available to those wishing to fish for abalone.

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 and level: Level 3 - Standardised catch rates / Fishing mortality

Breeding stock levels: Adequate

A stock assessment of the greenlip/brownlip abalone fishery was undertaken for the 2010 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 review[1], 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 2010, the SCPUE for the combined greenlip stocks was 37 kg whole weight per hour (Greenlip Brownlip Abalone Table 1). This was an increase from the 2009 value of 34 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 2009 and 2010 for the Augusta region, but was stable on the South Coast of Area 3 (Greenlip Brownlip Abalone Figure 3a). No estimates were available for the Area 2 fishery.

Fishing mortality of brownlip abalone in Area 3 increased between 2008 and 2010, after having declined in previous year (Greenlip Brownlip Abalone Figure 3b). No estimates were available for the Area 2 fishery.

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) with individual abalone 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 155 mm shell length for the faster-growing portions of the fishing grounds, and 150 mm for the remainder.

In 2010, the average sizes of greenlip and brownlip caught were 197 g and 256 g respectively which are both well above the minimum breeding sizes of 140 g for greenlip and 160 g for brownlip respectively.

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 2010, the average sizes of greenlip and brownlip caught were 197 g and 256 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 (1,196 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. Divers are now recording their encounters with great white sharks and these will be documented 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 22,400 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 2010: **$7.8 million**

The estimated average price received by commercial fishers was $103/kg meat weight ($39/kg whole weight) for greenlip and $88/kg meat weight ($35/kg whole weight) for brownlip abalone, resulting in a fishery valued at $7.8 million, compared to $7.7 million in 2009, and $9.2 million in 2008.

Greenlip prices in 2010 were lower than 2009 ($105/kg), and were also the lowest for the last 12 years due to increasing value of the Australian dollar and reduced demand.

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 2010) 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 2010 was 1,196 days (main stocks), which is within the governance range and indicates that the fishery as a whole is performing satisfactorily.

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

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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

Contributors

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GREENLIP/BROWNLIP ABALONE TABLE 1

Greenlip and brownlip abalone catch and effort[1] by quota period.

Quota period[2]	Greenlip TAC kg whole weight	Greenlip caught kg whole weight (all stocks)	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 day)	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	171,221	160,156	41,900	39,050	199,206	1,205	130 (49)	34
2010	171,221	165,558	41,900	39,006	204,564	1,196	138 (52)	37

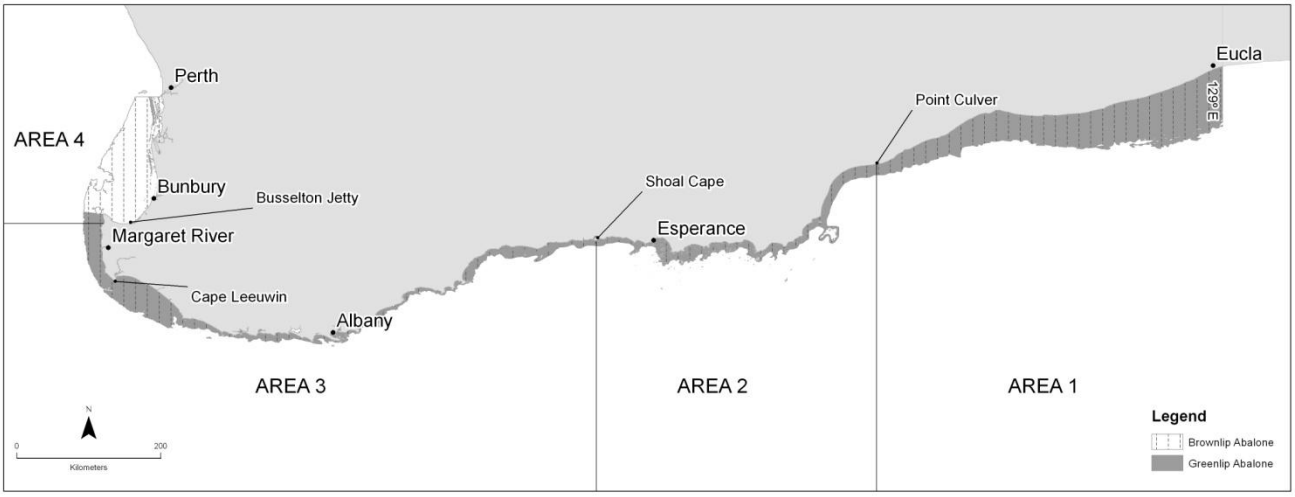
1. Data source: quota returns.
2. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.
3. Effort (diver days): main stocks are separated from stunted stocks, which are subject to controlled fishing regimes and not directly 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.

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.

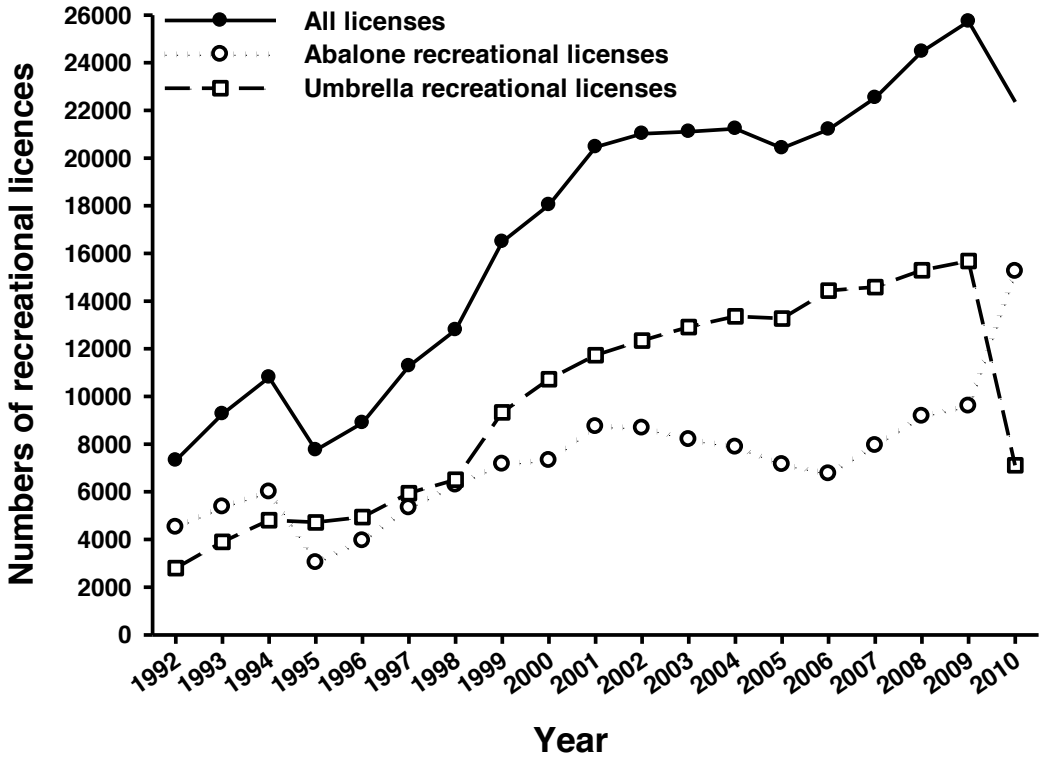
Location	Year	Effort	Greenlip		Brownlip	
			Catch Rate	Catch (tonnes)	Catch Rate	Catch (tonnes)
West Coast	2004	10,100 (6,500 – 13,600)	0.6	4 (2–6)	0.4	3 (1–5)
	2006	8,000 (4,700 – 11,300)	0.3	2 (0–3)	0.4	3 (0–5)
	2007	6,300 (3,800 – 8,800)	0.7	3 (0–6)	0.1	<1 (0–1)
South Coast[1]	2004	2,700 (1,700 – 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).



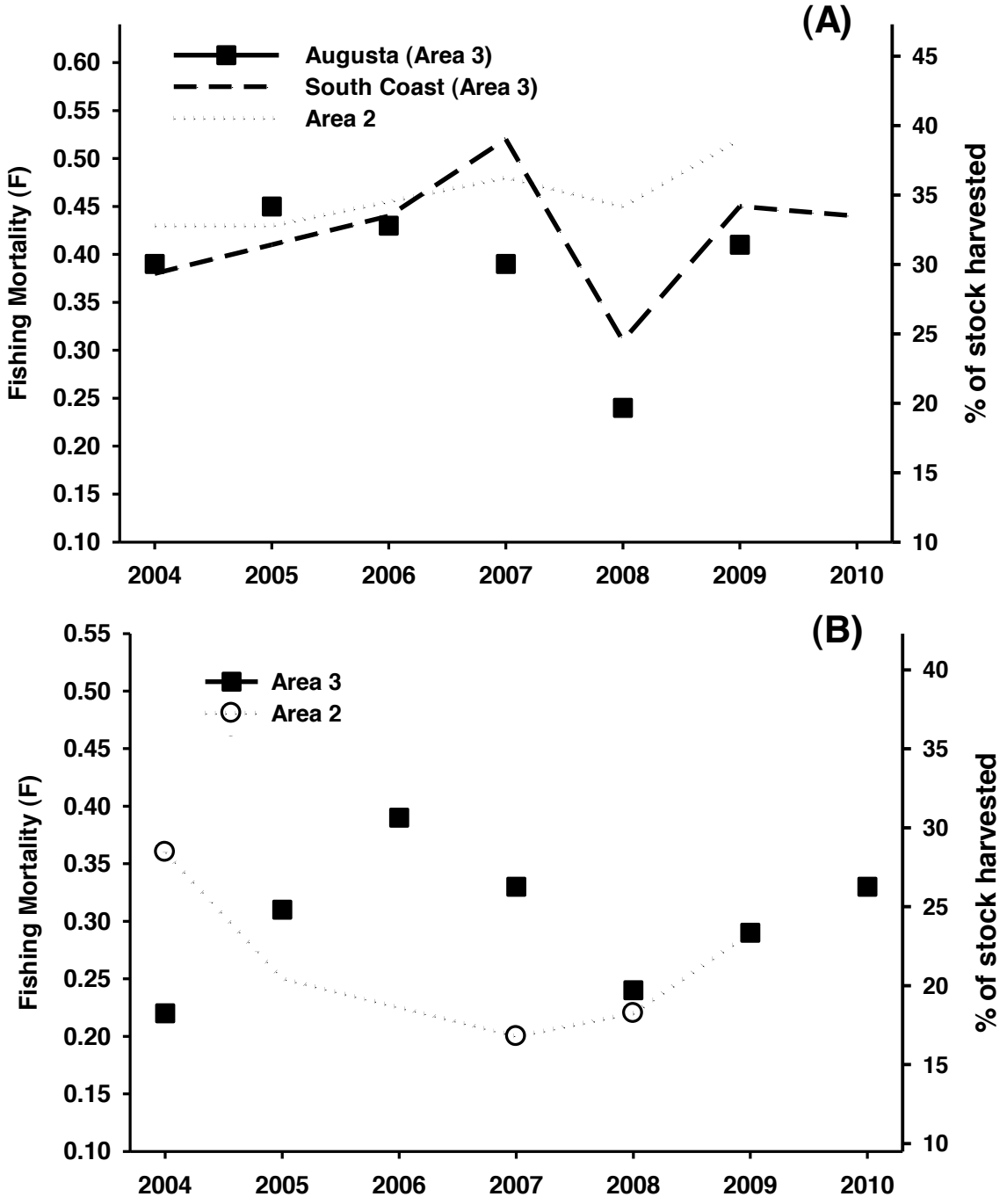
GREENLIP/BROWNLIP ABALONE FIGURE 1

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

Main Features

Status		Current Landings (2010)	
Stock levels:		Commercial total	689 t (finfish only)
Australian herring	Uncertain	South Coast Salmon Fishery	289 t (salmon only)
Australian salmon	Acceptable	South Coast herring trap net fishery	147 t (herring only)
Sea mullet	Acceptable	South Coast Estuarine Fishery	223 t (finfish only)
Black bream (Stokes Inlet)	Acceptable	Other commercial	30 t (finfish only)
Black bream (Beaufort Inlet)	Acceptable		
Black bream (Wilson Inlet)	Acceptable	Recreational	not available for current year.
Black bream (Oyster Harbour)	Acceptable	Most recent survey was in 2000/01.	
Black bream (Walpole-Nornalup Inlet)	Not assessed	2000/01 finfish catch	368 t (key species only)
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 catch various finfish species, mainly using trap nets (herring only), beach seines, haul nets and gill nets. The main target species are Australian salmon (*Arripis truttaceus*) and Australian herring (*Arripis georgianus*), with small quantities of southern sea garfish (*Hyporhamphus melanochir*) and sea mullet (*Mugil cephalus*) 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 two 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. Australian 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. Beach seine nets, gill nets and haul nets in the South Coast and West Coast Bioregions take the majority of the remaining commercial Australian 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. Thirteen estuaries are conditionally open to commercial fishing as part of the South Coast Estuarine Managed Fishery. This is a multi-species fishery targeting many estuarine 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 and Australian herring.

Recreational

Most finfish caught recreationally in South Coast Bioregion 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, various species of whiting (Sillaginidae), 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, mainly targeting 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)

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

In the South Coast Bioregion, Australian herring can be taken commercially by holders of an unrestricted fishing boat licence. The use of trap nets is restricted to holders of fishing boat licenses with Condition 42, who can only operate at 10 specific beaches along the south coast.

The South Coast Salmon Managed Fishery covers 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 129º 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, Waychinicup 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 1982 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 Bioregion estuaries and nearshore waters take a diverse array of finfish species. South Coast Bioregion size and possession limits apply to these species. Refer to the 'Recreational Fishing Guide - South Coast Bioregion' for details. A State-wide Recreational Fishing from Boat Licence (RFBL) was introduced on 2 March 2010. A RFBL is required to undertake any general fishing activity (including crabbing) conducted with the use of a powered boat anywhere in the State.

As many of the recreationally targeted species are also targeted by the commercial sector, resource-sharing issues are a consideration in these fisheries.

Indicator species

The Department of Fisheries recently selected indicator species for monitoring and assessing the status of the South Coast Bioregion's finfish resources (DoF 2011[1]). This review identified Australian herring, Australian salmon, sea mullet, black bream and cobbler as indicators for this Bioregion's nearshore and estuarine finfish suites. Australian herring and sea mullet are currently assigned to the 'low risk' category (mixed species daily bag limit of 40 applies to recreational fishers). Australian salmon and black bream are assigned to the 'medium risk' category (individual species bag limits of 4 and 8, respectively). Cobbler is assigned to the 'high risk' category (daily bag limit of 4).

Research summary

Monitoring of fisheries and fish stocks in estuaries and nearshore waters of the South Coast Bioregion 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

[1] Department of Fisheries (DoF). 2011. Resource Assessment Framework (RAF) for Finfish Resources in Western Australia. Fisheries Occasional Publication No. 85. Department of Fisheries, Perth.

of various fish species (including Australian herring, Australian salmon, whiting, mullet and cobbler). In addition, a voluntary daily logbook for Australian salmon (South Coast Salmon Managed Fishery Licence) and Australian herring (Fishing Boat Licence Condition 42) commercial fishers provides more detailed effort information and also documents other factors affecting catches such as market influences, weather, water temperature, etc.

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 to the South Coast Bioregion include a shore-based creel survey in 1994 and 1995 (Ayvazian *et al.* 1997[1]), a national phone survey in 2000/01(Henry and Lyle 2003[2]) and an estuary creel survey in 2002/03 (Smallwood and Sumner 2007[3]). Recreational catch and effort data is also obtained from a voluntary recreational angler diary program that was introduced in 2004.

Fishery-independent surveys of juvenile Australian herring, Australian 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 Australian herring and 3-4 years later for Australian 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 estimate adult abundance and fishery catches in Wilson Inlet about 4 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 State NRM-funded research project designed to provide more rigorous monitoring and assessment of the status of Australian herring commenced in mid-2009. Recreational anglers and commercial fishers provided samples of Australian herring to enable researchers to establish the age structure of fishery catches in the West Coast and South Coast Bioregions. This information will be used to develop methods to monitor levels of fishing mortality for Australian herring and other species for consideration by managers. The NRM-funded project is also examining aspects of stock structure, including the proportions of Australian herring in the West Coast fishery that originate from nursery sites in the South Coast Bioregion.

Retained Species

Total commercial finfish landings (2010):

466 tonnes in nearshore waters

223 tonnes in estuarine waters

Commercial landings by fishery (2010):

South Coast Salmon	**289 tonnes (salmon only)**
Herring trap net	**147 tonnes (herring only)**
South Coast Estuarine	**223 tonnes (finfish only)**

Commercial finfish catches (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 and line) are not included in this report. Catches by all methods and all fisheries are included in the catches reported for key species and in individual stock assessments.

In 2010, the total commercial catch of finfish by estuarine and beach-based fisheries in the South Coast Bioregion was 688 t and included at least 34 individual species. The majority of the catch consisted of Australian salmon (43% by weight) caught by the South Coast Salmon Managed Fishery, Australian herring (27%) caught primarily by the trap net fishery and cobbler and black bream (10% each) caught by the South Coast Estuarine Managed Fishery.

In 2010, the nearshore finfish catch was comprised predominantly of Australian salmon (62% by weight) and Australian herring (34%). The estuarine finfish catch was comprised mainly of cobbler (31%), black bream (29%), sea mullet (13%) and Australian herring (10%).

Since 2000, 95% of landings by the South Coast Estuarine Fishery have been finfish. The non-finfish component is dominated by blue swimmer crabs (*Portunus pelagicus*), which ranged from 1 t in 2006 to 39 t in 2001. In 2010, 7 t of blue swimmer crab was reported for this fishery. The majority of estuarine finfish landings were taken by gill nets (88%), with smaller amounts taken by haul nets and fish traps.

Key finfish species - nearshore

Australian herring: Australian herring is a pelagic, schooling fish comprising a single stock across southern Australian waters. 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.

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

2 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.

3 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.

Within the South Coast Bioregion, 91% of landings since 2000 were taken by the trap net fishery (i.e. Condition 42 licence holders), 5% 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 Australian herring declined from 818 t in 2000 to 212 t in 2010 (South Coast Nearshore and Estuarine Figure 1). Annual landings in both Bioregions followed a similar downward trend over the same period, declining from 705 t to 183 t in the South Coast Bioregion and from 143 t (in 2001) to 29 t in the West Coast Bioregion. The 2010 catch of 29 t in the West Coast Bioregion is the lowest reported for this region. Commercial fishery landings in South Australia have also followed a downward trend.

Total WA commercial landings of Australian herring peaked at 1,537 t in 1991, when an historical peak catch of 1,427 t was taken in the South Coast Bioregion. The annual South Coast Bioregion catch declined sharply to 633 t in 1993, and then fluctuated between 626-1,001 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 an historical low of151 t in 2009. A relatively low annual catch of 183 t was again reported in 2010.

Recent low catches in the South Coast Bioregion 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, 68% of total commercial landings of Australian salmon in WA have been taken in the South Coast Bioregion, with the remaining 32% taken in the West Coast Bioregion. Within the South Coast Bioregion, the South Coast Salmon Managed Fishery took almost 100% of landings.

Total WA landings of Australian salmon have been declining since 1995 when a peak of 4,046 t was reported. (South Coast Nearshore and Estuarine Figure 2). In 2010, the total WA catch of 360 t is the lowest on record and well below the previous record low of 753 t reported in 2009. This trend reflects declining catches on the South Coast Bioregion, where the annual catch has steadily declined from an historical peak of 2,728 t in 1995 to 291 t in 2010. Commercial fishery landings in South Australia also followed this trend. By contrast, the West Coast Bioregion catch trend has been more stable over the long term but is more influenced by water temperature with strong Leeuwin Current years resulting in low or nil catch (see West Coast Nearshore and Estuarine Report). As for Australian herring, the cause of the decline in the Australian 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 nearly entirely restricted to estuaries. From 2001 to 2010, 95% of commercial landings of cobbler were caught in estuaries of the South Coast Bioregion, with 5% taken from estuaries of the West Coast Bioregion. Less than 1% has been taken from ocean waters. 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, 9% from Irwin Inlet, 8% from Oyster Harbour and 3% from Princess Royal Harbour.

In 2010, 70 t of cobbler was caught in the South Coast Estuarine Managed Fishery. The majority (52 t or 75%) of the cobbler was caught in Wilson Inlet. Wilson Inlet has historically produced the vast majority of South Coast Bioregion 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 2010, 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 2001 to 2010, 45% (by weight) of total commercial landings of sea mullet in WA were taken in the Gascoyne Bioregion, with 41% from the West Coast, 13% from the South Coast and 1% from the North Coast Bioregions.

Historically, the majority of the South Coast Bioregion commercial catch of sea mullet is taken in estuaries (96% for the period 2001-10). 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 55 t (in 2007).

From 2001 to 2010, 30% of total commercial landings of sea mullet in the South Coast Bioregion were taken in Wilson Inlet, 18% in Beaufort Inlet, 17% in Oyster Harbour and 15% in Gordon Inlet. Minor sea mullet landings were reported in all other estuaries open to commercial fishing over this period.

Black bream: From 2001 to 2010, 93% of commercial landings of black bream were caught in the South Coast Bioregion, with the remaining 7% from the West Coast Bioregion. In the South Coast Bioregion, total landings over this period were mainly taken in Beaufort Inlet (32% of landings), Stokes Inlet (31%), Wilson (16%) and Oyster Harbour (11%). Minor black bream landings were reported in all other estuaries open to commercial fishing over this period.

Since 2000, total annual South Coast Bioregion landings of black bream have ranged from 30 t (in 2000) to 65 t (in 2010). The 2010 catch was the highest recorded on the South Coast Bioregion since 1993 (when the catch was 70 t).

Since 1980, Stokes Inlet has contributed the greatest proportion of black bream landings of any single estuary and had the most stable trend in annual landings (average 12 t per year 1980-2010). In 2010, the black bream catch in Stokes

Inlet was 37 t, the highest recorded for this estuary.

Minimal landings were taken in Beaufort Inlet prior to 1993. From 1993 to 2005, landings gradually increased and have remained relatively high in subsequent years. Annual landings of black bream in Wilson Inlet 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 Bioregion black bream landings from the mid 1990s to 2010.

Recreational catch estimate (2010): 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)

Recreational catch levels of finfish in nearshore and estuarine waters of the South Coast Bioregion were not estimated in 2010. 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, the current total catch level cannot be estimated.

Overall, the most abundant species in the retained catch (nearshore and estuarine combined for the South Coast Bioregion) in 2000/01 were Australian herring (45% by number), King George whiting (*Sillaginodes punctata*) (12%), trevally (10%), whiting (various species, excluding King George) (8%), black bream (7%) and Australian salmon (3%). The nearshore and estuarine waters in the region from Denmark to Esperance contributed 90% of all South Coast Bioregion 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 Australian 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.

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.

A comprehensive Statewide Recreational Boat Fishing Survey commenced in January 2011. Survey results from up to 23,000 interviews of recreational boat fishers are due in 2012. However, catch and effort data from shore-based fishers who are believed to take the majority of the recreational nearshore and estuarine finfish catch, will not be included. The Department of Fisheries recently conducted a pilot study of shore-based fishers in the Perth Metropolitan area in an attempt to determine the best method to quantify recreational fishing catch and effort from this sector (Smallwood *et al.* 2011[1]).

Recreational catch share:

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.

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 Scheme (VFAS) (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, licensees, 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

[1] Smallwood CB, Pollock KH, Wise BS, Hall NG and Gaughan DJ. 2011. Quantifying recreational fishing catch and effort: a pilot study of shore-based fishers in the Perth Metropolitan area. Fisheries Research Report 216. Department of Fisheries, Perth.

of licensees in the fishery due to a VFAS. 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 assessed as both the number of fishing days and the average number of boats fishing per month has followed a stable trend in recent years. In 2010, the fishery reported a total of 3,261 fishing days and an average of 17 boats fished per month.

In 2010, 52% of effort (method days) occurred in Wilson Inlet, 11% in Princess Royal Harbour, 11% in Oyster Harbour, 9% in Irwin Inlet, 7% in Beaufort Inlet and 5% in Stokes Inlet. Broke Inlet, Oldfield River and Hamersley River combined for the remaining 5% of effort. Four estuaries (Gordon Inlet, Culham Inlet, Jerdacuttup Lakes and Waychinicup Inlet) were not fished during 2010.

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 VFAS to the current level of 11 (operating from 10 beaches). In 2010, only 4 teams recorded effort during the 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 licensees 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 2010, Australian salmon landings were reported by 11 of the 18 licensed 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%).

The 2011 Statewide Recreational Boat Fishing Survey will provide recreational boat fishing effort data for the South Coast Bioregion in 2012.

Stock Assessment

Assessment complete	**Yes**
Assessment method	**Level 2 - 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**

Indicator species - nearshore

Australian herring: Australian herring form a single, genetically homogeneous breeding stock across southern Australia. Spawning occurs mainly along the lower west coast of WA during May-June. Eggs and larvae are dispersed by the Leeuwin Current to coastal nurseries distributed from the West Coast Bioregion to Victoria. A strong Leeuwin Current associated with a *La Niña* event can result in high annual recruitment outside the West Coast Bioregion due to greater larval dispersal. Australian 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 to spawn. These fish originate from juvenile nurseries in the South Coast Bioregion, South Australia and (to a lesser extent) Victoria. Australian 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 Australian 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 2010 (see West Coast Nearshore and Estuarine Figure 2). 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 Bioregion stock abundance on the status of the entire stock is uncertain. Research is underway to determine the current age structure and fishing mortality, and to examine the extent of connectivity of Australian 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. The Leeuwin Current disperses eggs and larvae to coastal nurseries distributed from the West Coast Bioregion to Victoria. As for Australian herring, Australian salmon in the South Coast Bioregion undertake a westward migration to the West Coast Bioregion, where they spawn during autumn. Unlike Australian herring, Australian salmon then migrate back to the South Coast Bioregion. Traditionally, commercial fishers have targeted Australian salmon during the autumn (mainly March/April) pre-spawning migration, but in recent years Australian 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. In 2010, landings returned to more historical levels with only 5% of the total landings taken during the July-December period.

Annual commercial landings of Australian salmon in the South Coast Bioregion have historically been highly variable. For the period 1964 to 2004, the catch ranged from 755 (in 1978) to 4,223 t (in 1968), with an annual average of 2,080 t. The South Coast Bioregion commercial catch and catch rate have been declining since 2005 (South Coast Nearshore and Estuarine Figures 2 and 5) with an average catch of 1,055 t for the period 2005-2010. The 2010 catch of 360 t was the lowest catch on record. Reduced targeting of Australian salmon by commercial fishers is believed to be the main reason for lower South Coast Bioregion 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 follows a more stable long-term trend, although the 2010 catch of 69 t was the 5th lowest on record (South Coast Nearshore and Estuarine Figures 2 and 5).

Australian 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 abundance of Australian salmon 3-4 years later. In 2010 there was low recruitment.

Indicator species - estuarine

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 7). 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 1980s, late 1990s and early 2000s. There was a decline in the catch rate in the mid 2000s before it again increased. While the 2010 catch of 52 t is just above the long-term average of 49 t (1980-2010), the standardised catch rate of 56 kg/method day is well above the average of 30 kg/method day to be the highest on record. This has continued a trend of 5 consecutive years of increasing catch rates. 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 forecasting variations in catch and catch rates.

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. In addition, while sea mullet has a tolerance to high salt levels (up to 75 ppt), growth and reproduction success may be inhibited due to increased salinity levels in estuaries as a result of primary and secondary salinisation.

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. Lower catch rates in 2008 and 2009 suggested sea mullet availability was returning to the long-term average level. In 2010, catch rates increased again to be the second highest on record.

Black bream: Black bream are restricted to estuaries. Each estuary hosts a discrete breeding stock of black bream, which is genetically distinct to other estuarine populations.

The majority of commercial black bream landings in the South Coast Bioregion are taken in four main estuaries - Stokes Inlet, Beaufort Inlet, Wilson Inlet and Oyster Harbour. From 1980 to 1995, commercial catch rates in these estuaries were relatively low and followed a stable trend, then steadily increased until about 2005 (South Coast Nearshore and Estuarine Figure 8). Since 2005, catch rates have been relatively stable in Beaufort Inlet and Oyster Harbour, declined slightly in Wilson Inlet and has increased in Stokes Inlet. In 2010, Stokes Inlet recorded the highest catch rate since records began.

Black bream landings vary in response to environmental factors in individual estuaries. Simultaneous increases in catch rates in numerous South Coast Bioregion estuaries from 1995 to 2005 suggest that a widespread factor, such as rainfall, has influenced black bream availability and recruitment across the region.

The current status of black bream in Walpole-Nornalup Inlet (closed to commercial fishing) cannot be assessed due to lack of recent data.

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 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 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 Australian 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 and declining.

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 over 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 2010, there were approximately 37 commercial fishers involved in the South Coast Salmon Fishery and approximately 11 commercial fishers involved in the South Coast herring trap net fishery. In 2010, the South Coast Estuarine Fishery employed an average of 21 fishers per month. Additional employment is created by these fisheries in the processing and distribution networks and retail fish sales sectors.

Australian herring and Australian 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 Australian herring and Australian 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 2003[1], Barharthah 2006[2]). 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.

Interviews conducted during the 2011 Statewide Recreational Boat Fishing Survey will provide important data on the social aspects of the South Coast Bioregion boat-based fisheries in 2012.

Economic Effects

Estimated annual commercial value (to fishers) for 2009/10:

South Coast Estuarine Fishery

$1,060,000 (finfish only)

South Coast Salmon + Herring trap net fisheries

$177,000 (finfish only)

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 – 1,200 tonnes**

South Coast Salmon Fishery

1,200 – 2,800 tonnes

(includes West Coast landings)

The 2010 South Coast Estuarine Managed Fishery total catch of finfish (223 t) was within the target range of 200-500 t.

The 2010 South Coast Bioregion catch of Australian herring (183 t) was below the target range of 200-500 t. Low catches in 2010 are 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 2010 (360 t) was well below the target range of 1,200-2,800 t. Low South Coast Bioregion catches in 2010 are believed to be due to a continuation of the combined effects of lack of targeting due to weak market demand, low catchability due to environmental factors (relatively high water temperatures) and low availability of fish due to low recent recruitment in 2006 and 2007 (South Coast Nearshore and Estuarine Figure 4).

The performance measure for the South Coast Salmon Fishery relates to annual salmon commercial catch, which is taken predominantly during the spawning season and is therefore an indicator of breeding stock levels. In 2010, the catch was below the target range. However, the low catch was primarily due to limited targeting due to weak market demand, low recruitment and low catchability due to environmental factors. Collectively, all available information suggests that the total breeding stock level was adequate in 2010.

Recreational

Current Fishing (or Effort) Level:	**Not available**
Target catch range:	**Not developed**

New management initiatives (for the next year)

The Department has no new management initiatives planned for the South Coast Bioregion nearshore or estuarine fisheries. Should the research projects mentioned in this section provide information suggesting an increased risk to sustainability, the Department will consult with the fishing sectors and introduce the appropriate arrangements as required.

External Factors

Climate change is expected to have impacts on nearshore and estuarine ecosystems. Changes in environmental variables such as ocean temperature, currents, winds, nutrient supply, rainfall, ocean chemistry and extreme weather conditions are expected to have major impacts on marine ecosystems

[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] Barhathah T. 2006. Department of Fisheries community survey 2005. Fisheries Occasional Paper No. 33. Department of Fisheries, Perth.

(Hobday *et al.* 2008[1]). These impacts are expected to create both difficulties and opportunities for fisheries.

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 Australian herring and Australian 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 Australian 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 Australian 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 Australian herring and Australian 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 Bioregion 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 Bioregion 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'.

Contributors

J. Brown, K. Smith, A. Howard and N. Chambers.

[1] Hobday, AJ, Poloczanska, ES and Matear, RJ (eds) (2008). Implications of Climate Change for Australian Fisheries and Aquaculture: a preliminary assessment. Report to the Department of Climate Change, Canberra, Australia. August 2008.

SOUTH COAST NEARSHORE AND ESTUARINE TABLE 1

Total annual catches of finfish (except sharks and rays) from the estuarine and beach-based nearshore commercial fisheries in the South Coast Bioregion, 2006 to 2010.

Species	Scientific name	Catch (tonnes)				
		2006	2007	2008	2009	2010
Australian salmon	*Arripis truttaceus*	790.7	246.1	545.1	258.0	291.3
Australian herring	*Arripis georgianus*	302.2	192.3	236.4	151.4	182.6
Cobbler	*Cnidoglanis macrocephalus*	44.5	68.1	77.4	86.6	69.7
Black bream	*Acanthopagrus butcheri*	34.0	46.1	37.8	50.0	65.4
Sea mullet	*Mugil cephalus*	18.1	52.8	21.8	26.3	31.9
Southern sea garfish	*Hyporhamphus melanochir*	15.7	18.0	16.8	7.6	13.7
King George whiting	*Sillaginodes punctata*	5.8	8.0	9.1	6.8	6.6
Flathead	Platycephalidae	8.8	9.1	9.2	5.2	2.9
Leatherjacket	Monocathidae	12.6	6.7	5.5	2.9	4.0
Silver bream (Tarwhine)	*Rhabdosargus sarba*	3.7	3.1	5.3	2.7	2.8
Yellow-eye mullet	*Aldrichetta forsteri*	3.6	3.0	4.6	3.4	2.6
Pink snapper	*Pagrus auratus*	1.9	3.2	3.6	1.9	0.9
Snook	*Sphyraena novaehollandiae*	1.3	2.4	2.9	2.4	1.3
Grunter (Trumpeter)	Teraponidae	3.4	2.5	0.3	1.7	0.3
Silver trevally	*Pseudocaranx georgianus*	1.8	2.3	1.2	1.3	1.3
Flounder	Pleuronectidae	2.7	1.7	1.1	0.2	1.5
Yellowtail scad	*Trachurus novaezelandiae*	3.5	1.1	0.3	0.2	0.6
Yellow-finned whiting	*Sillago schombergkii*	0.1	0.1	1.1	0.2	0.2
Mulloway	*Argyrosomus japonicus*	0.2	0.2	0.5	0.3	0.4
Tailor	*Pomatomus saltatrix*	0.2	0.2	0.1	0.1	0.4
Other finfish	Teleostei	5.7	4.6	4.9	5.9	4.5
TOTAL		**1260.7**	**672.2**	**985.3**	**615.3**	**684.7**

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 2003[1]).

Species	Scientific name	2000/01 Catch (tonnes)
Australian salmon	*Arripis truttaceus*	117
Trevally	*Pseudocaranx* spp.	93
Australian herring	*Arripis georgianus*	79
King George whiting	*Sillaginodes punctata*	40
Black bream	*Acanthopagrus butcheri*	28
Whiting	*Sillago* spp.	11
TOTAL		**368**

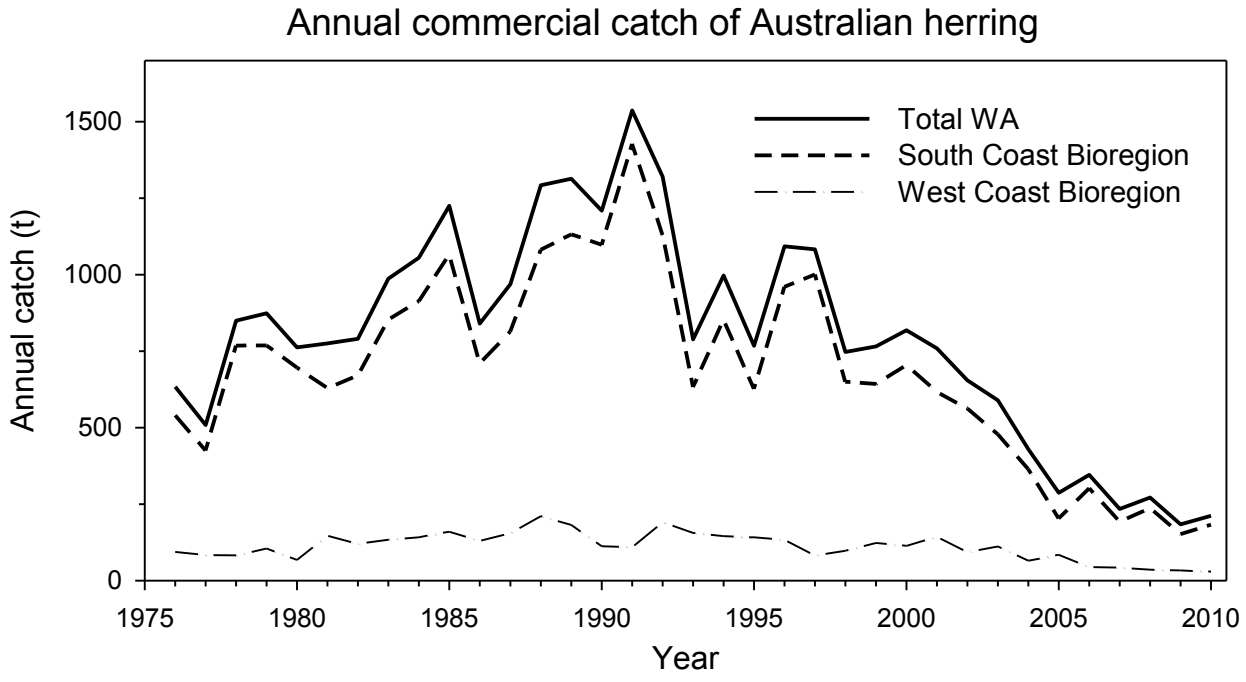
SOUTH COAST NEARSHORE AND ESTUARINE TABLE 3

Estimated total recreational catches of key species in estuaries in the South Coast Bioregion in 2002/03 (Smallwood and Sumner 2007[2])

Species	Scientific name	2002/03 Catch (tonnes)
Black bream	*Acanthopagrus butcheri*	23.3
King George whiting	*Sillaginodes punctata*	10.9
Trevally	*Pseudocaranx* spp.	6.1
Australian herring	*Arripis georgianus*	4.1
Southern blue-spotted flathead	*Platycephalus speculator*	2.6
Pink snapper	*Pagrus auratus*	2.6
Tarwhine	*Rhabdosargus sarba*	0.5
Southern sea garfish	*Hyporhamphus melanochir*	0.2

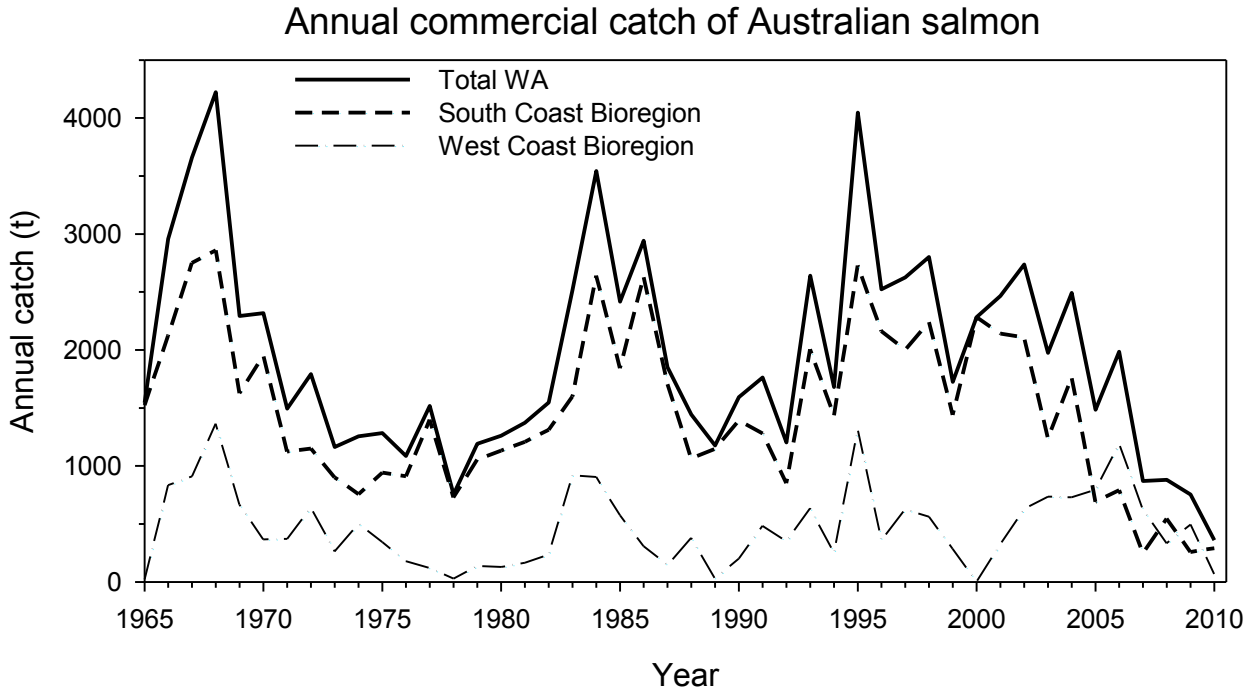
[1] Henry GW and Lyle JM. 2003. The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

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.



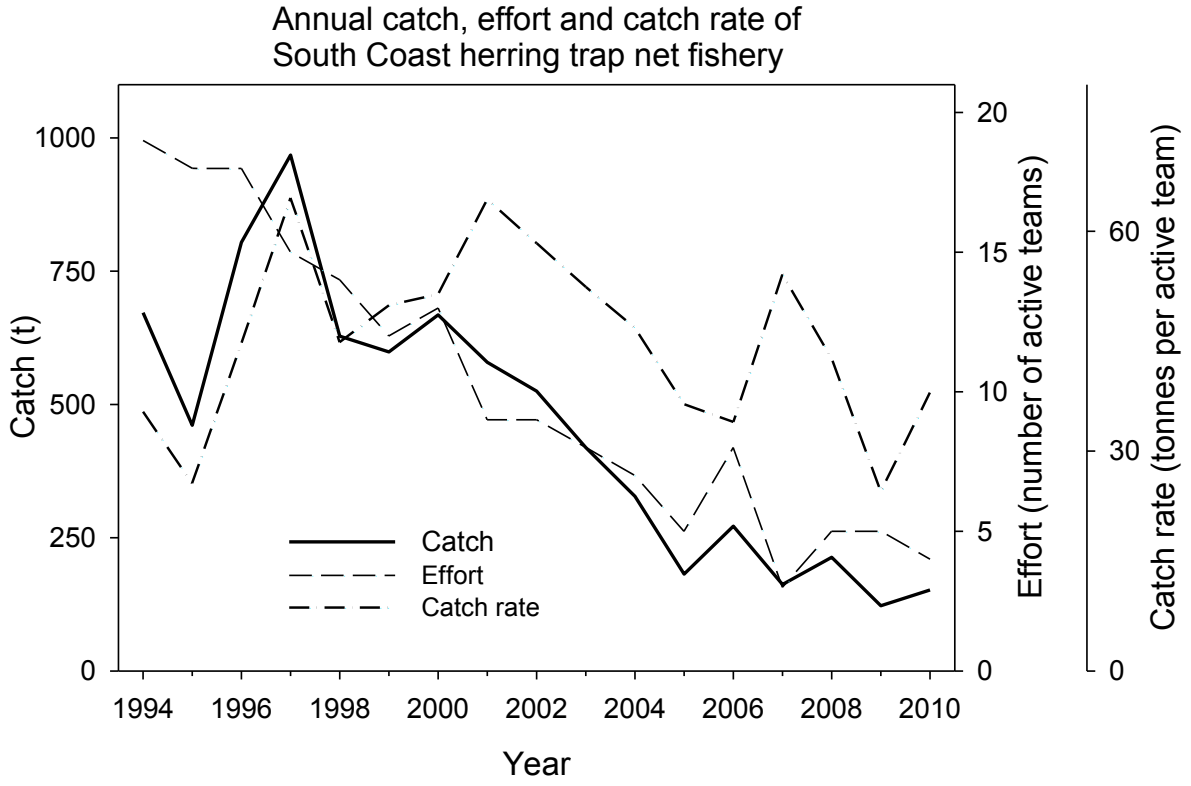
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 1

Total annual commercial catches of Australian herring in the South Coast and West Coast Bioregions, 1976 – 2010.



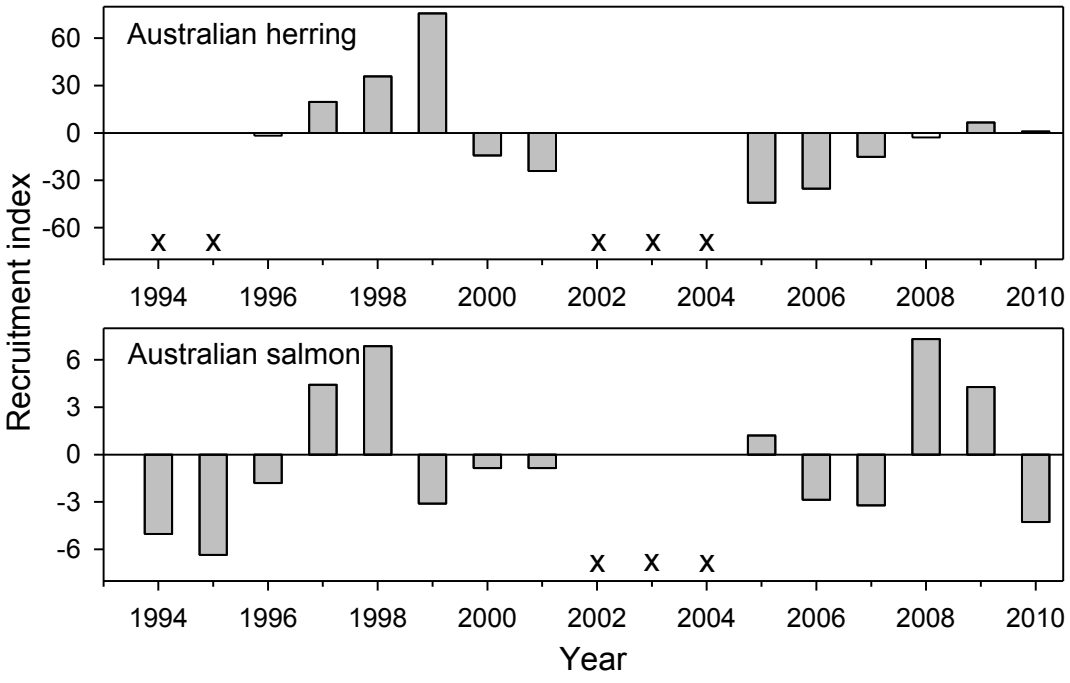
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 2

Total annual commercial catches of Australian salmon in the South Coast and West Coast Bioregions, 1965 – 2010.



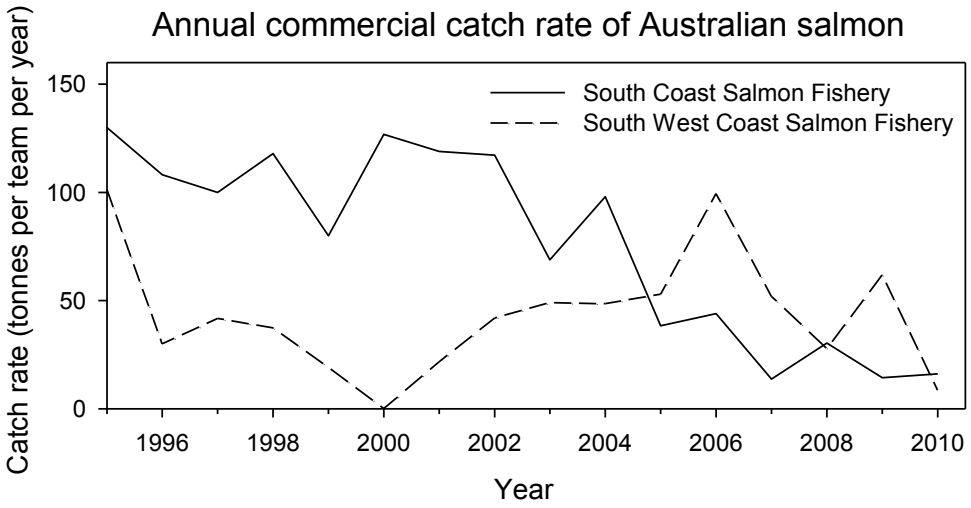
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 3

Total annual catch, effort and catch rate of Australian herring by the South Coast commercial trap net fishery, 1994 – 2010.



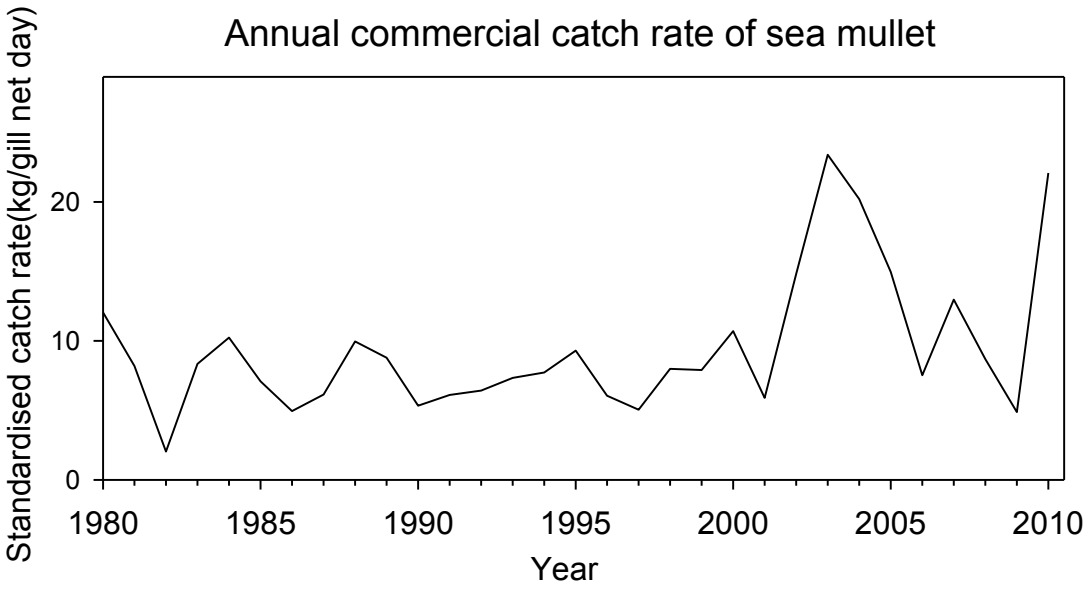
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 4

Annual fishery-independent relative recruitment indices for Australian herring and Australian salmon in the South Coast Bioregion, 1994 – 2010. (x – no sampling conducted in that year). Bars above the line reflect better than average number of recruits.



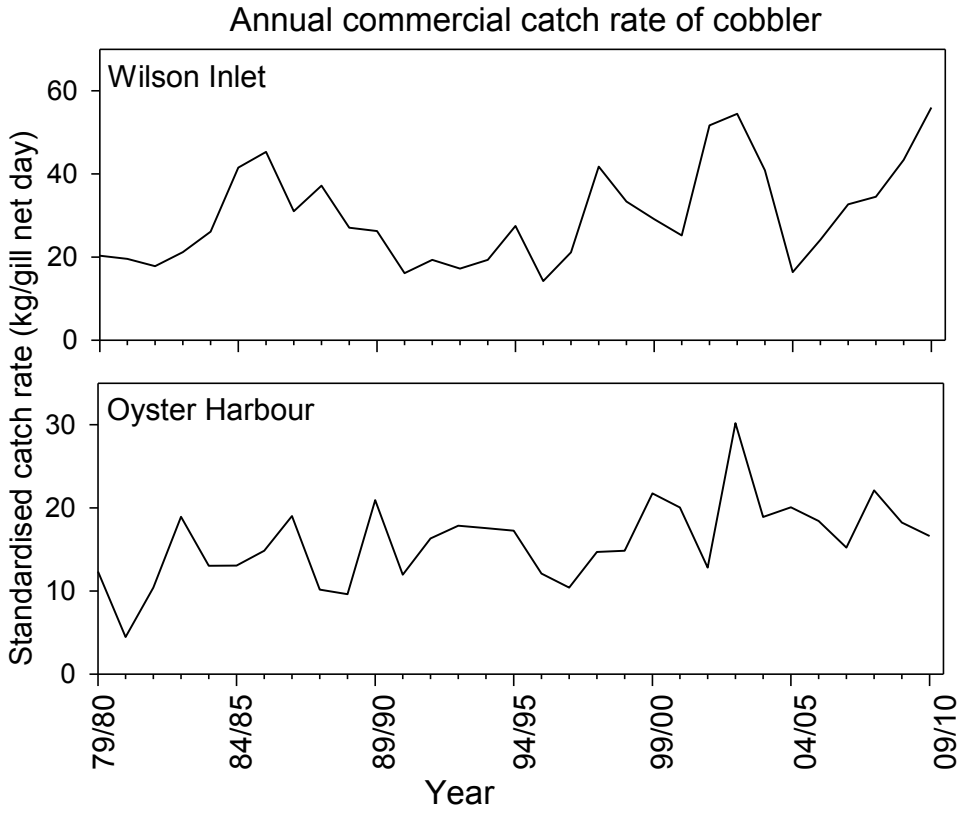
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 5

Total annual commercial catch rate (tonnes per licensee per year) of Australian salmon in the South Coast Salmon Fishery (South Coast Bioregion) and the South West Coast Salmon Fishery (West Coast Bioregion), 1995 – 2010.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 6

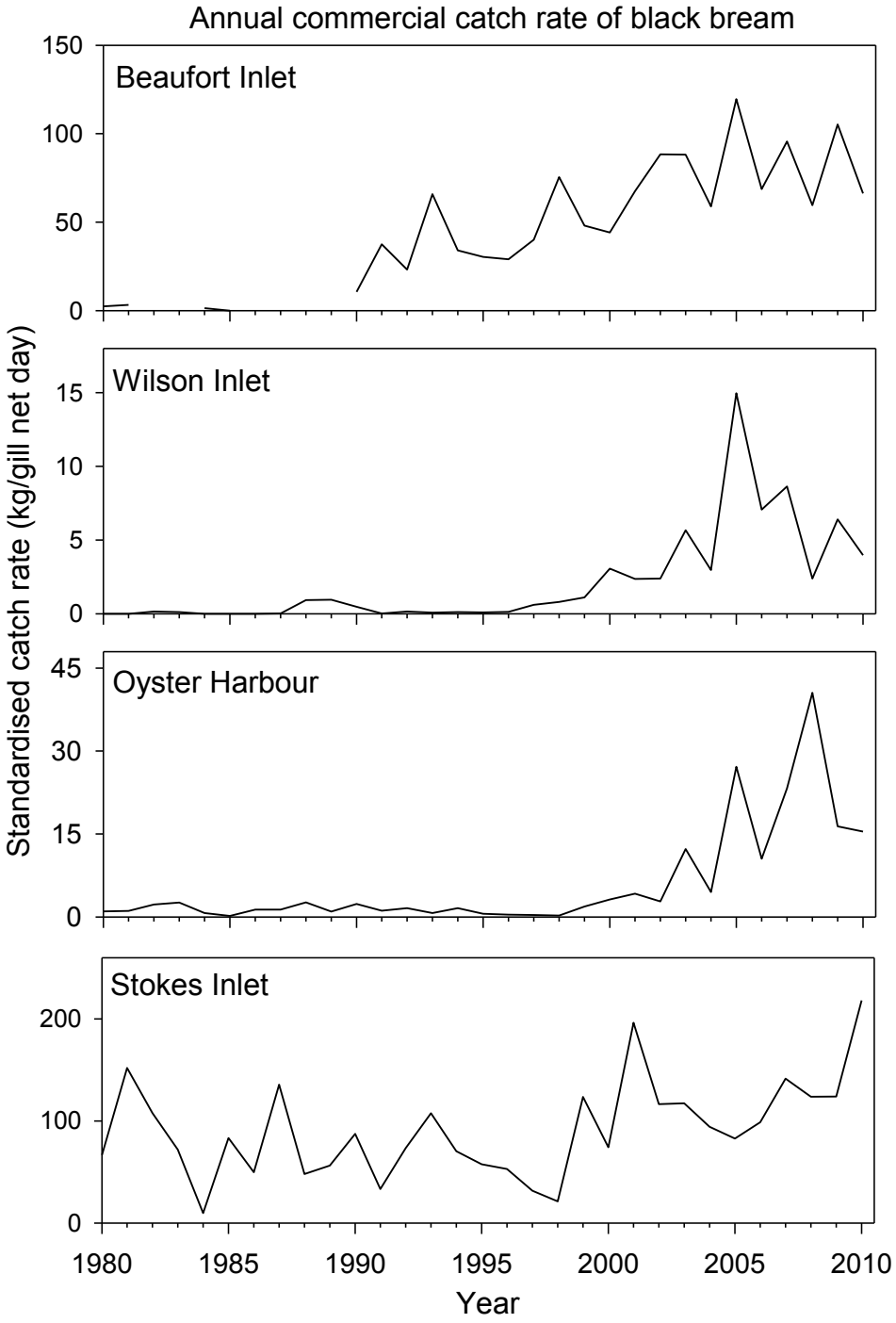
Annual commercial catch rate of sea mullet in Oyster Harbour, 1980 – 2010.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 7

Annual commercial catch rates of cobbler in Wilson Inlet and Oyster Harbour, 1979/80 – 2009/10

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SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 8

Annual commercial catch rates of black bream in Beaufort Inlet, Wilson Inlet, Oyster Harbour and Stokes Inlet, 1980 – 2010.

South Coast Purse Seine Fishery Report: Statistics Only

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*), scaly mackerel (*Sardinalla lemuru*), sandy sprat (*Hyperlophus vittatus*) blue sprat (*Spratelloides robustus*) and maray (*Etrumeus teres*).

Boundaries

The Fishery consists of five Management Zones (South Coast Purse Seine Fishery Figure 1). The Albany Zone (Zone 2, plus the King George Sound Zone - Zone 1) extends from Point D'Entrecasteaux to Cape Knob. The Bremer Bay Zone (Zone 3) extends from Cape Knob to longitude 120ºE. The large Esperance Zone (Zone 4) extends from 120ºE to the WA/SA border. An additional zone (Zone 5) exists between Cape Leeuwin and Point D'Entrecasteaux but has not been significantly fished to date. Catches are reported for the major zones (Zones 1 and 2 combined, Zone 3 and Zone 4) plus total catches (South Coast Purse Seine Fishery Figure 2).

Management arrangements

This fishery is primarily managed through output controls in the form of individual transferable quota (ITQ) units. Four (zones 1 – 4) of the five zones in the fishery have been allocated a set amount of ITQ units whose values are determined by dividing the total allowable catch for that zone by the total number of units allocated to that zone. The TAC has been relatively stable over the past 10 years and will be reviewed on an as needs basis but is primarily dependant on the status of fish stocks. The total number of units allocated across each of the four 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 each have an annual TAC of 1500 tonnes. Zone 5 of the fishery is considered a development zone and can only be fished by a licence holder in the SCPS fishery with a minimum holding in another zone, it has no specific TAC or units and has not been fished for a number of years.

Landings and Effort

Effort in the fishery increased in the 2009/10 season to more than 1,450 days, an increase of approximately 6% over 2008/09 effort levels and the second highest level of effort since 2002. Effort increases were confined to the Albany (Zones 1 and 2) and Esperance Zones (Zone 4), with a decline in effort reported in the Bremer Bay Zone (Zone 3).

Commercial pilchard catches during the 2009/10 season increased to 2,647 t, extending the trend of increasing catches in the fishery since the late 1990s and underlining the recovery in biomass since the virus and a return to economic levels for the fishers (South Coast Purse Seine Figure 2). The 2009/10 catch has increased more than 25% on the 2008/09 season where just over 2,001 t of pilchard were landed. More than 8 t of other pelagic species were also landed, dominated by yellowtail scad.

Most of the commercial catches were reported from the Albany Zone (1,796 t). Catches from the Esperance Zone (Zone 4) increased from 139 t in 2008/09 to 429 t in 2009/10, with a decline in catches over a similar period reported from the Bremer Bay Zone (2008/09: 511.7 t; 2009/10: 422 t); however much lower effort was reported from the Bremer Bay Zone in 2009/10. Overall effort and catches remain below those recorded during the late 1980s and 1990s.

Fishery Governance

Target commercial effort range: Not available

For the 2009/10 season, the catch (2,647 t) was well below the total TAC for the entire fishery (5,683 t) (South Coast Purse Seine Fishery Table 1). In addition, the 2009/10 catches from each of the three major Management Zones are well below their respective TACs. The fleet and infrastructure for this fishery continues to rebuild but reports of below market size fish (i.e. small fish) 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 not possible 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 Zones is likely to be appropriate and the current level of fishing is acceptable. Further, catches in other jurisdictions are also increasing further supporting the continued increase and recovery of the biomass of pilchards across southern Australia.

New management initiatives (2011/12)

A code of conduct introduced in the Albany zones of the fishery by the working group established by the Department of Fisheries in 2006 continues to reduce fleshy footed shearwater interactions in the south coast purse seine fishery. Minor modifications to the code in 2010 will be adopted for the 2011/12 season. The working group set up to deal with the fleshy footed shearwater interactions effectively winds up at the end of the 2010/11 season. Industry is determined to continue to maintain low interactions with fleshy footed shearwaters and will continue using the code into the future. There are no significant legislative management changes planned for this fishery.

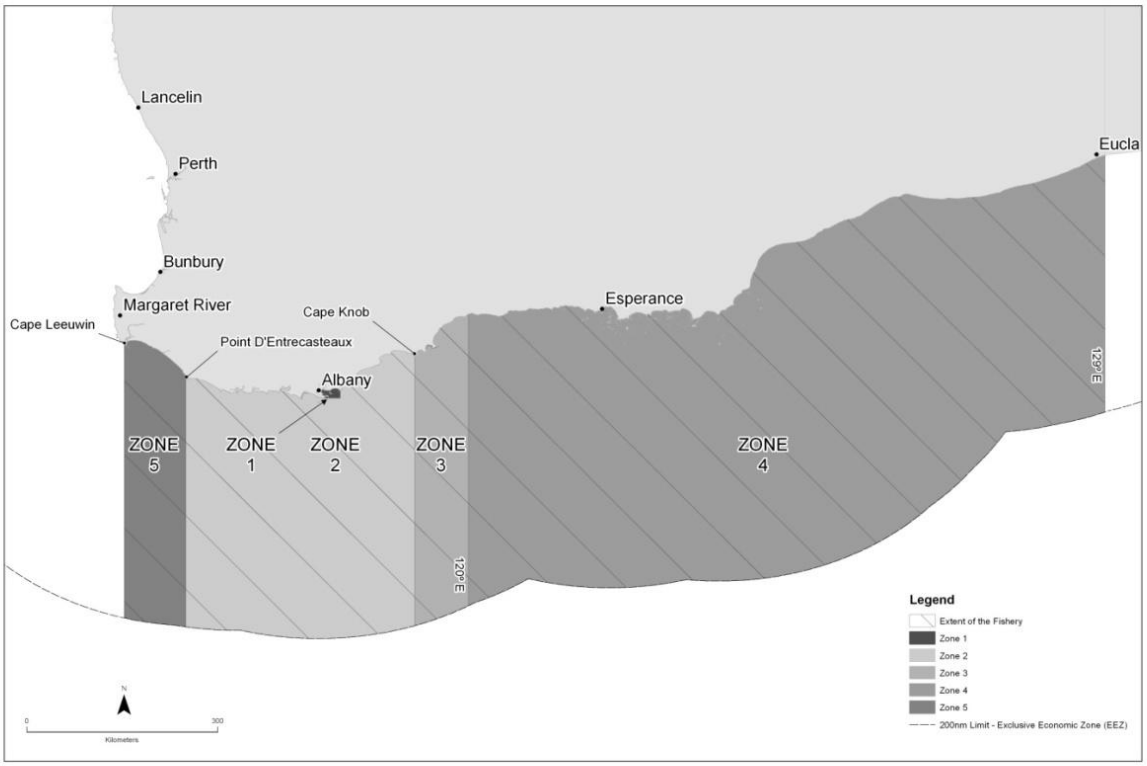
Contributors

B. Molony, E. Lai and N. Chambers

SOUTH COAST PURSE SEINE FISHERY TABLE 1

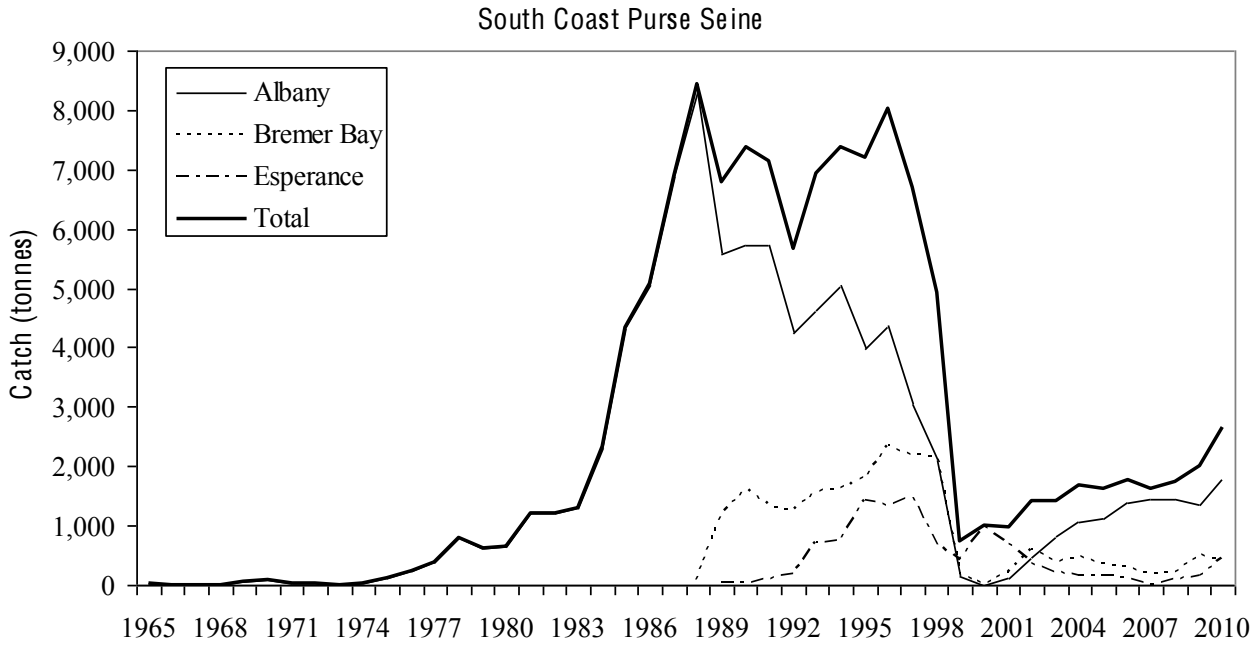
2009/10 pilchard catches and TACs in tonnes (t) for each of the major Management Zones.

Management Zone	TAC (t)	2009/10 catch (t)	2009/10 catch as percent of TAC
Albany (Zones 1 and 2)	2,683	1,796	66.9%
Bremer Bay (Zone 3)	1,500	422	28.1 %
Esperance (Zone 4)	1,500	429	28.6 %
Total for Fishery	5,683	2,647	46.6 %



SOUTH COAST PURSE SEINE FISHERY FIGURE 1

Map of the extent of the Mackerel Managed Fishery.



SOUTH COAST PURSE SEINE FISHERY FIGURE 2

Annual catches of pilchards along the south coast, by major fishing zone, 1965 - 2010.

Demersal Gillnet and Longline Fisheries Status Report

Main Features

Status	
Stock level	
Gummy shark	Acceptable
Dusky shark	Recovering
Sandbar shark	Not Acceptable
Whiskery shark	Acceptable
Fishing Level	
JASDGDLF Zone 1	Acceptable
JASDGDLF Zone 2	Acceptable
WCDGDLF	Acceptable

Current Landings (2009/10)	
Demersal Gillnet and Demersal Longline Fishery	
Total sharks and rays	1,229 t
Scalefish	226 t
Indicator species	
Gummy shark	508 t
Dusky shark	237 t
Sandbar shark	107 t
Whiskery shark	145 t
Catch of sharks and rays by other commercial fisheries (2009/10)	2 t
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 in continental shelf waters along the south and lower west coasts. The majority of operators use demersal gillnets and power-hauled reels to target sharks, with 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 off 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, however, have a more limited southern range and are an indicator species of the South Coast Bioregion inshore demersal suite. These four species have been selected as indicators for the status of the temperate shark 'suite' as they account for approximately 80% of the fisheries' shark catch and represent the range of life history strategies of the other shark species caught by the fisheries. 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; Recfishwest; 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 three management zones (Demersal Gillnet and Longline Figure 1). 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). A small number of Zone 3 units permit fishing throughout Zone 1 and eastwards to 116° 55'40" E. For the purposes of this report, Zone 3 catch and effort data are amalgamated into Zone 1 or Zone 2 as appropriate.

The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery technically extends northwards from 33° S latitude to 26° S longitude (Demersal Gillnet and Longline Figure 1). 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 was also prohibited off the Metropolitan coast (between latitudes 31° S and 33° S) on 15 November 2007.

Management arrangements

The Southern and West Coast fisheries are regulated through two complementary management plans. The JASDGDLF 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 an interim 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 a specified length of net or an equivalent number of hooks for one month. However, in 2009, the Department transitioned the fishery to a more explicit hourly effort management system, with the objectives of removing excessive latent effort capacity and restricting effort within each management zone to 2001/02 levels. All units now permit the use of 27 m of gillnet or 9 longline hooks for 288 hours in the WCDGDLF, 264 hours in Zones 1 and 3 of the JASDGDLF or 380 hours in Zone 2 of the JASDGDLF.

Additional measures to address remaining sustainability concerns for the fisheries' key stocks have been in effect since the 2006/07 season. These included:

- a two month closure (16 August to 15 October), during the main whiskery shark pupping season, of inshore waters to 200m depth throughout all of the WCDGDLF and the waters of the South Coast west of 118° E (in the JASDGDLF) to assist in the recovery of the over-exploited whiskery shark stock;
- a maximum (inter-dorsal fin) size limit of 70 cm for dusky sharks to protect their breeding stock; and
- a general prohibition of metal trace wire and large hooks (except in the Northern Shark and Mackerel Fisheries), which had previously been used to target large whaler sharks.

The shark management arrangements above 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 which incidental shark catches have been assessed as posing low sustainability risks.

In addition, to further assist in the protection of medium-high risk dusky and sandbar whaler shark stocks, a 70 cm maximum (inter-dorsal fin) size limit for all 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 between latitudes 31° S and 33° S (inshore of 250 metres depth) has now been closed to most commercial fishing activities, including those of the WCDGDLF. To offset the Metropolitan Area Closure and mitigate potential impacts of effort displacement to northern grounds of the fishery, the Government established a Voluntary Fisheries Adjustment Scheme with the aim of buying-back 33% of WCDGDLF entitlement. This scheme is now closed and resulted in approximately 36% of entitlement being removed.

In April 2009, the two fisheries (collectively referred to as the WA Temperate Demersal Gillnet and Demersal Longline Fisheries, TDGDLF) were declared as approved Wildlife Trade Operations (WTOs) 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.

Following the outcomes of the Wetline Review, the Government made a commitment to address the long-term sustainability of demersal scalefish on the West Coast by reducing both commercial and recreational demersal scalefish catches by at least 50% of 2005/06 levels. Demersal scalefish are an important component of the TDGDLF catch and the fisheries are being closely monitored to ensure the combined catch of demersal scalefish taken from the commercial sector does not exceed the target (see West Coast Demersal Scalefish Fishery Status Report).

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 fisheries. The extensive biological and fishery information gained from these studies have been reported in three FRDC final reports, numerous international journal publications and 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. A new three year FRDC-funded study of the movements of the fisheries' four indicator shark stocks will commence in 2011. Results from that study will be used to reassess the status of these stocks with greater reference to their spatial and temporal dynamics.

Current research monitoring involves analysis of fishing returns data and periodic biological sampling of commercial and fishery-independent catches. To support the fishery management arrangements introduced in 2006, improve assessments of key stocks and facilitate the more detailed reporting requirements of the fisheries' export accreditation under the Commonwealth's 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 was undertaken between 2009 and 2010. As well as rectifying previously misreported fishing returns data, this exercise generally

improved reporting standards and has provided the basis for the development and implementation of new catch and effort data validation protocols.

In addition to research on the fisheries' target stocks, some tactical research has been completed on Threatened Endangered and Protected (TEP) species bycatch. Two National Heritage Trust funded projects investigated movements and aggregation locations of grey nurse sharks (*Carcharias taurus*) and a recent FRDC-funded project examined the relative spatial risks of Australian sea lion (*Neophoca cinerea*) interactions with demersal gillnets. A further FRDC-funded study to estimate quantitative rates of sea lion encounters with demersal gillnets will be undertaken in 2010-11. WA Government funded research into white shark (*Carcharodon carcharias*) movements in the Perth Metropolitan region may also yield additional information on managing issues related to bycatch of protected species.

Retained Species

Commercial landings (seasons 2009/10)[1]:

All sharks (and rays):	**1,229 tonnes**
Indicator shark species:	**996 tonnes**
Gummy:	**508 tonnes**
Dusky[2]:	**237 tonnes**
Whiskery:	**145 tonnes**
Sandbar:	**107 tonnes**

Other finfish (i.e. non shark) catch: In addition to their primary catch of sharks, the JASDGDLF and WCDGDLF land a variety of scalefish species, which totalled 226 t in 2009/10 (Demersal Gillnet and Longline Figure 3). This catch included 75 t of demersal species taken in the West Coast Bioregion and 130 t of demersal scalefish taken in the South Coast Bioregion (Demersal Gillnet and Longline Table 1). For details of other fisheries' demersal scalefish catches in those bioregions, see Demersal Scalefish Fishery Status Report and South Coast Wetline Fishery Report.

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 those catches' contribution to identified sustainability risks to some stocks (eg. dusky shark), the retention of sharks and rays was prohibited in most non-target fisheries throughout the State by commercially protecting all sharks and rays (elasmobranchs) in November 2006. Reported elasmobranch catches by vessels operating in other managed fisheries between North West Cape and the South Australian border subsequently declined to less than 5 t per year (2.0 t in 2009/10).

[1] All reported weights are live weight

[2] Dusky shark catches include catches of bronze whaler (*Carcharhinus brachyurus*), which cannot be accurately separated in catch returns data prior to 2006/07.

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 recreational take of sharks in the west coast bioregion would have been about 13.5 t or approximately 3% of the bioregion's commercial shark catch in 2005/06. A new State-wide recreational fishing boat survey commencing in 2011 will provide updated estimates of the recreational take of sharks across the State in 2012.

Fishing effort/access level

There are 57 licences in the JASDGDLF (24 in Zone 1 and 33 in Zone 2) and 20 WCDGDLF permits, which can be used collectively in conjunction with a fishing boat licence. Only 7 Zone 1, 15 Zone 2 and 4 WCDGDLF vessels reported active fishing returns during 2009/10, similar to the levels of participation in the fisheries over the last four years.

As gillnetting is by far the dominant method employed in the fisheries, fishing effort is standardised as equivalent gillnet effort by transforming the historically small longline shark catches by gillnet Catch Per Unit Effort (CPUE). Although standardised fishing effort has previously been reported in units of kilometre gillnet hours (km gn.hr), the hourly component of effort reported in monthly fishing returns prior to 2006/07 is known to be a poor indication of the time nets actually spent fishing (i.e. 'soak time'). With the transition from monthly to hourly effort entitlement units and the introduction of a daily catch and effort reporting system in 2006/07, actual soak times have been more accurately reported over the last four years. Thus, the hourly components of fishing effort reported in monthly and daily fishing returns are not directly comparable. To allow for historical comparison and assessment of effort and CPUE trends in the fisheries, the entire 35 year time series of effort data have been recalculated in comparable units of kilometre gillnet days (km gn.d; Demersal Gillnet and Longline Figure 4). The 2001/02 hourly effort levels were previously referred to as 'target' levels, given the changes outlined above these no longer accurately reflect the actual effort in 2001/02.

Fishery and zone-specific limits on demersal gillnet and demersal longline fishing effort, equivalent to their 2001/02 levels, were agreed for the start of the 2006/07 season by specifying the number of days that monthly units could be fished in each management zone. These (daily) effort limits were considered likely to deliver sustainable catches of target, byproduct and bycatch species and acceptably low risks to TEP species. Effort limits were subsequently re-

defined and legislated as hourly units of entitlement using conversion rates of 24 hours day-1 in Zones 1 and 3 of the JASDGDLF, 20 hours day-1 in Zone 2 and 24 hours day-1 in the WCDGDLF. Thus, specified fishing effort limits (based on 2001/02 daily effort levels) for each management zone of the fishery are:

JASDGDLF Zones 1 and 3:	84,075 km gn.hr (3,503 km gn.d)
JASDGDLF Zone 2:	144,102 km gn.hr (7,205 km gn.d)
WCDGDLF[1]:	67,692 km gn.hr (2,832 km gn.d)

Expended effort in 2009/10 was 58,606 km gn.hr (3,083 km gn.d) in Zone 1; 120,007 km gn.hr (6,729 km gn.d) in Zone 2 and 34,132 km gn.hr (1,561 km gn.d) in the WCDGDLF. Overall, 72% of the fisheries' effort capacity was utilised in 2009/10 (70% in Zone 1, 83% in Zone 2 and 50% in the WCDGDLF).

Stock Assessment

Assessment complete: **Yes**

Assessment method and level:

Gummy shark **Level 2 - CPUE (annual- relative to previous age structured model)**

Dusky shark **Level 2 - CPUE (relative to previous Level 4 assessment)**

Sandbar shark **Level 2 - CPUE (relative to previous Level 4 assessment)**

Whiskery shark **Level 5 - Age Structured Model**

Breeding stock levels:

Gummy shark **Acceptable**

Dusky shark **Recovering**

Sandbar shark **Not Acceptable**

Whiskery shark **Acceptable**

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 simulation models. For assessment purposes, monthly catch and effort data are corrected to account for missing fishing returns prior to 1989/90, inaccurately reported species compositions and an increasing effort efficiency of 2% yr-1 prior to 1995/96, to account for major advances in gear technology (eg. monofilament nets and GPS) and vessel development (i.e. introduction of larger vessels). Missing, misreported and confounded catches submitted in daily/trip logbook returns between 2006/07 and 2008/09 were recovered or corrected using fishers' personal records, fish processor returns, face to face and phone interviews with fishers or were derived from average fish weights in accurately-reported logbook records or from observed size frequency data and available length weight relationships.

Trends in the relative abundance of the fisheries' four indicator species are inferred from each species' 'effective' CPUE. Effective CPUE is calculated by dividing the corrected gillnet-only catch by the equivalent gillnet effort from the regions of the fisheries that overlap each species' primary distribution (as defined below). Due to the introduction in 2006 of an annual two month closure to protect near-term pregnant whiskery sharks and the prohibition of demersal gillnet fishing in the metropolitan region in November 2007, catch and effort data reported from west of 118°E during August, September and October and between latitudes 31°S and 33°S in all months are excluded from all effective CPUE time series.

Gummy shark: The best (median) estimate from age-structured modelling indicated that in 1997/98 the Western Australian gummy shark stock was 42.7% of its virgin biomass (B0), slightly above its minimum acceptable level of 40% of B0. As gummy shark catches are almost exclusively comprised of adults, the upward trend in effective CPUE from the area off the south coast between longitudes 116°E and 129°E between the mid 1990s and 2005/06, suggested that breeding biomass steadily increased following reductions in demersal gillnet fishing effort commencing in 1992 (Demersal Gillnet and Longline Figure 5). Although recent CPUE has been higher than at any time since records began, the unprecedented spike and subsequent decline (to expected levels) in effective CPUE over the last four years is inconsistent with previous data and will be considered in more detail during development of a new stock assessment model that incorporates contemporary catch, effort, size and movement information that is due to be developed over the next three years.

Dusky shark: Due to the size selectivity characteristics of the mesh sizes permitted in the fishery and its area of operation, dusky shark catches have historically consisted of neonate (young of the year) and one to two year old fish, which collectively accounted for 89% of the observed catch during the 1990s. Due to the age-selective nature of the fishery and longevity of the species, which takes about 30 years to reach maturity and may live for more than 50 years, the available time series of catch and effort data are insufficient for developing a dynamic population simulation model for this stock (as has been used for gummy and whiskery sharks). The status of the Western Australian dusky shark stock was therefore assessed using stochastic demographic modelling techniques to evaluate the sustainability of empirically-estimated fishing mortality rates of sharks born between 1994 and 1996.

The most recent demographic assessment was conducted in 2005 and subsequent assessments of stock status have relied on analyses of catch and CPUE data from south of 28°S latitude to 120°E longitude off the south coast, in relation to the demographic rates estimated by that model. This analysis confirmed that demersal gillnet and longline fishing mortality

[1] The WCDGDLF limit is adjusted to 64% of the 2001/02 effort level to account for the reduction in entitlement units arising from the 2008 Voluntary Fishery Adjustment Scheme.

rates were likely to have been sustainable for the cohorts of sharks born in 1994/95 and 1995/96. However, the model also predicted that very low levels of fishing mortality (1–2% yr-1) applied to sharks older than 10 years of age would result in negative rates of population growth. Although the area of the WCDGDLF between 26° 30' S and North West Cape was closed in 1993 to protect adult dusky sharks, they are known to have been caught by various fisheries operating within and outside WA jurisdiction. Previous assessments therefore concluded that the declining trend observed in the effective CPUE series between the mid 1990s and 2004/05 (Demersal Gillnet and Longline Figure 6) could indicate that breeding biomass had been gradually depleted by these poorly-quantified sources of fishing mortality.

The last four years of effective CPUE data, however, suggest that either any downwards trend in recruitment may have stabilised or even reversed or that the period of declining CPUE was part of a longer-term stable trajectory. Given that the mean annual effective CPUE reported during the last four years has been higher than mean of the previous 20 years' data and that recent catches of juvenile sharks of this species have been reduced by half of the number determined to be sustainable in 1994/95 and 1995/96, along with the comprehensive measures to mitigate cryptic mortality of older dusky sharks that have been introduced since 2006[1], the current management is considered suitably precautionary to ensure that the recovery of this stock is occurring.

Whiskery shark: Previous age structured modelling of the whiskery shark stock (based on hourly CPUE data) concluded that total biomass was depleted to less than 40% of B0 by the early 1990s but the stock had shown preliminary signs of recovery to slightly above 40% of B_0 by the late 2000s. Using the new series of effective CPUE data from south of 28°S latitude to 129°E longitude off the south coast (Demersal Gillnet and Longline Figure 8) in the model, results support the conclusion that total biomass was heavily depleted during the 1980s. However, this model implementation indicates that total biomass at the commencement of mandatory catch and effort reporting in 1975/76 was less certain than previous assessments suggested (95% confidence intervals that biomass was between 69% and 100%). Significantly, the model also suggests (with 95% confidence) that biomass may only have fallen as low as 45.4% in 1995/96. Since then, the best (median) estimates of total biomass have indicated only very modest recovery at best (mean annual increase of 0.25% yr-1) and that current biomass was 52.1% of B0 in 2009/10 (95% confidence intervals of 46.4 to 56.8%). Further analyses of CPUE data are currently being undertaken in conjunction with exploration of alternative model assumptions, in an attempt to better understand these model results. Nevertheless, as these and previous model outputs suggest that whiskery shark biomass currently exceeds the minimum acceptable level and all recent modelling indicates that total and mature female biomass trends are increasing, the status of the WA whiskery shark stock is now considered to be acceptable.

Furthermore, accelerated rates of whiskery stock recovery are expected to become evident in catch and CPUE data when sharks born since the introduction of the annual closed season (see management arrangements above) begin recruiting to the fishery in 2012/13.

Sandbar shark: Due to the sandbar shark's longevity and age-specific nature of fishing mortality in the target fisheries, stock assessment was undertaken using empirically-derived estimates of fishing mortality and demographic modelling techniques, similar to those used for dusky shark. FRDC-funded research undertaken between 2000 and 2005 confirmed that sandbar sharks taken in the TDGDLF were the same unit stock as was being targeted in the Northern Shark Fisheries. The model indicated that combined levels of fishing mortality in the target TDGDLF and Northern Shark Fisheries, as well as in non-target commercial fisheries and the recreational fishing sector were increasingly unsustainable between 2001 and 2004 and had probably been so since at least 1997/98. As those mortality rates corresponded to combined reported catches of 250–440 tonnes year-1, the combined catch of 918 tonnes by the target sector in 2004/05 (762 tonnes of which was reported by the northern shark fisheries) is considered to have been highly unsustainable. This conclusion is supported by fishery-independent survey data collected from the area between northern Shark Bay and Eighty Mile Beach where mature sandbar sharks are prevalent, which indicate there was a significant decline in breeding stock abundance between 2002 and 2005.

Subsequent assessments of stock status have used analyses of the combined catches by the TDGDLF and northern shark fisheries (see Northern Shark Fisheries Status Report), relative to those fisheries' catches during the assessment period. Although an effective CPUE region has been identified as south of 26°S latitude to 118°E longitude off the south coast (Demersal Gillnet and Longline Figure 9), the full extent of expected reductions in recruitment caused by previous excessive catches of breeding stock, are unlikely to be reflected in CPUE data until cohorts born since 2004/05 enter the fishery between 6 and 9 years of age (i.e. over the coming three years). Although the significant declines in WCDGDLF fishing effort may mask the magnitude of reductions in those cohorts' abundance, TDGDLF sandbar shark catches in 2008/09 and 2009/10 were at levels allowing gradual recovery of the breeding stock. With the breeding stock likely to be close to the minimum acceptable limit (40% of B0), the considerable latent effort potential in the WCDGDLF will need to be carefully monitored over coming years to ensure that catch levels of sandbar sharks are maintained consistent with continued stock recovery.

Other sharks: The four indicator species of the temperate shark 'suite' account for approximately 80% of the fisheries' and bioregional shark catch and represent the range of life history strategies of other shark species caught by the fisheries. Thus, the status of indicator stocks is believed to generally reflect the status of other sharks in the South and West Coast bioregion.

[1] i.e. commercial protection of sharks in most non-target fisheries, total protection of all whaler sharks with an inter-dorsal fin length greater than 70 cm in the South and West Coast Bioregions, 70 cm maximum (inter-dorsal fin) size limit for dusky sharks in the TDGDLF, implementation of bycatch reduction devices in trawl fisheries, prohibition of metal snoods in most commercial fisheries.

Non-Retained Species

Bycatch species impact: **Low**

The catch composition of the fishery was examined in detail for the period 1994 to 1999. 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 maximum potential fishing effort is now explicitly capped at approximately 68% 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. 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. 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 is 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. The recent multi-fisheries bycatch risk assessment project also assessed the cumulative bycatch risk to these species as low-moderate.

Two studies have assessed risks to Australian sea lions from demersal gillnet captures in these fisheries to be moderate-high in the West Coast Bioregion and suggested that that several sea lion colonies in the south east of the State and at Beagle Island off the west coast to be at greatest risk. Although observed rates of sea lion captures were extremely low (n=1) during the late 1990s, further work is underway to estimate potential levels of sea lion interactions with these fisheries.

Ecosystem Effects

Food chain effects: **Low**

The recent analysis of potential changes in ecosystem structure of finfish on the south and west coast bioregions (Hall & Wise, 2010) found no evidence of any systematic change in species diversity, richness or trophic index indicating that this fishery is not having a material impact on food chain or trophic structure.

Habitat effects: **Negligible**

The level of effort is such that the gear is deployed infrequently over approximately 40% of the fisheries' operational area (Demersal Gillnet and Longline Figure 1) and under normal circumstances the physical impact of the gear on the bottom is minimal. Moreover the very small footprint of each net would combine to make a very small percentage (<< 5%) of the area would be contacted by this gear on an annual basis.

Social Effects

Direct: Fishing returns reported that 56 skippers and crew were employed in the JASDGDLF and 9 in the WCDGDLF during 2009/10. As sharks are generally not targeted by recreational fishers in Western Australia, 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 recreationally caught fish. However, others consider them to be important components of marine ecosystems that need to be conserved.

Economic Effects

Estimated annual commercial value (to fishers) for year 2009/10:

JASDGDLF:	**$4.2 million (shark*)**
	$0.9 million (scalefish)
WCDGDLF:	**$0.7 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

Target commercial catch range:

Key shark species	**725–1,095 tonnes**

Individual target catch ranges for the key species in 2009/10 were as follows:

Gummy shark	**350–450 tonnes**
Dusky shark	**200–300 tonnes**
Sandbar shark	**< 120 tonnes**
Whiskery shark	**175–225 tonnes**
Current Fishing Level	
JASDGDLF Zone 1	**Acceptable**
JASDGDLF Zone 2	**Acceptable**
WCDGDLF	**Acceptable**

Maximum acceptable effort levels for each management zone have been based on their respective 2001/02 (daily) levels. These levels are considered likely to deliver sustainable harvests of the fisheries' target and byproduct species and acceptably low levels of bycatch and protected species interactions. Under explicit hourly-gear input control arrangements, effort should not exceed these limits.

Gummy shark catches have exceeded the upper limit of their acceptable range since 2003-04, and reached a historically high level in 2007-08 (755 t). As the steadily increasing CPUE trend observed between the early-mid 1990s and 2005/06 is believed to have been a result of increasing stock abundance, the consistently high catches reported in recent years are not of concern. However, until the implications of the unprecedented recent spike in effective CPUE can be ascertained and a new stock assessment model developed, CPUE will be closely monitored to ensure that it remains at expected levels and the downwards trajectory of the last two years does not continue.

Dusky shark catches have been within their acceptable range for the last 3 years and were only 5 tonnes below the minimum limit in 2006/07. As 28% of potential effort capacity was unutilised in 2009/10 (higher proportion in the WCDGDLF), there is considerable scope for dusky shark catches to increase in coming years, particularly if recent CPUE data reflect stable or increasing recruitment. The acceptable catch range will therefore require re-evaluation if catches increase in coming years.

Whiskery shark catches have been maintained slightly above or below the minimum acceptable level for the last decade. As the latest model results suggest that the biomass is stable or slowly increasing above its minimum level (40% of B0) and increasing catch rates are expected to occur as a result of the recovery measures introduced in 2006/07 (particularly the seasonal closure), catches are expected to rise in coming years. Therefore, the acceptable whiskery shark catch range will need to be adjusted upwards as the magnitude and rate of stock recovery can be determined.

Sandbar shark catches exceeded the maximum acceptable catch of 120 t by 7% and 35% in 2006/07 and 2007/08, respectively. However, as WCDGDLF effort subsequently declined, catches declined to acceptable levels of 81 t in 2008/09 and 107 t in 2009/10. The implications of these catches also need to be considered in reference to the recent pattern of catches of adult sharks in the northern shark fisheries (see Northern Shark Fisheries Status Report).

New management initiatives (for 2010/11)

The future of the whiskery shark 'pupping' closure will be reviewed in late 2010, with a view to implementing a longer term arrangement to ensure their sustainability.

A desktop study to estimate potential interaction rates of Australian sea lions with demersal gillnets in the TDGDLF will begin in 2010/11. The outputs from this study will be used to evaluate management options to ensure these interactions are maintained within acceptable levels.

The Commonwealth Government is expected to release the Southwest Marine Bioregional Plan (including a proposed marine reserve zoning scheme) in 2010/11, which has significant potential to impact on the operation of the TDGDLF. In addition, the State Ngari Capes Marine Park, which is likely to have some impact on Zone 1 of the JASDGDLF, is expected to be progressed during 2010/11.

External Factors

There are a number of factors outside of the control of the fishery which have negatively impacted 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, the potential for ongoing catches of the breeding stock in the northern shark fisheries has been a cause for concern. Unquantified mortality of older juvenile and adult dusky sharks from entanglement in plastic packing straps and from fisheries outside of Western Australian jurisdiction may also pose a risk to 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.

Contributors

R. McAuley and N. Sarginson

DEMERSAL GILLNET AND LONGLINE TABLE 1

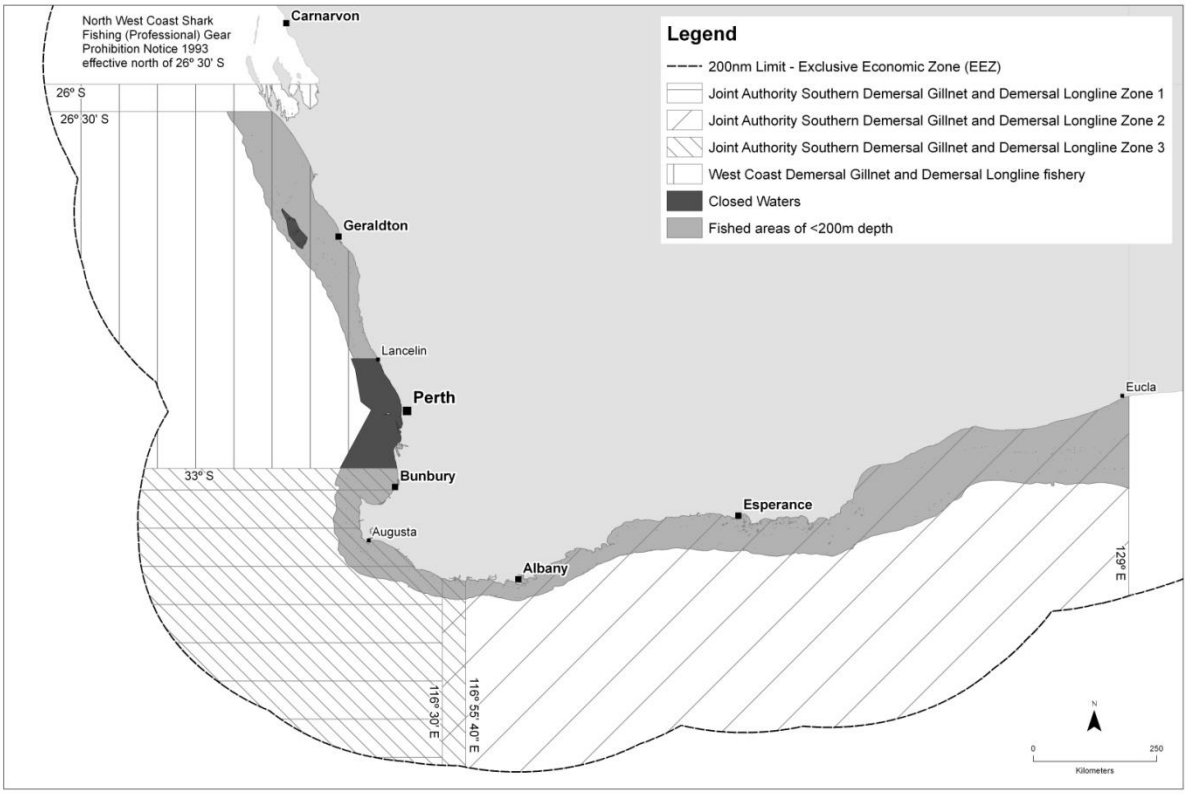
Summary of 2009/10 catch (t live wt.) by the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Data are given by management zone and also by Bioregion (italicised). Indicator species and catches are highlighted in bold.

Name	Species or taxon	JASDGLF		WCDGDLF	Bioregion		Total
		Zone 1	Zone 2		South Coast	West Coast	
Sharks and rays							
Gummy	***Mustelus antarcticus***	**30.1**	**476.8**	**1.3**	**497.3**	**11.0**	**508.3**
Dusky whaler	***Carcharhinus obscurus***	**106.6**	**80.9**	**49.1**	**162.6**	**74.0**	**236.7**
Whiskery	***Furgaleus macki***	**46.1**	**85.4**	**13.1**	**108.8**	**35.9**	**144.6**
Sandbar	***Carcharhinus plumbeus***	**14.2**	**3.1**	**89.2**	**12.7**	**93.9**	**106.6**
Hammerheads	F. Sphyrnidae	24.6	36.4	10.0	54.7	16.3	71.0
Spinner (long nose grey)	*Carcharhinus brevipinna*	28.7	9.3	12.6	31.7	18.9	50.6
Wobbegongs	F. Orectolobidae	31.4	11.7	7.1	31.5	18.7	50.2
Common saw shark	*Pristiophorus cirratus*	1.3	17.8		18.8	0.2	19.0
Rays	Batoidea	2.4	8.3	5.7	9.9	6.5	16.4
School	*Galeorhinus galeus*		6.4		6.4		6.4
Other elasmobranchs		4.9	10.9	10.0	12.5	13.3	25.8
Total elasmobranchs		290.4	740.7	198.1	940.5	288.8	1,229.3
Scalefish							
Queen Snapper	***Nemadactylus valenciennesi***	**23.0**	**37.6**	**0.4**	**48.2**	**12.8**	**61.1**
Blue Groper	***Achoerodus gouldii***	**31.8**	**23.5**	**0.8**	**41.5**	**14.7**	**56.2**
Pink snapper	***Pagrus auratus***	**7.2**	**10.2**	**7.4**	**13.7**	**11.1**	**24.8**
Dhufish	***Glaucosoma hebraicum***	**16.0**	**1.6**	**6.1**	**11.9**	**11.8**	**23.7**
Redfishes	***Centroberyx* spp.**	**2.4**	**8.1**	**<0.1**	**8.8**	**1.7**	**10.5**
Samsonfish	*Seriola hippos*	2.2	2.6	4.4	3.8	5.4	9.1
Mulloway	*Argyrosomus hololepidotus*	2.0	3.2	2.3	4.9	2.7	7.6
Sweetlips	F. Haemulidae			6.6		6.6	6.6
Boarfishes	F. Pentacerotidae	1.7	4.9	<0.1	6.0	0.6	6.5
Baldchin groper	***Choerodon rubescens***	**<0.1**		**1.9**	**<0.1**	**1.9**	**1.9**
Other scalefish		9.6	10.0	7.3	16.0	10.9	26.9
Total scalefish		94.2	96.9	35.3	148.8	77.7	226.5

Name	Species or taxon	JASDGLF		WCDGDLF	Bioregion		Total
		Zone 1	Zone 2		South Coast	West Coast	
'Demersal scalefish suite' component		*88.7*	*88.9*	*26.7*	*129.7*	*74.7*	*204.4*
Fishing effort (km gn.d)[1]		3,083 (88)	6,729 (93)	1,561 (55)			11,373 (84)
Fishing effort (1000 km gn.hr)[2]		58.6 (70)	120.0 (83)	34.1 (50)			212.7 (72)

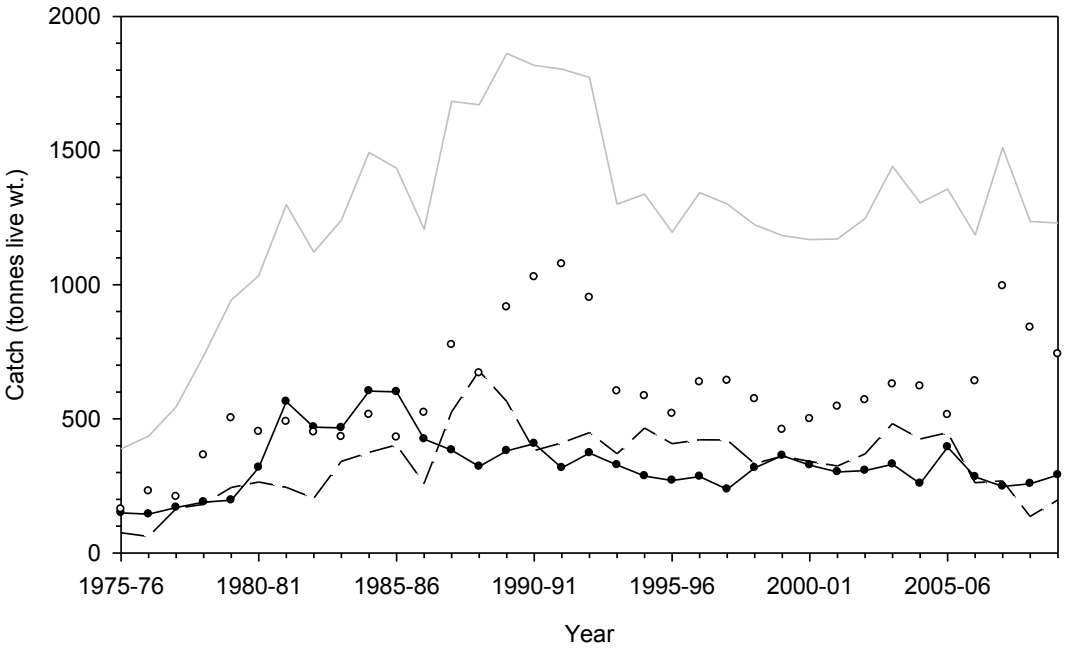
1. Values in parentheses are percentages of respective 2001/02 levels

2. Values in parentheses are percentages of each management zone's maximum hourly effort capacity



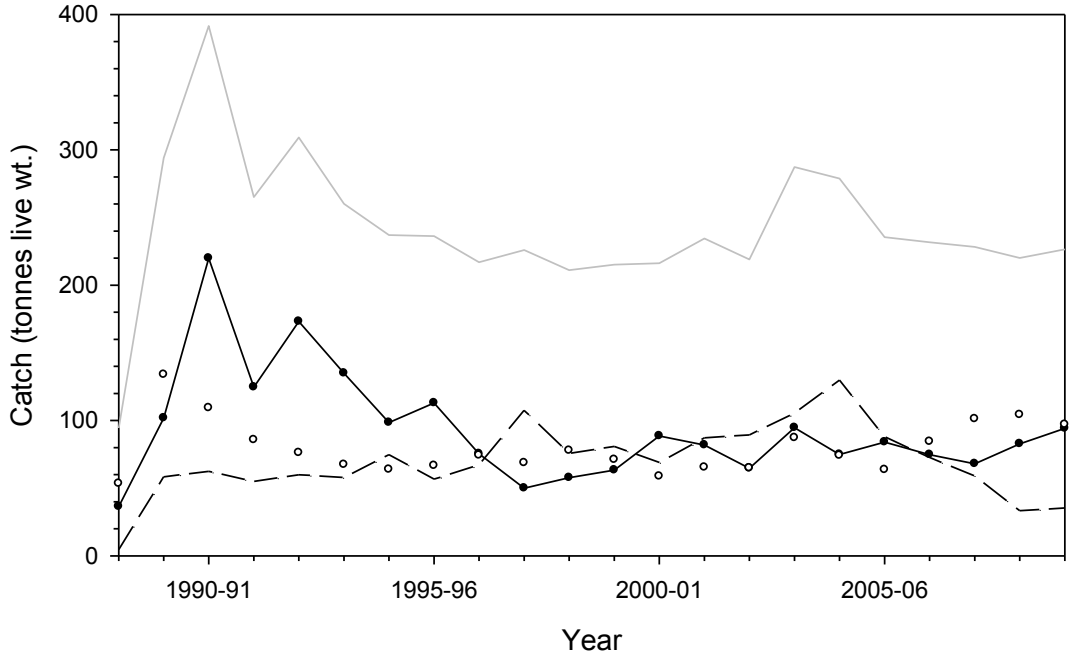
DEMERSAL GILLNET AND LONGLINE FIGURE 1

Management boundaries of the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Black shading represents fished areas of less than 200m depth.



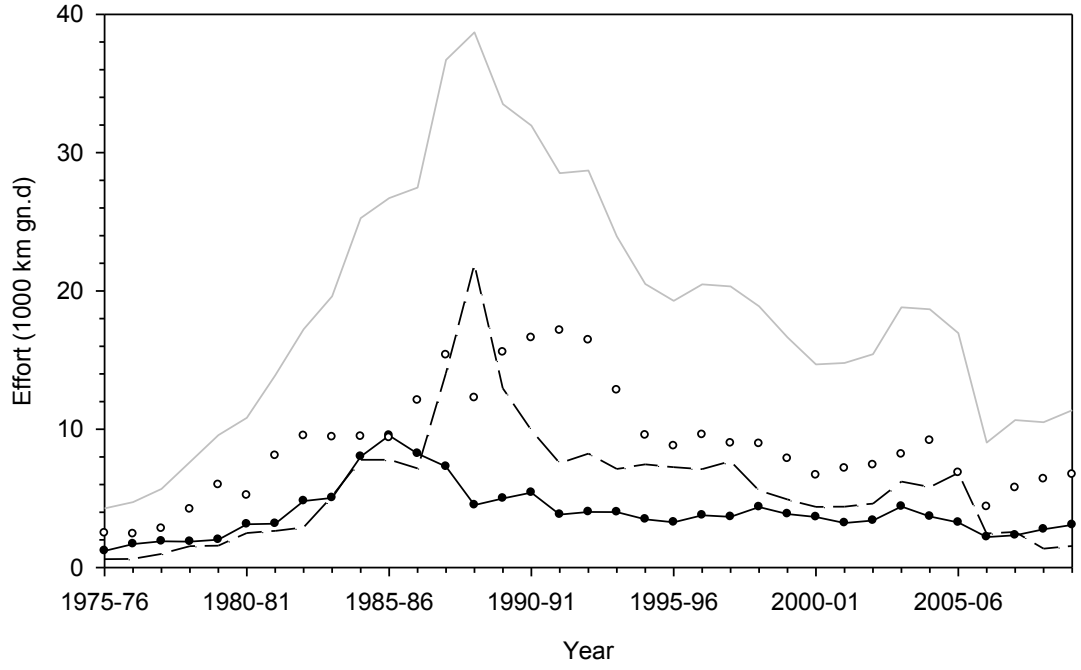
DEMERSAL GILLNET AND LONGLINE FIGURE 2

Total elasmobranch catches, 1975/76 – 2009/10. Black circles = JASDGDLF Zone 1; white circles = JASDGDLF Zone 2; dashed black line = WCDGDLF; plain grey line = total from the three management zones.



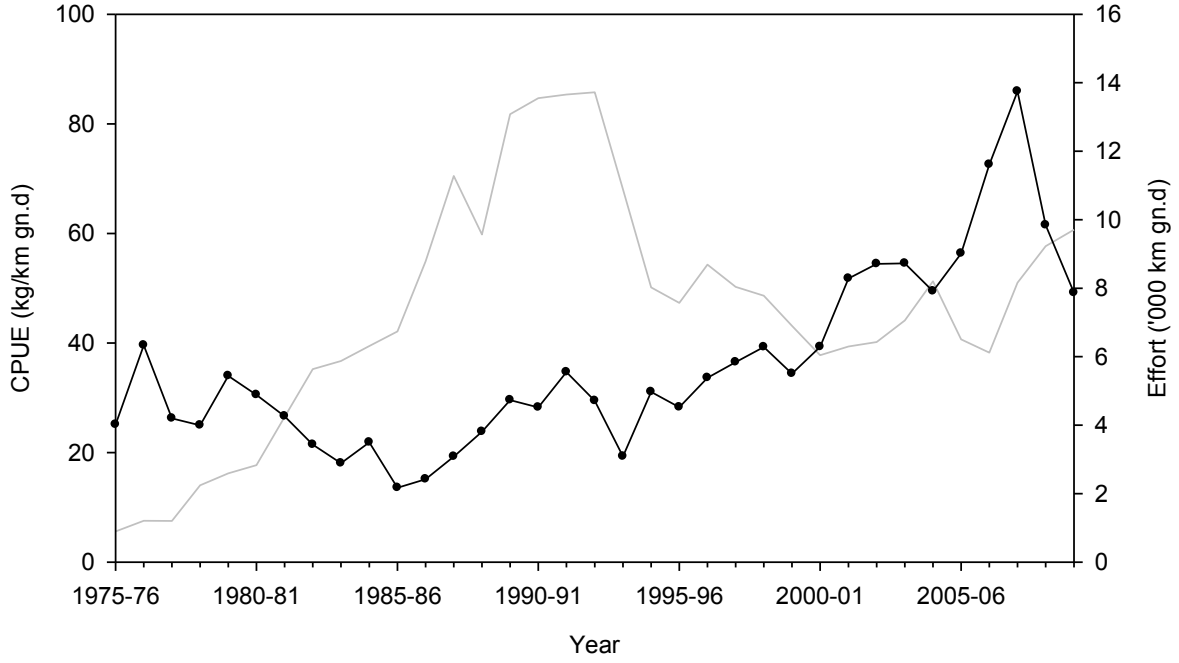
DEMERSAL GILLNET AND LONGLINE FIGURE 3

Total scalefish catch, 1988/89 – 2009/10. Black circles = JASDGDLF Zone 1; white circles = JASDGDLF Zone 2; dashed black line = WCDGDLF; plain grey line = total from the three management zones. Catches prior to 1988/89 cannot be distinguished from other fisheries' gillnet and longline catches and are omitted.



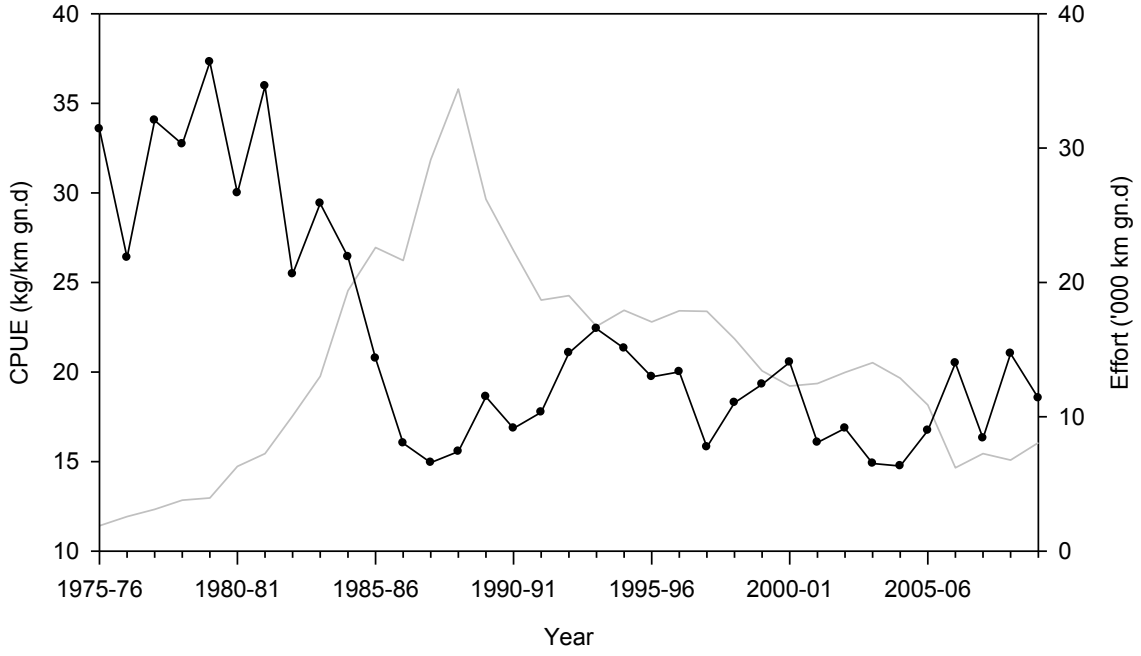
DEMERSAL GILLNET AND LONGLINE FIGURE 4

Standardised demersal gillnet and demersal longline effort, 1975/76 – 2009/10. Black circles = JASDGDLF Zone 1; white circles = JASDGDLF Zone 2; dashed black line = WCDGDLF; plain grey line = total from the three management zones.



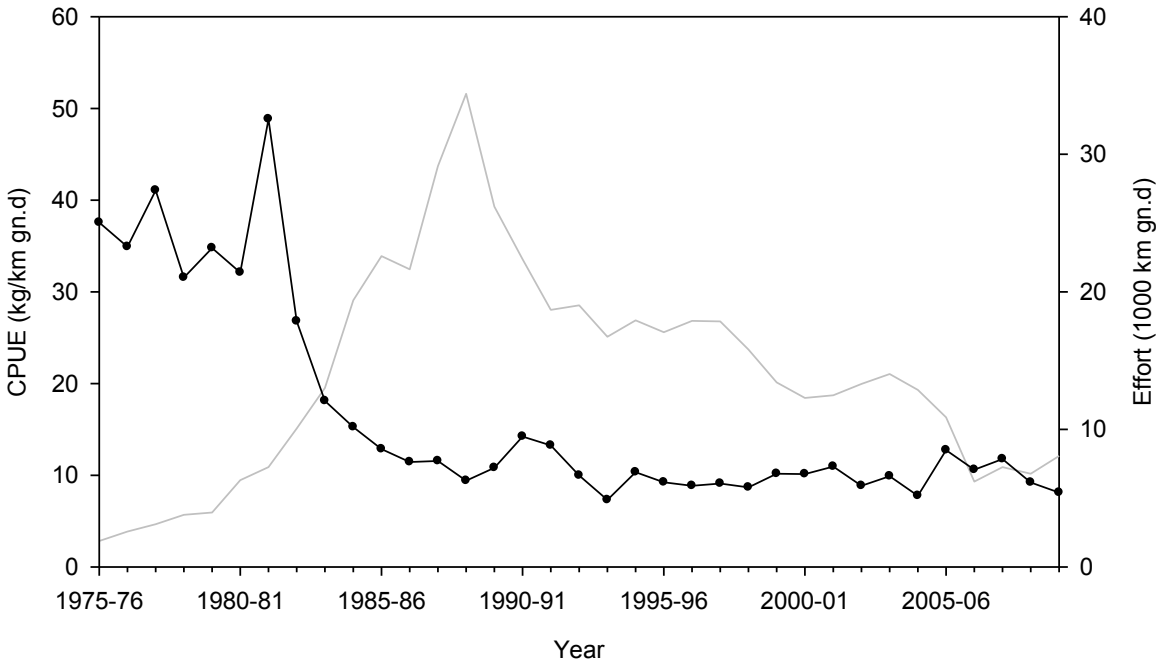
DEMERSAL GILLNET AND LONGLINE FIGURE 5

Gummy shark effective effort (grey line) and CPUE (black circles), 1975/76 – 2009/10.



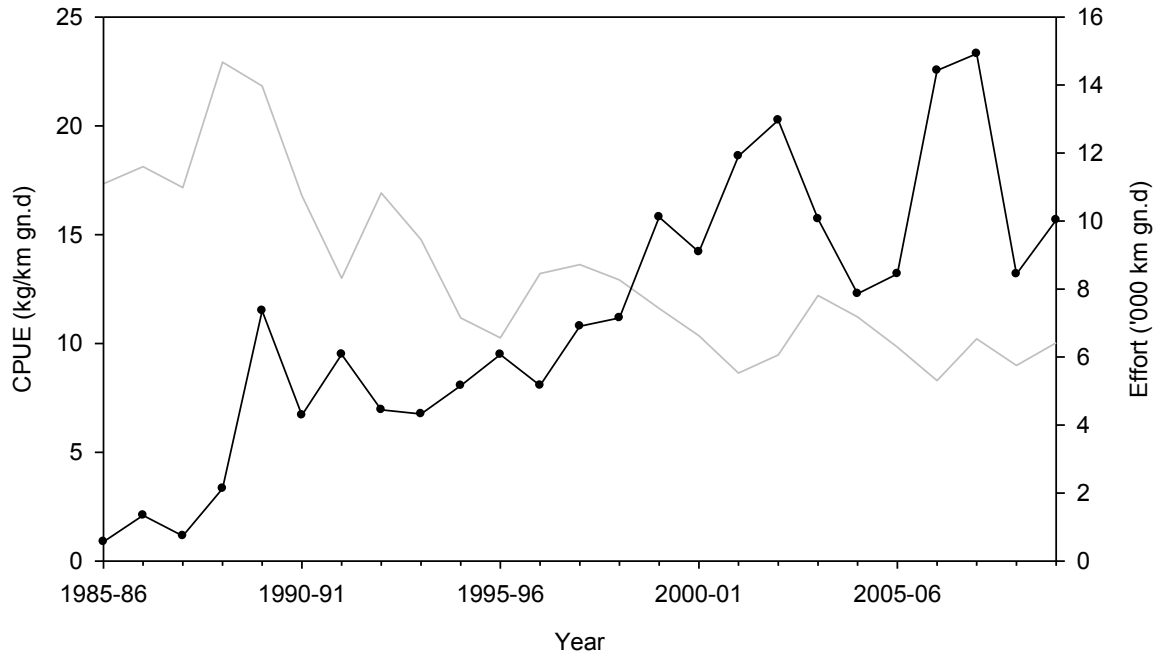
DEMERSAL GILLNET AND LONGLINE FIGURE 6

Dusky shark effective effort (grey line) and CPUE (black circles), 1975/76 – 2009/10.



DEMERSAL GILLNET AND LONGLINE FIGURE 7

Whiskery shark effective effort (grey line) and CPUE (black circles), 1975/76 – 2009/10.



DEMERSAL GILLNET AND LONGLINE FIGURE 8

Sandbar shark effective effort (grey line) and CPUE (black circles), 1985/76 – 2009/10.

South Coast Demersal Scalefish Resource Report: Statistics Only

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, handlines and trolling 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 demersal species by the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery operating in the South Coast Bioregion is also managed separately (see Demersal Gillnet and Longline Fisheries Status Report).

Recreational

Recreational fishers, mostly using line based methods from boats target this suite of species.

Boundaries

The fishery operates in the South Coast Bioregion, from 115° 30' to the WA/SA border (South Coast Wetline Figure 1).

Management arrangements

Commercial

Fish Resources Management Act 1994, Fish Resources Management Regulations 1995 and subsidiary legislation

The commercial 'wet line' fishery is currently 'open access' for the holder of a valid Fishing Boat Licence (for the boat) and a Commercial Fishing Licence (for the fisher).

Recreational

Fish Resources Management Act 1994, Fish Resources Management Regulations 1995 and subsidiary legislation

Recreational Fishing from a Boat Licence

Total Landings (Season 2010):

98.3 tonnes (demersal scalefish only)

Commercial

Estimates of catches are monitored through the mandatory CAES logbook system. Bight redfish, blue groper, blue morwong and pink snapper have been identified as indicator species of the inshore demersal suite of finfish for the South Coast Bioregion. These species make up a bulk of the catches from this suite by the commercial fishery. In addition, Hapuku, blue-eye trevalla and eightbar grouper have been identified as indicator species for the offshore demersal suite of finfish in the South Coast Bioregion. Indicator species are used to monitor the status of the resource and fishery.

The catch of 98.3 t of demersal scalefish during 2010 is lower than catches taken in recent years but within the range of catches since 2000 (80–140 t, South Coast Demersal Line Fishery Figure 2). The slightly lower catches reported since 2007 are mainly due to the ability to now better allocate catches east and west of 115° 30' to the South Coast Demersal and West Coast Demersal Scalefish fisheries respectively.

Recreational

Estimates of the recreational catch levels of this suite are not available. A State-wide recreational survey is currently underway and will result in estimates of recreational boat-based catches from this fishery being available in 2012.

Fishery Governance

Target commercial catch range: Not available

A formal catch range has not been developed for this fishery. However, the 2010 catch levels of the inshore demersal suite falls within the 70 t -140 t range of catches reported since 2000 and is likely to be sustainable. Catch levels will be more closely monitored in future and additional monitoring of the resources and fishery is proposed.

Current Fishing (or Effort) Level: Not available

This fishery is likely to undergo review in the near future. Development of an interim catch range will be considered during this review.

New management initiatives (2010/2011)

Following the introduction of the *West Coast Demersal Scalefish (Interim) Management Plan 2007* and reductions in effort applied to the West Coast Rock Lobster Managed Fishery, there have been concerns about a shift in effort to the South Coast and resultant increase in catches of scalefish off the south coast. This situation had not occurred at this stage.

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 (an indicator species of the offshore demersal suite) of the south coast are possibly being overfished. A research project to undertake stock assessment of the key species is now planned.

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.

Contributors

B. Molony, E. Lai and N. Moore

SOUTH COAST DEMERSAL SCALEFISH RESOURCE TABLE 1

Catches (t) of indicator species, demersal species and total scalefish catches by the commercial sector of the South Coast Demersal Line Fishery, 2007–2010.

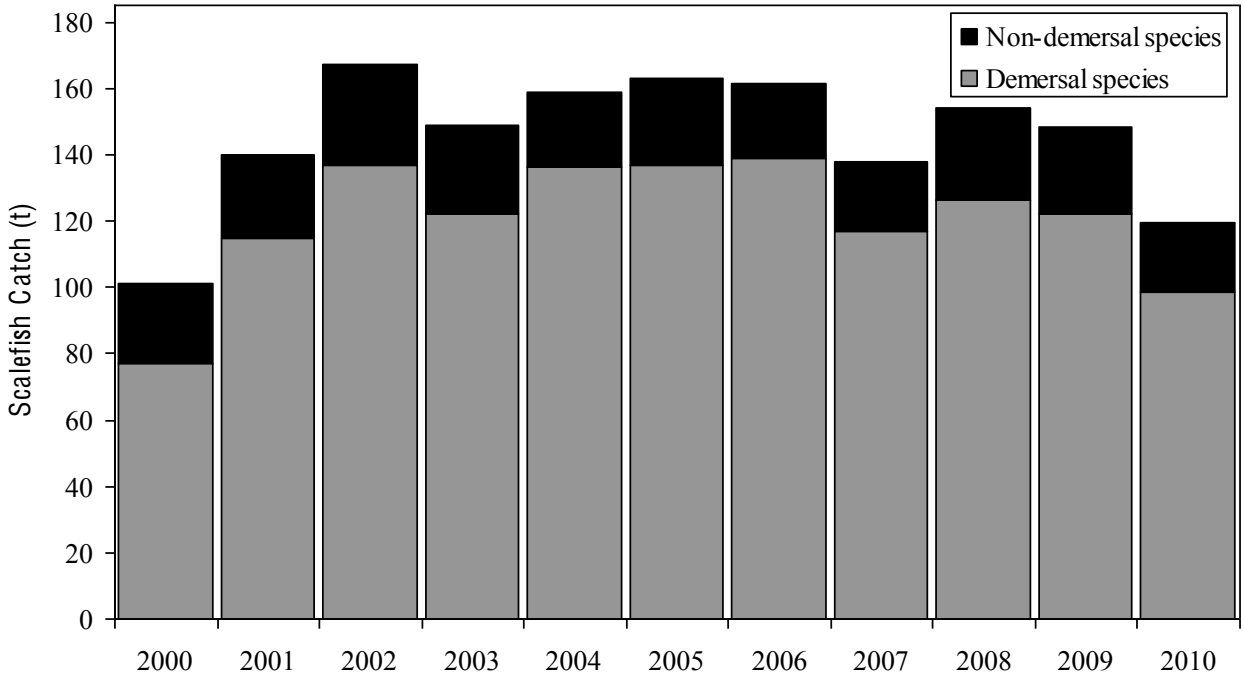
Species	2007	2008	2009	2010
Bight Redfish*	37.0	47.2	33.5	26.8
Blue groper	1.1	1.1	1.2	0.4
Blue Morwong	5.1	5.2	8.0	4.4
Pink Snapper	37.3	37.9	44.9	38.8
Hapuku	14.2	13.1	18.5	11.5
Blue-eye trevalla	4.9	5.5	2.4	3.2
Eightbar grouper	2.5	0.6	0.7	0.5
Other demersal scalefish	15.0	15.6	12.5	12.7
Total demersal scalefish	117.1	126.4	121.9	98.3
Total non-demersal scalefish**	20.6	27.6	26.5	21.3
Total Scalefish	137.7	153.9	148.4	119.6

* Estimates of bight redfish catches represent catches by this fishery of fishes reported as ‘Bight redfish’, ‘yelloweye redfish’ and ‘redfish’. Line catches of redfish from the south-west zones of the West Coast Demersal Scalefish Fishery are almost exclusively Bight redfish. In addition, the Commonwealth Great Australian Bight trawl fishery operating in the South Coast Bioregion only reports catches of Bight redfish. It is likely that catches of 'redfish’ by the South Coast Demersal Line Fishery are likely to be of Bight redfish. This may be confirmed in the near future via catch or market sampling.

** Non demersal scalefish includes fishes from the pelagic suite (mainly Samson fish) and nearshore suite (mainly skippy)



SOUTH COAST DEMERSAL SCALEFISH RESOURCE FIGURE 1
Map of the extent of the South Coast Demersal Line Fishery.



SOUTH COAST DEMERSAL SCALEFISH RESOURCE FIGURE 2
Catches (t) of demersal and non demersal scalefish in the South Coast Demersal Line Fishery, 2000--2010

AQUACULTURE

Regional Research and Development Overview

Abalone is considered a key species for aquaculture development on the south coast of WA.

An abalone farm and associated hatchery near Bremer Bay is in the process of being upgraded to cater for planned expansion and production increases. The land-based farm and hatchery are being operated according to a recently-reviewed Biosecurity Plan, developed with input from the Department of Fisheries.

An offshore abalone farm near Augusta is achieving encouraging early results, in growth and survival, for abalone grown out using purpose-built concrete structures located on the sea bed.

In June 2010, the Department of Fisheries released its new abalone policy entitled *Abalone Aquaculture in Western Australia*. The Policy was developed in consultation with the wild-capture and aquaculture industry sectors. The Department continues to closely monitor an abalone disease outbreak off the coasts of Victoria and Tasmania and has implemented measures to prevent the entry of the virus into Western Australia.

COMPLIANCE AND COMMUNITY EDUCATION

Commercial and recreational fisheries compliance in the South Coast bioregion is undertaken by Fisheries and Marine Officers (FMOs) 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 South Coast Marine Education Officer manages the Education program for the South Coast.

Activities during 2009/10

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 2,747 hours of "in-field" compliance activity during 2009/10 (South Coast Compliance Table 1) representing an increase from the previous year (South Coast Compliance Figure 1).

Officers made contact with a total of 263 commercial fishers in the field, across the south coast. Generally only minor breaches were detected, mainly in terms of licensing issues, quota management and breaches of individual fisheries management arrangements. 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 fishing 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, 13 infringement warnings and 14 infringement notices were issued and a further 11 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 3,940 recreational fishers. During 2009/10, 64 infringement warnings and 10 infringement notices were issued and 2 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 MarineDiscoveryWest incursions and excursions to over 1700 primary and secondary students across the region in 70 structured sessions. A further 185 people took part in structured community education activities such as school holiday programs and workshops. Two regional events were also attended with around 750 contacts made. Where possible education initiatives were delivered in collaboration with other environmental education providers.

Initiatives in 2010/11

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 whiskery pupping 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.

FMOs will structure recreational fishing compliance programs to address a growing concern of increased catches of demersal scalefish by recreational fishers due to 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 have been developed with the Department of Environment and Conservation with a focus on joint operations to maximize the management presence in the marine park.

The education program for the south coast will continue to expand through a delivery of structured programs to schools and contribution to school curriculum resources within Marine WATERs (Western Australian Teacher Education Resources). Community education of the Walpole-Nornalup Marine Park is a priority work area for the Marine Education Officer and thus will continue to work with other departments and agencies to deliver a program that will incorporate and reinforce management initiatives. The Marine Education Officer will also support community participation initiatives such as ‘fish frame’ collections.

SOUTH COAST COMPLIANCE TABLE 1

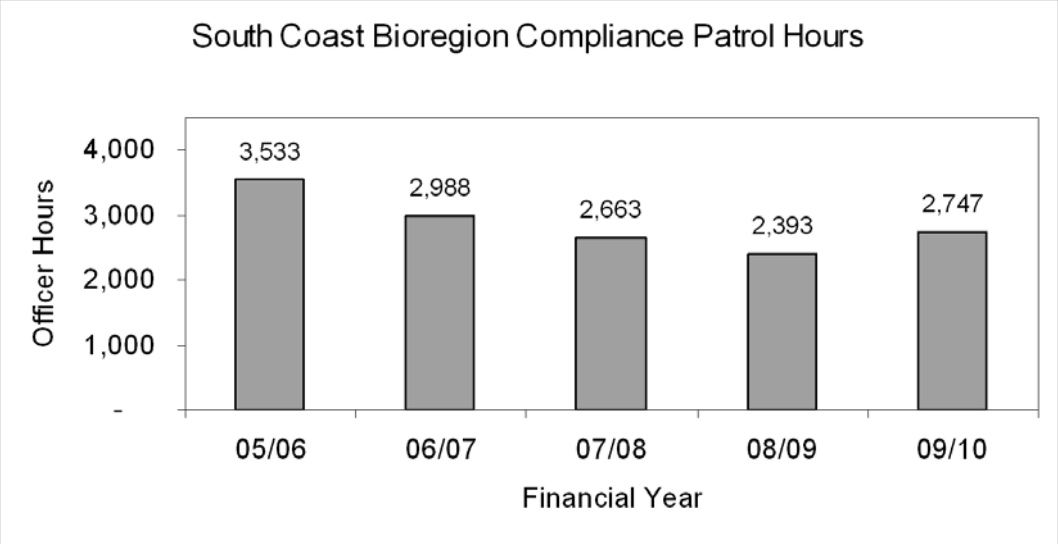
Summary of compliance and educative contacts and detected offences within the South Coast bioregion during the 2009/10 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,747 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	263
Infringement warnings	13
Infringement notices	14
Prosecutions	11
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	3,940
Infringement warnings	64
Infringement notices	10
Prosecutions	2
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	111
Fishwatch reports**	21
VMS (Vessel Days)****	4,321

*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.

**** VMS (Vessel Days) represents the number of vessel days recorded in this bioregion. That is, a count for each day that each vessel was polled within the bioregion.



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 2009/10 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

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.

The State Government has recently announced funding of a stock enhancement project at Lake Kununurra to create a recreational barramundi fishery in the region.

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.

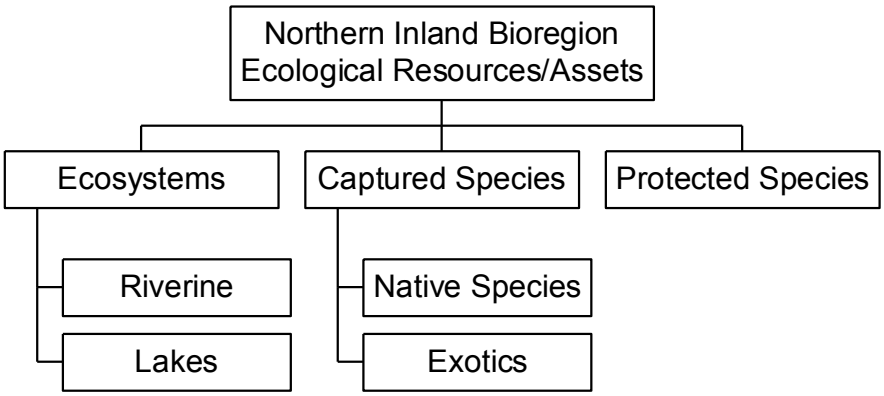
ECOSYSTEM BASED FISHERIES MANAGEMENT

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 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.

FISHERIES
Lake Argyle Silver Cobbler Fishery Report: Statistics Only

Fishery Description

Commercial
The only commercial freshwater fishery in Western Australia is in Lake Argyle in the north-eastern Kimberley (Lake Argyle Silver Cobbler Figure 1). 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 (LASCF) 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 LASCF 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. The Lake Argyle Silver Cobbler Fishery Bycatch Action Plan and Code of Practice were revised in 2010.

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 2010):

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 2), 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 2).

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 and 2010 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 2).

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 2010 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 current target catch range was developed by applying an autoregressive moving average control quality procedure to the annual catches from 1990 to 2002. 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.

Current Fishing (or Effort) Level Acceptable

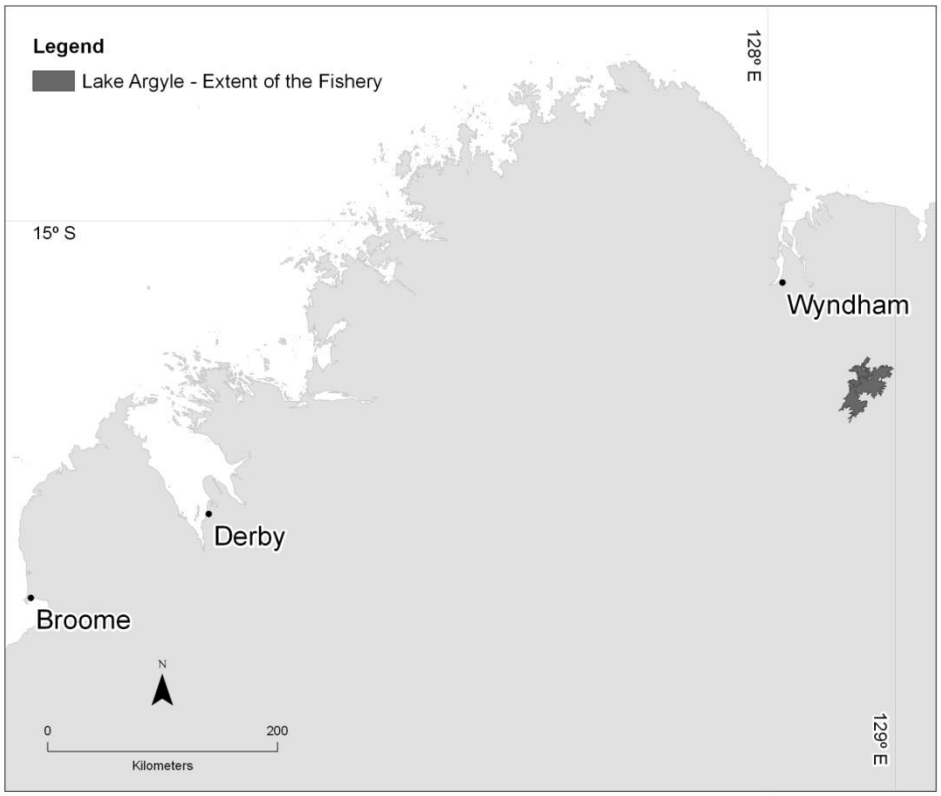
The level of catch in the fishery in 2010 was slightly below that reported in 2009 but well below that reported in 2008 and 2007. While the recent levels of catch are below the target range, given the current low effort they are considered acceptable.

New management initiatives (20010/11)

Future management measures for the LASCF 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 LASCF code of practice into the formal management arrangements for the Fishery in the future, and iii) a possible shift in the seasonal closures to better accommodate the wet-season breeding period for the target species.

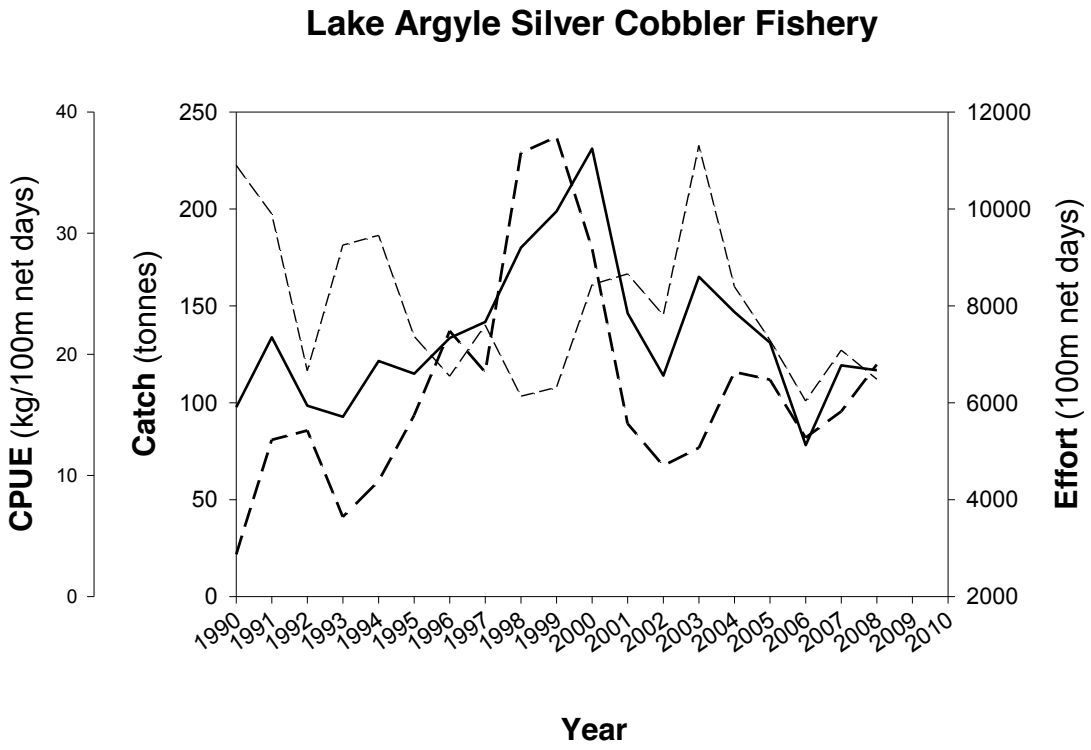
Contributors

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LAKE ARGYLE SILVER COBBLER FIGURE 1

Location of the Lake Argyle Silver Cobbler Fishery in northwestern Australia illustrating the remoteness and extent of the fishery.



LAKE ARGYLE SILVER COBBLER FIGURE 2

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 and 2010 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 continues to progress slowly. An area may eventually be vested in the Minister for aquaculture purposes. The issue of a lease has been delayed while the relevant group reviews its options in respect of an alternative site.

A licence to produce barramundi has been issued but is inactive at present. This group is also pursuing a land based lease to support its proposed aquaculture activities. For proponents considering aquaculture in Lake Argyle, identifying a site suitable for land based support facilities has proved difficult.

A proposal to formulate a project to use aquaculture in Lake Argyle as a means to sequester carbon is being contemplated.

COMPLIANCE AND 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 2009/10

During 2009/10, Fisheries and Marine Officers (FMOs) recorded 622 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 2,043 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 2010/11

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.

The Department will establish a District Office in Kununurra staffed by one FMO who will conduct compliance Patrols with staff from other Government Agencies that are already established in the area. This presence will greatly increase the ability of the Department to effectively carry out its compliance and education program in the East Kimberley.

The Department will establish a Northern Region Mobile Patrol, the patrol will be staffed by two FMO's and will be focused on compliance and education of recreational fishers. A large portion of this mobile patrols time will be spent ensuring that fishers are aware of, and comply with, bag, size and possession limits relating to Barramundi, which is one of the States iconic fisheries that is primarily inland based.

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 visitors, children in regional towns and remote Aboriginal communities are planned, through fishing clinics and school presentations promoting 'fish for the future' messages.

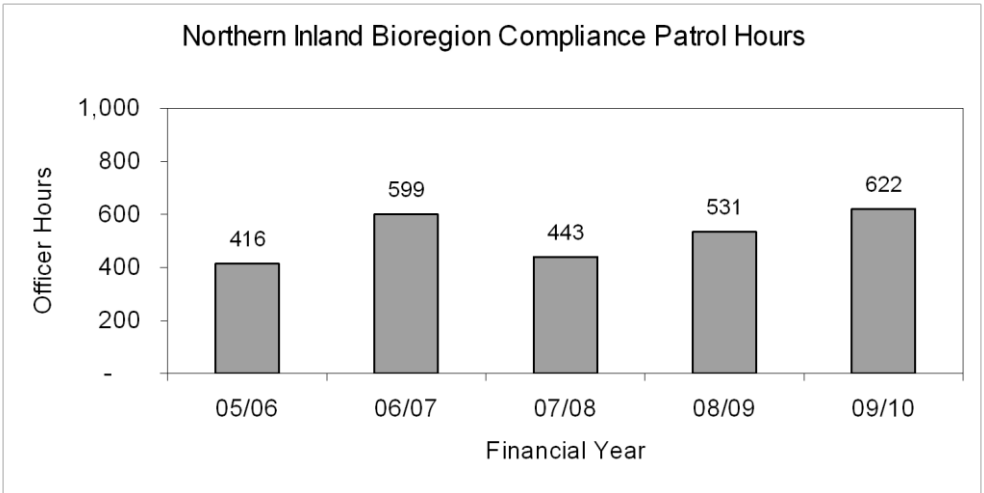
NORTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Northern Inland bioregion during the 2009/10 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	622 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	13
Infringement warnings	1
Infringement notices	0
Prosecutions	0
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	1,719
Infringement warnings	17
Infringement notices	13
Prosecutions	0
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	311
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 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 COMPLIANCE FIGURE 1

This figure gives the "On Patrol" officer hours showing the level of compliance patrol activity delivered to the Northern Inland bioregion over the previous five years. The 2009/10 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

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, this area 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.

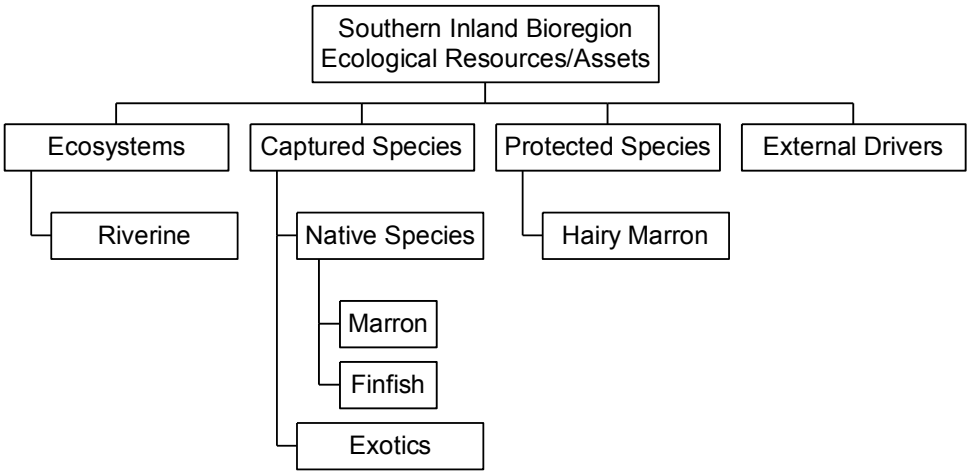
ECOSYSTEM BASED FISHERIES MANAGEMENT

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 has been completed through a state NRM funded project with the report to be completed shorlty.

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 (i.e. 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 abundance 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 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 further 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 trails 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. Research is ongoing into establishing production of threatened native fish species to facilitate stock enhancement in priority waterbodies in the region.

FISHERIES
Licensed Recreational Marron Fishery Report

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial	nil
Fishing level	Acceptable	Recreational catch estimate	102,900 marron

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.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

Fish Resources Management Regulations 1995

Consultation process

Meetings between the Department of Fisheries, Recfishwest and Freshwater fishers.

Boundaries

The recreational marron fishery extends from the Hutt River north of Geraldton to waters near Esperance. The fishery operates in freshwater dams and rivers, although 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. For the 2010 season, licensed fishers were permitted to fish for marron from 8th January to 5th February 2010. 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 snare only 'Trophy Waters' with a minimum legal size of 90 mm carapace length and a daily bag and possession limit of 5 marron.

Research summary

Detailed research on the marron stocks in south-west rivers has been undertaken since the 1970s. Current research involves the annual scientific monitoring of stock levels before the summer fishing season, surveys of catches taken by recreational licence holders and volunteer logbook holders and biological characteristics (growth, size-at-maturity, fecundity etc) of key marron populations in different catchments. These data enable trends in stock levels to be monitored and recommendations to be made for adjustments to fishery management when necessary. The following status report is based on these research findings.

Retained Species

Commercial landings: Nil

Recreational catch estimate (season 2010)

102,900 marron

The total marron catch for the 2010 season was estimated at approximately 102,900 ± 9,400 standard error (SE) marron (See Fig. 1). This is an increase (~25%) compared to the previous season (2009: 79,400 ± 8,000 marron). The increase in catch in numbers is due to an increase in effort and increase in catch rate. The catch for 2010 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.

Total effort for the 2010 season was estimated from phone surveys at around 25,700 days. Fishing effort was similar to the previous season of 24,300 days. The number of participating fishers was stable from 2009 to 2010 (~8800). The average number of fishing days per fishermen was also stable from 2009 (2.9 days) to 2010 (2.93 days).

In 2010, dams received the highest proportion of total effort since 2000 (40%). 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%) and the Collie River (~12%). The Murray,

Preston and Donnelly rivers all received similar amount of effort of less than 5%.

Stock Assessment

Assessment complete: **Yes**

Assessment Method and level:

Level 4 - Fishery Independent Direct Survey

Breeding stock levels: **Acceptable**

Fishery-dependent catch and effort data (e.g. CPUE as determined by logbook or phone survey) can be poor indicators of true stock abundance especially in heavily managed fisheries like the Recreational Marron Fishery. In 2006 a new stock assessment program using traps was initiated that provided fishery-independent data on relative abundance and average size (mm Orbital Carapace Length [OCL]) of marron in three dams (Waroona Dam, Wellington Dam, Harvey Dam) and eight rivers (Shannon, Warren, Donnelly, Blackwood, Preston, Collie, Murray and Moore River). These three dams and eight rivers account for more than 75% of the total fishing effort of the Recreational Marron Fishery (see Fig. 2).

The annual fishery-independent survey provides vital data for monitoring trends in stocks, evaluating the performance of changes in management on stocks and will allow for recommendations to be made for adjustments to the management of the fishery when necessary.

Relative abundance and size of marron varies greatly spatially among the surveyed rivers and dams (Fig. 3). Size of animals in most locations has stayed relatively stable, however, animals in the Shannon River have shown an increased in size since the river was closed to fishing in 2007.

In addition to data on abundance and size, the annual fishery independent survey also provides information on size-at-maturity and fecundity for each of the rivers and dams.

From the locations surveyed, the current breeding stock levels appear adequate (based on typical size-at-maturity). Size-at-maturity, i.e. size at which 50% of the females are mature, seems to be below the minimum legal size of 80 mm Rostrum Carapace Length (RCL) for the majority of marron stocks in the south-west (e.g. Warren River ±56 mm RCL, Murray River ±54 mm RCL, Collie River ±42 mm RCL, Preston River ±60 mm RCL, Waroona Dam ±63 mm RCL, Drakesbrook Dam ±31mm RCL, Wellington Dam ±54 mm RCL). Present size restrictions seem to adequately protect the majority of the female breeding stocks. The exception with regards to size-at-maturity, are the stocks in Harvey Dam and Hutt River, where a larger female size-at-maturity of about 85 mm and 95 mm, respectively, occurs. A larger minimum legal size of 90 mm RCL has been introduced to protect the breeding stocks and these water bodies are managed as 'Trophy' waters.

A tagging program may be incorporated in the annual fishery-independent stock assessment, to obtain information on growth and mortality of marron in the different rivers and dams and to aid with abundance calculations.

Non-Retained Species

Bycatch species impact: **Negligible**

The marron fishery does capture small quantities of non-target species, principally gilgies (*Cheraxquinquecarinatus, C. crassimanus*) and koonacs (*C. plebejus, C. glaber*). Although little is known about their biology, the impact of the marron fishery on these species is thought to be low as gilgies and koonacs are smaller than marron and are not targeted by marroners.

Protected species interaction: **Negligible**

A second type of marron has been identified ('Hairy' marron) which is threatened mainly by the extension in range of the more common 'Smooth' marron, which is the basis of the recreational marron fishery. In late 2002, recreational marron fishing upstream of Ten Mile Brook Junction (including all its tributaries) on the Margaret River was prohibited to remove the impacts of fishing on the remaining 'Hairy' marron stocks. However, illegal fishing is still reported in this reach of the Margaret River. A recovery plan, developed jointly between the Department of Fisheries, the Department of Environment and Conservation, and other stakeholders on the recovery team is underway for the 'Hairy' marron.

Ecosystem Effects

Food chain effects **Low**

The removal of legal-sized marron from freshwater rivers is unlikely to have a significant effect, noting that the bulk of the marron biomass is below legal size and that marron of all sizes have similar food and habitat requirements. Marron taken from man-made dams do not significantly impact natural freshwater ecosystems.

Habitat effects **Negligible**

The impact of this fishery on the aquatic habitat is negligible. The major effects are litter in surrounding areas and the trampling of areas of riparian vegetation by marroners and subsequent bank erosion.

Social Effects

For the 2010 season, a total of 22,612 licences were sold, including umbrella licences (14,841). This is similar to 24,854 licences in 2009. The marron fishery in the 2010 season involved 8,789 licence holders undertaking about 25,700 fishing days, and provided a major recreational activity in regional areas of the south-west of the State.

Economic Effects

The value of the 2010 season recreational marron catch could not be calculated as no data on the size of marron captured has been collected. In the past, this data was collected as part of the Marron logbook program, however, this program ceased operation in 2008. Since then, the marron logbook

program was combined with the Research Angler Program logbook (RAP logbook). Too few records of marron catches (size and abundance) have been captured by this logbook on which to base economic calculations. Revenue from marron licence sales was estimated at approximately $311,000, which is used to support recreational fishery management, research and compliance. In addition, the estimated 25,700 days of marroning in regional locations is likely to have provided a significant economic boost to regional towns in the south-west.

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. Effort has steadily increased since 2003 with a proportionate increase in catch. In 2007 the marron season was increased from 16 to 23 days. The season was increased to 29 days in 2009 with fixed dates whereas previously seasons varied each year to match with lunar cycles. 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) will be monitored to determine the impact of the changes in season length and increase in legal minimum size.

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 2010 with a 29 day season.

New management initiatives (2010/11)

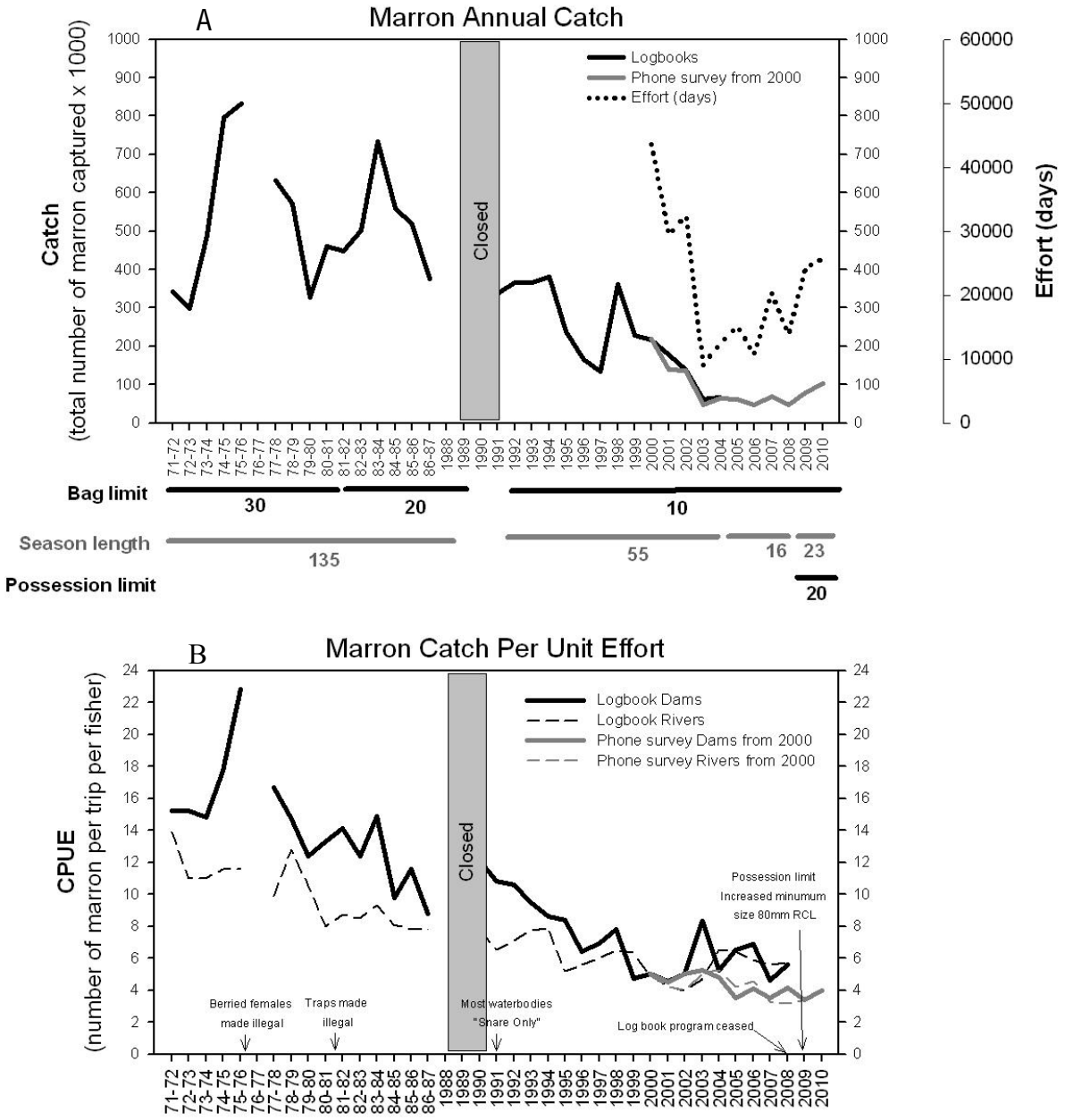
For 2011 the marron season will start on 08 January and run for a 28 day period until 05 February. Fisheries managers and scientists will continue to monitor the impact of changing rainfall patterns in the south-west on marron populations. In 2011 the Department will be reviewing the current Shannon river closure which is closed to provide a representative river system where researchers can assess the role of environmental factors on marron populations.

External Factors

Winter rainfall plays a major role in marron reproduction, growth and survival. Rainfall increases the quality of areas for marron by transporting leaf-litter into streams (providing food sources for marron growth and reproduction) and by maintaining water volume and quality. A second major issue in this fishery is access to irrigation dams. The Water Corporation closed access to Stirling Dam in 2001 and Logue Brook Dam in 2008 to divert the water to the metropolitan water supply, and there is a strong possibility of limitations to fishing in Wellington Dam in the near future. Drakesbrook Dam, the next in line for maintenance work, is expected to be unavailable for recreational marron fishing in 2010 to possibly 2013. The Department of Fisheries is developing a memorandum of understanding (MOU) for working with the Water Corporation to ensure the refurbished and refilled dams will provide a high-quality marron fishery by installing refuges, adding marron and controlling introduced species.

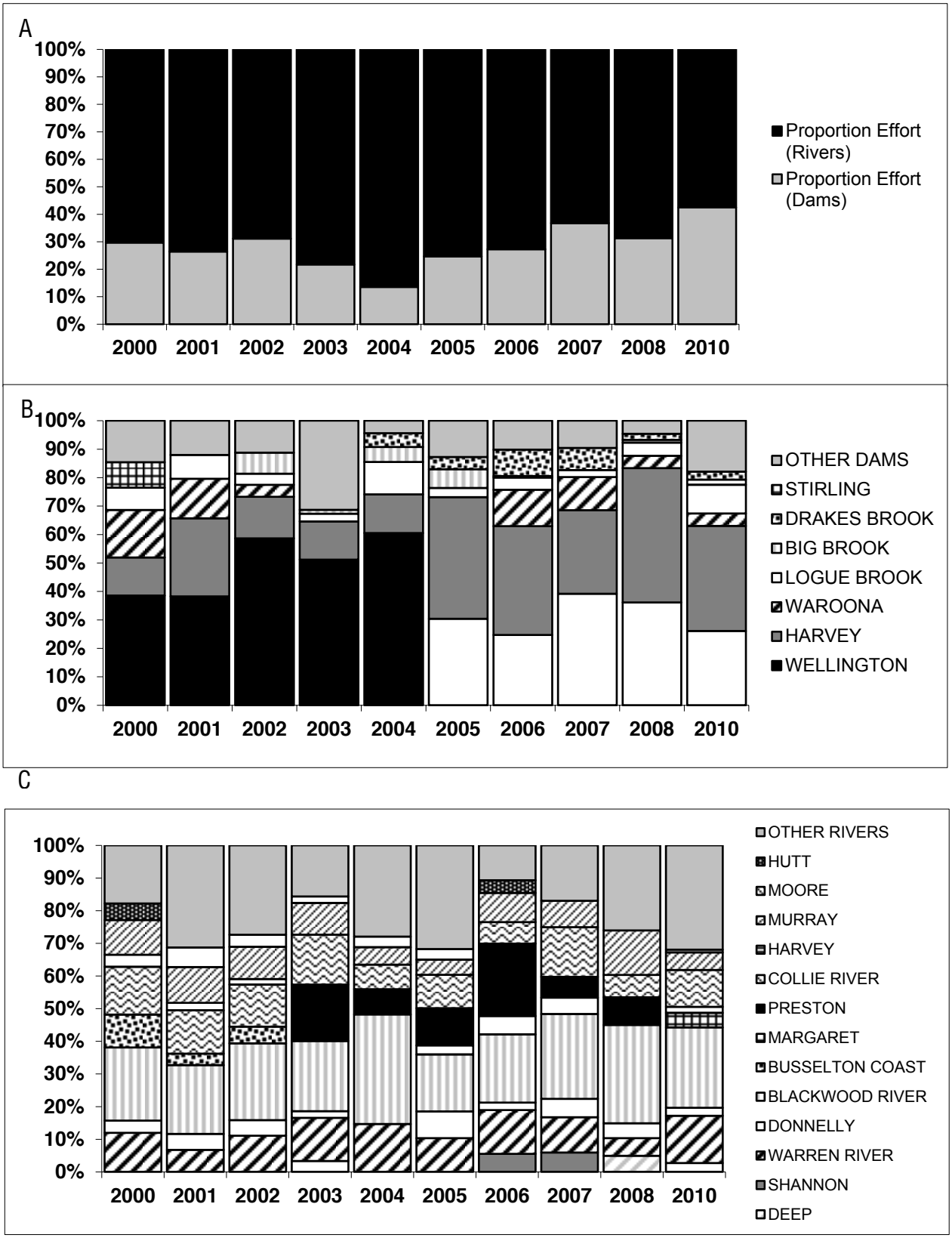
Contributors

R. Duffy and A. Warmbrunn



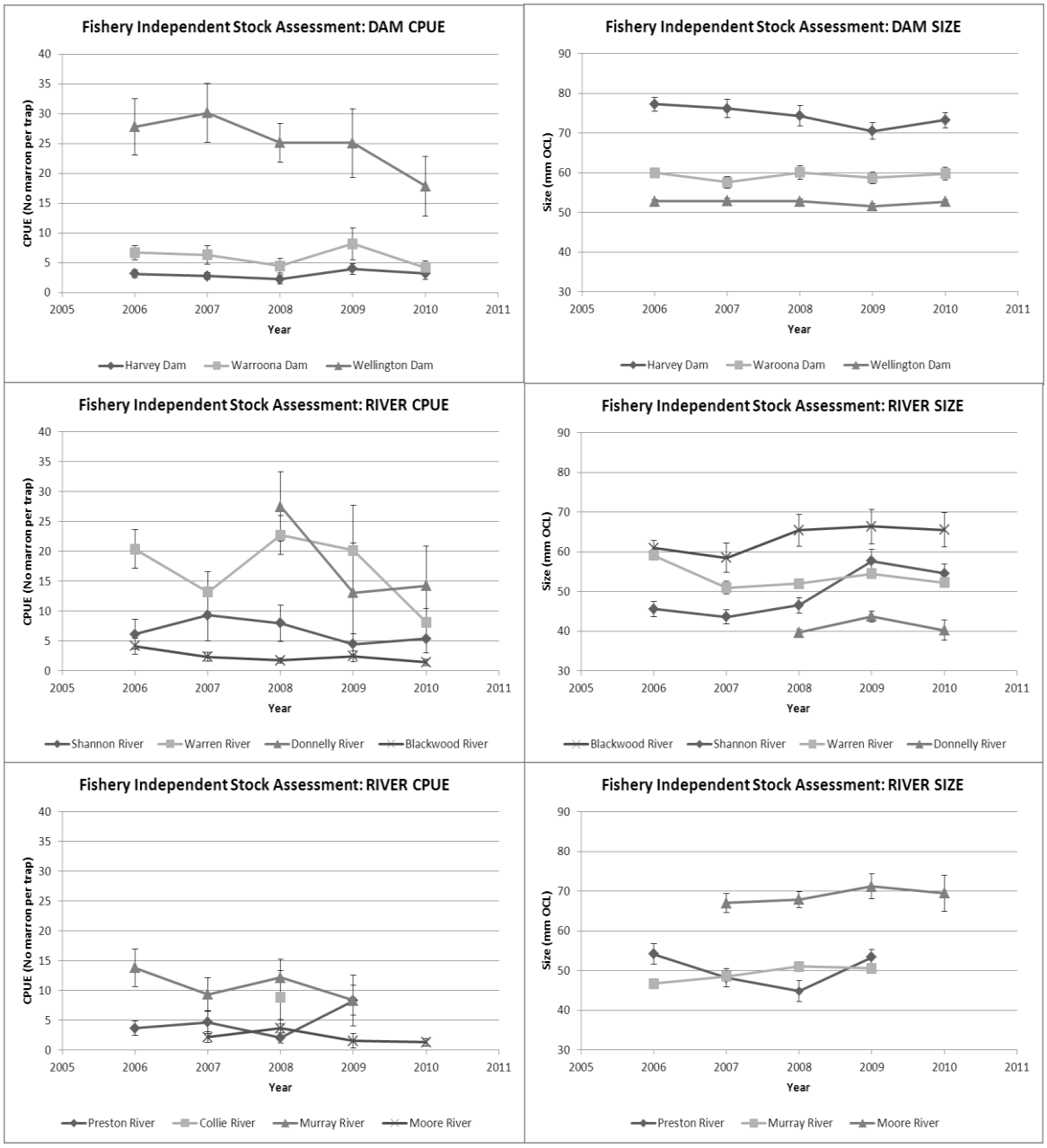
RECREATIONAL MARRON FIGURE 1

The estimated total catch (a) and catch per unit effort (b) of the recreational marron fishery between 1971 and 2010.



RECREATIONAL MARRON FIGURE 2

The distribution of effort over (a) rivers and dams, (b) among dams and (c) among rivers of the recreational marron fishery between 2000 and 2010.



RECREATIONAL MARRON FIGURE 3

The relative abundance (CPUE) and size (mm OCL) of marron in three dams and eight rivers as determined by the fishery-independent stock assessment. Note: some are missing data for 2009 and 2010 as these sites were not sampled.

Licensed South-West Recreational Freshwater Angling Managed Fishery Report: Statistics only

Fishery Description

The south-west recreational freshwater fishery is primarily an angling fishery for rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) which are the subject of an annual controlled stocking program by the Department of Fisheries. In addition, anglers take the native freshwater cobbler (*Tandanus bostocki*) and an exotic species, redfin perch (*Perca fluviatilis*). Redfin perch were previously released in the south-west and now occur as self-breeding populations in most water bodies.

Boundaries

The south-west freshwater angling license authorizes anglers to fish for freshwater finfish species in all inland waters of Western Australia south of 29 o latitude (Greenough) and above the tidal influence including all lakes, dams, rivers and their tributaries.

Management arrangements

Access to this fishery is controlled by licenses, seasonal closures, fishing gear restrictions, minimum sizes, and bag limits. People under 16 years of age are not required to hold a license to go freshwater angling. Licensed anglers may only use a single rod, reel and line or single handline when targeting these species.

To protect newly released trout, a closed season applies from 1 May to 31 August in rivers and dams in the south-west of the State, with the exception of the Murray, Blackwood, Donnelly and Warren Rivers and sections of the Serpentine River. However, fishing for trout on the streams, brooks and tributaries flowing into these rivers is prohibited during the closed season. In addition fishing for all species is totally prohibited in Waroona Dam, Logue Brook Dam and their tributaries during the closed season.

A combined daily bag limit of 4 applies to rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), together with a minimum legal size limit of 300 mm. Waroona Dam is 'artificial lure only' (no bait areas) and a reduced bag limit (2 trout per day) also applies to this water. These measures are designed to improve the quality of the trout fishery over the spring period.

A daily bag limit of 40 applies to freshwater cobbler (*Tandanus bostocki*). No minimum legal size limit applies to this species. No bag limit or size limit applies to redfin perch (*Perca fluviatilis*) and anglers are encouraged not to return any redfin to the water as this feral species negatively affects the marron fishery and predates actively on trout fry.

The trout stocking program administered by the Department of Fisheries in consultation with RecFishWest, focuses on public waters where trout have been stocked or been present since the 1930s. All trout stocked into public waters are produced at the Department of Fisheries, Pemberton Freshwater Research Centre (PFRC).

Landings and Effort

Commercial catch estimate (season 2009/10)

Not applicable

Recreational catch estimate (season 2009/10)

76,600 retained fish

A total of 107,800 fish were landed in this fishery by recreational anglers in the 2009/10 season, including 76,600 retained fish and 31,200 captured and released fish. The estimated catch was composed of 14,000 rainbow trout, 2,400 brown trout, 74,700 redfin perch, 3,400 native freshwater cobbler and 13,300 black bream (Freshwater Angling Figure 1).

The overall catch for the 2009/10 season was approximately 10,000 fish higher compared to the 2008/2009 season (the last season with data). Landings of each species has also increased: redfin perch increased by 55% from 48,200 fish; rainbow trout landings increases 14% from 12,300; brown trout increased 50% from 1,600; black bream increased 350% from 2,900 fish; and landings of native catfish increased 89% from 1,800 fish (Freshwater Angling Figure 1).

Estimates of fishing effort are based on telephone surveys of license holders. Total effort was estimated to be 26,800 days, similar to the previous reported season (24,900 days).

A catch rate of 4.02 fish of all species per day was estimated for the 2009/10 season. This included 2.86 retained fish and 1.16 released fish per angler per day. This is higher (~50%) than for the 2008/09 season and at the upper end of the catch range reported for the last ten years.

The stock levels of both rainbow and brown trout as indicated by catch rates and catches, have remained reasonably stable over the past ten years (Freshwater Angling Figure 1). Both species of trout display little or no breeding in local waters and the fishery is supported through the stocking of fry, yearling and ex-broodstock trout by the Department of Fisheries. Red-fin perch breed in all waters, and dominate all freshwaters. The management arrangements (e.g. minimum legal size, bag limit) for native freshwater cobbler are currently under review based on historical and recent scientific data.

Fishery Governance

Target catch (or effort) range **Not applicable**

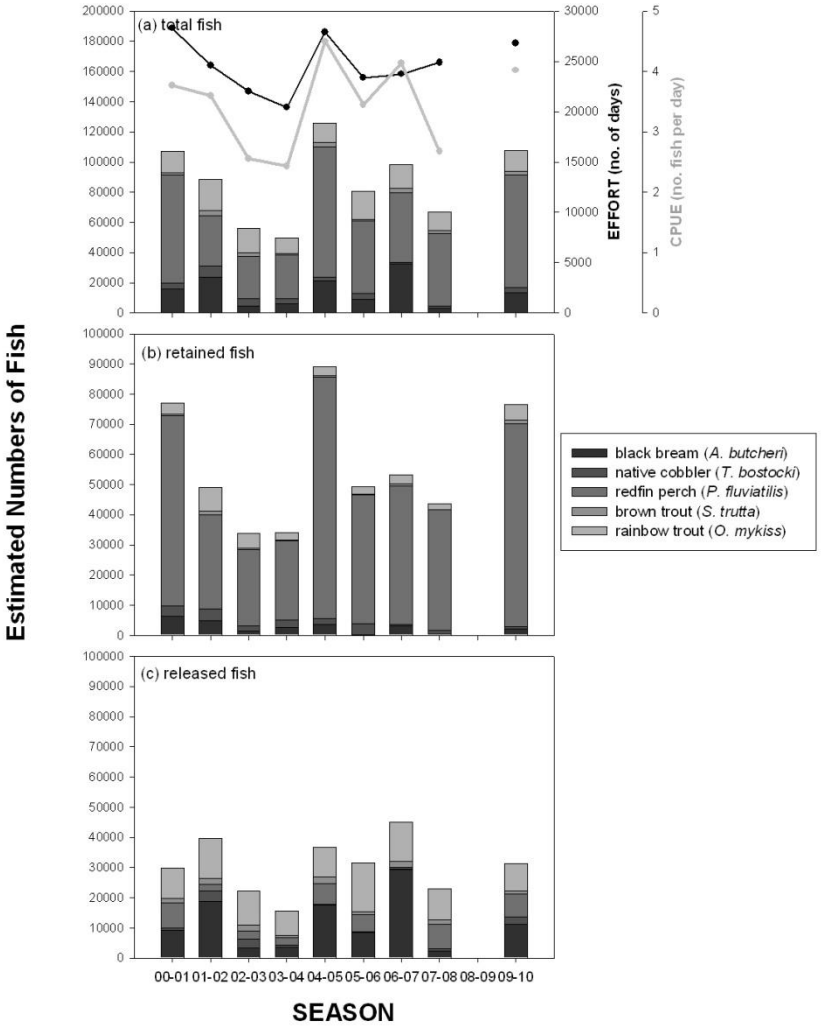
Current fishing (or effort) level **Not applicable**

New management initiatives (2009/10)

Baltson's Pygmy Perch (*Nannatherina balstoni*) and Western Trout Minnow (*Galaxias truttaceus hesperius*) are native freshwater fish species found in waters of the South West of WA that are both listed under the EPBC Act (1999) as Critically Endangered. In response to the threatened status of these native fish species, the Department of Fisheries is currently developing a strategy to minimise the impacts of trout stocking on threatened native fish species.

Contributors

R. Duffy and N. Harrison



FRESH WATER ANGLING FIGURE 1

Estimates of the development of total catch, effort and CPUE (a) and total numbers of fishes reatined (a) and released (b) by species in the south-west freshwater angling fishery since the 2000-01 season.

AQUACULTURE

Regional Research and Development Overview

Previous research undertaken at the Pemberton Freshwater Research Centre focused on marron husbandry and selective breeding research for yabbies and marron along with the evaluation of the use of grains in aquaculture feeds. Industry sectors continue to apply the results of the research to commercial operations. Current research is focussing on captive breeding programs for conserving endangered marron and native fish.

The Pemberton Freshwater Research Centre continues to be a major supplier of trout fingerlings to the aquaculture industry and for recreational fisheries restocking. However, the recent drought together with increasing draw-off of catchment water for new agriculture ventures is threatening the viability of the hatchery.

A Ministerial Exemption issued to enable a commercial operator to collect marron from farm dams on a number of private properties expired in May 2010. The Department of Fisheries is reviewing the outcome and will soon 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 highest risk of non-compliance in the Southern Inland bioregion is within the recreational marron fishery. As the marron season lasts for just 28 days, 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 2009/10

During 2009/10, FMOs delivered 1,650 hours of compliance patrol hours to the Southern Inland bioregion (Southern Inland Compliance Table 1) – which is a decrease from the compliance hours delivered in the previous year (Southern Inland Compliance Figure 1).

Officers conducted patrols throughout the bioregion in vehicles, dinghies and canoes, making 2,849 field contacts with recreational fishers and 74 contacts with commercial fishers. During the year, 22 infringement warnings and 13 infringement notices were issued with 57 prosecutions instigated for recreational offences.

The marron fishery continues to be the major focus for the compliance and education program in this bioregion. The 2010 marron season was the last 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 2009 the compliance activities for the 2010 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 is the 8th January each year, ending 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 2010/11

Joint operations with regional Water Corporation Rangers and DEC officers will continue during 2010/11. 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.

Initiatives which target fishers prior to the start of the marron fishery will be a focus of the southern region Community Education team's activities with school and at public events. In conjunction, awareness of freshwater biodiversity posed and the threat posed by introduced species will be promoted. The Community Education Team will maintain partnerships with natural resource management groups to enable a holistic approach to catchment management and issues facing the sustainability of freshwater species.

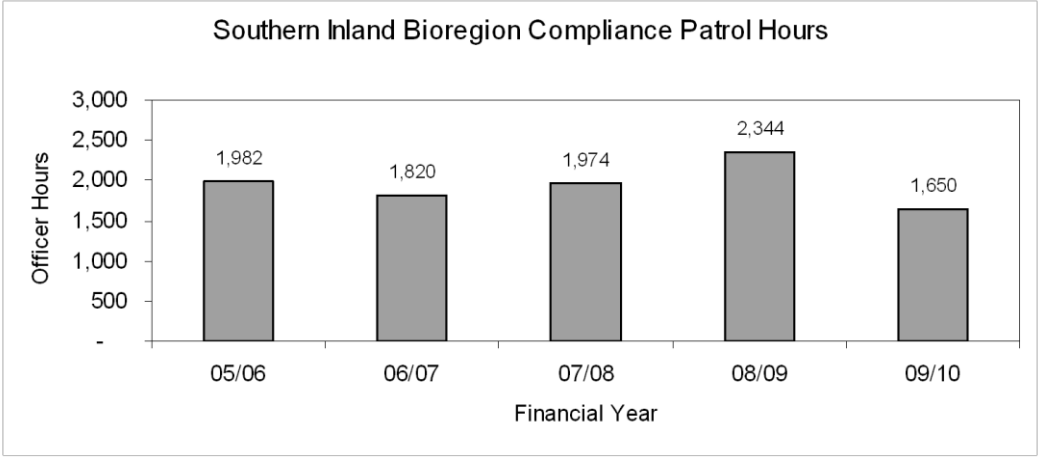
SOUTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Southern Inland bioregion during the 2009/10 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	1,650 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	74
Infringement warnings	22
Infringement notices	11
Prosecutions	19
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	2,849
Infringement warnings	22
Infringement notices	13
Prosecutions	57
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	1,321
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 COMPLIANCE FIGURE 1

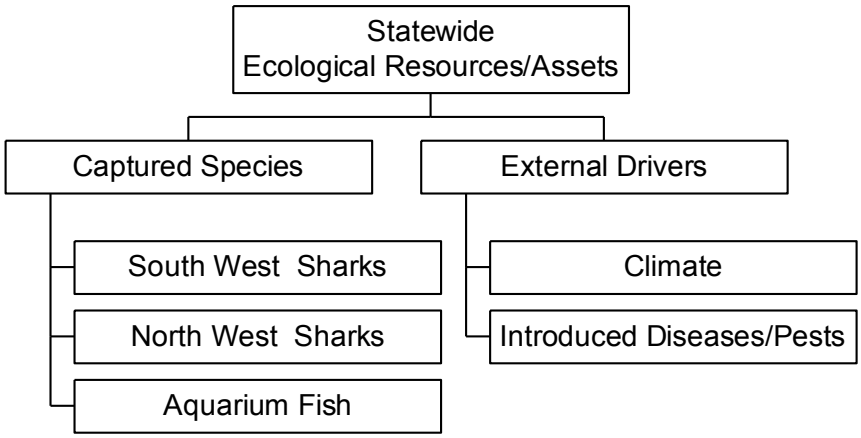
In this figure, "On Patrol" Officer Hours shows the level of compliance patrol activity delivered to the Southern Inland bioregion over the previous five years. The 2009/10 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. The totals exclude time spent on other compliance related tasks, e.g. travel time between patrol areas, preparation and planning time.

STATEWIDE

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Statewide 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 a single 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 Statewide 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. The State based fisheries for these assets is currently being reviewed and no catches by these fisheries were recorded during the past season.
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 HIGH in Medium 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.

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. The development of new Marine Parks across the State has brought an increased requirement for ecosystem resource condition monitoring in order to underpin effective management of these protected areas. Future directions of research will therefore 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

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 the period from 2005 to 2010 the number of species landed ranged from 183 to 288). 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 that operates 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 also 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 km2. During the past three years the fishery has been active in waters from Esperance to Broome with popular areas being around Perth, Geraldton, 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 2010, 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 are 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 2,000 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 26,046 fish were landed in 2010. 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 as either - kg, numbers or litres depending upon the species or species group involved (Marine Aquarium Fish Table 1). The reported landings of aquarium fish for 2010 were higher than those reported in 2009, whereas the syngnathid catch remained stable between 2009 and 2010 (i.e. 340 and 338 respectively). The syngnathid catch reported in both 2009 and 2010 is significantly less than that reported in 2008.

Effort in the fishery has decreased from 981 (2007) and 932 (2008) fishing days to 639 fishing days in 2009 and 533 fishing days in 2010, with 10 licences reporting some level of activity. Effort in the fishery is concentrated in a number of discrete areas adjacent to the limited number of boat landing sites along the Western Australian coastline.

The level of effort in the MAF now includes the effort of both MAF licensees and also those fishers that hold an exemption authorisation to collect land hermit crabs - *Coenobita variabilis*). In 2010, of the 5 land hermit crab exemption holders, 4 collectors reported some level of activity.

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 2010, the catch of syngnathids was 338. Therefore, the catch level has remained relatively constant between 2009 (340 syngnathids) and 2010 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:

2000 Syngnathids

Current Fishing (or Effort) Level: Acceptable

The current effort level in the fishery is relatively constant from year to year and the operating extent of the fishery is very low relative to the widespread distribution of the numerous species targeted. No other fisheries exploit these species and therefore there is extremely limited potential for any impact on breeding stocks. Therefore the current level of fishing activity is considered acceptable.

New management initiatives (2011/12)

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. SEWPaC approved the MAF as ecologically sustainable under the provisions of the EPBC Act 1999 and therefore declared the fishery as an approved Wildlife Trade Operation (WTO) for three years.

Amendments were made in February 2010 to the previous Ministerial Exemption for the Marine Aquarium Fish Managed Fishery to cater for operational changes in the fishery and to update the taxonomic categories of species caught.

Contributors

S.J. Newman, C. Bruce, M. Cliff, S. Brand-Gardner and M. Holtz.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Managed Fishery and associated endorsements in 2010.

Common Name	Quantity (numbers)	Weight (kg)	Litres (l)
Fish	25,708		
Syngnathidae (not included in Fish)	338		
Hermit crabs (land hermit crabs only - *Coenobita variabilis*)[1]	105,774		
Invertebrates	27,487		
Hard coral		6,234.95	
Soft coral[2]		5,076.70	
Living rock and Living sand		15,780	
Sponges	2,856		

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 4,724kg 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 'Algae/Seagrasses' cannot be shown in the Marine Aquarium fish Table 1 in 2010.

4 Due to confidentiality provisions the reported catch of 'Bryozoans' cannot be shown in the Marine Aquarium fish Table 1 in 2010.

Specimen Shell Managed Fishery Status Report

Main Features

Status		Current Landings	
Stock level	Acceptable	Specimen Shell Catch Total	
Fishing level	Acceptable	Shell numbers	15,467 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 and by also wading along coastal beaches below the high water mark While the fishery covers the entire Western Australian coastline, there is some concentration of effort in areas adjacent to population centres such as Karratha, Carnarvon, metropolitan Perth, Mandurah, 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 22 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 2010):

15,467 shells

Recreational catch estimate (season 2010):

Unknown

Commercial Landings

In 2010, the total number of specimen shells collected was 15,467 distributed over a wide range of species. In the past 5 years, more than 513 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 31% of those collected in 2009 and 16% of those collected in 2010. 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 8 of these are regularly active. Effort has been stable over the past 5 years, at an average of around 1,073 days fished. In 2010, 901 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 2010 season the catch rate was approximately 17 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) harvested in 2010, 60% of the shells taken were not harvested. Between 2005 and 2010, the overall average was 64% of shells sighted not taken. The measure of the number of shells sighted is reported correctly in about 57% 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, which is demonstrated by the increase in the percentage of the number of vulnerable shells sighted from 22% in 2009 to 57% in 2010. 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. Again, the 2010 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 2010, the catch level of approximately 15,500 shells and catch rate of 17 shells/day are both within 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: **Low**

Reports of interactions with protected species are required to be recorded on monthly catch and effort returns. In 2010, the fishery had only 1 reported interaction with protected species this was with a sea snake but resulted in no injuries to either party.

Ecosystem Effects

Food chain effects: **Negligible**

Habitat effects: **Negligible**

Social Effects

In 2010 there was 32 authorisation holders in this fishery with around 8 licences recording consistent activity, the number of people employed regularly in the fishery (licensees plus crew/ dive buddies) is likely to be around 15. There was also around 24 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 2010:

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 (2010/11)

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.

External Factors

During the summer of 2010/2011, the West Coast experienced a marine heatwave with sea surface temperatures of up to 5 degrees above average. This event has been widespread with fish kills being recorded across many fish species. Anecdotal reports from industry divers suggest that certain sponges also experienced major mortalities, in particular those species that form a commensal relationship with some species of specimen shells. This may have an effect on the specimen shell fishery in the future.

Contributors

A. Hart, C. Bruce, M. Cliff and S. O'Donohue.

APPENDICES

APPENDIX 1
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APPENDIX 2
Table of catches from fishers' statutory monthly returns for 2009/10

This table contains the landed[1] and estimated live weight[2] 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. Data for the Indian Ocean Territories Fishery have not been included in this table.

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH			
Amberjack	*Seriola dumerili*	19	19
Australian sardine (Pilchard)	*Sardinops sagax ocellatus*	2,652	2,652
Barracuda (northern pike)	*Sphyraena spp*	3	3
Barramundi (giant perch)	*Lates calcarifer*	39	63
Bass grouper	*Polyprion americanus*	3	3
Bigeye (not tuna)	*Priacanthidae*	25	25
Boarfish	*Pentacerotidae*	6	7
Bream, black	*Acanthopagrus butcheri*	67	67
Bream, monocle	*Scolopsis spp.*	14	14
Bream, Robinson's	*Gymnocranius grandoculis*	32	32
Bream, silver (tarwhine)	*Rhabdosargus sarba*	3	3
Bream, western yellowfin	*Acanthopagrus latus*	8	8
Catfish, sea (golden cobbler)	*Ariidae*	13	13
Chinaman fish (not cod)	*Symphorus nematophorus*	8	8
Cobbler	*Cnidoglanis macrocephalus*	66	93
Cobbler, silver	*Arius midgleyi*	39	58
Cod	*Serranidae*	74	74
Cod, bar (grey-banded, eight-bar)	*Epinephelus octofasciatus*	13	13
Cod, breaksea	*Epinephelides armatus*	5	5
Cod, chinaman	*Epinephelus rivulatus*	1	1
Cod, Rankin	*Epinephelus multinotatus*	111	111
Cod, spotted	*Epinephelus microdon, E.areolatus, E. bilobatus*	36	36
Dhufish, West Australian (jewfish)	*Glaucosoma hebraicum*	77	80

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Emperor, blue-lined (grass; black snapper)	*Lethrinus laticaudis*	2	2
Emperor, blue-spot	*Lethrinus hutchinsi*	212	212
Emperor, red	*Lutjanus sebae*	295	295
Emperor, red-spot (snapper)	*Lethrinus lentjan*	24	24
Emperor, spangled	*Lethrinus nebulosus*	68	68
Emperor, sweetlip	*Lethrinus miniatus*	56	56
Emperor, yellow-tailed	*Lethrinus atkinsoni*	1	1
Flagfish (Spanish flag)	*Lutjanus vitta, L.quinquelineatus, L.carponotatus, L.lutjanus*	79	79
Flathead	*Platycephalidae*	5	5
Flounder	*Bothidae*	1	1
Garfish, sea	*Hyporhamphus melanochir*	29	29
Groper (wrasses)	*Labridae*	1	1
Groper, baldchin	*Choerodon rubescens*	20	21
Groper, blue	*Achoerodus gouldii*	49	57
Halibut	*Psettodes erumei*	1	1
Hapuku	*Polyprion oxygeneios*	18	18
Herring, Australian	*Arripis georgianus*	215	215
Herring, Perth	*Nematalosa vlaminghi*	1	1
Javelin fish	*Pomadasys spp.*	25	25
Jobfish (goldband snapper) –see Snapper, goldband			
Jobfish, rosy –see Snapper, rosy			
Jobfish (sharptooth snapper) –see Snapper, sharptooth			
Kingfish, black (cobia)	*Rachycentron canadum*	12	12
Knifejaw	*Oplegnathus woodwardi*	2	2
Leather jacket	*Monacanthidae*	9	14
Mackerel, grey (broad-barred)	*Scomberomorus semifasciatus*	13	13
Mackerel, other	*Scombridae*	1	1
Mackerel, scaly	*Sardinella lemuru*	317	317
Mackerel, Spanish	*Scomberomorus commerson*	213	295
Mangrove jack	*Lutjanus argentimaculatus*	8	8

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Mullet, other	*Mugilidae*	3	3
Mullet, red	*Mullidae*	33	33
Mullet, sea	*Mugil cephalus*	274	275
Mullet, yellow-eye	*Aldrichetta forsteri*	31	31
Mulloway	*Argyrosomus hololepidotus*	21	22
Mulloway, northern (black jew)	*Protonibea diacanthus*	4	5
Parrot fish	*Scaridae*	6	6
Perch, darktail sea (maroon sea) -see Snapper, marron			
Perch, Moses –see Snapper, Moses			
Perch, pearl	*Glaucosoma buergeri*	32	32
Perch, red, maroon sea perch	*Lutjanus spp (large)*	21	21
Perch, yellowtail	*Amniataba caudavittatus*	1	1
Perches, other	*Lutjanidae*	5	5
Pike, sea	*Sphyraena novaehollandiae*	3	3
Pomfret, black	*Parastromateus niger*	1	1
Queenfish	*Scomberoides commersonnianus*	< 500 kg	1
Redfish	*Centroberyx spp.*	6	6
Redfish, bight	*Centroberyx gerrardi*	55	56
Redfish, yelloweye	*Centroberyx australis*	28	29
Rockcod, birdwire	*Epinephelus merra*	1	1
Rockcod, blackspotted	*Epinephelus malabaricus*	20	20
Rockcod, goldspotted	*Epinephelus coioides*	10	10
Rockcod, tomato	*Cephalopholis sonnerati*	1	1
Salmon, Western Australian	*Arripis truttaceus*	342	342
Samson fish (sea kingfish)	*Seriola hippos*	45	47
Scad, yellowtail	*Trachurus novaezelandiae*	11	11
Shark, blacktip	*Carcharhinus spp.*	2	3
Shark, bronze whaler (dusky whaler)	*Carcharhinus obscurus*	125	196
Shark, common saw	*Pristiphorus cirratus*	8	19
Shark, eastern school	*Galeorhinus galeus*	4	6
Shark, golden (copper whaler)	*Carcharhinus brachyurus*	28	41
Shark, gummy	*Mustelus antarcticus*	321	509

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Shark, hammerhead	*Sphyrnidae*	45	71
Shark, mako (shortfin)	*Isurus oxyrinchus*	2	3
Shark, pencil	*Hypogaleus hyugaensis*	1	2
Shark, spinner (long-nose grey)	*Carcharhinus brevipinna*	32	51
Shark, thickskin (sandbar)	*Carcharhinus plumbeus*	67	107
Shark, tiger	*Galeocerdo cuvier*	2	4
Shark, whiskery	*Furgaleus macki*	97	145
Shark, wobbegong	*Orectolobidae*	32	50
Shark, other		3	6
Shovelnose (fiddler rays)	*Rhinobatidae & Rhynchobatidae*	1	4
Skates and rays, other		7	18
Smelt, hardy head	*Atherinidae*	4	4
Snapper, bullnose (variegated emperor)	*Lethrinus ravus*	3	3
Snapper, crimson (formerly red snapper)	*Lutjanus erythropterus*	177	177
Snapper, fingermark, golden	*Lutjanus johnii*	2	2
Snapper, frypan	*Argyrops spinifer*	34	34
Snapper, goldband	*Pristipomoides multidens*	661	661
Snapper, long nose	*Lethrinus olivaceus*	12	12
Snapper, maroon (formerly maroon sea perch)	*Lutjanus lemniscatus*	8	8
Snapper, Moses (formerly Moses Perch)	*Lutjanus russelli*	25	25
Snapper, nor-west	*Lethrinidae*	9	9
Snapper, pink	*Pagrus auratus*	442	445
Snapper, queen	*Nemadactylus valenciennesi*	62	69
Snapper, red (swallowtail) –see Snapper, crimson			
Snapper, rosy (formerly Rosy jobfish)	*Pristipomoides filamentosus*	29	29
Snapper, ruby	*Etelis spp.*	61	61
Snapper, saddletail sea (formerly scarlet sea perch)	*Lutjanus malabaricus*	178	178
Snapper, sharptooth	*Pristipomoides typus*	8	8
Sole	*Ammotretis rostratus*	1	1
Sprat, blue	*Spratelloides robustus*	1	1
Sweep	*Scorpis aequipinnis*	1	1
Sweetlip	*Haemulidae*	45	45
Tailor	*Pomatomus saltatrix*	26	26

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Threadfin	*Polynemidae*	16	23
Threadfin bream (butterfish)	*Nemipteridae*	174	174
Threadfin, giant (king salmon)	*Eleutheronema tetradactylum*	62	65
Trevalla, deepsea	*Hyperoglyphe antarctica*	8	8
Trevally, golden	*Gnathanodon speciosus*	3	3
Trevally, other (skippy)	*Carangidae*	108	108
Trevally, skipjack	*Pseudocaranx dentex*	7	7
Tripletail	*Lobotes surinamensis*	5	5
Trout, coral	*Plectropomus maculatus*	13	13
Trout, spotted (duskytail grouper)	*Epinephelus bleekeri*	5	5
Trumpeters	*Terapontidae*	1	1
Tuna, other	*Scombridae*	2	2
Tuna, yellowfin	*Thunnus albacares*	1	1
Tuskfish, bluebone	*Choerodon spp.*	8	8
Whitebait	*Hyperlophus vittatus*	126	126
Whiting, golden-lined	*Sillago analis*	7	7
Whiting, King George	*Sillaginodes punctata*	9	9
Whiting, other	*Sillaginidae*	3	3
Whiting, western sand	*Sillago schomburgkii*	132	132
Other fish		86	88
TOTAL FISH		**9,288**	**9,945**
CRABS			
Crab, blue swimmer (blue manna, sand)	*Portunus pelagicus*	1,078	1,078
Crab, champagne (spiny)	*Hypothalassia acerba*	9	9
Crab, coral	*Charybdis feriata*	2	2
Crab, crystal (snow)	*Chaceon bicolor*	152	152
Crab, giant (king)	*Pseudocarcinus gigas*	7	7
Crab, mud	*Scylla spp.*	3	3
TOTAL CRABS		**1,251**	**1,251**
PRAWNS			
Prawn, banana	*Fenneropenaeus merguiensis*	241	241
Prawn, brown tiger	*Penaeus esculentus*	816	816

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
PRAWNS (continued)			
Prawn, coral	*Metapenaeopsis spp*	223	223
Prawn, endeavour	*Metapenaeus spp.*	119	119
Prawn, western king	*Melicertus latisulcatus*	1,392	1,392
Prawns, other	*Penaeidae*	< 500 kg	< 500 kg
TOTAL PRAWNS		**2,791**	**2,791**
LOBSTERS			
Bugs	*Scyllaridae*	12	12
Rock lobster, southern	*Jasus edwardsii*	48	48
Rock lobster, western	*Panulirus cygnus*	5,899	5,899
TOTAL LOBSTERS		**5,959**	**5,959**
MOLLUSCS			
Abalone, brownlip	*Haliotis conicopora*	12	30
Abalone, greenlip	*Haliotis laevigata*	59	158
Abalone, Roe's	*Haliotis roei*	82	82
Cuttlefish	*Sepiidae*	52	52
Octopus	*Octopus spp. (mainly O. tetricus)*	85	106
Scallop, saucer	*Amusium balloti*	505	2,524
Squid	*Sepioteuthis spp., Loligo spp.*	89	89
Trochus	*Trochus niloticus*	13	13
TOTAL MOLLUSCS		**898**	**3,055**
OTHER CLASSES			
Beche de Mer	*Holothuridae*	57	171
TOTAL OTHER CLASSES		**57**	**171**
GRAND TOTAL		**20,244**	**23,172**

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.
3. Weight figures are round off to the nearest tonnage.

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 2009/10

Information modified from Aqua Info Number 28 2009/10

Highlights for 2009/10

There were 471 licensed aquaculture producers

The farm gate value of aquaculture production in WA (excluding marine algae and pearl oysters) was over $10.6 million

The most valuable industry sector was barramundi ($4.5 million), followed by mussels ($1.9 million), marron ($1.4 million) and yabbies ($0.8 million)

The industry sector with the most participants was marron with 182 productive licences.

Introduction

The statistics contained in this document represent the reported production and estimated value of the non-pearling/algal aquaculture industry in Western Australia for the financial year 2009/10. 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.

This information is obtained from quarterly records received from industry which are summarised by the Department of Fisheries and reported to Parliament by the Minister for Fisheries. They are also used in the bioregional sections of the *State of the Fisheries and Aquatic Resources Report*, and they are presented in the annual report on Australian Fisheries Production compiled by the Australian Bureau of Agricultural and Resource Economics (ABARE) and in other relevant 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 figures presented are based on the data present in the Aquaculture Production Returns Database, as of the 18th January 2011.

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 2009/10

A total of 471 aquaculture licence holders were required to submit quarterly returns for one or more quarters in the 2009/10 financial year. Of the 471 licences, 253 i.e. 54 per cent recorded production on their returns. Marron had the largest number of producers with 182 licences recording production (Aquaculture Production Table 1).

Estimated aquaculture production increased by four per cent, up from 1121 tonnes produced in 2008/09 to 1166 tonnes in 2009/10 (excludes algae, pearl oysters, and ornamental species) (Aquaculture Production Table 2). Production of finfish and freshwater crustaceans remained stable while mussel production increased and ornamental production decreased.

The estimated value of Western Australian aquaculture (excluding algae and pearl oysters) decreased by seven per cent from $11.4 million to $10.6 million in 2009/10 (Aquaculture Production Table 3). Finfish aquaculture made up half of the total value for 2009/10.

AQUACULTURE PRODUCTION TABLE 1.

Growout production for the Western Australian aquaculture industry in 2009/10

Common name	Productive licences	Quantity	Units*	Average price/ unit	Value
Barramundi	6	435.9	tonnes	$10.35	$4 512 123
Mussels	17	506.5	tonnes	$3.69	$1 870 531
Marron	182	53.3	tonnes	$27.12	$1 445 252
Yabbies	15	41.1	tonnes	$18.49	$ 760 595
Silver perch	12	27.2	tonnes	$15.99	$ 435 624
Ornamental fish & crustaceans	14	46 359	No.	n/a	$ 230 856
Koi carp	9	38 787	No.	$4.76	$ 184 708
Rainbow trout	7	7.5	tonnes	$13.51	$ 101 681
Goldfish	5	15 035	No.	$3.47	$ 52 139
Other species with <5 producers**	<5	94.2	tonnes		$1 018 211
Algae	<5	**			**
Total (not including algae or pearls)					**$10 611 720**

* Tonnes refer to whole weight

** Industry figures have not been included to protect the confidentiality of individual producers, as there are less than five productive licensees.

Data Comparisons Over the Past Five Production Years (2005/06-2009/10)

AQUACULTURE PRODUCTION Table 2.

Estimated quantity of growout production of aquaculture species/categories in Western Australia over the past five financial years.

Common name	Units	2005/06	2006/07	2007/08	2008/09	2009/10
Mussels	tonnes	765.2	621.9	481.2	433.5	506.5 ↑
Barramundi	tonnes	18.5	43.2	365.9	455.2	435.9 ↓
Marron	tonnes	49.3	58.1	51.1	52.8	53.3 ↑
Yabbies	tonnes	69.3	87.9	60.8	44.1	41.1 ↓
Silver perch	tonnes	20.7	26.5	16.9	28.5	27.2 ↓
Rainbow trout	tonnes	29.6	11.7	13.3	11.7	7.5 ↓
Ornamental fish & crustaceans	No.	68876	61492	55047	50598	46359 ↓
Koi carp	No.	26149	30124	35620	34270	38787 ↑
Goldfish	No.	34244	35836	33918	36199	15035 ↓
Other species with < 5 producers	tonnes	46.8	65.2	97.2	94.9	94.2 ↓

AQUACULTURE PRODUCTION Table 3.

Estimated farm gate value ($) of growout aquaculture species/categories in Western Australia over the past five financial years.

Common name/ Category	2005/06	2006/07	2007/08	2008/09	2009/10
Barramundi	$ 162 733	$ 467 280	$3 870 071	$4 793 106	$4 512 123 ↓
Mussels	$2 159 056	$1 811 298	$1 531 849	$1 618 594	$1 870 531 ↑
Marron	$1 160 834	$1 387 449	$1 298 672	$1 434 494	$1 445 252 ↑
Yabbies	$1 036 980	$1 381 248	$1 059 532	$ 810 608	$ 760 595 ↓
Silver perch	$ 258 949	$ 317 275	$ 245 157	$ 405 506	$ 435 624 ↑
Ornamental fish & crustaceans	$ 161 412	$ 294 308	$ 237 408	$ 276 986	$ 230 856 ↓
Koi carp	$ 248 098	$ 137 195	$ 160 597	$ 168 279	$ 184 708 ↑
Rainbow trout	$ 172 459	$ 105 391	$ 135 007	$ 140 422	$ 101 681 ↓
Goldfish	$ 55 797	$ 65 536	$ 80 732	$ 73 992	$ 52 139 ↓
Other	$ 624 347	$ 883 044	$1 554 289	$1 715 130	$1 018 211 ↓
Total (not including algae & pearls)	**$6 040 665**	**$6 850 022**	**$10 173 312**	**$11 437 116**	**$10 611 720**

APPENDIX 3
Research Division - Other Activities
Pemberton Freshwater Research Centre activities 2010/11

The Department of Fisheries 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, 36 research tanks, fish hatching and larval rearing troughs. The nearby Dr Noel Morrissy Research Ponds on Thomsons Flat feature 25 earthen ponds, ranging in size from 150m2 breeding ponds to 1000m2 commercial growout -scale ponds, 28 tanks and a post-harvest handling facility. This site 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 native fish, crayfish and trout 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 biodiversity client groups. As part of the NRM funded hatchery infrastructure modifications space has been allocated for community education material on the department's activities and the recommencement of tours of the facility by the public.

PFRC provides facilities, expertise and stock to support research and industry development in the four key areas of i) conserving and recovering biodiversity, ii) recreational fishing, iii) aquaculture and iv) freshwater fisheries.

Key PFRC projects in 2010/11 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 2010/11 the PFRC produced 672,000 fry. These consisted of 649,000 Rainbow trout fry and 23,000 Brown trout fry, representing a decrease in production of 2.3% and 23% respectively, compared with 2009/10. The majority of production (83%) consisting of 535,000 Rainbow trout fry and 21,000 Brown trout fry were stocked into public waterways to support recreational fishing. A further 78,000 Rainbow trout (12%) were sold to individuals and clubs for stocking private farm dams for recreational fishing and tourism.

Included in the 78,000 trout fry sold to the recreational groups, were 36,000 sterile triploid rainbow trout fry, a 30% increase upon 2009/10 triploid production. All the triploids were sold to private waters for recreational fishing.

The remaining 5% of trout produced (38,000) were retained for future brood stock for PFRC, yearling stocking, research and sales for private waters.

In 2010/11 during the Winter-Spring months some 24,500 Rainbow yearlings as well as 2,700 Rainbow and 480 Brown trout ex brood stock, were released to public waters for recreational fishing and control of stunted redfin perch populations.

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 to develop improved protocols using a hydrostatic pressure chamber and tetraploids.

Brown trout embryo survival

In 2005 Brown trout embryo survival was sub-optimal, however after consulting with stakeholders, prior to PFRC 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. This research can only be undertaken during the brief spawning period each year. Factors being investigated include poor sperm motility, water quality and 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 egg fertilisation rates. However, visual assessment of sperm motility is labour intensive. Consequently sperm motility assessment was postponed until the purchase of computing equipment and software. Computer Assisted Sperm Analysis software (CASA) was purchased by the department in late 2010. This software will enable research staff to efficiently analyse and quantify trout sperm fitness during the 2011 spawning season.

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 28oC without any mortalities. This temperature tolerance is superior to most domesticated lines elsewhere and is significant in regards to adapting to global warming. Due to resource limitations in 2009 and 2010 the commencement of a trout selective breeding program to further increase temperature tolerance was delayed until the 2011 spawning season.

Sterile triploid trout production

Triploids are valuable for stocking and the environment 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 and trialled at PFRC in 2006. Juveniles were produced, however resource limitations prevented the percentage of triploids and tetraploids being analysed in either 2008/09 or 2009/10 or 2010/11. These samples have been frozen and will be analysed when finances permit. In 2010/11 Department of Fisheries researchers have worked with colleagues from The University of Western Australia to develop a more efficient technique of quantifying the percentage of triploids , diploids and tetraploids from egg samples. This will enable research in this area to recommence in 2011.

Native and endangered fish conservation and biodiversity research

In response to a declining prevalence of native fish in the southwest Department of Fisheries researchers established brood stock populations of two endemic species Pygmy Perch (*Edelia vittata*) and Western Minnows (*Galaxias occidentalis*) at PFRC. The aim of this research is to develop large-scale pond production techniques for these species to enable stocking of public and private water bodies. In 2010/11 both Pygmy Perch and Western Minnows were successfully spawned and reared at PFRC.

One of the challenges of captive breeding for release programs is to ensure that genetic drift within the hatchery environment does not result in progeny that are less fit for survival in the wild. At PFRC an innovative strategy developed by Department of Fisheries researchers to address this challenge received NRM funding in 2010. This strategy is based upon the upstream spawning migration of native fish. This means that juveniles produced in the PFRC hatchery and tagged, if released into the adjacent Lefroy Brook, when they reach sexual maturity will return to the hatchery to spawn. From several thousand fish released only those genetically fit enough to survive in the wild will return to PFRC to spawn. The NRM funding enabled a fish ladder supplied with water from PFRC to be constructed between the hatchery and the Lefroy Brook. In future years, by releasing juveniles produced at PFRC at the mouth of the Fish Ladder, after spending two years in the wild they will now be able to swim back up the fish ladder and into the hatchery to provide the next generation of PFRC broodstock.

During the planning stage of the PFRC fish ladder, consultation between Department of Fisheries researchers and Department of Water engineers identified critical knowledge gaps in the design specification's required for native fish to successfully migrate up a fish ladder. While there are proposals by university researchers to commence testing some design specifications (i.e. swimming ability) using laboratory scale swim chambers, the lack of a full scale fish ladder for research has limited the variables that can be examined. Consequently, the PFRC fish ladder has been designed so that it can not only be used to validate results from laboratory experiments, but can also be modified to test the effects of variables such as board height, pool length, pool depth, barrier type, flow rate etc. in a full scale working model. The information obtained from these experiments will lead to improved and scientifically validated designs for fish ladders in WA.

It is thought that the decline in prevalence of native fish is related to the increased spread of introduced *Gambusia* (*Gambusia holbrooki*), but research at PFRC and a NRM funded survey by Department of Fisheries researchers in 2010 indicates that other factors may also be responsible. Although *Gambusia* were originally introduced to control mosquito populations, 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 borne diseases such as Ross River virus.

Broodstock populations of two other freshwater native fish species that have been listed as critically endangered and vulnerable to extinction, the Trout Minnow (*G. truttaceus*) and Balson's Pygmy Perch (*N. Balstoni*), are also being established at PFRC. In addition to establishing a living gene bank before these species become extinct, the focus of this project is to close their life-cycles, develop large scale production techniques and restock waterbodies within their original distribution.

Native and endangered crayfish conservation and biodiversity research

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 living gene bank and breeding population of the critically endangered "hairy" Margaret River marron, before it became extinct in the wild. The South West Catchments Council (SWCC) provided funding for Department of Fisheries researchers working in collaboration with The University of Western Australia to develop a molecular genetic test (RAPID's) to identify "pure" marron

from hybrids. This resulted in the establishment of the only "pure" brood stock population of the rare Margaret River marron at PFRC. These broodstock at PFRC produced over 1200 juveniles in their first breeding season. These juveniles were 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 2010 during field sampling to monitor the wild population in the Margaret River a tagged marron, which had been released as juvenile in 2009, was recaptured.

In addition, a living gene bank representing marron populations from three other river systems are bred and reared in the captive breeding program 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, combined with limited supply from industry, is likely to necessitate re-establishing the selective breeding program at PFRC.

Activities of the Fish Health Unit during 2010/11

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 permanently staffed by 1 full-time and 1 part-time fish pathologist, one research scientist, one laboratory manager and one technical officer. During the year, two additional technical officer positions were employed on externally funded projects. Until May 2011, the Principal fish pathologist also filled the role of supervising scientist for Biodiversity and Biosecurity group within the research Division.

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. Emphasis has been placed on staff visiting aquaculture farms to encourage sustainable farming practices.

Key activities and achievements of the unit during 2010/11 were as follows:

- The fish health laboratory received a total of 186 diagnostic cases during the 2010/11 – a 74% increase on the previous period. This reflects a general upturn 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 product destinations within the industry.
- The provision of pearling translocation certificates also showed an increase, from 6 to 13 in this reporting period.
- 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 5 cases of notifiable diseases reported in 2010/11, the diseases were all records of iridovirus in ornamental fish in quarantined imported fish from overseas.
- 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 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 in early 2010 to purchase a real-time PCR machine and a laser microdissection microscope. This was installed and staff were trained in its use during July and August 2010 and the machine is now in operation.
- 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, including major fish kills along the west coast between the Abrolhos Islands and Moore River in February 2011 that were associated with the record high temperatures in the Leeuwin Current. Most 'fish kills' were due either to poor water quality or toxic algal blooms. During the year, the fish kill program was successfully introduced into the Indian Ocean Territories and kits were left at the islands, under agreement with the federal government.
- A range of national committees including the national Subcommittee for Aquatic Animal Health, the Fisheries Research Development Corporation Subprogram on Aquatic Animal Health, and the Aquatic Animal Health Project under the Australian Biosecurity Intelligence Network 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.
- 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. As part of that activity, two technical officers from Tahiti visited Perth and received training in laboratory techniques. The Vietnamese government funded one pathologist to hold a training workshop in Vietnam during 2010.

Biosecurity group activities - Indian Ocean Territories 2010/11

The Biodiversity and Biosecurity branch have implemented a series of biosecurity related projects during 2009 – 2010. All projects aim to detect the presence of introduced marine pests (IMPs) using a suite of tools including ongoing background monitoring and large-scale Port monitoring. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. A large-scale, nationally approved, survey of Christmas Island Port has been completed that will inform the Department of the status of IMPs in the Port. The survey was undertaken with funding from the Department of Regional Australia, Regional Development and Local Government and with the assistance of Parks Australia staff.

Indian Ocean Territories Fishery Status Report

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 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, 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 Commonwealth, 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 services, fish habitat protection advice, fish pathology and licensing services. The Commonwealth Minister for Regional Australia, Regional Development and Local government 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 joculator*), 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 2 and 3).

Recreational

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 2 and 3).

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 2 licenses in the fishery. In 2010, 2 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. Data for this fishery cannot be reported due to confidentiality limitations (i.e. less than 3 vessels).

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. Data for this fishery cannot be reported due to confidentiality limitations (i.e. there is only one licence in the fishery).

Recreational

Island-specific recreational fisheries management arrangements for the Indian Ocean Territories are currently being progressed to legislation.

Research summary

Risk assessment workshops were undertaken in 2006, 2007 and 2009, to identify and refine fisheries management and research 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. The Biosecurity group have implemented a nationally approved, marine pest survey of the Christmas Island Port which aimed to inform the Department of the status of introduced marine pests within the port. No marine pest species were detected during the survey.

Retained Species

Commercial landings (season 2010)

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 2 vessels and thus the exact catch data is not reportable due to confidentiality provisions. The total catch for the last few years is of the order of single digit tonnes, with the catch in 2010 less than that reported in 2009.

There is no commercial line fishery at the Cocos (Keeling) Islands.

The CKIMAFF targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), 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 2010)

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. Island-specific recreational bag limits, area closures, and gear restrictions are currently being progressed.

Fishing effort/access level

Commercial

Effort in the CILF has been relatively stable over the past three 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 the Cocos (Keeling) Islands 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**

Holuthurians: In 2006 a large-scale assessment of the holothurian communities inhabiting the lagoon and outer reef at the Cocos (Keeling) Islands was undertaken to determine the status of key holothurian species and enable recommendations to be made regarding the feasibility of a commercial holothurian fishery being developed in the region. Analysis of abundance and distribution data found that the holothurian 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 holothurian community found at the Cocos (Keeling) Islands is near to pristine, due to a lack of historical fishing pressure. Holothurian 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 between 2007 and 2011 indicate that the current abundance of gong gong is 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 access 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)[1] 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 recreational fishers in the waters of the lagoon targeted these species 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 (little is known about the stock structure of many fish 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 localised 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 joculator* and to a lesser extent *Centropyge flavissima. Centropyge joculator* is endemic to the Cocos and Christmas Islands and inhabits fringing reefs from 15 to 70 m.

[1] Lincoln-Smith, M.P., Skilleter, G.A., Underwood, A.J., Stark, J., Smith, A.K., Hawes, P.M.H, Howitt, L., White, G.A. and Chapman, M.G. 1995. Cocos (Keeling) Islands: Quantitative baseline surveys for core marine reserves and biosphere reserve in the South Keeling lagoon (prepared for Australian Nature Conservation Agency Project 153). The Institute of Marine Ecology, University of Sydney and The Ecology Lab Pty. Ltd., Sydney, Australia

Little is known about the biology of *C. joculator* although Allen et al. (2007)[1] 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 2 people were employed in the CILF around Christmas Island during 2010. 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 2010.

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 2010: **Not assessed**

The value of the CILF is not known. The value of the CKIMAFF is also unknown, although *C. joculator* commands a high price on the international market (reported in excess of $700.00 each).

Fishery Governance

Commercial

Target commercial catch range **Not available**

Current Fishing (or Effort) Level **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 (2012)

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

[1] Allen, G.R., Steene, R.C. and Orchard, M. 2007. Fishes of Christmas Island (Second Edition). Christmas Island Natural History Association, Christmas Island, Indian Ocean, Australia. 284p

identified for a number of species.

Island-specific fisheries management arrangements for the Indian Ocean Territories are currently being progressed.

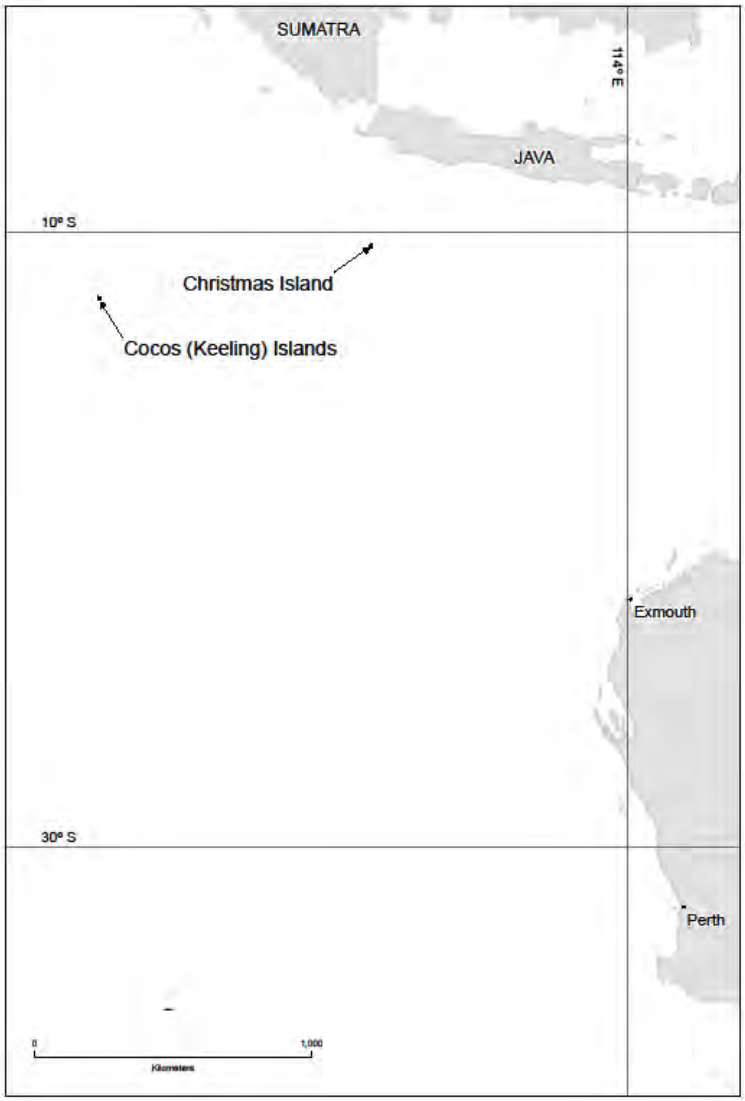
The effective implementation of any future fisheries management legislation at the Indian Ocean Territories, will require the development of community education and compliance enforcement programs.

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.

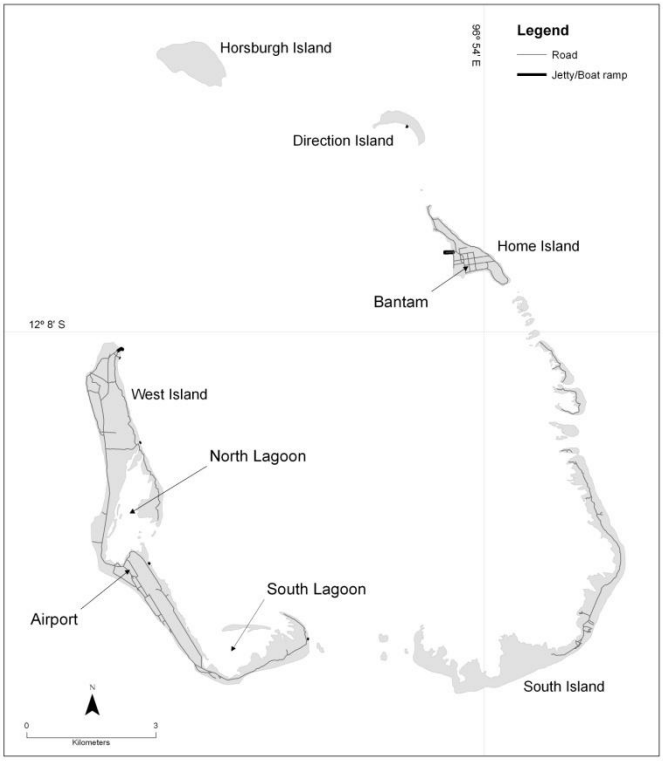
Contributors

S.J. Newman, L. Bellchambers, C. Skepper, M. Pember, S. Evans, B. Rome, S.D. Bridgwood and R. Green



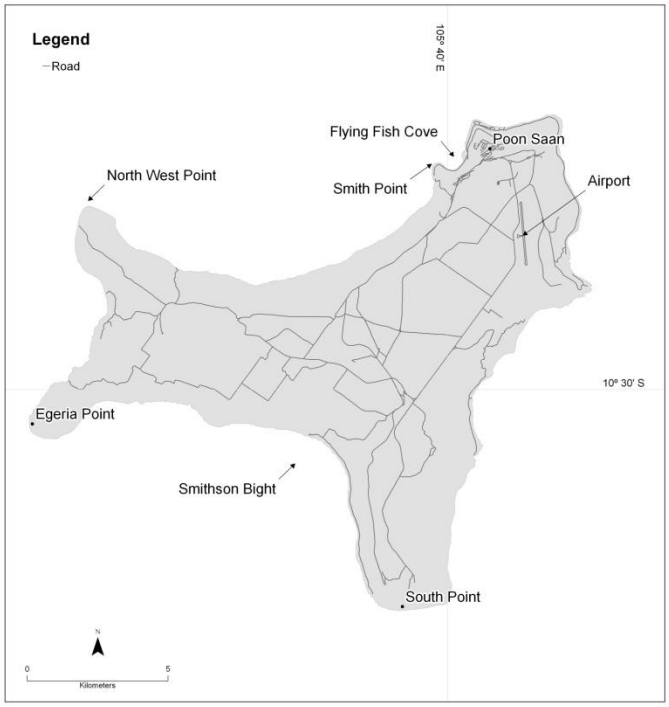
INDIAN OCEAN TERRITORIES FIGURE 1

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.



INDIAN OCEAN TERRITORIES FIGURE 2

Location of the major Islands and landmarks within the Cocos (Keeling) Islands in the Indian Ocean.



INDIAN OCEAN TERRITORIES FIGURE 3

Location of the key landmarks around Christmas Island in the Indian Ocean.

Finfish Ageing Laboratory

Finfish age estimates are a vital tool of fisheries research, monitoring and assessment. The age structure of a stock is used as the basis for estimating fishing mortality rates which provides information on stock status and risks to its sustainability, critical information for management of fishery resources. Moreover age estimates provide biological information including growth rates, age at onset of sexual maturity or sex change, longevity, and recruitment patterns.

The standard practice for ageing finfish is to remove their sagittal otoliths (earbones) and interpret the alternating opaque and translucent bands that are deposited at regular intervals throughout a fish's life, similar to the growth rings of trees (Finfish Ageing Laboratory Figure 1). For sharks, vertebrae are used. For a minority of species the otoliths can be interpreted whole (e.g. Australian herring). Most require prior processing by specialist laboratory staff at the Finfish Ageing Laboratory (FAL). This entails embedding otoliths in resin, cross sectioning, then mounting on a glass slide for microscopic inspection.

Since 1990 about a quarter of a million fish from over 40 species have been aged, the vast majority from fish frames donated by fish processors and recreational anglers as part of stratified sampling programs. The FAL has also supported research activities of university students, and collaborates in projects funded externally by establishments such as the Fisheries Research and Development Corporation and WA Natural Resource Management Office.

The FAL has also assisted with fish stock identification by preparing otoliths for chemical analyses. As the growth bands in otoliths are continuously deposited, they record the chemistry of a fish's environment over time. Staff at the FAL micro-mill otoliths to allow chemical signatures to be determined, which are compared to the location of capture, providing insight into movement and population structure. Another technique, known as laser ablation inductively coupled plasma mass spectrometry, is used to assess population structure and movement associated with fish age. Understanding the spatial configuration of fish stocks assists in determining spatial management arrangements for different regions/stocks.

The Department of Fisheries is responsible for managing finfish resources across four marine Bioregions (North Coast, Gascoyne, West Coast and South Coast) in Western Australia, each containing hundreds of species, requiring prioritisation of the FAL's workload. The recently published Resource Assessment Framework (RAF) for Finfish Resources[1] details five ecological suites within each Bioregion, based on broad habitat and depth criteria: estuarine, nearshore, inshore demersal, offshore dermersal, and pelagic (Finfish Ageing Laboratory Figure 2).

Each suite within each Bioregion still contains a large number of species however, so a much smaller number of fished species are identified as indicators of the status of sustainability of the finfish resources for each suite. For example, King Threadfin (*Polydactylus macrochir*) and Blue Threadfin (*Eleutheronema tetradactylum*) are used to assess the status and risk to sustainability of the nearshore suite of species in the North Coast Bioregion.

Ecological suites are ranked in terms of their risk to sustainability. For example the sustainability risk for the pelagic suite of the South Coast Bioregion is ranked as low; the nearshore suite for the Gascoyne Bioregion is medium; and the nearshore demersal suite for the West Coast Bioregion is high. The rankings are used to determine the priorities of the FAL, resulting in indicator species from the high risk suites dominating the workload (Finfish Ageing Laboratory Table 1).

The FAL allows for a limited amount of processing of species not prioritised by the RAF. Examples include extraordinarily large/old individuals that may provide new insights into a species' longevity, limited samples from a species with no previous age information, and research into the wider ecosystem effects of fishing (eg, trawling) using age data from non-target species.

The expanding demand for age data has recently lead to improved management arrangements for the FAL, enhancing quality control, staff administration and training, budgeting, timely supply of consumables, maintenance of valuable capital equipment, and accountability. Tasks and functions continue to evolve to support sustainable fisheries management.

Current FAL initiatives include documentation of methods for processing and interpreting otoliths, and converting raw interpretive data into age estimates. An otolith archive is being formally established and progressively updated, and is available for use by external research groups. Protocols are being developed to periodically test otolith readers using the archive, ensuring long-term comparability of age data. In July 2011 the FAL will participate in a national conference on quality control in the routine ageing of fish.

Beginning with this issue of the State of The Fisheries and Aquatic Resources Report, a summary of the activities and output of the FAL shall be annually reported and set out in the context of the framework used to assess the state of finfish resources in Western Australia. In 2010, a total of 16,660 fish from 22 species were aged, 13 being indicators. The large majority were indicator species from suites with a risk to sustainability ranked by the RAF as either "high" (12,105, 72.7%) or "medium" (1,529, 9.2%) (Finfish Ageing Laboratory Table 1).

Contributor

J. Norriss

1 Department of Fisheries WA, 2011 Resource Assessment Framework for Finfish Resources. Fisheries Occasional Paper No 85. Department of Fisheries, Western Australia. 24p.

FINFISH AGEING LABORATORY TABLE 1.

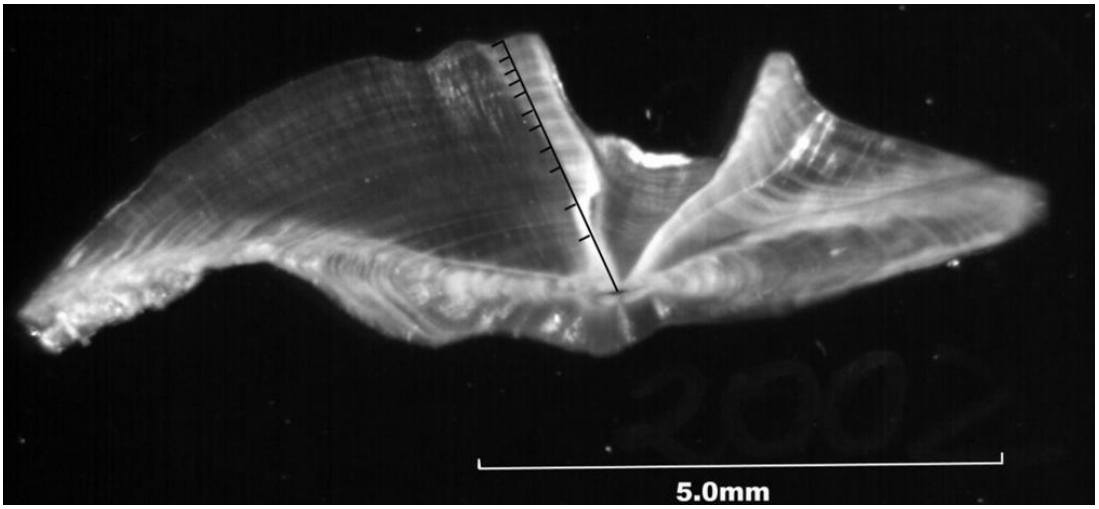
The number of fish processed and aged by the Fish Ageing Laboratory in 2010, by Bioregion, species, ecological suite, risk to sustainability for that suite (*high, †medium) as set out in the RAF (Department of Fisheries WA, 2011), and whether it is an indicator species for the suite.

Bioregion and Species North Coast	Number processed	Ecological suite	Indicator species
Goldband snapper *P. multidens*	505	Inshore demersal*	Yes
Red Emperor *L. sebae*	601	Inshore demersal*	Yes
Rankin Cod *E. multinotatus*	880	Inshore demersal*	Yes
Crimson Seaperch *L. erythropterus*	1,020	Inshore demersal*	No
Brownstripe snapper *L. vitta*	166	Inshore demersal*	Yes
Blue spot Emperor *L. punctulatus*	1,514	Inshore demersal*	Yes
Yellowspotted rockcod *E. areolatus*	50	-	No
Frostback rockcod *E. bilobatus*	49	-	No
Duskytail grouper *E. bleekeri*	1	Inshore demersal*	No
Total	**4,786**		

Bioregion and Species Gascoyne Coast	Number processed	Ecological suite	Indicator species
Pink snapper *P. auratus* oceanic	464	Inshore demersal*	Yes
Pink snapper *P. auratus* Inner Shark Bay	296	Nearshore†	Yes
Goldband snapper *P. multidens*	41	Inshore demersal*	Yes
Spangled Emperor *L. nebulosus*	229	Inshore demersal*	Yes
Red Emperor *L. sebae*	291	Inshore demersal*	No
Yellow tail Emperor *L atkinsoni*	8	Inshore demersal*	No
Total	**1,329**		

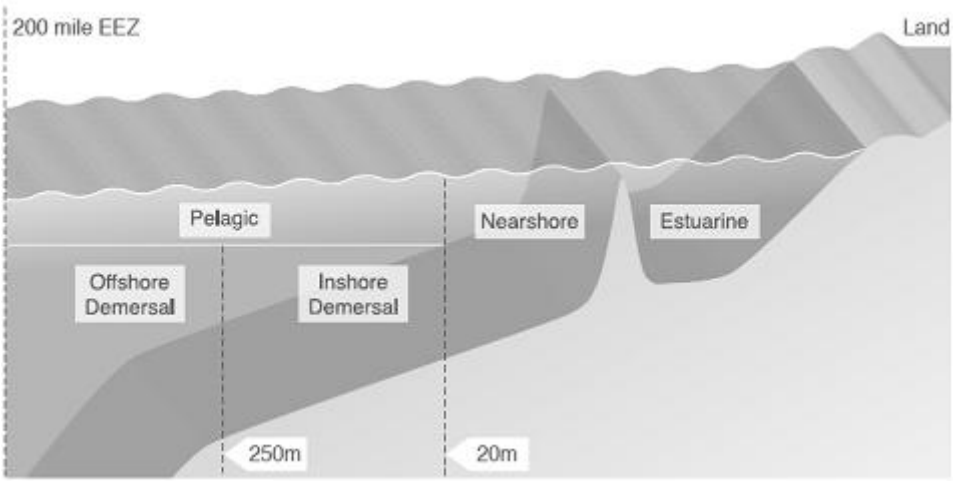
Bioregion and Species West Coast	Number processed	Ecological suite	Indicator species
Dhufish *G. hebraicum*	1,065	Inshore demersal*	Yes
Pink snapper *P. auratus*	942	Inshore demersal*	Yes
Baldchin Grouper *C. rubescens*	572	Inshore demersal*	Yes
Breaksea Cod *E. armatus*	464	Inshore demersal*	No
Redthroat Emperor *L. miniatus*	675	Inshore demersal*	No
Coral Trout *P. leopardus*	435	Inshore demersal*	No
Tailor *P. saltatrix*	457	Nearshore†	Yes
Australian herring *A. georgianus*	4,297	Nearshore†	Yes
Sea Garfish *H. melanochir*	372	Nearshore†	Yes
Total	**9,279**		

Bioregion and Species South Coast	Number processed	Ecological suite	Indicator species
Garfish *H. melanochir*	33	Nearshore†	No
Australian herring *A. georgianus*	659	Nearshore†	Yes
Cobbler *C. macrocephalus* Wilson Inlet	574	Estuarine†	Yes
Total	**1,266**		
GRAND TOTAL	**16,660**		



FINFISH AGEING LABORATORY FIGURE 1.

Transverse section of otolith from a 68 cm total length dhufish, *Glaucosoma hebraicum*. The number of annually deposited growth bands (highlighted) indicate an age of approximately 11 years.



FINFISH AGEING LABORATORY FIGURE 2.

Schematic representation of the five suites of finfish species within each marine Bioregion of Western Australia. Source: Resource Assessment Framework (RAF) for Finfish Resources (Department of Fisheries WA, 2011).

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 2009/10 season or the calendar year 2010.

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 2009/10 or 2010	Comment
Fishery: Abalone *Date of certification:* March 2008 *Approval type:* Accredited Export Exempt Fishery *Expiry date:* 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	Exploratory quota. No fishing in 2010.
	Roe's abalone Area 2 (spawning stock)	Effort range 80–106 diver days; total catch 19.8 t	Acceptable	80% of quota taken in Area 5 due to adverse weather.
	Roe's abalone Area 5 (spawning stock)	Effort range 100–140 diver days; total catch 20 t	Acceptable	
	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	
	Roe's abalone Area 8 (spawning stock)	Effort range 140–200 diver days; total catch 12t	Acceptable	
Fishery: Abrolhos Islands and Mid West Trawl *Date of certification:* 17 March 2005 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: March 2013	Scallops (spawning stock)	The residual stock index determines a predicted catch that sets the length of the next season	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2009/10 or 2010	Comment
Fishery: Beche-de-mer *Date of certification:* December 2004 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: December 2010	Beche-de-mer species (spawning stock)	Sandfish acceptable catch range: 20-100 t. Catch rate above 25 kg/hr. Redfish acceptable catch range: 40-100 t. Catch rate above 60 kg/hr.	Acceptable	Species specific performance indicators were developed for the first time in 2010. These replaced the old fishery-wide indicators.
Fishery: Broome Prawn *Date of certification:* August 2004, extended April 2010 *Approval type:* Accredited Export Exempt Fishery *Expiry date:* August 2015	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any one year	Acceptable	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
Fishery: Exmouth Gulf Prawn *Date of certification:* March 2003 *Approval Type:* Accredited Export Exempt Fishery *Expiry date*: 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
	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	

Fishery details	Issue/species	Performance measure	Current performance in 2009/10 or 2010	Comment
Fishery: Gascoyne Demersal Scalefish Managed Fishery *Date of certification:* September 2009 *Approval type:* Export exemption *Expiry date*: September 2014	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).
Fishery: Kimberley Prawn *Date of certification:* November 2004, extended April 2010 *Approval Type:* Accredited Export Exempt Fishery *Expiry date*: August 2015	Banana prawn (spawning stock)	Total catch within acceptable range of 200–450 t	Acceptable	
	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	
Fishery: Mackerel *Date of certification:* November 2009 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: 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: Marine Aquarium Managed Fishery *Date of certification:* October 2008 *Approval type:* Approved Wildlife Trade Operation Exemptions *Expiry date*: October 2011	Seahorses of hippocampus species	Total catch < 2000. Number taken - 338	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2009/10 or 2010	Comment
Fishery: Northern Demersal Scalefish *Date of certification:* June 2010 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: 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 above the upper limit due to increases in Zone A catches, catches of goldband were above 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	
Fishery: Onslow and Nickol Bay Prawn *Date of certification:* November 2004, extended April 2010 *Approval Type:* Accredited Export Exempt Fishery *Expiry date*: August 2015	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	Below target in Nickol Bay due to low effort.
	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
	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	
Fishery: Pearl Oyster *Date of certification:* September 2003, extended October 2008 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: October 2013	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.

Fishery details	Issue/species	Performance measure	Current performance in 2009/10 or 2010	Comment
Fishery: Pilbara Trawl *Date of certification:* November 2004 *Approval type:* *:*Approved Wildlife Trade Operation Exemption *Expiry date*: June 2013	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	
	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 – 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	

Fishery details	Issue/species	Performance measure	Current performance in 2009/10 or 2010	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	
	Western Australian salmon (spawning stock)	Expected catch range under the current management regime is 1,200–2,800 t	Acceptable	2010 catch below target range due to weak market demand, low catchability due to environmental factors and low recruitment in 2006 and 2007. Stock level considered adequate.
Fishery: Salmon *Date of certification:* November 2004, extended November 2009 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: November 2014	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Acceptable	
Fishery: Shark Bay Crab Interim Managed Fishery *Date of certification:* November 2004 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: July 2011	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	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2009/10 or 2010	Comment
Fishery: Shark Bay Prawn *Date of certification:* February 2003 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: February 2013	King prawn (spawning stock)	Total catch within historical acceptable range of 1,100–1,600 t, given no change in effort	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 2010 season, 2 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	
	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	

Fishery details	Issue/species	Performance measure	Current performance in 2009/10 or 2010	Comment
Fishery: Shark Bay Scallop *Date of certification:* February 2003 *Approval type:* Export exemption *Expiry date*: February 2013	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 2010 season, 1 turtle was recorded as caught in nets and was recorded as being returned to the sea alive.
	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
Fishery: South Coast Crustacean *Date of certification:* September 2004 *Approval type:* Wildlife Trade Order *Expiry date*: September 2011	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	
Fishery: Specimen Shell *Date of certification:* 25 May 2005 *Approval type:* Export exemption *Expiry date*: May 2015	Dusky and sandbar sharks	Review and report outcomes of actions taken to rebuild stocks,	Underway	Recovery of dusky and sandbar breeding stocks will take decades to manifest in existing fishery data
Fishery: Temperate Demersal Gillnet and Demersal Longline (Shark) Fisheries *Date of certification:* April 2009 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: March 2012	Australian sea lion interaction rates with demersal gillnets	(a) undertake a study to estimate risk of interactions between fishers and Australian sea lions by 30 March 2011 and (b) implement an appropriate observer program based on results of (a)	(a) underway (b) pending (a)	Part (a) commenced in 2010 with deadline extended to August 2011
	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	

Fishery details	Issue/species	Performance measure	Current performance in 2009/10 or 2010	Comment
Fishery: Western Rock Lobster *Date of certification:* August 2002 *Approval Type:* Accredited Export Exempt Fishery *Expiry date*: September 2012	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.
	Champagne crab (spawning stock)	Catch to remain below historical high of 50 t per annum	Acceptable	
Fishery: West Coast Deep Sea Crab *Date of certification:* May 2010 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: May 2013	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.
	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.		
Fishery: West Coast and South Coast Purse Seine *Date of certification:* February 2009 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date:* February 2012	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
Lynda Bellchambers	Adjunct Researcher, Centre for Marine Futures, University of Western Australia
David Fairclough	Adjunct Lecturer (Mar 2008 – Feb 2011), Centre for Fish and Fisheries Research, Murdoch University
	Adjunct Senior Lecturer (Mar 2011 – Feb 2014), Centre for Fish and Fisheries Research, Murdoch University.
	PhD co-supervision, Murdoch University, supervises Elaine Lek - "Comparisons of the biology of three sympatric species of wrasse (Labridae) in Western Australia".
Danielle Johnston	Adjunct Senior Lecturer, School of Animal Biology, University of Western Australia
Brian Jones	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	EU COST Action LarveNet member
	MSc co-supervision, Edith Cowan University, supervises Justin King - ‘Artemia production’
	MSc co-Supervisor, Wageningen University, Holland, supervising Vincent Boer
Craig Lawrence	Adjunct Associate Professor, The University of Western Australia
	PhD supervision, University of Western Australia, supervises Miriam Sullivan- Aquarium fish welfare
Rod Lenanton	Adjunct 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.
	Member of the Technical Advisory Panel (TAP) for the Swan River Trust
Stephen Newman	Adjunct Professor, Marine Ecology Group, School of Plant Biology, University of Western Australia.
	Adjunct Associate Professor, Centre for Fish and Fisheries Research, Murdoch University
Corey Wakefield	Honours co-supervision, University of Western Australia, supervises Matthew Jones – “A comparison of demersal fish assemblages across trap, trawl and targeted fishery closed areas of the Pilbara Demersal Scalefish Fishery, Western Australia”.
	Masters co-supervision, University of Western Australia, supervises Claire Wellington – “Description and comparison of demersal fish assemblages of the continental slope of Western Australia”.

GLOSSARY OF ACRONYMS

AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AGD	(Commonwealth Government) Attorney General's Department
AIMWTF	Abrolhos Islands and Mid West Trawl Managed Fishery
BPMF	Broome Prawn Managed 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
CSLPF	Cockburn Sound (Line and Pot) Managed Fishery
CW	Carapace Width
DEC	Department of Environment and Conservation (formerly Department of Conservation and Land Management)
DFAC	Developing Fisheries Assessment Committee
DVI	digital video imagery
EPBC	(Commonwealth Government) 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
FRMA	Fish Resources Management Act
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
IMP	Introduced Marine Pests
IQF	Individual Quick Frozen
ISO	International Organisation for Standardisation
ITE	Individual Transferable Effort
ITQ	Individual 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
KPMF	Kimberley Prawn Managed Fishery
LASCF	Lake Argyle Silver Cobbler Fishery
LML	Legal Minimum Length
MAF	Marine Aquarium Fish Managed Fishery
MBP	Marine Bioregional Plan
MFL	Managed Fishery Licence
MOP	Mother-of-Pearl
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MPP	Management Planning Panel
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NBPMF	Nickol Bay Prawn Managed Fishery
NDSF	Northern Demersal Scalefish Managed Fishery
NHT	Natural Heritage Trust
NPF	Northern Prawn Fishery
NRM	Natural Resource Management
OCL	Orbital Carapace Length
OPMF	Onslow Prawn Managed Fishery
PCR	*Polymerase Chain Reaction*
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
RFBL	Recreational Fishing from Boat Licence
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
SBCIMF	Shark Bay Crab Interim Managed Fishery
SBSF	Shark Bay Snapper Managed Fishery
SCEF	South Coast Estuarine Managed Fishery
SCTF	South Coast Trawl Fishery
SEWPaC	(Australian Government) Department of Sustainability, Environment, Water, Population and Communities (formerly Department of Environment, Water, Heritage and the Arts)
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
SWTMF	South West Trawl Managed Fishery
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TAE	Total Allowable Effort
TARC	Total Allowable Recreational Catch
TDGDLF	Western Australian Temperate Demersal Gillnet and Demersal Longline Fisheries
TEP	Threatened, Endangered and Protected
TL	Total Length
TPSA	Tiger Prawn Spawning Area
VFAS	Voluntary Fisheries Adjustment Schemes
VMS	Vessel Monitoring System
WADNHFMAC	Western Australian Demersal Net and Hook Fisheries Management Advisory Committee
WAFIC	Western Australian Fishing Industry Council
WAFMRL	Western Australian Fisheries and Marine Research Laboratories
WAMSI	Western Australian Marine Science Institute
WANCSF	Western Australian North Coast Shark Fishery
WCBBF	West Coast Beach Bait Managed Fishery
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
WCDSF	West Coast Demersal Scalefish Fishery
WCDSIMF	West Coast Demersal Scalefish (Interim) Managed Fishery
WCEF	West Coast Estuarine Managed Fishery
WCRLF	West Coast Rock Lobster Managed Fishery
WDWTF	Western Deepwater Trawl Fishery
WRLC	Western Rock Lobster Council
WTO	Wildlife Trade Operation

STATE OF THE FISHERIES AND AQUATIC RESOURCES REPORT 2010/11

Erratum page 38

There is a typographical error in a sub-heading on page 38 of the *State of the Fisheries and Aquatic Resources Report 2010/11*.

In the West Coast Rock Lobster Fishery Status Report, the figure in the sub-heading 'Retained Species Commercial landings (season 2009/10)' should be 5899 tonnes – not the 899 tonnes shown.

Please note that the correct total is shown in the rest of this report (pages 36-49) and also in Appendix 2 (page 329).

The Department of Fisheries wishes to apologise for any confusion this error has caused.

14 November 2011

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