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

Status reports of the fisheries and aquatic resources of Western Australia 2012/13

State of the fisheries



Fish for the future



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

Status reports of the fisheries and aquatic resources of Western Australia 2012/13

State of the fisheries

Edited by W.J. Fletcher and K. Santoro

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

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OVERVIEW FROM THE DIRECTOR

GENERAL

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia (SRFAR)* provide the public with an annual update on the state of the fish stocks and other aquatic resources of Western Australia (WA) managed by the Department of Fisheries (Department). These reports outline the most recent assessments of the cumulative risk status for each of the aquatic resources (assets) within WA's six Bioregions using an Ecosystem Based Fisheries Management (EBFM) approach. This world leading approach details all the fisheries and fishing-related activities within each of the Bioregions which now includes analyses and reports on the activities and processes undertaken by the Department to manage the broader aquatic environment, such as habitats, ecosystems and aquatic pests.

The *SRFAR* summarises the Departmental activities undertaken during 2012/13 and the outcomes generated by the preceding years. It documents recent changes to management or policy settings, compliance and education operations along with the assessments generated from the ongoing monitoring of stock levels and ecosystem condition. This document provides a comprehensive reference for the current status of all 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 only fisheries jurisdictions in the world to fully implement a comprehensive and practical EBFM framework. EBFM provides a thorough, risk based framework for the overall management of aquatic resources because it explicitly considers all ecological resources and community values within a Bioregion to determine which of these require direct management intervention. A key finding from this annual report is that the risks to most aquatic ecological resources in WA 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 unaffected 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’, which therefore require direct management, continue to meet their annual performance targets or have targeted research programs to reduce their interactions. The only ecosystems and component species in WA that are considered to be at unacceptable levels continue to be the estuarine and river systems of the south west region. These risks are not the result of fishing related activities.

The report also documents that the vast majority of stocks that support Western Australia's significant fisheries continue to be in a healthy condition. Approximately 97% of

commercial fisheries are now targeting stocks where no additional management is required to either maintain or achieve an acceptable breeding stock level. A detailed investigation of Australian herring off the South Coast and West Coast Bioregions found that this stock has been declining over the past decade due to lower recruitment levels associated with increased water temperatures experienced over this period. To rebuild the stock, additional management actions will be developed over the coming year. A further three fisheries in the Gascoyne and northern part of the West Coast Bioregion (Shark Bay Scallops, Shark Bay Crabs and Abrolhos Island Scallops) were also assessed as having inadequate breeding stocks but this was generated solely from the negative impacts of the marine heatwave event that affected this entire region in 2011. These fisheries were all closed for the past season to protect residual stocks.

A summary of these status reports 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).

The comprehensive set of information used to generate the bioregional and resource level status reports presented in this document has provided the Department with the basis to adopt a world leading methodology to implement the Government's third party certification initiative. All commercial fisheries in WA are now scheduled to undergo pre-assessment for the Marine Stewardship Council (MSC) certification system using a bioregional approach. The Gascoyne was the first bioregion to have an integrated set of reports compiled that covered the information relevant for all commercial fisheries in the Bioregion to enable their assessment against the three MSC principles (target species, ecosystem and governance). The set of reports for the Gascoyne have been submitted for assessment to an internationally accredited certifying body. A similar process will be undertaken for each of the three remaining marine bioregions in WA. Recommendations from these third party assessments will be incorporated within the management settings, monitoring programs and reporting systems over coming years.

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
Director General

October 2013

EDITOR'S INTRODUCTION

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2012/13* uses the Ecosystem Based Fisheries Management (EBFM) framework which is now the basis for management of Western Australia's aquatic resources (Fletcher, *et al.*, 2010, 2012¹). The format for this document is therefore consistent with the Department's full implementation of a risk-based approach to resource management (Fletcher 2012²). How this document fits within this process is outlined in Editor's Figure 1.

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 IMCRA³ 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. Given the increased activities and documentation within these categories that is occurring as part of the MSC initiative, these sections will all be updated progressively over the coming years with the Gascoyne Coast being the first bioregion to adopt the new standard.

Within each Bioregion the set of individual fishery reports are generally resource-based rather than activity (sector) based. 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) with each report containing descriptions of all the commercial and recreational activities. Taking this Bioregional approach to the management of ecological assets ensures that the aggregate catch harvested from each stock is identified to enable their cumulative effect to be assessed. This approach is consistent with the Department's IFM initiative and the proposed new Act. The structure of the reports should enable readers to more easily assess the interrelationships between fisheries and how the catch is shared among sectors.

The long-standing involvement by our commercial, recreational and aquaculture stakeholders in specific research projects and monitoring programs is recognised. This includes the provision of logbook data, voluntary participation in recreational fishing surveys, biological samples, access to vessels and information which are essential to the generation of many of the status reports presented in this document. The input from other science groups from WA, other parts of Australia and internationally 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.

While the *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2012/13* provides the general public, interested fishers and other stakeholders with a ready reference source, it also meets the reporting requirements of the Department, including the need to annually report on the 'state of fisheries managed under' the FRMA⁴ to the Western Australian Parliament and to the Commonwealth Government, on the performance of fisheries that are relevant under their EPBC Act. In addition, with the government initiative to have all WA commercial fisheries undergo per-assessment for Marine Stewardship Council (MSC) certification this has resulted in some slight changes in the terminology that may be used within some sections of these reports in order to match that used in the MSC assessment criteria.

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



Dr Rick Fletcher
Executive Director Research

October 2013.

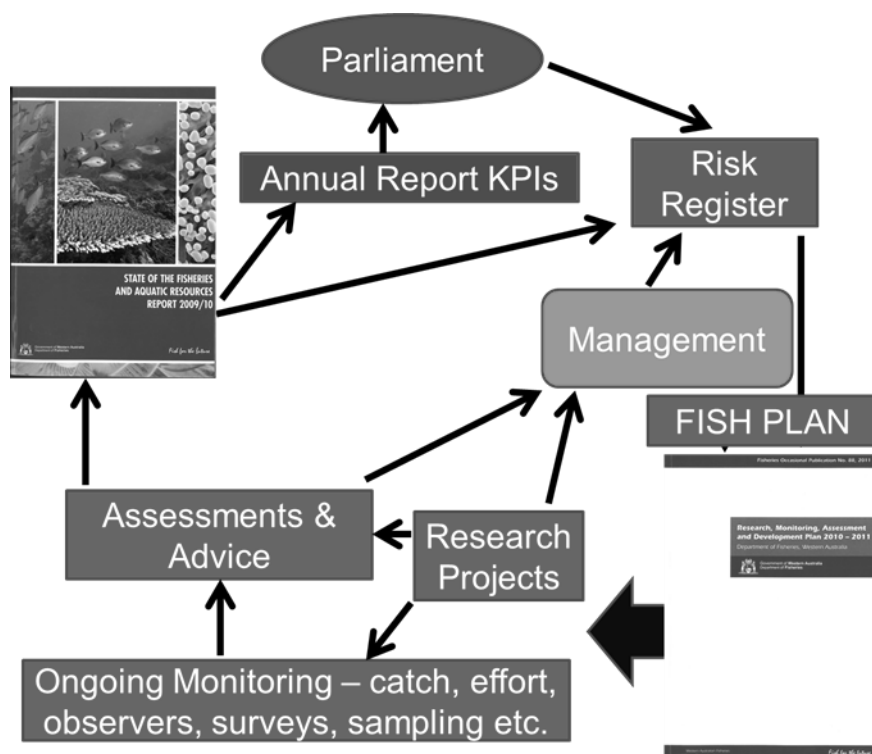
1 W.J. Fletcher, J. Shaw, S.J. Metcalf & D.J. Gaughan (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34 (2010) 1226–1238

Fletcher, W.J., Gaughan, D.J., Shaw, J. and Metcalf, S.J. (2012) *Ecosystem Based Fisheries Management: Case Study Report West Coast Bioregion*. Fisheries Research Report No. 212, Department of Fisheries, Western Australia 104p.

2 Fletcher, W.J., (2012) National Application of Sustainability Indicators for Australian Fisheries- Part 2: Ecosystem based frameworks for aquaculture, multi-fishery and international applications. FRDC Report – Project 2000/145 Part 2. Fisheries Research Report No 235 Department of Fisheries, Western Australia.

3 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>

4 Section 263 of the FRMA.



EDITOR'S FIGURE 1

An outline showing how the SRFAR fits within the risk based annual planning cycle now used for determining Departmental priorities and activities.

HOW TO USE THIS VOLUME

To obtain full benefit from the information provided in this edition of the *Status Reports of Fisheries and Aquatic Resources of Western Australia*, 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* 2012/13 to Parliament) and especially those associated with the ecological resource level reports.

The terms and headings are a combination of the reporting structures first outlined in the national Ecologically Sustainable Development (ESD) reporting structure (Fletcher *et al.* 2002)¹, plus the more recent Ecosystem Based Fisheries Management (EBFM) framework (Fletcher *et al.* 2010, 2012)² and Resource Assessment Framework (DoF, 2011)³. As part of implementing the Marine Stewardship Council (MSC) initiative and the development of the pre-assessment material on each of the fisheries within each of the four marine bioregions, in some cases the terminology that is used in reports has been updated to be consistent with the MSC criteria. 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.

Bioregions

As noted above, with the adoption of the EBFM approach, readers need to note the fully bioregional structure of this report. A 'Bioregion' refers to a region defined by common oceanographic characteristics in its marine environment or 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)⁴ 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 the main features of its aquatic environment, plus the major commercial and recreational fisheries and aquaculture industries that operate in the area. It now also has a section that outlines the current risk status of each of the high level, ecological resources/assets located within each Bioregion (see below).

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 1). 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.* (2012)⁵ 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 (Introduction Figure 2).

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.

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., Metcalfe, 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

Fletcher, W.J., Gaughan, D.J., Metcalfe, S.J., Shaw, J. 2012. Using a regional level, risk-based framework to cost effectively implement Ecosystem Based Fisheries Management (EBFM). In: Kruse, G.H., Browman, H.I., Cochrane, K.L., Evans, D., Jamieson, G.S., Livingston, P.A., Woodby, D., Zhang, C.I. (eds) *Global Progress on Ecosystem-Based Fisheries Management*. pp. 129-146. Alaska Sea Grant College Program. doi: 10.4027/gpebfm.2012.07

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

⁴<http://www.environment.gov.au/coasts/mbp/publications/imcra/pubs/imcra4.pdf>

5 Fletcher, W.J., (2012) National Application of Sustainability Indicators for Australian Fisheries- Part 2: Ecosystem based frameworks for aquaculture, multi-fishery and international applications. FRDC Report – Project 2000/145 Part 2. Fisheries Research Report No 235 Department of Fisheries, Western Australia.

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. White Sharks) and protected 'non-fish' (e.g. mammals) as defined in the FRMA.

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)¹ and Fletcher *et al.* (2011)². This enables the analysis of risk (using a five year time horizon) for objectives related to captured species, habitat and community structure/ecosystem sustainability, plus social and economic outcomes to be completed in a practical and consistent manner (Introduction Table 1).

The accepted international definition of risk is “*the uncertainty associated with achieving objectives*” (ISO, 2009)³, therefore any uncertainties from a lack of specific data are explicitly incorporated into the assessment enabling the calculation of risk to be completed with whatever data are available. All risk scoring considers both current level of activities and management controls already in place or planned.

Risk Category	Description
Negligible	Not an issue
Low	Acceptable; no specific control measures needed
Moderate	Acceptable; with current risk control measures in place (no new management required)
High	Not desirable; continue strong management actions OR new and/or further risk control measures to be introduced in near future
Significant	Unacceptable; major changes required to management in immediate future

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

2 Fletcher, W.J., Shaw, J., Gaughan, D.J. and Metcalf, S.J. (2011). Ecosystem Based Fisheries Management case study report – West Coast Bioregion. Fisheries Research Report No. 225. Department of Fisheries, Western Australia. 116 pp.

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

Within each Bioregion, the EBFM process initially identified hundreds of separate ecological assets, social, economic and governance issues and risks (Fletcher *et al.* (2011)). 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.

Recreational Fishing Estimates

To cost effectively monitor recreational fisheries in WA the Department of Fisheries has developed an integrated system of survey methods to provide a robust approach for obtaining annual estimates of recreational catch by boat-based fishers at both the state-wide and bioregional levels. These surveys utilise the Recreational Fishing from Boat Licence (RFBL) as the basis for sampling. They not only provide estimates of catch and effort but provide the information for the validation of these estimates by enabling comparisons across the various methods.

The integrated survey includes three complementary components: (i) off-site phone surveys encompassing an initial Screening Survey, a 12-month Phone-Diary Survey, followed by post-enumeration surveys; (ii) on-site boat-ramp surveys (including a state-wide Biological Survey and a Perth metropolitan Validation Survey); and (iii) a remote Camera Survey. This first survey was undertaken for the 12-month period from 1 March 2011 to 29 February 2012.

Estimates of recreational catch and effort at state-wide and bioregional levels from the surveys have been presented in Ryan *et al.* (2013)⁴, and provide data for the catch and effort by the recreational sector throughout this report. These estimates will be examined against previous recreational surveys, whilst noting differences in survey methodology, to determine if there have been any material changes in recreational catch levels. This approach will particularly focus on the indicator species used to monitor the status of each of the bioregional level suites.

The state-wide survey of boat-based recreational fishing will be repeated every second year and the next series of surveys are currently underway with a census period from 1 May 2013 to 30 April 2014.

Harvey Strategy

A Harvest Strategy Policy is under development. A harvest strategy articulates all performance levels and the management actions designed to achieve the agreed objectives. These objectives articulate what is to be achieved, and why, both for the resource and the relevant fisheries.

4 Ryan, K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. and Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia. 162 pp.

Breeding Stock Status

The assessments of breeding stock for captured species are undertaken using a number of techniques (see below) to determine if the stock is considered to be at an adequate level or not. The stock status levels are defined as:

Adequate: reflects levels and structure of parental biomass for a stock where annual variability in recruitment of new individuals (recruits) to the stock is considered to be mostly a function of environmental effects or recruit survival, not the level of the egg production.

Recovering: reflects situations where the egg production has previously been depleted to unacceptable levels by fishing or some other event (e.g. pilchard herpes virus in the 1990s) but is now considered to be recovering at an acceptable rate due to the implementation of effective management actions and/or natural processes.

Inadequate: reflects situations where excessive fishing pressure (catch) or some external event (e.g. the marine heat wave that affected the Gascoyne region in 2011) has caused parental biomass to fall to levels where the egg production are depleted to levels that may affect recruitment (often called recruitment overfished if caused by fishing) and revised management of the stock is not currently in place to generate an acceptable rate of recovery.

Retained Species (Stock Assessment Methods)

A stock assessment is the collection and analysis of fisheries data needed to underpin the harvest strategy and determine stock status and fishery performance.

In only some cases is the egg production by the breeding stock directly measured. In most cases a variety of indirect measures are used. Each of the status reports clearly identifies what type of stock assessment method(s) have been used to determine the status of stocks. The specific methods used for monitoring and assessment vary among stocks and indicator species. The choice of methods 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 and the level of precaution in management settings. 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 and these are often used together with a 'weight of evidence' approach:

Level 1	Catch data only
Level 2	Level 1 plus fishery-dependent effort
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 either fishery-independent surveys of relative abundance, exploitation rate, recruitment; or standardised fishery-dependent relative abundance data.

Level 5 Levels 1 to 3 and/or 4 integrated within a simulation, stock assessment model.

Multi species assessments: For each marine bioregion, all species of finfish and invertebrate are now allocated to one of five 'suites' estuarine, nearshore, inshore demersal, offshore demersal or pelagic (DoF, 2011¹). For each of these suites one or more 'indicator species' (which in general includes the most popular and/or vulnerable species in the suite) have been selected to reflect the status of the entire suite. If one or more indicator species is considered to be at risk, the entire suite is considered to be at risk and additional management actions are indicated.

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 generated by removing fish from the ecosystem, and direct physical interactions of fishing gear with the sea floor. Each fishery is considered in terms of its potential/relative effects on the food chain and the habitat, and an outline of the assessment of current ecological risk ('negligible', 'low', 'medium', 'high' or 'significant') is provided. More details on the information used within these risk assessments will generally be available in the EBFM reports for each bioregion (e.g. Fletcher *et al* 2011²).

Economic Effects

As part of the EBFM framework we have categorised the different levels of Gross Value of Product (GVP) for commercial fisheries into six levels. This provides a mechanism for reporting on all fisheries including those where the small number of operators would not allow specific values to be provided. It also covers situations where the calculation method for GVP are currently under review and specific values may not be appropriate

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

2 Fletcher. W.J., Shaw, J., Gaughan, D.J. Metcalf, S.J. (2011). Ecosystem based fisheries management case study report West Coast Bioregion. Fisheries Research Report 225, Department of Fisheries, Western Australia. 116 pp.

Level 0	nil
Level 1	< \$1 million
Level 2	\$1 – 5 million
Level 3	\$5 -10 million
Level 4	\$10 - 20 million
Level 5	> \$20 million

Target catch (or effort) range (Current fishing level)

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.

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.

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

For most of the fisheries in WA, the 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.

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

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 interpret changes in catch and/or effort and therefore 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 between collection and analysis.

Therefore, the statistics in this volume refer either to the financial year 2011/12 or the calendar year 2012, 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 2011/12, 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 2013.

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).

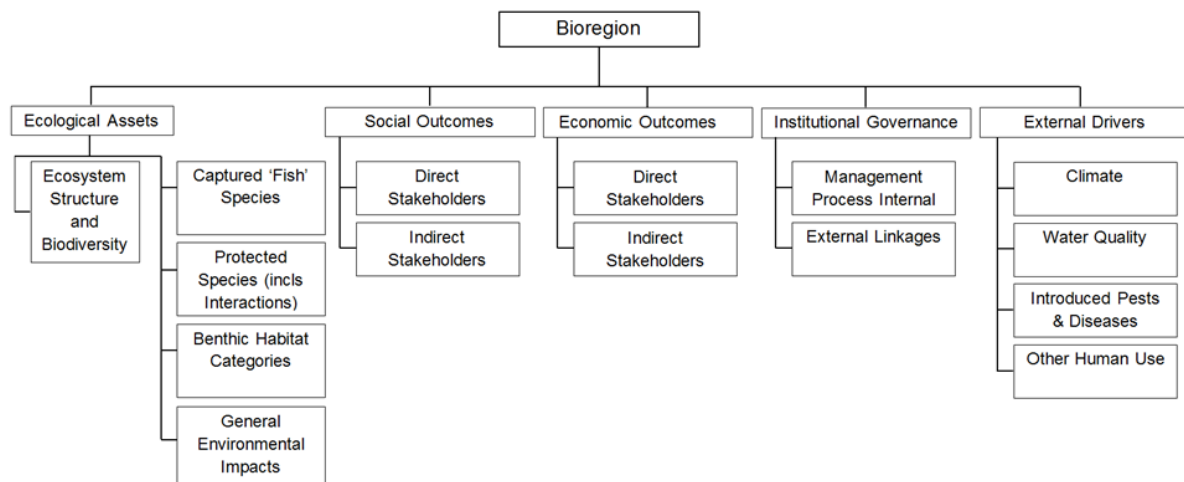
Consequently, the *State of Fisheries and Aquatic Resources Report* also reports on the ecological performance of the relevant fisheries against the specific performance measures used or developed during the EPBC Act assessment process. These may vary among future editions as EPBC conditions change and 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.

INTRODUCTION TABLE 1

Risk Categories, descriptions and likely management responses (modified from Fletcher 2005, Fletcher *et al.* 2011¹).

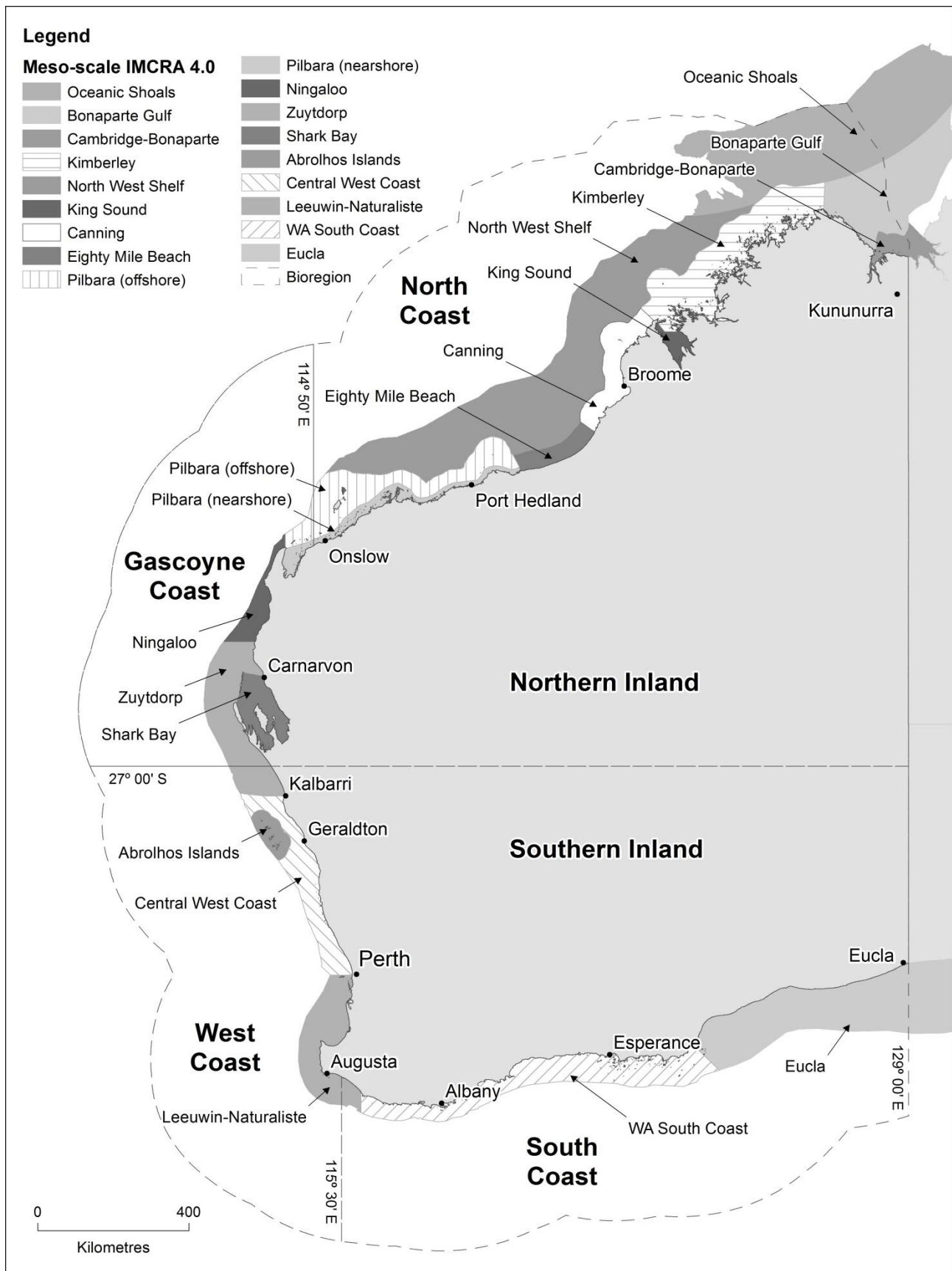
Risk Category	Description	Likely Reporting Requirements	Likely Management Response
Negligible	Not an issue	Minimal	Nil
Low	Acceptable; no specific control measures needed	Justification required	None specific
Moderate	Acceptable; with current risk control measures in place (no new management required)	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

**INTRODUCTION FIGURE 1**

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.

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

Fletcher, W.J., Shaw, J., Gaughan, D.J. and Metcalf, S.J. (2011). Ecosystem Based Fisheries Management case study report – West Coast Bioregion. Fisheries Research Report No. 225. Department of Fisheries, Western Australia. 116 pp.



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 boundaries¹.

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

OVERVIEW OF THE STATUS OF KEY ECOLOGICAL RESOURCES (ASSETS)

ECOSYSTEM STRUCTURE AND BIODIVERSITY

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 2012/13.

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 the 38 fisheries reviewed, the 'Stock Status and Catch Ranges for Major Commercial Fisheries' in the Outcomes section of the Annual Report records that breeding stock assessments are available for the major species taken in 36 (95%) of these fisheries. For the other two fisheries, insufficient data were available on the target species to make a critical assessment. In situations where unmonitored stocks are assessed as having the potential to become overfished, they are given priority for new research and/or management.

Within the group of 36 assessed fisheries, 29 involve stocks that were considered to have adequate breeding stock levels and a further three (West Coast Demersal Scalefish Fishery, the Southern and Northern Shark Fisheries) to have breeding stocks considered to be recovering at acceptable rates (89 per cent of fisheries). All of these recovering fisheries target relatively long lived species so their recovery is expected to take a number of years to complete. The management generated reductions in catch levels for all sectors of the West Coast Demersal Scalefish Fishery have now been in place for a number of years and the detailed reassessment completed in 2012/13 determined that these actions appear to be successful in initiating a recovery for this suite of species. For the Southern Shark Fishery the most recent assessments also showed continued recovery of dusky and whiskery sharks. The Northern Shark Fishery continues not to operate, therefore there has been no catch of sandbar sharks by this fishery for the past four years

Of the remaining fisheries, only the Australian Herring Fishery has been assessed as having stock levels that are not

considered adequate to ensure catches could be sustained at desirable levels given effort levels and normal environmental conditions. A detailed investigation of Australian herring off the South Coast and West Coast Bioregion found that this stock has been declining over the past decade due to lower recruitment levels associated with increased water temperatures experienced over this period. A further three fisheries were also assessed as having inadequate breeding stocks solely resulting from the negative impacts of environmental perturbations, not fishing. The increased mortality of adults and extremely poor recruitment levels observed for Shark Bay crabs, Shark Bay scallops and scallops in the Abrolhos Island region was initiated by the marine heat wave event which began in 2011. Consequently, these fisheries were all closed for the past season to protect residual stocks. Therefore, while a total of 11 per cent of fisheries have stock levels that are not considered adequate, only one fishery (or 3% of those assessed) is considered inadequate as a result of exploitation (Overview Figure 1).

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) by the Department's Research Division. 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). The Department's 2012/13 Budget Papers state that the target is eighty eight percent (88%).

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. Additional considerations include market conditions, fleet rationalisation or other factors that 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 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 (see

Overview Table 1).

The Major Commercial Fisheries which have target catch or effort ranges account for most of the commercial value of WA's landed catch. Comparisons between the actual catches (or effort) with the target ranges have been undertaken for 29 of the 38 fisheries referred to in 'Stock Status and Catch Ranges for Major Commercial Fisheries' section, three less than the number used last year. The increase in the number of fisheries not assessed was generated by a combination of environmentally induced stock issues in some regions (see above) and poor economic conditions for some fisheries which meant a number of fisheries were either closed or did not have material levels of catches during this reporting period. Three fisheries (Shark bay crabs, Shark Bay scallops, Abrolhos Islands and mid-west trawl) which were affected by unusual environmental conditions that impacted their recruitment to the extent that the fisheries were set to zero (0) catches. The setting of zero catches in these fisheries highlights the significant management interventions of the Department to reduce further impacting of the stocks by fisheries, permitting the recovery and rebuilding of these stocks. These stocks are being closely monitored by the Research Division to allow their reopening when stocks have rebuilt to the level to support sustainable fishing.

Of the 29 fisheries where 'target ranges' were available and a material level of fishing was undertaken in 2011/12, ten were catch-quota managed [through a TAC allocated through Individually Transferable Quotas (ITQ)] with 19 subject to effort control management.

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, purse seine fisheries). In the 19 effort-controlled fisheries, all but one produced catches that were within (13) or acceptably above (1) or below (4) their target catch ranges. The catch of snapper in the West Coast Demersal was unacceptably above the range for this species in some management areas, although the overall fishery catch was within the range. Management of this fishery is currently being reviewed.

In summary, 28 of the 29 fisheries assessed (97%) were considered to have met their performance criteria, or were affected by factors outside the purview of the management plan/arrangements (Overview Figure 2), which is well above the target level.

Benthic Habitat and Biodiversity

Monitoring

A number of monitoring tools is used to assess the condition of ecosystems and associated biodiversity within the context of Ecosystem Based Fisheries Management. Detailed assessments of risk to the structure and benthic habitat of specific ecosystems can be found within each bioregional risk assessment of ecological assets. Across the marine bioregions, risks to benthic habitat and ecosystem structure and biodiversity have been generally assessed as ranging from negligible to at most only moderate. The exceptions to this are the estuarine ecosystems of the West Coast Bioregion which are identified as being at significant risk due to pressures from external (non-fishing) pressures largely associated with deteriorating water quality.

Management

Based on the results of marine ecosystem monitoring coupled to specifically identified management objectives, different degrees of protection are afforded to areas in accordance with categories established by the International Union for the Conservation of Nature (IUCN; http://www.iucn.org/about/work/programmes/pa/pa_products/wcpa_categories/). These categories range from sustainably managed multiple use categories (Category VI) to complete no take areas where no extractive activity is permitted (Category I). Spatial closures are identified following a risk based assessment of ecological parameters within a defined bioregion, and can involve total or partial closures to fishing activity. Closures can be used alone, but are often used in combination with other fisheries management tools to achieve specific objectives.

Mechanisms in use for the protection of marine habitats in Western Australian state waters include:

- Spatial closure to trawl-based fisheries under the Fish Resources Management Act 1994 (IUCN management category IV)
- Establishment of Fish habitat Protection Areas (FHPAs; IUCN management category I)
- Closures to fishing under section 43 of the Fish Resources Management Act 1994 (IUCN management category III)
- Establishment of marine parks through the Conservation and Land Management Act 1984 (CALM Act) and the Fish Resources Management Act 1994 (IUCN management categories I-VI)
- Marine protected areas off WA can also be created in Commonwealth waters under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC).

A summary of the effective habitat protection afforded to shelf waters off WA is detailed in Overview Table 2.

Protected Species

In accordance with EBFM principles, risk-based assessment of the impact of commercial and recreational fishing activities on protected fish and non-fish species is undertaken. Specific detail may again be found within each bioregional risk assessment of ecological assets. Risks associated with interactions with protected species were generally assessed as being negligible to low with the exception of risks to mammals (dolphins) resulting from the Pilbara trawl fishery. Dolphin exclusion devices have reduced the incidence to acceptable levels and further refinements to net design are in progress. Risks associated with birds and mammals (sea lions) in the South coast bioregion were also assessed as moderate and appropriate management measures are being undertaken to attempt to mitigate these risks. Most recently the level of entanglements of whales in pot ropes has required establishment of a steering group and initiation of research projects for mitigation.

GENERAL ENVIRONMENTAL IMPACTS

Introduced Pests and Diseases

The Department of Fisheries is the lead state government agency responsible for the management of aquatic biosecurity in Western Australia. Aquatic biosecurity threats include disease outbreaks in wild and farmed fish and the introduction of marine and freshwater pest species that are not native to WA.

Introduced marine species are organisms that have moved, or been moved from their natural environment to another area. Many of these organisms remain inconspicuous and innocuous causing no known adverse effects. However, some can potentially threaten human health, economic values or the environment, in which case they are then referred to as marine pests. Introduced marine species are a global problem, and second only to habitat change and loss in reducing global biodiversity (Millennium Ecosystem Assessment, 2005)¹.

The introduction of marine species into a new region can be deliberate or accidental. Deliberate introductions may result from aquaculture practices or releases from aquariums. Accidental introductions are primarily due to shipping and recreational craft moving from country to country, with the pests being transported in ballast water, on ship hulls, or within a vessel's internal seawater pipes. Introduced marine species also arrive naturally via marine debris and ocean currents.

In recognition of an increasing risk presented by aquatic pests and diseases to WA associated with increasing international travel, transport and trade, the Department has developed the capacity for rapid detection and identification of aquatic pests and diseases. Rapid detection of introduced aquatic pests and diseases is important in preventing their spread and establishment. This section provides an overview of the Department's activities with respect to marine pests and diseases monitoring in the state in 2012/13. Further detail is reported at the bioregional level and further information on Departmental activity in this field may be found in the

appendix (Activities of the Fish Health Unit during 2012/13 and Activities of the Biosecurity Research Group 2012/13).

The Marine Biosecurity Research group has implemented a system to monitor high risk ports around the state for the presence of marine pests. As an ocean bound nation Australia relies heavily on maritime transport, with over 95% of our imports and exports carried by sea. The large ocean going vessels that transport these goods represent one of the largest vectors of introduced species, while recreational vessels represent the major secondary vector that can spread pests from ports and marinas around the coastline. For these reasons our ports and marinas become high risk areas for the introduction of a marine pest. The Commonwealth Government, together with the states and territories have developed a national system of policies and procedures to try and reduce the risk of marine pests arriving in Australian waters. Part of this system includes the monitoring of high risk ports, which are those ports that receive large numbers of vessels, high risk vessels (such as dredges) or are geographically close to areas with known invasive marine species. This section details the results of the monitoring conducted in 2012/13 for detection of introduced marine pests (Overview Table 3).

The Department provides the Federal Department of Agriculture Forestry and Fisheries with a quarterly report on nationally notifiable aquatic diseases detected in Western Australia. This information is compiled with that of other Australian jurisdictions and is provided quarterly to the World Organisation for Animal Health (OIE). Summary data is available at <http://www.oie.int/>

The Department coordinates the fish kill response program within Western Australia. This program forms part of a national program endorsed by Primary Industries Standing Committee and Natural Resource Management Standing Committee in December 2006. The number and cause of fish kills is also a key indicator in the "State of the Environment Report" (SOE) issued from time to time by the environmental protection authority (IW19 Number and location of significant fishkills). The number of significant fishkills investigated in Western Australia since the last SOE report is shown in Overview Table 4.

¹ Millennium Ecosystem Assessment (2005) Ecosystems and human well-being: Biodiversity synthesis. World Resources Institute, Washington DC. 86 pp.

OVERVIEW TABLE 1

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 assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported1- 2011/12 or 2012	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION					
West coast rock lobster	Size-structured Population Model (Level 5)	Adequate	6,938 (Q)	6,647	Acceptable A Total Allowable Commercial Catch (TACC) of 6,938 t was set for the 2011/13 extended season. The entire TACC was not landed because a number of operators, especially in the southern zone, ran out of time to obtain their entire quota.
Roe's abalone	Catch Rates & Direct Survey (Level 4)	Adequate	92.8 (Q) (530 – 640 days)	67.0 (372 days)	Acceptable Catch was less than the quota due to significant reductions in commercial effort (days fished) in all regions except Area 2 driven by economic reasons (low value of catch) and concern over potential negative effects on growth in the Perth metro fishery resulting from the 2011 marine heatwave.
Octopus	Catch Rates (Level 2)	Adequate	50 - 250	208	Acceptable Fishery in developing phase. Target range to be reviewed following completion of current study.
Abrolhos Islands and mid west trawl	Direct Survey & Catch Rates (Level 4)	Inadequate (non - fishing)	95 – 1,830	0	NA The fishery was not opened due to annual survey indicating low scallop abundance resulting from low recruitment due to the extreme environmental conditions of early 2011. The low recruitment has resulted in a very low spawning stock despite no fishing activity.
Cockburn Sound crab	Direct Survey (Level 4)	Adequate	Under Review	46	NA The catch was relatively low due to a large number of sub-legal sized crabs not moulting during summer, potentially due to density dependent growth or resource competition.

OVERVIEW

Fishery/ Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported1- 2011/12 or 2012	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION (continued)					
Estuarine finfish (west coast)	No Assessment	N/A	75 – 220 (Peel-Harvey only)	99	Acceptable Catches of west coast estuarine finfish have been stable since 2000.
West coast beach bait	Catch (Level 1)	Adequate	60 – 275 (whitebait only)	83	Acceptable Annual whitebait catch fluctuates in response to environmental variations.
West coast purse seine	Catch (Level 1)	Adequate	0 – 3,000 (Q)	219 t (scaly mackerel and pilchard combined)	NA Continued low catches compared to pre-2005 due to low fishing effort levels. 2012 catch was highest since 2006.
West coast demersal scalefish	Catch by sector (Level 1) Fishing Mortality (F) (Level 3)	Recovering	< 450 (Demersal Suite)	407	Not Acceptable While the total catch of the demersal suite by all relevant commercial fisheries (West Coast Demersal Scalefish (Interim) Managed Fishery WCDSIM; SouthWest Trawl Managed Fishery SWTMF; Cockburn Sound Line and Pot Fishery CSLPF; West Coast Rock Lobster Managed Fishery WCRLF; Demersal Gillnet and Demersal Longline Fishery DGDLF) was within acceptable levels, the combined rec and commercial catch of snapper in the Mid-west and Kalbarri areas was too high and the combined catch of Baldchin groper in Abrolhos Islands also exceeded acceptable levels.
Shark Bay prawn	Direct Survey/Catch Rate (Level 4)	Adequate	1,501 – 2,330	1,592	Acceptable King and tiger prawn catches were both within their historical target ranges however this range is being reviewed. Both species were within the predicted catch range.

Fishery/ Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported1- 2011/12 or 2012	Catch (or effort) level acceptable and explanation if needed
GASCOYNE COAST BIOREGION					
Exmouth Gulf prawn	Direct Survey/Catch rate (Level 4)	Adequate	771 – 1,276	288	Acceptable The total catch was well below the target range as a result of poor recruitment due to environmental conditions. King prawns were below the target catch range but within the catch prediction.
Shark Bay scallop	Catch Rates and Direct Survey (Level 4)	Inadequate (non - fishing)	1,250 – 3,000	0	NA The fishery was not opened due to very low stock abundance resulting from the low recruitment due to the extreme environmental conditions (marine heatwave and floods) in late 2010/early 2011 in Shark Bay. The two years of low recruitment also means that the spawning stock in 2013 will be well below average despite no fishing.
Shark Bay Crabs	Catch Rates/Size Distributions (Level 3)	Inadequate (non - fishing)	Under development	113 (59 trap; 54 trawl)	NA The marine heat wave and floods over the 2010/11 summer have negatively impacted on the crab stock available for the 2012 season. Due to low stock levels, a voluntary closure commenced in April 2012 for both the trawl and trap sectors.
Shark Bay beach seine and mesh net	Catch Rates (Level 2)	Adequate	235 – 335	188	Acceptable Catch declined to below target range due to large reduction in effort and associated decline in sea mullet catch; catches of other target species were maintained at 2011 levels. Catch rates of species other than sea mullet moderately increased.

OVERVIEW

Fishery/ Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported1- 2011/12 or 2012	Catch (or effort) level acceptable and explanation if needed
GASCOYNE COAST BIOREGION (continued)					
West Coast Deep sea crab	Catch Rate (Level 2)	Adequate	154 (Q) (50,000 - 80,000 potlifts)	139.5 (138.7 crystal crab) (54,301 potlifts)	Acceptable The catch is within the target catch range, with the standardised catch rate of legal crabs is at the highest level in a decade with effort within its target range. Nominal effort estimate at the lower end of the target range.
Gascoyne Demersal Scalefish (Snapper only)	Composite Assessment (Level 5)	Adequate	277 (Q) (380 – 540 days)	235 (362 days) plus 40 recreational catch	Acceptable Spawning biomass is above the threshold level and at the current TACC, is projected to reach the target level by 2014- 15. Catch rate is well above the threshold level.
NORTH COAST BIOREGION					
Onslow prawn	Catch (Level 1)	Adequate	60 – 180	0	NA No fishing occurred in 2012.
Nickol Bay prawn	Catch (Level 1)	Adequate	90 – 300	129	Acceptable Catch of banana prawns were slightly lower than the projected catch range but within the target catch range.
Broome prawn	Catch (Level 1)	Adequate	55 – 260	12	NA The very low level of effort continued because of the cost of fishing, high fuel prices and long distances to steam and low returns.
Kimberley prawn	Catch (Level 1)	Adequate	240 – 500	329	Acceptable The banana prawn catches were slightly above the catch prediction but within the target range.

Fishery/ Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported1- 2011/12 or 2012	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (continued)					
Kimberley gillnet and barramundi	Catch Rates (Level 2)	Adequate	32 – 45 (barramundi)	40	Acceptable The catch of barramundi is within the acceptable range. The acceptable catch ranges need to be reviewed.
Northern demersal scalefish	Catch and Catch Rates/ Integrated Model (Level 2 & 5)	Adequate	Total 600 – 1,000 (goldband < 488) (red emperor < 149)	Total 1,107 (goldband 487) (red emperor 134)	Acceptable Total catch is above the upper limit across the fishery due to an increase in catch in Zone B. Catches of goldband snapper and red emperor were both within the acceptable catch range. Full assessments and review of catch ranges are scheduled over next two years.
Pilbara fish trawl	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	Adequate	2,000 – 2,800	1,312	NA Reduced catch due to reductions in effort since 2009. Full assessment and review of catch range scheduled over the next two years.
Pilbara demersal trap and line	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	Adequate	400 – 600 (trap) 50 – 115 (line)	416 (trap) 86 (line)	Acceptable Both the trap and line catch were within acceptable ranges.
Mackerel	Catch (Level 1)	Adequate	246 – 410 (Q, Spanish Mackerel)	318	Acceptable Catch rates are stable or increasing in all three management areas.
Northern shark	Sandbar shark: Catch (relative to previous direct survey) (Level 3) Blacktip sharks: Catch (Level 1)	Sandbar shark: Recovering Blacktip shark: Acceptable	< 20 (sandbar)	0	NA No fishing effort continued for this year. Sandbar sharks are now considered to be recovering The black tip assessment is based on NT analysis

OVERVIEW

Fishery/ Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported1- 2011/12 or 2012	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (continued)					
Pearl oyster	Catch rate predictions, standardised CPUE (Level 3)	Adequate	754,800 oysters (Q) (14,071 – 20,551 dive hours)	685,888 oysters (15,589 dive hours)	Acceptable Quota this year also included 150,000 large MOP (Mother-of- Pearl) oysters fished under an R&D permit to explore the potential for an MOP fishery.
Beche-de- mer	Catch Rate (Level 2)	Adequate	Sandfish 20 – 100 Redfish 40 - 150	Sandfish 13 Redfish 0	Acceptable No fishing occurred for Redfish in 2012. Sandfish catch below historical range due to low effort (413 hours fished compared to historical average of 2,200)
SOUTH COAST BIOREGION					
South Coast crustacean	No	NA	50 – 80 (southern rock lobster)	51.2 southern rock lobster (21.7 of deep sea crab)	Acceptable The management arrangements, including the acceptable catch range, are currently being reviewed.
Abalone (greenlip/ brownlip)	Standardised Catch Rate/ Fishing Mortality (Level 3)	Adequate	209 (Q) (907 – 1,339 days)	202 (1,438 days)	Acceptable Effort range slightly exceeded due to operational developments in the fishery such as use of 2 divers per day on some vessels and new divers with lower catching efficiency. Effort ranges will be reviewed in 2013.
Estuarine finfish (south coast)	Catch Rates (Level 2)	Adequate	200 – 500	186 (finfish) 14 (crab)	Acceptable Stock levels of key species are considered adequate.
WA salmon	Catch Rates (Level 2)	Adequate	1,200 – 2,800	117	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 needs to be undertaken.

Fishery/ Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2011/12 or 2012	Catch (or effort) level acceptable and explanation if needed
SOUTH COAST BIOREGION (continued)					
Australian herring	Fishing mortality (Level 3)	Inadequate	475 – 1,200 (south coast only)	85	NA Formal stock assessment completed in late 2012. Historically low commercial catch reflects poor recent recruitment and low stock abundance. A review of acceptable catch range is under revision.
Albany/King George Sound purse seine	Catch (Level 1)	Adequate	2,683 (Q)	1,641	Acceptable Higher catch in 2011/12 due to increased effort.
Bremer Bay purse seine	Catch (Level 1)	Adequate	1,500 (Q)	Less than three licences operated	Acceptable Catch levels similar to previous years and acceptable given effort levels.
Esperance purse seine	Catch (Level 1)	Adequate	1,500 (Q)	Three licences operated	Acceptable Catch levels lower than in previous years but acceptable given effort levels.
Southern and West Coast demersal gillnet and longline	Gummy shark - CPUE (relative to previous Level 5 assessment) (Level 2) Dusky shark - CPUE (relative to previous Level 4 assessment) (Level 2) Sandbar shark - CPUE (relative to previous Level 4 assessment) (Level 2) Whiskery shark - Age Structured Model (Level 5)	Gummy and whiskery sharks: Adequate. Dusky and sandbar sharks are likely to now be recovering.	725 – 1,095 (key species only)	720	Acceptable Total catch was slightly below its target range, as were catches of whiskery sharks. Whiskery catches have been maintained below their historical target range due to reductions in effort and the intended effects of the seasonal closure.
NORTHERN INLAND BIOREGION					
Lake Argyle catfish	Catch (Level 1)	Adequate	90 – 155	119	Acceptable Catch is within the acceptable range.

¹ Catch figures supplied for latest year/ season available.

OVERVIEW

OVERVIEW TABLE 2 - EFFECTIVE PROTECTION STATUS OF BENTHIC HABITAT IN WESTERN AUSTRALIAN STATE WATERS

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. This table does not yet include the closures that will be implemented by the Commonwealth in 2014.

Bioregion	Total Area of Shelf (sq nm)	Area of shelf equivalent to IUCN marine protected area ≤Category IV (sq nm) (%)	Maximum area of Actual trawling activity (sq nm)	Total area of habitat effectively protected (%)
West Coast	19600	11000 (56%)	300	19300 (98%)
Gascoyne	15800	5600 (35%)	1100	14700 (93%)
North Coast	98600	40700 (41%)	10500	88100 (89%)
South Coast	31800	-	500	31200 (98%)
TOTAL	165800	57300 (35%)	12400	153300 (92%)

OVERVIEW TABLE 3 - DETECTION OF MARINE PEST SPECIES IN 2012/13 RESULTING FROM SURVEILLANCE AT MAJOR PORTS

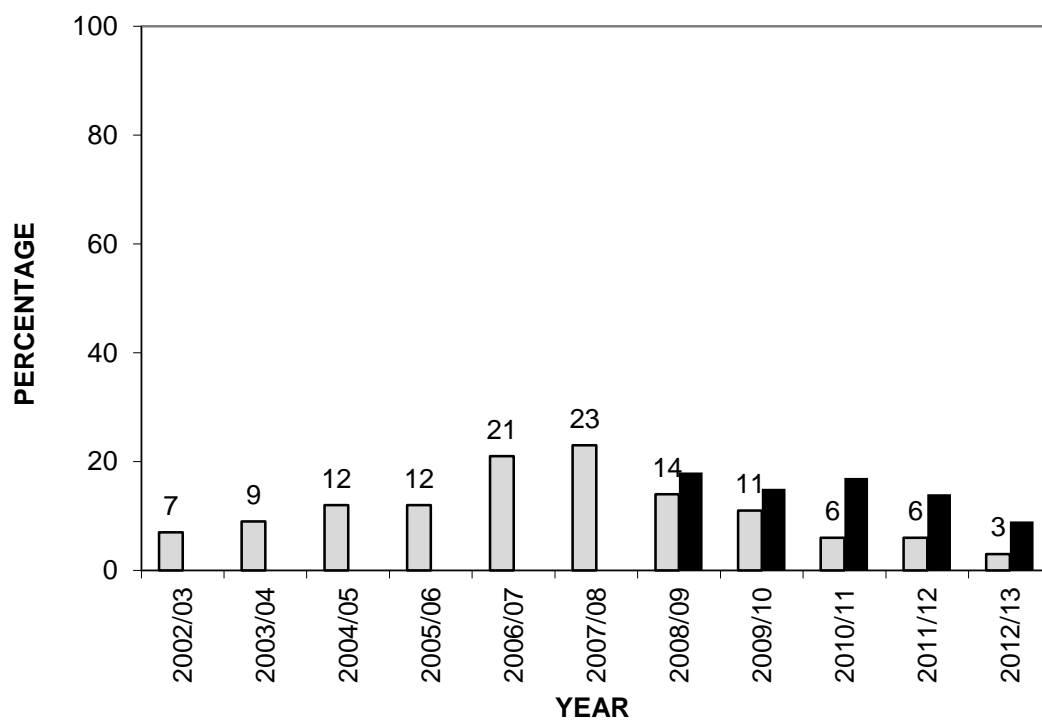
No pest monitoring was conducted in the Gascoyne or South Coast Bioregions in 2012/13.

Bioregion	Common Name	Scientific Name	Type of Organism	Pest status
West Coast	Mediterranean fanworm	<i>Sabella spallanzanii</i>	Polychaete	Pest
	Scallop	<i>Scaechlamys livida</i>	Mollusc	Introduced species
	Aeolid nudibranch	<i>Godiva quadricolor</i>	Mollusc	Introduced species
		<i>Alexandrium catanella</i>	Dinoflagellate	Pest
	Ciona	<i>Ciona intestinalis</i>	Ascidian	Introduced species
	Asian paddle crab	<i>Charybdis japonica</i>	Crab	Pest
	Ivory barnacle	<i>Balanus improvisus</i>	Barnacle	Pest
		<i>Balanus pulchellus</i>	Barnacle	Introduced species
	Asian green mussel	<i>Perna viridis</i>	Mussel	Pest
	Asian date mussel	<i>Musculista senhousia</i>	Mussel	Pest
		<i>Didemnum perlucidum</i>	Ascidian	Introduced species – likely pest
North Coast		<i>Theora fragilis</i>	Mollusc	Introduced species
		<i>Didemnum perlucidum</i>	Ascidian	Introduced species – pest-like characters

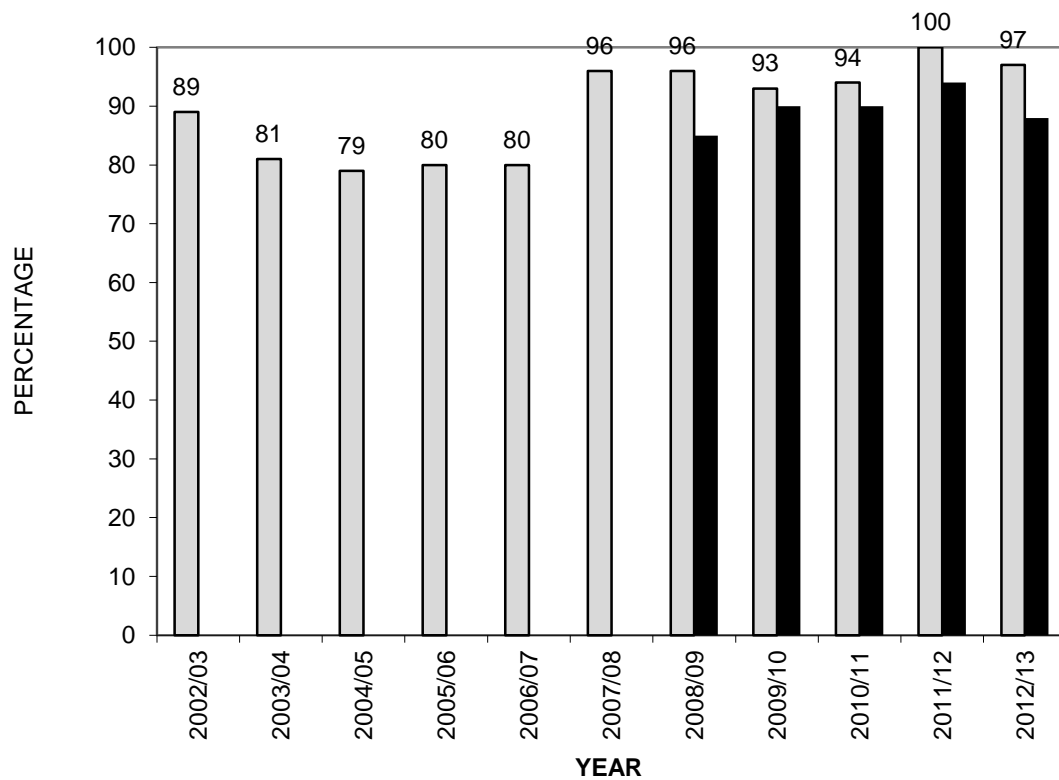
OVERVIEW TABLE 4

The number of significant fishkills investigated in Western Australia since the last SOE report

Year	Number of FishKills
2007	23
2008	36
2009	18
2010	18
2011	29
2012	17

**OVERVIEW FIGURE 1**

The proportion (%) of commercial fisheries where breeding stocks of the major target species are both assessed and considered to be at risk from fishing related impacts. Dark bars indicate target levels.



OVERVIEW FIGURE 2

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

WEST COAST BIOREGION

ABOUT THE BIOREGION

The marine environment of the West Coast Bioregion between Kalbarri and Augusta is predominantly a temperate oceanic zone, but it is heavily influenced by the Leeuwin Current, which transports warm tropical water southward along the edge of the continental shelf. Most of the fish stocks of the region are 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 Coast and even into the South Coast.

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 Midwest Coast, plus behind Rottnest and Garden Islands in the Perth metropolitan area.

The two significant marine embayments in the West Coast are Cockburn Sound and Geographe Bay. 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.

Southward of Cape Naturaliste, the coastline changes from limestone to predominantly granite and becomes more exposed to the influences of the Southern Ocean

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

The principal commercial fishery in this region is the western rock lobster fishery, which is Australia's most valuable single-species wild capture fishery. There are also significant commercial fisheries for other invertebrates including scallops, abalone, blue swimmer crabs and octopus that use trawl, diving and potting methods. Commercial fishers also take a range of offshore 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 very 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 galloprovincialis*) 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. Initiatives to expand the number of aquaculture sectors in this bioregion currently include those for octopus, live rock/coral and finfish.

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 Ngari Capes Marine Park between Cape Leeuwin and Cape Naturaliste; and the Rottnest Island Marine Reserve. (West Coast Ecosystem Management, Figure 2).

The Commonwealth Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has also undertaken a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay. The Commonwealth Minister for the environment has announced the final reserve network for the South-west which spans the West Coast and South Coast Bioregions.

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.

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.

Risk Assessment of Regional Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined in 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.

Summary of Monitoring and Assessment of Ecosystem Assets

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

Ecological risk assessments 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 suitable reference area in deep water was identified and closed to lobster fishing

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

in March 2011 as part of a project funded by the Fisheries Research and Development Corporation (FRDC) and Western Australian Marine Science Institution (WAMSI). Continued monitoring will provide the contrast required to enable the potential impacts of lobster fishing on deep water ecosystems to be quantified. Recent work has concentrated on identifying relationships between lobster size, abundance and key habitats.

Research focusing on the Abrolhos Islands FHPA has been expanded. A holistic research and monitoring program examining key habitats and their associated finfish and invertebrate assemblages is now underway. The Department, independently and through collaborations with other institutes, such as the University of Western Australia, is establishing long term monitoring programs to assess and monitor both key finfish and invertebrates species as well as monitoring shallow water (<30m) coral reef habitats. The establishment of larger scale habitat maps across the shallow water environments (<30m) of the Abrolhos is also being undertaken to provide important baseline information on marine communities. The first detailed habitat map, focussing on the Wallabi Group and funded by the state NRM in 2009/10 is now complete. This biological information is complemented by environmental data loggers, to assist researchers in quantifying the effects of natural (i.e. climate change) and anthropogenic (i.e. fishing activities, tourism, aquaculture) impacts on the habitats and marine communities of the Abrolhos Islands FHPA.

The Department is establishing an ongoing ecosystem monitoring and research program to underpin management of the Ngari Capes Marine Park. The research and monitoring program within the Ngari Capes Marine Park represents one tool (and forms part of the “weight-of-evidence”¹) to assess the effectiveness of the overall management strategies being applied to Western Australia’s fish resources in the wider West Coast Bioregion.

In the West Coast Bioregion, the Department continues to undertake research, and facilitate research by other agencies (e.g. DPaW, CSIRO) and universities (e.g. Curtin, Murdoch and the University of Western Australia), to assess the impacts on fisheries from other anthropogenic activities and environmental processes in order to 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 actively engages with natural resource management groups within the West Coast to promote sustainable use of the aquatic environment. It has implemented emergency-response measures in a number of risk areas, including the development of ‘introduced aquatic organism incursion’ and ‘fish kill incident response’ programs to minimise risks to the marine environment

through the introduction of exotic aquatic pests and diseases.

The Marine Biosecurity Research and Monitoring Group continue to implement a series of biosecurity related projects initially developed in 2010 as well as developing new initiatives during 2012 – 2013. These projects aim to rapidly detect the presence of introduced marine pests (IMPs) using a suite of tools and sampling techniques. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. The Marine Biosecurity Research and Monitoring Group has developed Commonwealth approved marine pest monitoring designs for Geraldton Port and HMAS Stirling and undertaken surveillance at both locations in 2012/2013. A large-scale, nationally approved survey of Fremantle Port was also completed in early 2013. In addition the Marine Biosecurity Research and Monitoring Group, with financial and *in-kind* assistance from Fremantle Port Authority and the Defence Services Group is running an Early Warning System program using *in-situ* settlement arrays to provide a mechanism for the early detection of marine pests in Fremantle Port and HMAS Stirling waters. Other biosecurity activities include surveillance for the invasive Asian paddle crab *Charybdis japonica* detected in 2012 by members of the public in the Swan River estuary. Since detection, the Marine Biosecurity Research and Monitoring Group have conducted extensive trap-based and diver surveillance of the target area in the lower reaches of the estuary. To date no further specimens of *C. japonica* have been detected by either the Department or the general public.

A project that was supported by WAMSI 4.4, developed a bycatch risk assessment method to rapidly assess the cumulative risk to sustainability of multiple fisheries². The Ranked Risk Assessment of Multiple Fisheries (RRAMF) allowed 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 endangered, threatened and protected species (ETPS). The RRAMF analyses reveal all bycatch species received low to moderate risk scores in these bioregions. The RRAMF for the ETPS 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 byproduct and target species catches.

1 Wise, B. S., J. St John, and R. C. Lenanton. 2007. Spatial scales of exploitation among populations of demersal scalefish: implications for management. Part 1: Stock status of the key indicator species for the demersal scalefish fishery in the West Coast Bioregion. Final report to Fisheries Research and Development Corporation on Project No. 2003/052. Department of Fisheries, Western Australia, Perth.

2 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.

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%)

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. The first significant bleaching of corals was observed during the marine heat wave event along the Western Australian coast in 2011 (Abdo <i>et al</i> 2012) ¹ , with the impact of this event being monitored as part of an ongoing monitoring program run by the Department. The program also includes monitoring of key invertebrate species, and the community structure of finfish 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 found no evidence of systematic changes that could be evidence of an unacceptable impact on this ecosystem (Hall and Wise, 2011) ² . Continued monitoring of a deep water closed area will aim to quantify potential ecosystem impacts of lobster fishing in these deeper water ecosystems.
	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 to a lesser extent Cockburn Sound are of particular concern.

1 Abdo, D.A., Bellchambers, L.M., Evans, S.N. (2012) Turning up the Heat: Increasing Temperature and Coral Bleaching at the High Latitude Coral Reefs of the Houtman Abrolhos Islands. PLoS ONE 7(8): e43878.

2 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. 112 pp.

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Leeuwin Naturaliste	Marine	LOW	The impacts from fishing and other sources on the marine communities are relatively low in this region. In collaboration with the Department of Parks and Wildlife (DPAW), the Department has established a EBFM stepwise, risk-based research and monitoring program within the Ngari Capes Marine Park. This represents one tool used by the Department to assess the effectiveness of its overall management strategies in the management of the fish resources within the wider West Coast Bioregion.
	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. An updated assessment is planned for 2013.
	Offshore demersal (>250m depth)	LOW	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 have now recovered and the fishery has re-opened. Research on the other stocks of crabs in this region (e.g. Peel/Harvey) has been completed and the stocks are all considered to be in an adequate state and fishing levels are acceptable.
	Shelf (Lobsters)	MODERATE	The stock levels of western rock lobster and prawns are both currently at appropriate levels. The strong management that was applied to the rock lobster fishery has ensured that the lobster spawning stock is currently at record high levels despite on-going relatively low puerulus recruitment over the past 6 seasons.
Molluscs	Nearshore	MODERATE	The stocks of abalone are conservatively managed with strong management controls on both commercial and recreational fishers but the heat wave in 2010/11 caused the almost total loss of Roes abalone in the Kalbarri region. Scallops are managed to acceptable levels using an input controlled system and a 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 (Fletcher et al., 2012¹).

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	MODERATE	Sea lion exclusion devices have now been implemented for rock lobster pots near sea lion breeding islands which has reduced the risk to low levels. The reduction in fishing effort for lobsters had considerably reduced potential entanglement of whales but the extension of the season post June has required a re-assessment of this risk due to increased entanglements in the winter season.
Protected 'Fish' Species	Fish	LOW	Blue groper (Rottnest Island), cobbler (Swan Canning) and white sharks are within this category and are already unable to be landed by commercial or recreational fishers.

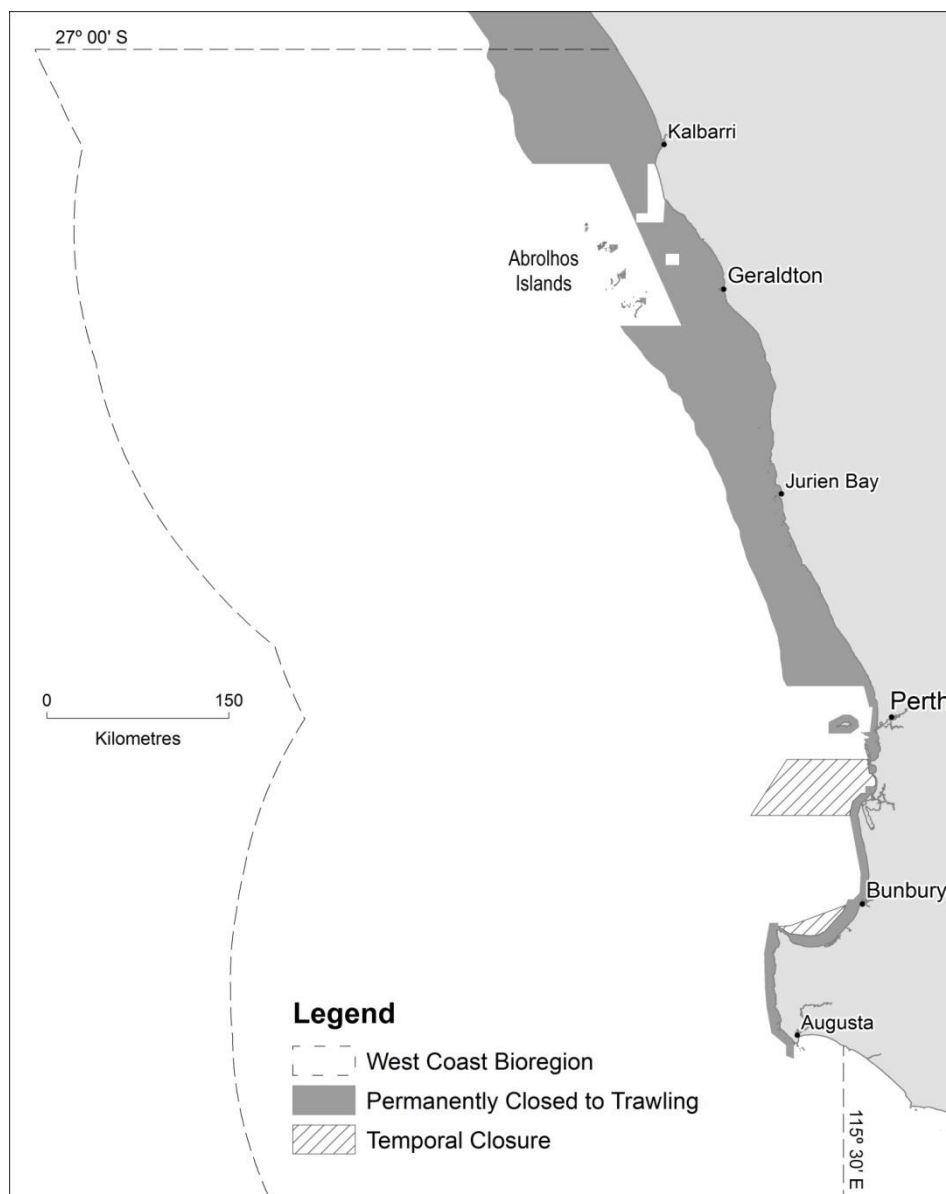
Benthic habitat: Details on the analyses for these scores are located in West Coast Ecosystem Management Table 1 above and in the individual fishery reports.

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 is 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. Reduced levels of pot fishing effort in this area are likely to have reduced the risk and this should be reviewed.
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 Fletcher, W.J., Gaughan, D.J., Shaw, J. and S.J. Metcalf (2012) Ecosystem Based Fisheries Management: Case Study Report West Coast Bioregion. *Fisheries Research Report No. 212, Department of Fisheries, Western Australia* 104 pp.

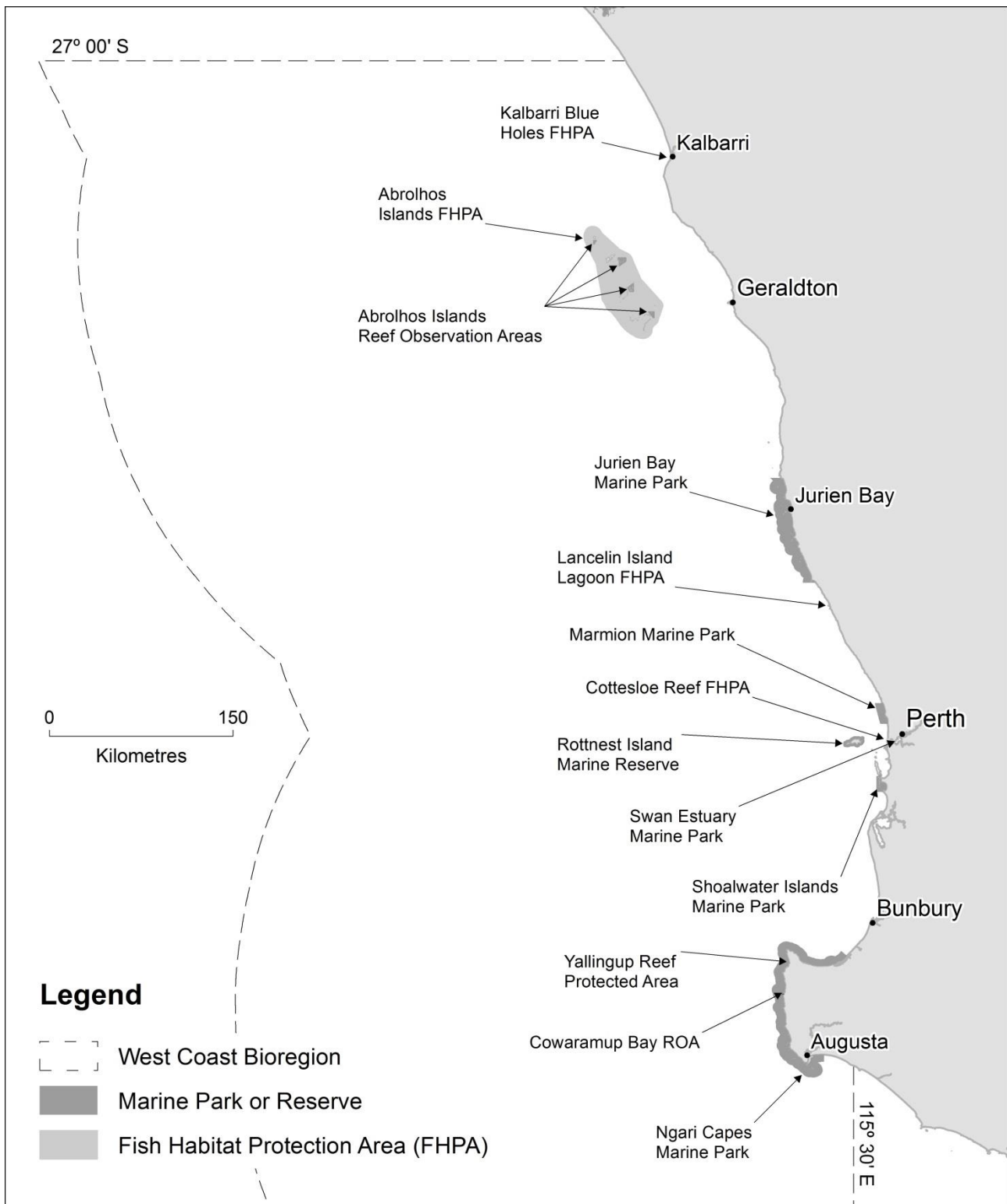
External Drivers: Details on some of the analyses used for these scores are located in the individual fishery reports plus there were whole of region assessments completed in the draft West Coast EBFM report.

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	MODERATE in short term	Port monitoring plans have been implemented targeting high risk port locations. These designs have been developed in line with the National System for introduced marine pest monitoring. The extent and findings of monitoring activities in this bioregion are detailed in the Introduced Pests Status Report at the end of this chapter.
	HIGH in medium term	
Climate	MODERATE in short 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.
	HIGH in medium term	



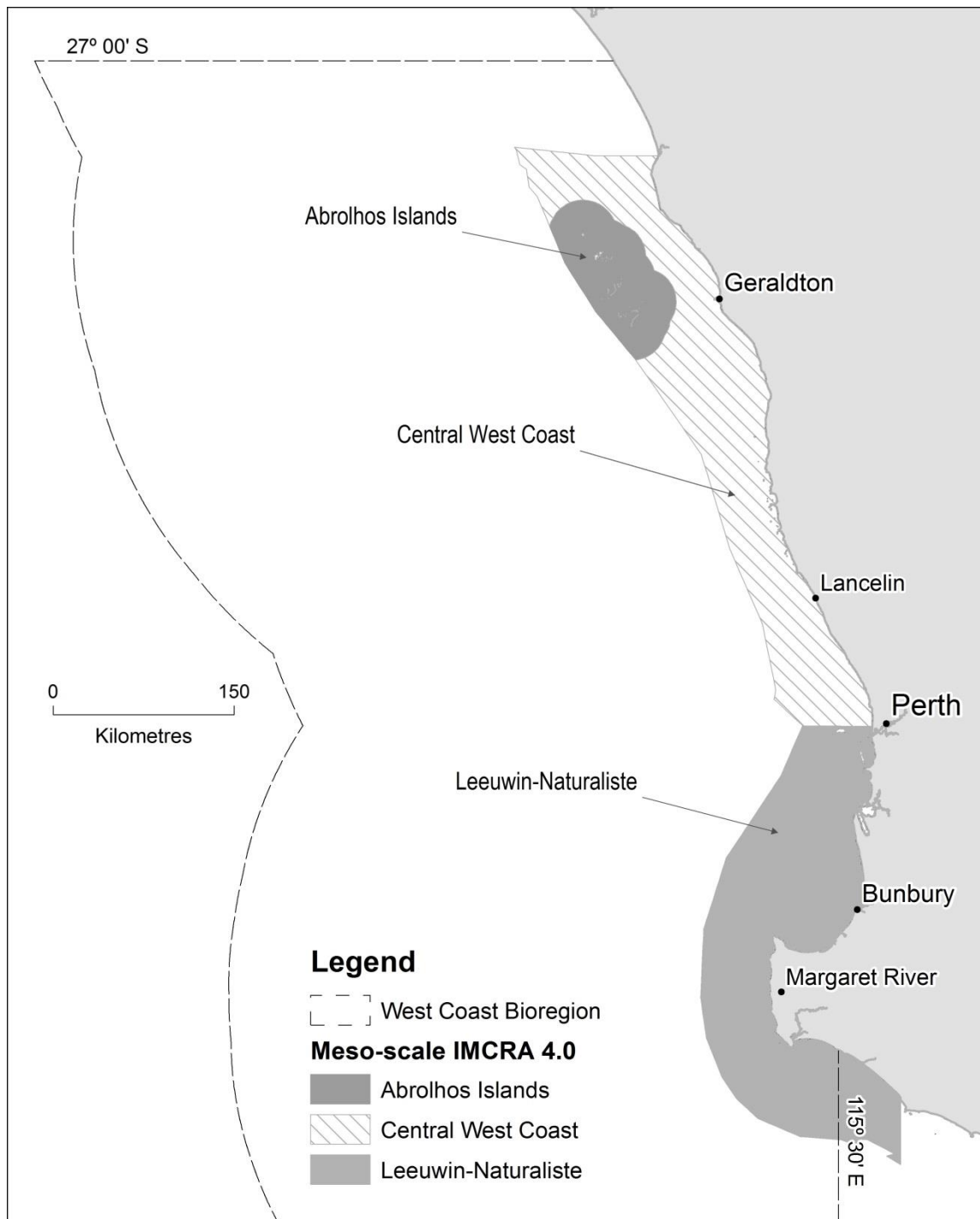
WEST COAST ECOSYSTEM MANAGEMENT FIGURE 1

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

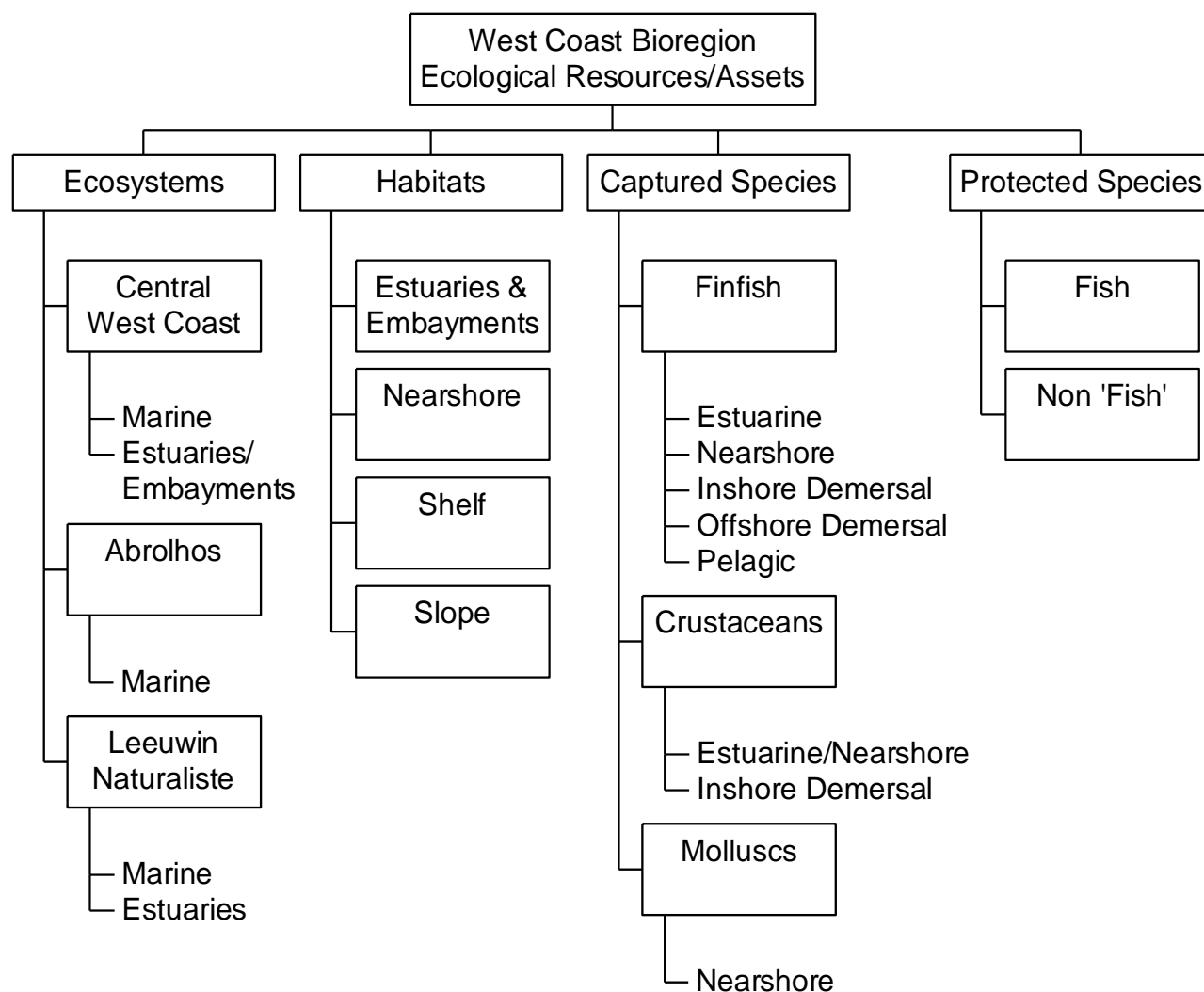
Map showing current and proposed formal marine protected areas in the West Coast Bioregion various areas of which are either consistent with IUCN categories I, II, III, IV or V.



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.

Introduced Pests Status Report

Regional Monitoring and Research Update

The introduction and spread of marine pests in WA waters poses a serious threat to native biodiversity and can have widespread effects on both our economy and health. To this end the Marine Biosecurity Research and Monitoring (MBRM) group are actively involved in developing and implementing targeted marine pest monitoring and research programs in two ports in the West Coast Bioregion. The aim is to detect the presence of introduced marine pests (IMPs) using a suite of tools. Early detection of IMPs is vital if any attempt at eradication or other management strategies is to be successful. In support of this objective, the MBRM group has implemented a biennial IMP surveillance program which adheres to the Australian Marine Pest Monitoring Guidelines and is endorsed by the Commonwealth. As part of this program, the group has conducted approved large-scale marine pest monitoring programs in Fremantle Port (2011 and 2013) and in Geraldton Port (2013). To complement

these surveys, the MBRM group has developed targeted supplementary monitoring designs to be completed in the intervening years at selected ports. A supplementary survey was completed in Fremantle in 2012 and is planned again for early 2014.

In addition, the Marine Biosecurity Research and Monitoring group, with financial and in-kind assistance from Fremantle Port Authority and the Defence Services Group is running an Early Warning System program using *in-situ* sampling equipment to provide a mechanism for the potential early detection of marine pests in Fremantle Port and HMAS Stirling waters.

Through this combined surveillance the introduced marine pest species that have been detected in this bioregion are reported in Introduced Pests Table 1.

The Marine Biosecurity Research and Monitoring group are

currently conducting five main research projects in the West Coast Bioregion as follows:

- Assessment of the likelihood of a marine pest being introduced into the ports of this bioregion;
- Determination of the efficacy of wrapping a recreational vessel hull to eliminate/kill biofouling on the wet areas of the hull;
- Quantification of the risk associated with recreational vessels for the introduction and translocation of marine pests along our coast;
- Evaluation of the efficacy of new sampling methods

(crab condos) to sample for non-aggressive pest crab species – this project is now completed and has been published in a peer reviewed journal and recommendations for its inclusion into the National System methodologies are being forwarded to the Commonwealth; and

- Determination of the growth, physiology, reproductive strategies, response to stress and impacts of the invasive ascidian *Didemnum perlucidum*.

While conducted in this bioregion, the research outputs are designed to be applicable to biosecurity management across the state.

INTRODUCED PESTS TABLE 1

Introduced marine species detected during MBRM activities in this bioregion.

Common name	Scientific name	Type of organism	IMS/IMP listing
Mediterranean fanworm	<i>Sabella spallanzanii</i>	Polychaete	Pest
Scallop	<i>Scaechlamys livida</i>	Mollusc	Introduced species
Aeolid nudibranch	<i>Godiva quadricolor</i>	Mollusc	Introduced species
	<i>Alexandrium catanella</i>	Dinoflagellate	Pest
Ciona	<i>Ciona intestinalis</i>	Ascidian	Introduced species
	<i>Didemnum perlucidum</i>	Ascidian	Introduced species – likely pest
Asian paddle crab	<i>Charybdis japonica</i>	Crab	Pest
Ivory barnacle	<i>Balanus improvisus</i>	Barnacle	Pest
	<i>Balanus pulchellus</i>	Barnacle	Introduced species
Asian green mussel	<i>Perna viridis</i>	Mussel	Pest
Asian date mussel	<i>Arcuata senhousia</i>	Mussel	Pest

FISHERIES

West Coast Rock Lobster Fishery Status Report

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

Main Features

Status		Current Landings (Season 2011/13)	
Stock level	Adequate	Commercial catch	6647 t
Fishing Level	Acceptable	Recreational catch (2011/12)	118 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 utilised a sophisticated Individual Transferrable Effort based system for over 20 years. In 2010/11, the fishery began the transition to quota management with a nominal Total Allowable Commercial Catch (TACC). In 2012/13 the fishery moved to an Individually Transferable Quota (ITQ) fishery. With annual production historically averaging about 11,000 t this has been Australia's most valuable single species wild capture fishery and was the first fishery in the world to achieve Marine Stewardship Council (MSC) certification. In early 2012 the fishery was re-certified by MSC for the third time.

Recreational

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

Governing legislation/fishing authority

Commercial

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995

West Coast Rock Lobster Management Plan 1993

West Coast Rock Lobster Managed Fishery Management Plan 2012

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

Fish Resources Management Regulations 1995

Recreational Fishing Licence

Other subsidiary legislation

Consultation processes

Commercial

The Department undertakes consultation with the Western Rock Lobster Council (WRLC) on operational issues. The WRLC is also the body that must be consulted prior to amending or revoking the management plan for the fishery. Industry Annual Management Meetings are convened by the Western Australian Fishing Industry Council (WAFIC) under a Service Level Agreement (SLA) with the Department. Also under this SLA, Statutory consultation with the WRLC is also undertaken by WAFIC under the SLA.

Recreational

Recfishwest

Boundaries

Commercial

The fishery is situated along the west coast of Australia between Latitudes 21°44' to 34°24' S. The fishery is managed in three zones: Zone A – Abrolhos Islands, north of latitude 30° S excluding the Abrolhos Islands (Zone B) and south of latitude 30° S (Zone C).

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 2011/13 Season

Commercial

The WCRLF is divided into three zones. Historically, this has enabled effort to be distributed across the entire fishery (to prevent concentration of effort and exploitation in localised areas) and has also permitted the implementation of management controls which addressed zone-specific issues.

In 2011/2013, management for the fishery continued the transition toward the implementation of a full ITQ based management system. One element of the transition to a full quota management system was to change the licensing period from 1 October to 30 September (historically fishing between 15 November and 30 June) to a licencing period commencing on 15 January and concluding on 14 January the following

year. The change to the licensing period from October/September to January/January was made to allow fishers to commence their “quota season” just prior to the Chinese New Year, which has previously been a period of very high market demand and correspondingly high beach prices. It was expected that fishers would concentrate their fishing effort during the higher value “reds” part of the season and finish fishing during the highly catchable but lower value “whites” part of the season in November/December.

To achieve this, the 2011/2013 fishing season was extended, permitting fishing in Zones B and C of the fishery from 15 November 2011 to 30 September 2012 and from 15 November 2012 to 14 January 2013. Zone A of the fishery remained open between 15 March and 30 September. To reflect the extended fishing season, the TACC for the 2011/2013 season was set at 6,938 tonnes. This TACC takes into account the previously approved TACC of 5,500 tonnes for the 2011/12 season, plus an additional 1,438 tonnes for the period between 15 November 2012 and 14 January 2013.

Biological controls for the fishery remained in place for the 2011/13 season with restrictions on size limits and protection of females in breeding condition; i.e. in tarspot, berried or setose condition.

Further management arrangements for the 2011/13 season were as follows:

- TACC of 6,938 tonnes
- Individual catch limits with the following number of kilograms per unit:
 - Zone A (from 15 November 2011 – 14 March 2012 and 1 July 2012 – 14 January 2013 noting closure from 1 October – 14 November) 52 kg in the waters of Zone B.
 - Zone A – 48 kg from 15 March 2012 to 30 September 2012 (fishing in Zone A waters)
 - Zone B – 96 kg for entire season
 - Zone C – 102 kg for entire season
- Fishing permitted in Zones B and C of the fishery from 15 November 2011 to 30 September 2012 and from 15 November 2012 to 14 January 2013
- Zone A licence holders permitted to re-enter Zone B after 30 June 2012, but not permitted to return to the Abrolhos Islands once fishing has recommenced in Zone B.
- Big bank to remain closed
- Catch and disposal records (CDR) books simplified, with new books issued for the 2011/13 season. Ongoing use of crate tags, authorised receivers, holding over books, and catch weighing procedures (including the use of landing areas) to monitor fishers’ catch.
- Minimum unit holding required to operate in the fishery reduced from 63 to 60 units of usual and current entitlement.

The use of the Department’s Interactive Voice Response (IVR) catch monitoring system became mandatory from the 15 November 2011. IVR records pre fishing, pre landing and post landing (including the landed catch) nominations which assist in maintaining the compliance integrity of the quota system.

The new management arrangements for the 2011/2013 season were designed to provide western rock lobster fishers with increased flexibility in their fishing operations, as well as to provide the opportunity to maximise the prices they receive for their product by fishing during periods where the market price for lobsters is high.

Recreational

The recreational component of the western rock lobster fishery is managed under fisheries regulations and other subsidiary legislation. A combination of input and output controls are used to ensure that the recreational sector enjoys the amenity of its access to the rock lobster resource, while fishing to their 5% allocated share (western rock lobster). In order to assist the recreational sector attain their full allocation the minimum size for western rock lobster was reduced from 77 to 76mm.

Recreational input controls include:

- Maximum of two pots per licence holder (no limit on total number of licences)
- Pots must meet specific size requirements and have gaps to allow under-size rock lobsters to escape
- Divers can only catch by hand, snare or blunt crook to prevent lobster damage
- Fishing for rock lobsters at the Abrolhos Islands is restricted to potting
- The season runs from 15 November to 30 June each year on the coast, with a shorter season (15 March to 30 June) at the Abrolhos Islands
- Night-time fishing for lobsters by either diving or potting is prohibited
- Minimum size reduced from 77 to 76mm
- Regulations relating the protection of breeding females and the maximum size of females that can be taken are the same as those for commercial fishers

Output controls in 2011/13 were unchanged, allowing a bag limit of six lobsters per person per day, a boat limit of 12 lobsters and a possession limit of 24 lobsters. There is also a requirement for recreationally-caught lobsters to be tail-clipped in order to stop these animals from being sold illegally as part of ‘shamateur’ activity. Within the recreational fishery between North-West Cape and Cape Leeuwin the requirement remains in place for pots to be equipped with escape gaps with a minimum height of 55mm and minimum width of 305mm.

Integrated Fisheries Management

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

Because of the extended commercial season in 2011/13 the comparison with recreational catch was based on November to June only which equated to 2.5 %, the same as the previous year.

Research summary

Research activities focus on assessing stock sustainability, forecasting future recruitment 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 voluntary logbook information, and a commercial monitoring program, all of which are used for modelling and stock assessment.

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

The latest ecosystem-based Fisheries Research and Development Corporation (FRDC) funded project aims to examine the effects of western rock lobster fishing on the deep-water ecosystem off the west coast of Western Australia. This was started in 2009, using a comparison between fished and unfished deep water areas. A report from this project is due in 2013.

Another project examining lobster populations in 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 five years after the no-take regions were implemented have shown a slight 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.

Concern about the status of the breeding stock in the Big Bank region resulted in this area being closed to lobster fishing. Additional independent breeding stock survey sites have been sampled in this area since 2009 to generate baseline information to assess the effects of this closure.

The fishery has experienced below average puerulus settlement for a number of years, with a record low settlement being recorded in 2008/09. A risk assessment workshop to examine the low puerulus settlement was held in April 2009 and a report on this workshop can be found on the Department's website (<http://www.fish.wa.gov.au/docs/op/op071/fop71.pdf>).

A significant amount of research has been focused on the cause of these low settlement levels in recent years. Six projects have been developed and funded by the Fisheries Research and Development Corporation (FRDC):

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.

These projects have added to the current knowledge of western rock lobster larvae and settlement and the relationships these have with the environment. The FRDC Project 1 above (in collaboration with CSIRO) identified earlier lobster spawning (from warmer waters) and reduced winter storms as two key factors that may be associated with this trend in lower settlement.

A project to assess the economic performance of the fishery has been funded by the Seafood CRC. This project is examining maximum economic yield assessment, in light of the recent move towards a quota management system, and ways to incorporate the economic assessment into the outputs generated by 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 some years. Estimates of recreational catch using this method have been compared to the estimates from mail surveys. Phone diary surveys are considered to be more accurate than those from mail surveys because they reduce the recall bias in the annual mail surveys and have a higher participation rate. Sample sizes for the phone diary surveys were increased after the 2006/07 survey to improve the accuracy of the estimates.

Retained Species

Commercial landings (season 2011/13):

6647 tonnes

Lobsters: Trends in the annual catches from the West Coast Rock Lobster Managed Fishery are shown in West Coast Rock Lobster Figure 1. Due to the extended season length (14 months) incorporated to allow future seasons to change their start date from the traditional start of 15 November to 15 January, the catch landed by the WCRLF over this extended season of 2011/13 (6647 t) was higher than in 2010/11 (5501 t). In 2011/13 catches in A, B and C Zones were 894, 2397 and 3356 t, respectively with Zone A 5.9% lower, Zone B 27.8% higher and Zone C 25.4% higher than the previous season. The catch taken represented about 96% of the Total Allowable Commercial Catch of 6938 t.

Octopus: Octopus are also caught in rock lobster pots within shallow water (<40 m). The catch rate of 0.02 octopus per pot lift recorded in 2011/13 from the new Catch and Disposal Records (CDR) data was within the historical range of 0.02 – 0.045 per pot lift (1985/86 to 2009/10) previously based on logbook data which represented both retained and returned octopus. The catch levels reported in CDRs only represent the octopus retained but given the value of octopus has increased in recent years, anecdotal evidence indicates that most octopus are now retained.

The catch rate of octopus (incidental landings) is an indicator for this fishery, and at 0.02 octopus per pot lift achieved the performance measure of being within 10% of the historical range \pm 10% (0.020–0.043 octopus per pot lift).

Recreational catch estimate (season 2011/12):

118 tonnes

Since the 1986/87 season, a mail survey has been used to estimate the total catch of the recreational sector. At the end of each fishing season, approximately 10% of people licenced to fish recreationally for rock lobster have been randomly sent a survey asking about their retained catch and level of effort for the season just completed. Typically, 40 – 60% of these surveys have been returned. It is well recognised that this survey method suffers from a recall bias (the inability of people to remember exact details of what fishing they may have completed as long as 7.5 months prior) and due to not all survey recipients returning the survey, a non-response bias (the possibility of non-respondents having different fishing behaviour and success than respondents). To reduce the impact of these biases on mail survey estimates of catch and effort, a phone-diary survey - considered to be less biased (Baharthah, 2007)¹ - has also been run for a number of seasons. Comparison of the two surveys has identified correction factors to standardise the catch rate and effort estimates from the far cheaper mail survey, to that of the phone-diary survey, compared to previous years where only the presented total catch estimate was adjusted.

The recreational catch of western rock lobster for 2011/12 was estimated at 118 t based on the adjusted mail survey, with 79 t taken by potting and 39 t by diving. This represents close to 2.5% of the total catch of lobsters taken during the period 15 November – 30 June, the period when the recreational fishing season is open.

Comparative catch estimates for this period during 2010/11 were 129 t, with 85 t by potting and 44 t by diving. The estimated recreational catch in 2011/12 was therefore 9% below the 2010/11 catch estimate. This is consistent with the forecast of a lower recreational catch in 2011/12 due to low puerulus settlement four years previously.

Fishing effort/access level

Commercial

In 2011/13 the numbers of vessels fishing for lobster were 74 in Zone A, 67 in Zone B and 132 in Zone C. Thus, in comparison to the 279 active boats in 2010/11, a fleet of 273 vessels fished in 2011/13, which was a reduction of 2%.

Under the new management arrangements (TACC), the maximum number of pots allowed to be used to catch rock lobsters is based on 50% of a vessel's unit entitlement. In 2011/13, the fishery recorded 3,602,555 potlifts a 52%

increase on the previous season's potlifts of 2,376,794. This increase at least partly reflects the increased season length but it also reflects the changing behaviour of fishers as they adapt to the new management arrangements that allow fishing in lower catch rate periods when the beach price is higher.

Recreational

A total of 37,335 licenses were sold that permitted fishing for lobsters during some part of the 2011/12 season with an estimated 13,110 (35%) utilised for lobster fishing. 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 2011/12 was 6% lower than the number of active licences in 2010/11 (14,000).

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 15 and 6 days, respectively during the 2011/12 fishing season. These rates were similar in the 2010/11 fishing season. Finally, the average catch taken by active pot and diving fishers were 19 and 13 lobsters, respectively during the 2011/12 fishing season. In the 2010/11 season the average numbers of lobsters caught by pot and dive fishers were similar at 20 and 13, respectively.

Stock Assessment

Assessment complete: Yes

Assessment method:

Size-structured population model

Breeding stock levels: Adequate

Targeted commercial catch next season

(2013/14): 5554 tonnes TACC²

IFM allocated maximum recreational catch next season (2012/13): 322 tonnes

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

Indices of egg production are the main indicators for assessing the health of the lobster stock. Prior to 2008/09 these were empirically-based measures presented as the north and south coast fishery-dependent breeding stock indices based on commercial monitoring data and the fishery-independent breeding stock survey (IBSS) indices. Since 2008/09 the development of a fully integrated stock-assessment model that incorporates these data sources along with other information has enabled more robust and spatially comprehensive estimates of egg production to be generated. These model-based indices are now used for assessing the health of this stock and their continued use was a key recommendation from the stock assessment review of the fishery completed in May 2010.

¹ Baharthah, T. 2007. Comparison of three survey methods applied to the recreational rock lobster fishery of Western Australia. Master of Science Thesis. School of Engineering and Mathematics. Edith Cowan University, Western Australia.

² Note this TACC covers a 12 month season.

The current focus for stock assessment is to determine what effects the current years of low puerulus settlements will have on future catches and breeding stock levels and to assess the effects of different management measures in mitigating any negative impacts.

The management arrangements implemented in recent years include reductions in the pot usage rate, increases in maximum size limit for females, the closure of Big Bank and use of a TACC, are designed to ensure that the overall breeding stock is above, and is projected to remain above, the threshold levels based on the early to mid 1980s with a probability greater than 75% (West Coast Rock Lobster Figures 2, 3 and 4). These model-estimates of breeding stock are supported by fishery-independent surveys that have been undertaken since the early 1990s and show that the breeding stock has been at record-high levels in the last two years.

A performance measure for the fishery is that the egg production index for three breeding stock management areas 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 secondary assessment measure is the catch per unit of effort (CPUE) achieved annually by the commercial fishery (West Coast Rock Lobster Figure 1). With the change in management from input (effort controlled), to output (TACC) based on individual catch limits in 2011/13, commercial fishing behaviour has changed dramatically. Under effort controls, fishers were driven to utilise and maximise (through improved behaviour) all available effort to maximise their catches. Under a TACC fishery, fishers are driven to maximise profits through catching the most valuable grades of lobsters during the most profitable periods of the season, while using as little effort as possible. This has resulted in an increase in pot soak times and a move to fishing more in lower catch rate periods when beach prices are generally at their highest. This impacts the relativity of commercial catch rates between the pre and post TACC phases of the fishery, therefore these two periods cannot be compared directly.

Commercial

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

Typically short-term fluctuations in abundance resulting from the cyclical nature of puerulus settlement were reflected in the legal-sized lobster abundance (CPUE) 3 to 4 years later. The increase in CPUE to 1.68 kg/pot lift (around 52% higher than the previous year) for the 2008/09 fishing season, however, relates more to the significant reduction in effort levels during that season. The low TACC set for the subsequent two fishing seasons (2009/10 and 2010/11) of 5500 t, about half the long-term average annual landing of 11

000 t successfully maintained high levels of legal biomass and high catch rates in these two seasons. It should be noted that the catch rate does not directly reflect the overall abundance of lobsters, because legal catches do not include the large biomass of under-size animals and breeding females, which are both fully protected. Currently catch rates within the fishery are close to record highs, well above the historical long term levels in each zone.

Recreational

The average recreational pot and diving diary-adjusted catch rates were 1.2 and 2.3 lobsters per person per fishing day in the 2011/12 fishing season. These catch rates are similar to the 1.3 lobsters for potting and 2.1 lobsters for diving calculated for the 2010/11 fishing.

Juvenile Recruitment and Recruitment 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. Investigations into additional factors that may be affecting these levels have been underway since the record lows occurred in in 2008 (see Research Summary above).

The annual indices of puerulus settlement for 2012/13 were similar to 2011/12 and while still at relatively low levels compared to historical averages at nearly all sampling sites they represent significant improvements compared with the previous four seasons (West Coast Rock Lobster Figure 5). The 2012/13 settlement will mainly affect catches during the 2016/17 fishing season.

Non-Retained Species

Bycatch species impact:

Low

Commercial western rock lobster fishers were not allowed to retain finfish bycatch during the 2011/13 fishing season.

Protected species interaction: **Sealions (Low)**

Whale Entanglements (Moderate)

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). SLEDs have also been required to be fitted to all pots fishing in areas less than 20 m in depth around the Easter and Pelsaert Groups in the Abrolhos Islands since 15 March 2011. Video trials have indicated that this device is successful in stopping sea lion pups from entering lobster pots and potentially drowning.

Approved SLED designs include an internal rigid structure,

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

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

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

The performance measure for this fishery is that no increase in the rate of capture of sea lions occurs. During the 2011/13 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. Given the significant reductions in effort and hence pot ropes in the water since this assessment was completed, the current risk is probably now even lower.

The performance measure for the fishery is that there is no increase in interactions with turtles. In 2011/13, 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 were occasional reports of a whale becoming entangled with pot ropes. The humpback whale is the predominant species that interacts with the WCRLF, during both its northward migration to the North West Shelf breeding grounds in June to August and then during its subsequent southward migration in October/November. Owing to the fishery's historical closed season, there was a limited period for interaction. The combination of an increasing population of whales and the extension of the fishing season to 10.5 months in 2012 and 12 months in 2013, interactions have increased to 13 in 2011/13.

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 WRLC 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 Commonwealth government expressed concern about the increase in whale entanglements in 2011/13 and has placed a number of conditions relating to mitigating the risk of entanglements on the fishery's current

export approval (Wildlife Trade Operation). Research is currently underway to examine ways to reduce the number of entanglements of whales with lobster gear.

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 (1989–2009), commercial lobster fishing has resulted in zero to four whale/dolphin interactions per season. Thirteen whale entanglements with lobster gear were recorded during the 2011/13 lobster season. The fishery has therefore not achieved this performance indicator.

Ecosystem Effects

Food chain effects:

Low

Overall, the fishery has previously been found to be unlikely to cause any significant trophic ('food web') cascade effects within shallow waters, 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. A rock lobster-specific ecological risk assessment completed in 2013 considered that, using the data generated from the considerable additional research that has been conducted on this issue over the past six years, the removal of lobster in deep-water regions are unlikely to be having a significant impact on the surrounding ecosystem. This forum subsequently classed this as a low risk.

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 Islands. 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 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 \$241 million. Employment is seasonal, the fishing season covering ten and a half months from 15 November 2011 to 30 September 2012 and open again 15 November 2012 until 14 January 2013.

A total of 273 vessels and approximately 764 people were

WEST COAST BIOREGION

engaged directly in fishing for rock lobsters in 2011/13. 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 20,000 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 2011/13: \$241 million

The price that commercial fishers received for the western rock lobster in 2011/13 was an estimated average of \$36.33/kg in all zones of the fishery. This was 3.1% increase on the \$35.20/kg paid in 2010/11, with the increase due partly to fishers only landing catch when the advertised beach price was high. The overall value of the fishery increased from the previous season's value of \$194 million as a result of more product being caught due to increased season length and because of the higher price paid by overseas buyers.

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

Fishery Governance

Commercial

Current Fishing (or Effort) Level: Acceptable

Commercial catch target (2013): 5554 tonnes

Between 1975/76 and 2011/13 commercial catches averaged 10,092 t including 14,523 t in 1999/2000. More recently, (post 2008/09) the annual catch levels have been based on much lower levels (down to 5,500 t). These 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 and poor settlement in 2009/10 followed a series of already low recruitment levels. This resulted in a series of catch limits for this period being imposed to generate a carry-over of legal biomass rather than continuing the historical strategy of catching a similar proportion of the available stock each year to ensure sufficient catch rate and breeding stock was available in what would have otherwise 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 where a catch limit of 5,500 tonnes +/- 10% was introduced with effort levels being adjusted throughout the season to maintain the catch within this limit.

A different strategy was adopted from the 2010/11 season as the fishery began the transition to quota. A total catch limit of 5,500 tonnes applied for the fishery with this being allocated to individual licensees. The 2011/13 season was a 14 month season therefore the catch target (TACC) was increased in

proportion to what previously would have been taken at the start of following season (less 25%). The 2013 season represents the first season when industry, through the Western Rock Lobster Council, was provided with a range of biologically acceptable TACCs, which also represented a level of fishing similar to that which took into account the assessment of maximum economic yield. From this range, the WRLC was able to recommend their preferred TACC.

Recreational

Current Fishing (or Effort) Level Acceptable

Target recreational catch limit (2011/12):

290 tonnes

Between 1986/87 and 2010/11 recreational catches have varied between 98 t in 1987/88 to 360 t in 2002/03. Variation of these catches results primarily from variable levels of recruitment, which are driven by the environmental conditions as described above. From 2009/10 onwards the commercial and recreational sectors have been managed under the principles of Integrated Fisheries management (IFM), which allocates the commercial and recreational sectors 95 and 5% of the total catch, respectively. Under this arrangement the recreational catch limit for 2011/12 based on a commercial catch of 5500 t was 290 t.

The recreational catch estimate for the 2011/12 season was 118 ± 10 t (95% confidence interval of the mean) which was well below their limit catch of 290 t.

New management initiatives (2012/13)

In the final transition to a full ITQ management system, a new management plan, the West Coast Rock Lobster Managed Fishery Management Plan 2012, will be drafted and come into effect on 15 January 2013. This new management plan will result in significant changes to licenses, fishing periods and catch reporting arrangements with a view to providing industry with a more flexible management system to allow fishers to focus on maximising their profitability. Some of the expected changes include:

- 12 month fishing season for all zones
- Grant of discrete Zone B units to Zone A fishers, representing their historical take of lobster from Zone B
- Allowance for the implementation of Fish Eye; an electronic data management system managed by the Department for submitting and recording information related to operating in, and catch taken from, the Fishery

External Factors

As outlined above, 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 has historically existed between Leeuwin Current strength and levels of puerulus settlement. The southward-flowing Leeuwin Current also affects the spatial distribution of puerulus settlement along the coast. Catches are also dependent upon the environmental conditions at the time of fishing.

The combined 2012/13 settlement levels were similar to the previous year and while both were improvements on the series of very low levels, they are still below the long-term average. Factors that may be contributing to this low settlement are currently being examined. There appears to be a change in the timing of the peak of settlement, traditionally the peak occurred in August/September now the peak appears in November/December. At this stage the earlier onset of spawning (which is influenced by water temperatures) and the reduced winter storms provides the best explanation of the downturn in settlement and this is being investigated further (see Research Summary).

Increases in sea-water temperatures over the last 30-40 years,

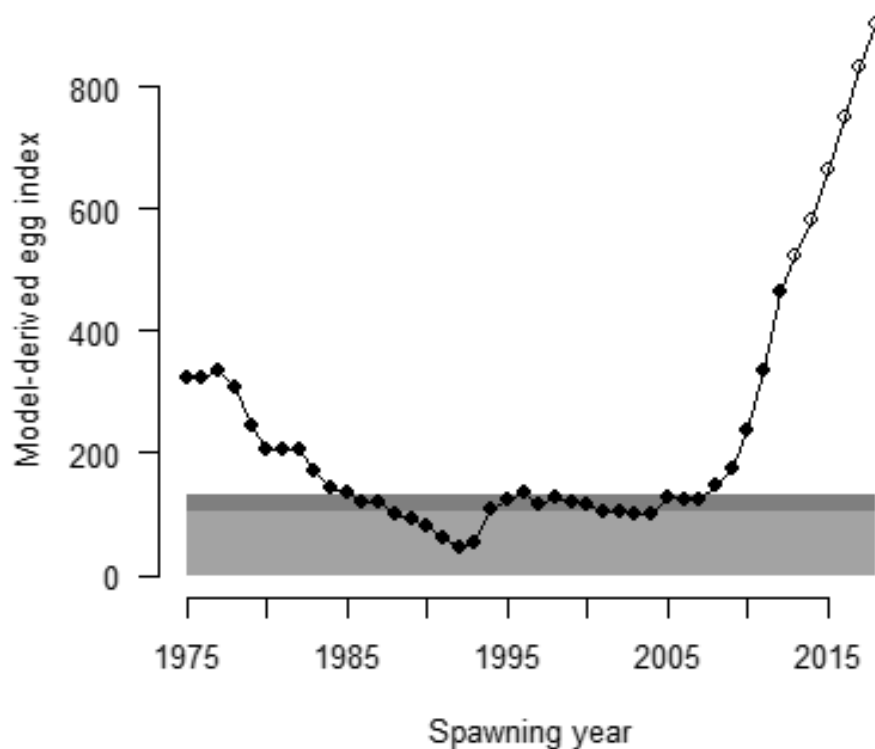
which may be related to climate change, appear to be affecting some of the biological parameters such as size at maturity and size of migrating lobsters. These changes are being taken into account in the stock assessment model and therefore in the future stock assessment of the fishery. An FRDC project 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.



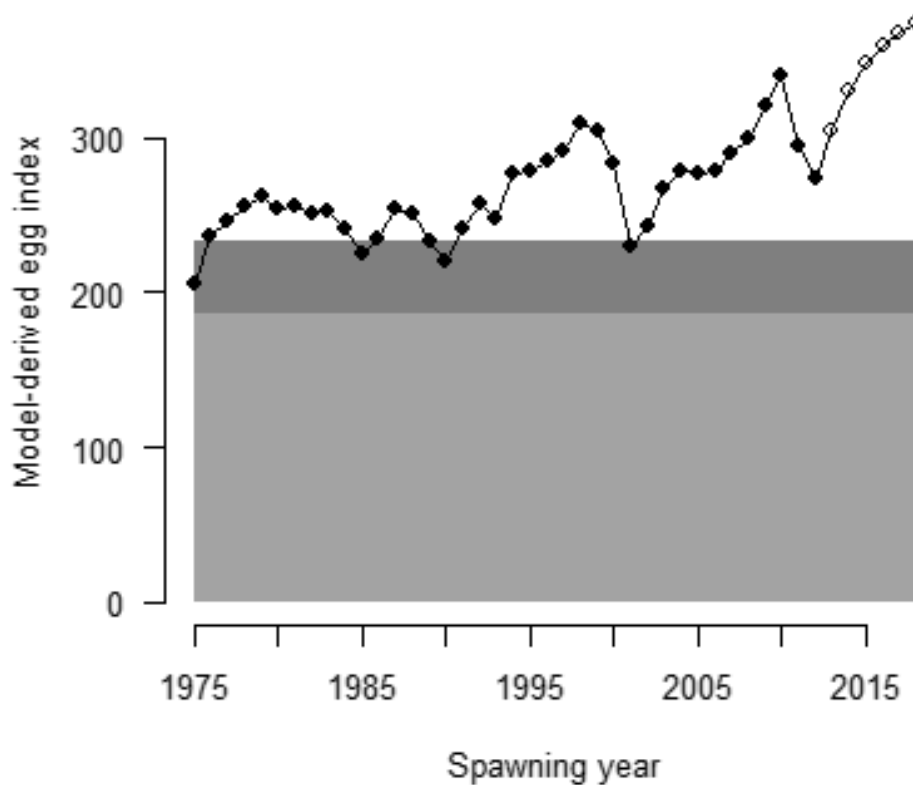
WEST COAST ROCK LOBSTER FIGURE 1

Annual catch (millions of kg), nominal fishing effort (millions of pot lifts) and catch rate (kg / pot lift) from fishers' compulsory monthly returns (pre 2010 season) and daily Catch Disposal Records for the West Coast Rock Lobster Managed Fishery from 1975/76 to 2011/13.



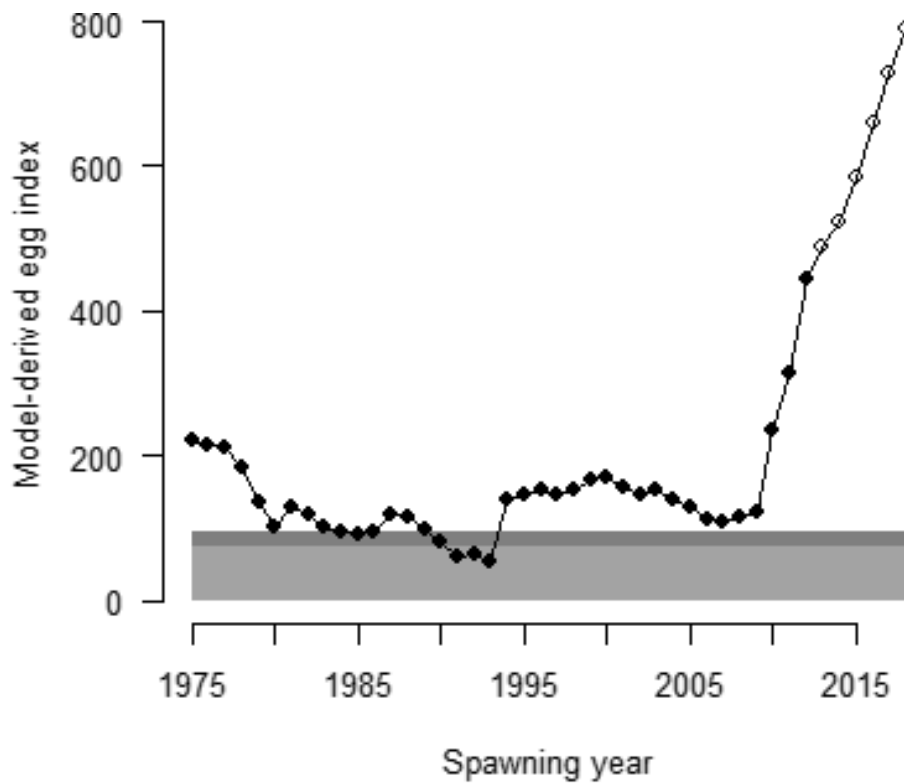
WEST COAST ROCK LOBSTER FIGURE 2

Egg production in the central Breeding Stock Management Area (deep water (> 40 m) Kalbarri, Dongara and Abrolhos Islands). Solid and open points represent historic and future levels of mean egg production under continued levels of commercial catch. The dark grey region represents the 1980's threshold and the light grey region the limit reference area.



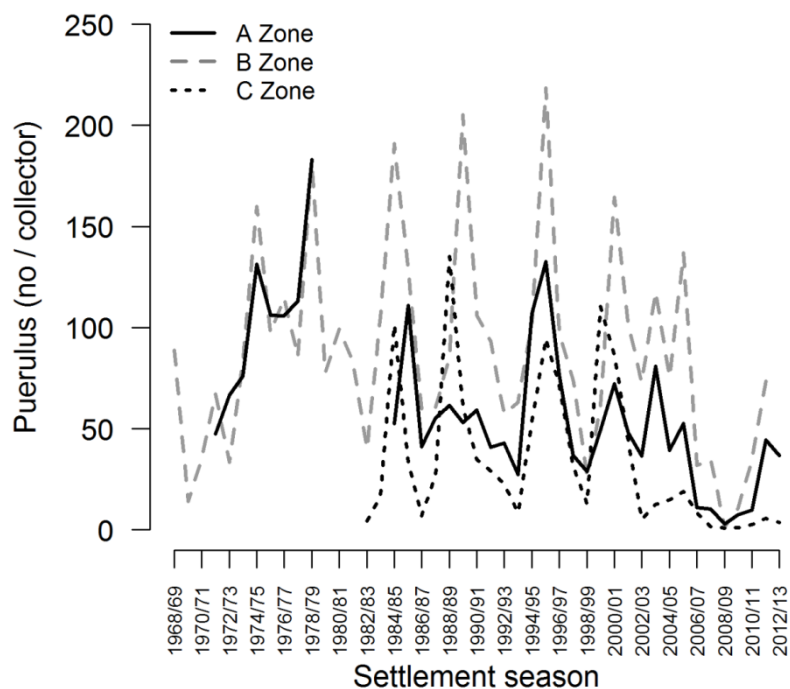
WEST COAST ROCK LOBSTER FIGURE 3

Egg production in the off shallow (<40 m) Breeding Stock Management Area (Abrolhos Islands). Solid and open points represent historic and future levels of mean egg production under continued levels of commercial catch. The dark grey region represents the 1980's threshold and the light grey region the limit reference area.



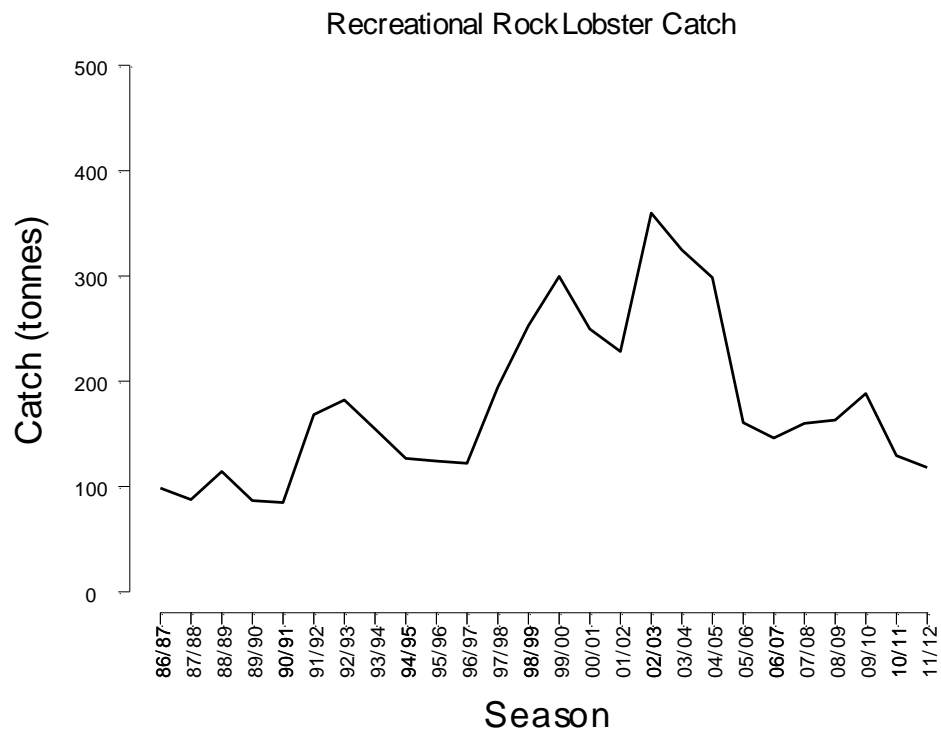
WEST COAST ROCK LOBSTER FIGURE 4

Egg production in the southern Breeding Stock Management Area (deep water (> 40 m) Fremantle, Lancelin and Jurien). Solid and open points represent historic and future levels of mean egg production under continued levels of commercial catch. The dark grey region represents the 1980's threshold and the light grey region the limit reference area.



WEST COAST ROCK LOBSTER FIGURE 5

Annual indices of puerulus settlement from 1968/69 to 2012/13 for A (Abrolhos, solid line), B (Seven Mile Beach, dashed line) and C (Alkimos, dotted line) zones.



WEST COST ROCK LOBSTER FIGURE 6

Estimates of the recreational rock lobster catch since 1986/87 using adjusted mail survey results.

Roe's Abalone Fishery Status Report

A. Hart, J. Brown and J. O'Malley

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial Catch	
		West Coast	28 t
		Other	39 t
Fishing level	Acceptable	Recreational Catch	
		West Coast	18 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 snorkelling, with the main area of focus for the fishery being the Perth metropolitan stocks (West Coast Fishery).

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.

Governing legislation/fishing authority

Commercial

Abalone Management Plan 1992

Abalone Managed Fishery Licence

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

Recreational

Recreational Abalone Fishing Licence

Consultation process

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

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 individually transferable quotas (ITQs).

The overall TACC for 2012 was 92.8 t whole weight (note this small species is generally landed in the whole condition). This was the same TACC as 2011 with the Area 8 fishery still closed as a result of catastrophic mortalities resulting from exceptionally high water temperatures in early 2011 (Pearce *et al.* 2011)¹. 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.

¹ Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. and Gaughan, D. 2011. The "marine heat wave" off Western Australia during the summer of 2010/11. Fisheries Research Report No. 222. Department of Fisheries, Western Australia. 40 pp.

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

A comprehensive Ecologically Sustainable Development assessment of the commercial fishery has been undertaken to identify any potential sustainability risks requiring direct management under the Commonwealth's EPBC Act requirements for export fisheries. 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. 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. However, the Northern Zone has been closed to fishing since 2011 due to large-scale stock mortalities resulting from exceptionally high water temperatures in early 2011 (Pearce *et al.* 2011). The West Coast Zone was open the first Sunday of each month from November 2012 to March 2013, five days in total. This was changed from the previous arrangement of 5 consecutive Sundays from the first Sunday in November. 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, and fishery-independent surveys of Perth metropolitan stocks. Size and density of Roe's abalone across the near-shore sub-tidal reef habitat is measured annually at 13 indicator sites between Mindarie Keys and Penguin

Island. Eleven 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).

Research translocation trials with funding assistance from the Seafood CRC are underway to see whether they can assist the recovery of abalone stocks in the Kalbarri region affected by the marine heatwave in 2011.

Recreational

Current annual recreational catch and effort estimates are derived from an annual field survey (West Coast Zone / Perth metropolitan fishery), and occasional telephone diary surveys covering all licence holders in the state (last completed in 2007).

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 700 interviews in 2012), 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. In 2007, around 500 licence holders were randomly selected from the licensing database, with selection stratified by licence type (abalone or umbrella-which was available at that time) 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 2012: 67 tonnes whole weight

Metro only: 28 tonnes whole weight

The TACC for the 2012 quota year was 93 t whole weight for Roe's abalone. The 2012 catch of 67 t whole weight (Roe's Abalone Table 1) was 14 tonnes lower than 2011 and about 72% of the TACC. Catch was 25 t less than the quota due to significant reductions in commercial effort (days fished) in all regions except Area 2. The effort reductions in effort driven primarily by economic reasons and a difficult weather conditions, and in the case of the Perth metro fishery (Area 7), there was also concern over potential negative effects on growth resulting from the 2011 marine heatwave. The Area 1 and Area 8 of the fishery were not fished in 2012 (Roe's Abalone Figure 1)

Recreational catch

Season 2012: Roe's Metro Fishery 18.6 tonnes

**(Season 2007): Roe's rest of state 14 tonnes
(31% of total catch)**

The recreational catch for Roe's abalone from the Perth metropolitan area in 2012 was 18.6 t (Roe's Abalone Table 2). This was a decrease of about 17% from 2011, and occurred as a result of the extremely poor weather conditions and a consequent large reduction in effort.

Based on the Perth recreational fishery for 2012 (18.6 t), and using the 2007 phone diary estimate for the rest of the state (14 t), recreational fishing represented about 33% of the total (commercial and recreational) Roe's abalone catch (100t) across the state in 2012.

Fishing effort/access level

Commercial

Total effort for dedicated Roe's abalone divers in 2012 was 372 diver days, lower than last year's effort of 426 diver days (Roe's Abalone Table 1). Reductions in effort in 2012, as outlined above, were driven by primarily economic reasons, and concern over potential negative effects on growth in the Perth metro fishery, resulting from the 2011 marine heatwave.

Recreational

For the 2012 season, 15,561 licences were issued allowing abalone fishing (Roe's Abalone Figure 3). This was the second year in which only abalone specific licenses were available to those wishing to fish for abalone. Umbrella recreational licenses, which allow for the catch of multiple species, have been phased out (Roe's Abalone Figure 3).

Effort in the Perth fishery for 2012 was 7,972 hours, a 30 % reduction from 2011 effort of 11,396 hours (Roe's Abalone Table 2) and the lowest in the 14 years of data collection. This was primarily due to poor weather conditions and a 10% drop in licenses issued. The new summer season was part of ongoing adjustments in management as part of the IFM process. Since 2006, daily season length has been shortened from 1.5 hours to 1 hour, and number of fishing days from 6 to 5. The new monthly Sunday fishing day coincided with high tide on most Sundays this year which contributed to the lower catch rate and effort.

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 level and 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 historically, however the raw CPUE data has been provided for comparative purposes.

The SCPUE for dedicated Roe's abalone divers in 2012 was

27.3 kg/hr, which was slightly lower than the 2011 catch rate (Roe's Abalone Table 1). The exception is Area 8 commercial (Northern Region for recreational), which has been closed to all fishing to promote stock recovery following an environmentally induced mass mortality (Pearce *et al.* 2011).

The catch rate of recreational fishers in the Perth metropolitan fishery of 25 abalone/hour in 2012 was greater than the 2011 catch rate of 23 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 2013 were 40 abalone m⁻², a drop of 9 m⁻² compared with 2012 (Roe's Abalone Table 4). Within the subtidal habitat, densities of sub-legal animals have also decreased and are back to densities recorded in 2009. Densities of legal-sized animals (60+ mm) on the platform habitat have increased in 2013 (11 m⁻²), compared to 9 m⁻² in 2012 (Roe's Abalone Table 4). With the significant decline in recreational catch in 2011 and 2012, legal-size densities are recovering towards historical levels.

In the subtidal habitat, legal-sized densities were 12 abalone m⁻² in 2013, which is an increase from 2011 (10 m⁻²) and close to their long-term average (Roe's Abalone Table 4).

Densities of legal-sized Roe's abalone in the MPA are about 40% higher on the platform habitat, compared with the fished stocks (Roe's Abalone Table 4). For sub-legal animals, densities have significantly declined and are now 25% lower than in the fished stocks (Roe's Abalone Table 4). There have been major declines in 2013 from 2012 in subtidal stocks of both legal and sub-legal sized stocks of 55% and 40% respectively at the MPA. This is indicative of environmentally related mortality.

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. 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 2012 the standardised CPUE were within the agreed ranges in all areas fished, indicating that overall breeding stock levels were adequate (Roe's Abalone Table 5). However the total catch indicator was only met in the Area 2 fishery. The low catch was due to poor economic and adverse weather conditions.

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 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.

The recreational fishery provides a major social benefit to those sectors of the community that appreciate the abalone as a delicacy, and 15,500 licenses were issued that would have allowed fishers to participate in the recreational abalone fishery (Roe's Abalone Figure 3).

Economic Effects

Estimated annual value (to fishers) for 2012:

Level 2 - \$1 -5 million (\$2.1 million)

The estimated average price for Roe's abalone in 2012 was \$25.50/kg. This value was the same as the value in 2011. On the basis of the average price, the fishery was worth approximately \$2.1 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 >\$US1.00 in 2011. 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 effort value of 372 diver days and SCPUE of 27 kg per hour (Roes Abalone Table 1) both fall below the expected effort ranges. In both cases the main reason was poor economic and adverse weather conditions which altered diver behaviour rather than stock sustainability issues.

Recreational (West Coast)

Target Catch range:

5 year moving average - 40 ± 2 tonnes

The governance range is based on the 5 year moving average of catch in the West Coast Fishery. This range takes in the permitted maximum variations of ± 2t around the TARC (Total Allowable Recreational Catch) of 40 t.

The 5-year (2008-2012) moving average for 2011 was 36 t. This was outside the governance range, and was caused by significant reductions in effort in 2011 and 2012, due primarily to poor weather conditions coupled with a new fishing season.

New management initiatives (2012/13)

The second year of the trial of a summer season for the West Coast Zone of the recreational fishery was undertaken for the 2012/13 summer. The season began on the first Sunday of November 2012 and extended till the first Sunday of March 2012, with fishing taking place between 7 and 8 am on the first Sunday of each month. The trial will continue for one more years. Evidence from the first two seasons indicates a considerable drop in effort.

The Northern Zone of the recreational fishery (Roes Abalone Figure 2), and the Area 8 commercial fishery (Roes Abalone Figure 1) were closed indefinitely for the 2011/12 season and beyond. This was to facilitate stock rebuilding following mass mortality from an environmental event (see External Factors).

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 average¹. This was widespread with fish kills being recorded across many fish species, however the Area 8 Roe's abalone fishery, particularly in the area around Kalbarri, were the most severely impacted. Mortalities on roe's abalone were estimate at 99.9%+ and a complete closure of the commercial and recreational fisheries

was implemented. Research translocation trials are underway to see whether they can assist the recovery.

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.

ROE'S ABALONE TABLE 1

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

Quota period ²	Roe's TACC kg whole weight ³	Roe's caught kg whole weight	Diver days ⁴ (Roe's divers only)	Raw CPUE (roei divers) kg per day)	SCPUE (kg per hour)
1990	105,000	116,447	936	112	
1991	101,000	109,489	832	118	
1992	105,000	111,341	735	134	26.9
1993	128,000	115,281	832	123	29.3
1994	125,960	117,835	908	113	27.2
1995	125,960	114,501	1,047	98	24.9
1996	125,960	118,715	1,004	106	28.2
1997	126,790	118,738	855	120	29.8
1998	93,960 ⁵	86,425	695	108	27.6
1999 ⁶	119,900	112,949	659	149	29.0
2000	115,900	107,735	647	144	28.3
2001	107,900	99,174	685	126	29.4
2002	107,900	100,471	700	125	27.9
2003	110,900	96,005	723	118	28.5
2004	110,900	107,593	736	126	27.6
2005	112,700	96,496	672	131	30.7
2006	112,700	98,370	625	136	32.4
2007	109,700	90,750	585	132	28.6
2008	106,700	93,197	580	133	28.4
2009	101,800	92,838	554	140	28.3
2010	101,800	91,418	567	134	29.3
2011	92,800	81,607	426	157	29.8
2012	92,800	67,029	372	147	27.3

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.

Year	Effort (hours)	Catch rate	Field Survey			
			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
2011	11,396	23	17.0	266,000	22.4	84
2012	7,972	25	17.9	205,493	18.6	90

ROE'S ABALONE TABLE 3

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

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

1. Both areas are within the West Coast Bioregion.

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

ROE'S ABALONE TABLE 4

Mean densities (abalone/m²) of sub-legal (<60 mm shell length) and legal-sized Roe's abalone (60 mm and over) from 13 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	40	29	44	26	4.9	14.0	9.2	21
1998	49	28	51	37	5.3	11.3	13.5	37
1999	55	29	52	26	4.3	6.9	12.0	27
2000	52	25	29	35	2.9	9.9	8.6	31
2001	51	26	38	34	4.2	10.1	7.8	28
2002	42	29	42	39	3.5	9.8	6.9	31
2003	33	27	34	41	5.0	11.2	4.1	25
2004	34	21	33	53	3.9	9.0	4.5	20
2005	35	19	43	40	5.2	8.7	8.7	22
2006	36	19	49	38	6.8	9.5	5.7	20
2007	39	17	42	35	5.3	11.0	6.7	19
2008	42	18	69	37	6.7	12.3	7.3	19
2009	51	16	67	38	8.7	12.0	10.8	24
2010	53	14	77	32	11.8	13.3	8.4	23
2011	51	11	66	26	9.8	12.2	6.4	22
2012	49	9	62	17	10.2	10.3	8.8	23
2013	40	11	30	18	8.8	12.3	3.8	14

ROE'S ABALONE TABLE 5

Assessment against agreed performance measures for 2012.

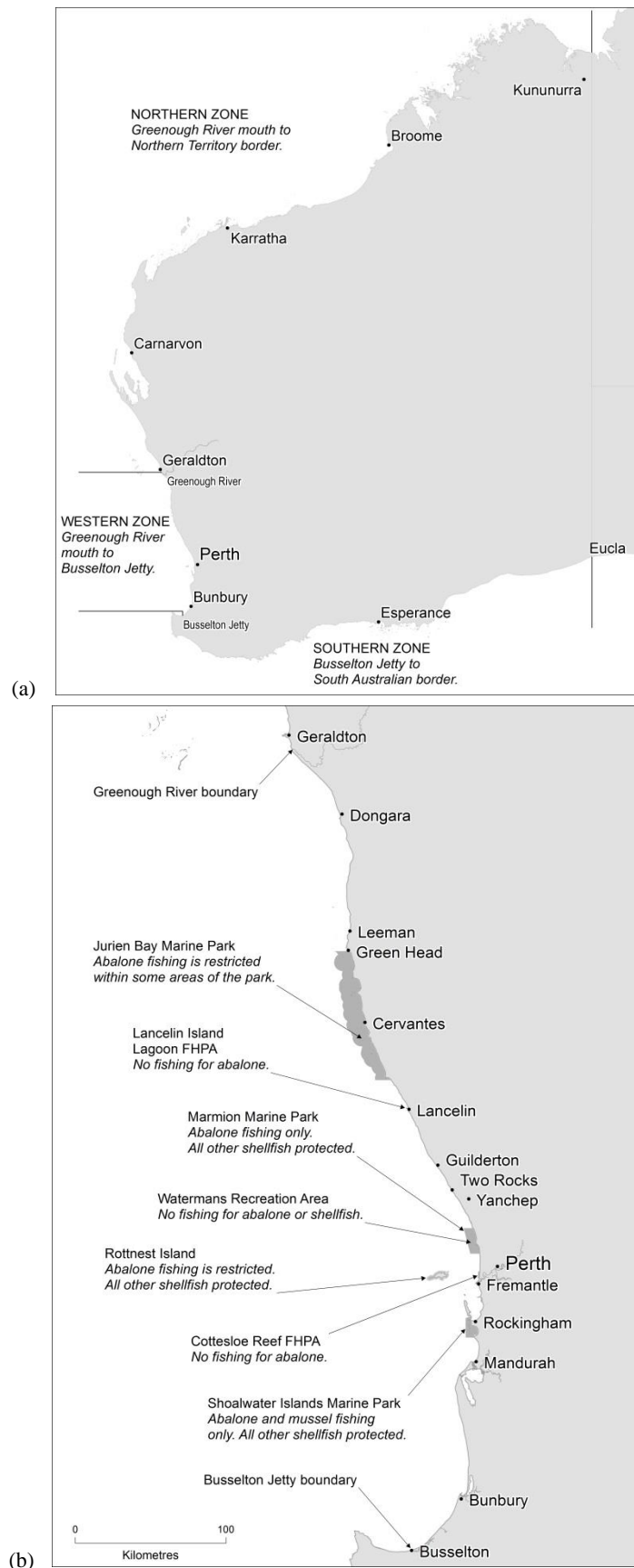
Performance Indicator	Performance Measure ¹	2012 Values	Assessment/Comments
<i>Area 1</i>			
Total catch (TACC)	5,000 kg	0	Exploratory quota – no fishing in 2012.
Effort range (Diver days)	14 – 43	0	See above.
<i>Area 2</i>			
Total catch (TACC)	19,800 kg	18,128	Met – 92% of quota caught.
Standardised CPUE	19 – 29	25	Met
<i>Area 5</i>			
Total catch (TACC)	20,000kg	12,509	Not Met – 63% of quota caught.
Standardised CPUE	15 – 23	21	Met
<i>Area 6</i>			
Total catch (TACC)	12,000 kg	8,497	Not Met – 71% of quota caught.
Standardised CPUE	17 – 25	18	Met
<i>Area 7</i>			
Total catch (TACC)	36,000 kg	27,895	Not Met – 77% of quota caught.
Standardised CPUE	29 – 42	34	Met.
<i>Area 8</i>			
Total catch (TACC)	9,000 kg		Not assessed – fishery closed.
Standardised CPUE	16 – 24		Not assessed – fishery closed.

1. 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 N (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.



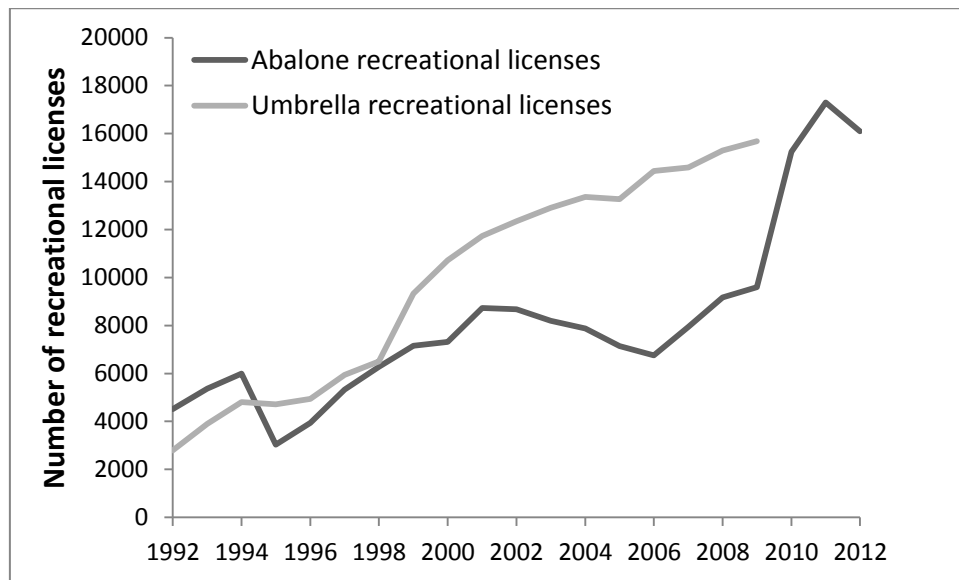
ROE'S ABALONE FIGURE 1

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



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 since 1992. Umbrella licences were discontinued in 2010.

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

E. Sporer, M. Kangas, S. Brown, N. Blay

Main Features

Status		Current Landings	
Stock level	Inadequate (non-fishing)	AIMWTMF:	Scallops nil (whole weight)
		SWTMF:	Scallops 40 t (whole weight) Prawns 8 t
Fishing level	Acceptable	SCTF:	Scallops 119 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 (*A. balloti*) and associated byproducts, although in years of low scallop catches licensees may use other trawl gear to target fin-fish species. Scallop landings for the fishery have varied dramatically over the years, depending primarily on the strength of recruitment. While the boundaries of the fishery covers a large section of the south coast, 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

South West Trawl Management Plan 1989

South West Trawl Managed Fishery Licence

Trawling Prohibition (Whole of State) Notice 1992

Surface Trawl Net Fishery (South Coast) Notice 1992

Trawling for Scallops (South Coast) Notice 1992

Condition 73 and/or 79 on Fishing Boat Licences

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

Consultation process

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

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	South of 32°16' S to west of 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 waters east of 115° E longitude. Condition 79 provides for the use of low opening otter trawl systems for taking scallops within the Recherche Archipelago. The four fishing boat licences have both conditions.

Management arrangements

AIMWTMF

The AIMWTF (including the Port Gregory prawn trawl area) operates under an input control and constant escapement

based management system. There was initially a maximum total net headrope capacity restriction of 336.5m (184 fathoms), 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 AIMWTMF as a licence condition. The fishery operates to a catch rate threshold level of 250 kg meat weight per 24 hours trawling to cease fishing.

Two restructures (2009 and 2010) have removed 113.4 m (62 fathoms) of headrope, reducing the current permitted overall net headrope capacity to 223.1 m (122 fathoms) with 10 licences. However, the total net headrope used by the 10 boats that remain in the fishery when fishing with two 12.8 m (7 fathom) nets is 256 m (140 fathoms), which is 33 m (18 fathom) in excess of the allowed capacity remaining after the VFAS. An exemption has been approved and there is an amendment sought to remove the current headrope unitisation from the Management Plan and establish standardisation of nets in the AIMWTMF. The same boats fish the AIMWTMF and the Shark Bay Scallop Managed Fishery and use the same size nets (two 12.8 m nets) in the Shark Bay scallop fishery and therefore these sized nets will also be the standard net for the AIMWTMF. This will make fishing more cost effective for licensees.

In 2012 the fishing season did not open for both the AIMWTMF and the Port Gregory prawn trawl area.

Because the AIMWTMF area is fished by the rock lobster and the scallop fishing sectors of the fishing industry, the fishery is spatially separated for the scallop sector into two parts: the traditional parts of the fishery which, are divided into nine fish grounds, and non-traditional areas. The traditional parts of the fishery contain known scallop grounds and these are the grounds historically fished by the scallop fleet. The non-traditional areas, comprise parts of the fishery where scallops are not commonly found and have not been traditionally fished by the scallop fleet. Trawl fishing can be undertaken in this area but there are guidelines for exploratory fishing before any commercial trawl fishing can be undertaken.

The Australian Government's Department of Sustainability Environment Water Populations and Communities (SEWPaC), has assessed the AIMWTMF under the provisions of the Environment Protection and Biodiversity Conservation Act 1999. The SEWPaC Minister granted a further 5-year export approval for the fishery until 15 March 2018.

SWTMF

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. 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.

SCTF

The SCTF is managed primarily by limited entry with only four licences permitted to operate in the fishery. There are also seasonal closures in specified parts of the fishery under

the Trawling for Scallops (South Coast) Notice 1992.

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

SEWPaC has assessed the SCTF under the provisions of the Environment Protection and Biodiversity Conservation Act 1999. The SEWPaC Minister granted a 3-year export approval for the fishery until 6 May 2016.

Research summary

Research monitoring of the scallop stocks for all these fisheries is undertaken using mandatory daily logbooks validated by processor returns. Advice on the status of stocks and appropriate season opening and closing dates is provided to industry and management. In the AIMWTMF there is also an annual pre-season survey that provides the information required for assessing the fishery. This preseason survey is undertaken in the traditional fish grounds and provides scallop abundance information for each fish ground and an overall catch prediction for the fishery.

Retained Species

Commercial landings (season 2012)

AIMWTMF:	Scallops nil whole weight
SWTMF:	Scallops 40 tonnes whole weight
	Prawns 8 tonnes
SCTF:	Scallops 119 tonnes whole weight

AIMWTMF

No scallop fishing occurred in this fishery during 2012 because the annual scallop survey showed scallop abundance below the limit level to commence fishing.

SWTMF

The recorded landings in the SWTMF for the season comprised 8 t of western king prawns and 40 t whole weight of scallops (West and South Coast Scallop Figure 2). Since 2004 annual king prawn landings have been low, in the range of 3 to 14 t. The scallop landings have declined from the peak in 2010 (217 t), similar to the decline observed to the very high catch of 1990 (221 t). Scallop recruitment and subsequent landings are variable with a historical range between 1 and 221 t whole weight (West and South Coast Scallop Figure 3). Being a multi-species fishery, other products retained include 6 t of mixed whiting spp., 2 t of blue swimmer crabs (*Portunus armatus*) and 1 t of squid. All other landings (mixed fish) were recorded as less than 1 t for each species for a total of (1.6 t).

SCTF

The scallop catch was 119 t (whole weight) which was lower than last year's catch of 176 t. There is generally low effort expended in the fishery and variable recruitment (West and South Coast Scallop Figure 3). Byproduct species landings were negligible with Balmain bugs (*Ibicus peronii*) the most abundant at 1.7 t with less than 1 t of cuttlefish, squid, octopus and mixed fish for a total landed catch of 1 t.

Recreational catch: Nil

Fishing effort/access level

AIMWTMF

In 2012 no commercial otter trawl fishing was undertaken in the AIMWTM including the Port Gregory area.

SWTMF

A total of 176 boat days were fished in the SWTMF a decrease compared to 2011 (279 boat days). This is also low compared to the effort levels (between 1990 and 2003) of generally over 400 boat days. Low effort also reflects the availability of boats to fish in this fishery, inclement weather conditions restricting fishing time and the rising cost of fishing. Also there has been a reduction of boats fishing because of a reduction of commercial License holders in two zones of the fishery who have bought out the other licenses. This allows one licensee to operate one boat whilst owning all three licenses in each zone resulting in a reduction of effort and improving economic efficiency. There is, however still potential for effort to increase markedly because of latent effort in this fishery.

SCTF

For the 2012 season four boats fished for scallops between April and December recording a total of 177 boat days. The effort expended each season in the SCTF is mostly affected by scallop recruitment levels. As a consequence, the level of effort utilised each year closely follows stock abundance and catch levels.

Stock Assessment

Assessment complete:

AIMWTMF: Yes

SWTMF and SCTF: Not assessed

Assessment method:

AIMWTMF: Level 4 - Direct survey, catch rate

Breeding stock levels:

AIMWTMF: Inadequate

SWTMF and SCTF: Not assessed

Projected catch range next season (2013)

AIMWTMF: Scallops nil 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 2011 recruitment survey abundance was the lowest observed since 1997 and believed to be mainly due to environmental conditions such as the La Niña conditions and strong Leeuwin Current. This resulted in predicted landings that were less than the target range (95-1830 t whole weight) and therefore, the fishery was not opened for 2012. The very low recruitment would have

resulted in a subsequent low breeding stock in 2012. The 2012 recruitment survey abundance was also very low, probably as a result of environmental conditions as well as the low breeding stock. The predicted landings for 2013 were again below the target range so the fishery did not open.

The main performance measure for the AIMWTM 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 2012 fishing season was not fished due to the low stock available and was all left as the breeding stock.

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. The overall extent of the fishery is 3808 square nautical miles and of that the permitted trawl area is 2420 square nautical miles, 64% of the extent of the fishery. No fishing was undertaken in 2012.

In the SWTMF trawling for scallops is focused on a few small offshore areas, while the prawn catch is mainly taken from Comet Bay (Zone D).

The large-mesh (100 mm) trawl gear used in the SCTF takes minimal bycatch. The areas trawled by the boats for scallops (primarily in waters near Bremer Bay, the Recherche Archipelago and Israelite Bay) represents a very small percentage of the fishing area within the SCTF waters, 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. There were no recorded captures of protected species in 2012 for either of these fisheries.

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 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 of crew for the year 2012 was nil in the AIMWTMF, 6 in the SWTMF and 12 in the SCTF.

Economic Effects**Estimated annual value (to fishers) for year 2011:**

AIMWTMF **Level 1 - \$ Nil**

SWTMF: **Level 1 - \$0.3 million**

SCTF: **Level 1 - \$0.6 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 \$5.0/kg and \$6.0/kg whole weight respectively. King prawn price was about \$15.00/kg.

Fishery Governance**Target catch range:**

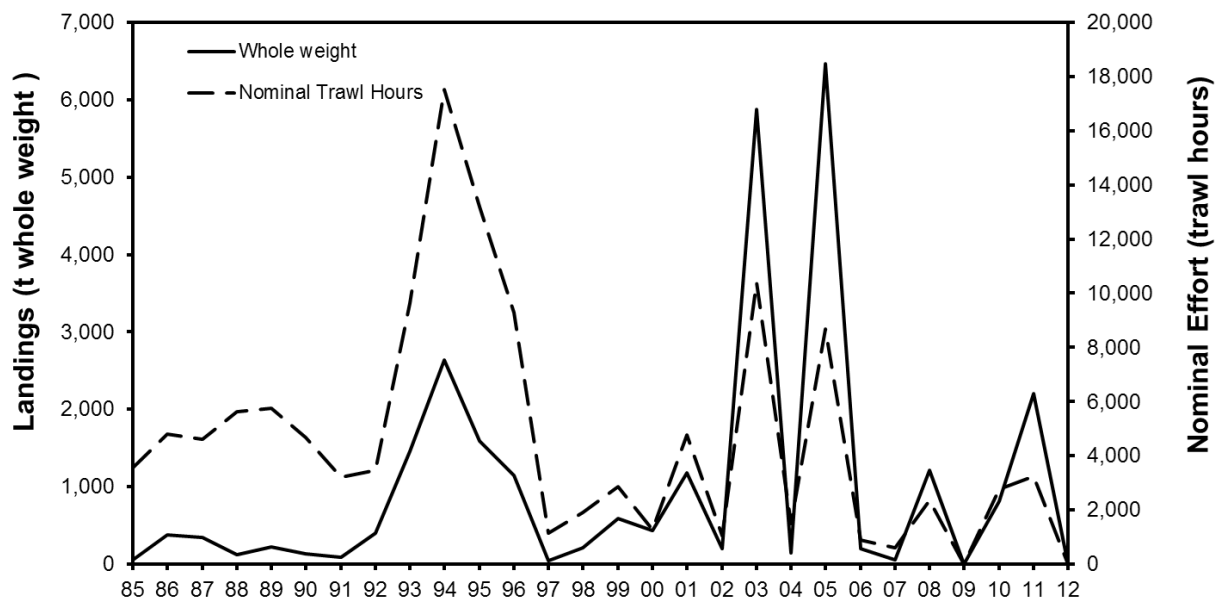
AIMWTMF: **95 – 1,830 tonnes whole weight**

Current fishing level: **N/A**

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. No fishing was undertaken in 2012.

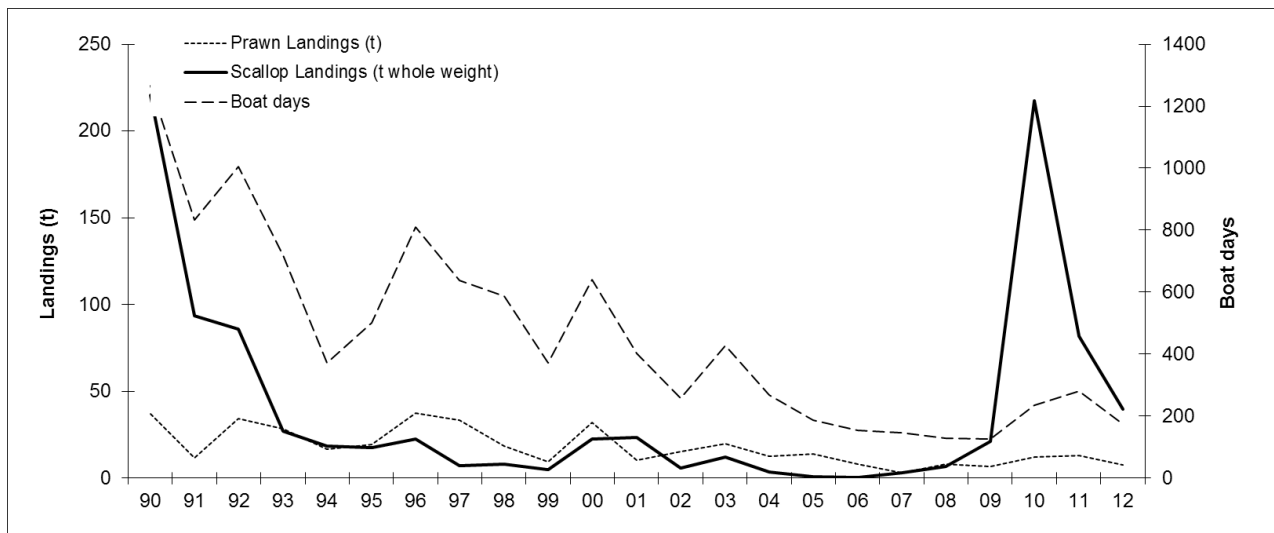
New management initiatives (2013) nil**External Factors**

High variability in the level of recruitment highlights the dependence of recruitment success upon environmental conditions, such as the Leeuwin Current, rather than spawning stock levels. The relationship between environmental factors and recruitment success is being evaluated for all these regions. The low 2011 recruitment is believed to be mainly due to environmental conditions such as the La Niña conditions and strong Leeuwin Current. The very low recruitment would have resulted in a subsequent low breeding stock in 2012. The low 2012 recruitment was probably influenced by the environmental conditions as well as the low breeding stock. This high variability in recruitment results in a variable level of fishing activity and quantity of catch. Additionally, the high cost of fishing in recent times 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.



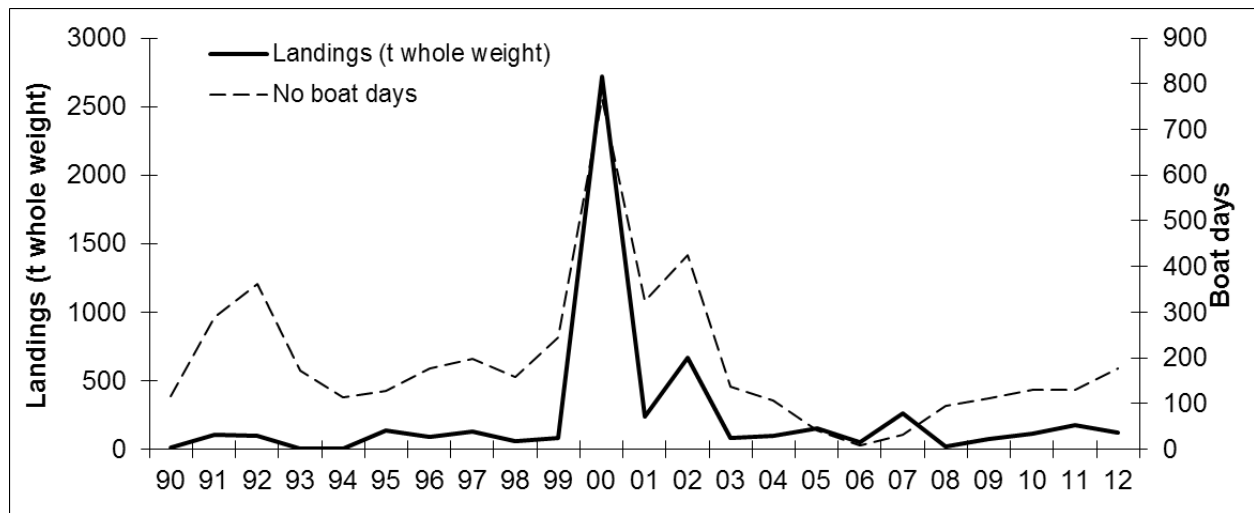
WEST AND SOUTH COAST SCALLOP FIGURE 1

Annual Scallop Landings and Nominal Effort for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985 – 2011. Note no fishing in 2012.



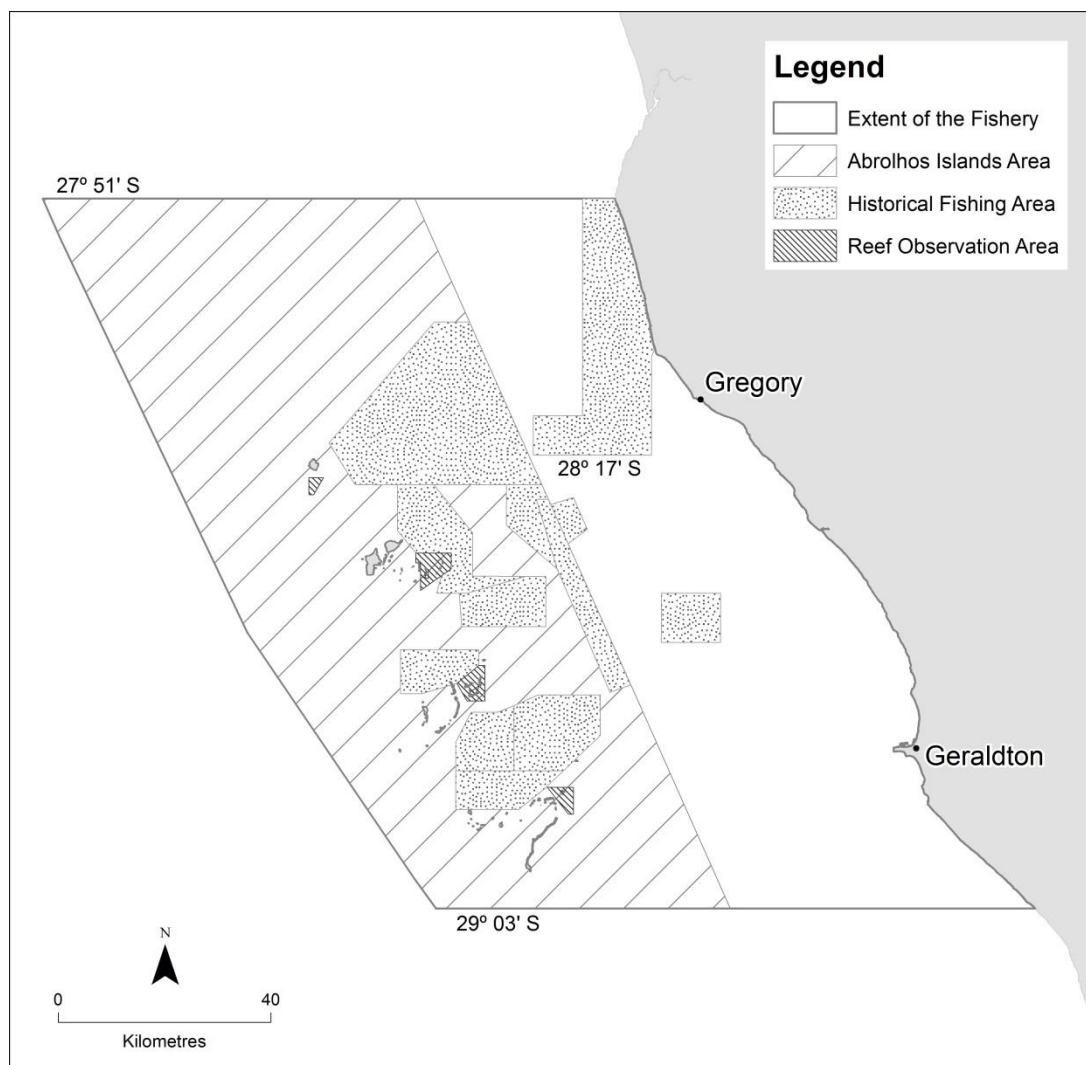
WEST AND SOUTH COAST SCALLOP FIGURE 2

Annual Scallop and Prawn Landings and number of boat days for South West Trawl Fishery, 1990 – 2012.



WEST AND SOUTH COAST SCALLOP FIGURE 3

Annual Scallop Landings and number of boat days for South Coast Fishery, 1990 – 2012.



WEST AND SOUTH COAST SCALLOP FIGURE 4

Boundaries of the Abrolhos Islands and Mid West Trawl Managed Fishery, extent of fishery, Port Gregory area, Kidney patch and reef observation areas. Note there was no fishing in 2012.

West Coast Blue Swimmer Crab Fishery Status Report

D. Johnston, D. Harris and J. Fissioli

Main Features

Status		Current Landings	
Stock level		Total Commercial catch (2011/12)	186 t
Cockburn Sound	Acceptable	Cockburn Sound	46 t
Peel-Harvey Estuary	Acceptable	Peel-Harvey Estuary	81 t
Fishing Level		Catch by other commercial fisheries	59 t
Total Recreational catch			
Cockburn Sound	Acceptable	West Coast Bioregion (Boat-based) (Feb 11- Mar 12)	87 t
Peel-Harvey	Acceptable	Peel-Harvey Estuary	
		(boat and shore) (Nov 07 - Oct 08)	107-193 t

Fishery Description

The blue swimmer crab (*Portunus armatus*) is found along the entire Western Australian coast, in a wide range of inshore and continental shelf areas, from the intertidal 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 Developing 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 byproduct 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. Blue swimmer crabs become sexually mature below 100 mm carapace width. The legal minimum size range varies between 127 – 135 mm carapace width in the fisheries of the West Coast Bioregion – well above the size at sexual maturity (86-97 mm carapace width depending on the fishery).

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 10 crabs per person or 20 crabs per boat. A Recreational Fishing from Boat Licence was introduced in March 2010 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 regardless of the number of fishers aboard.

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 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 all waters 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.

Following a rebuilding of the Cockburn Sound crab stock, the fishery was re-opened on 15 December 2009. A precautionary management approach has been adopted since

re-opening the fishery with several changes being made over the past few years (see Johnston *et al.*, State of Fisheries Reports, 2010, 2011, 2012)¹.

There was further easing of fishing arrangements for the 2011/12 season, with a decrease in minimum size of males and a season extension for the commercial and recreational sectors. The following management controls were implemented:

- a 20% reduction in commercial pot numbers;
- a commercial size limit of 130 mm for male crabs and 135 mm for female crabs;
- a recreational size limit of 127 mm;
- a limited commercial season from 15 December 2011 to 15 June 2012; and
- a limited recreational season from 15 December 2011 to 31 July 2012.

There was slight easing of fishing arrangements for the 2012/13 season, with a decrease in minimum size of females to 130 mm CW (all other season arrangements remained the same).

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.

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 monthly catch and effort returns, voluntary daily log books from fishers in the Mandurah to Bunbury Developing Crab Fishery, and data from on-board catch monitoring conducted by the Department of Fisheries' research staff in each of the West Coast Bioregion's commercial crab fisheries.

In addition, direct surveys generating recruit, residual and breeding stock indices, along with data on the general crab population, have been conducted in Cockburn Sound for about 10 years and in the Peel-Harvey for five years.

A stock-recruitment-environment model has been developed for Cockburn Sound, which correlates water temperature in

¹ Johnston, D. and Harris, D. (2010). West Coast Blue Swimmer Crab Fishery Status Report. In: State of the Fisheries and Aquatic Resources Report 2009/10 eds. W.J. Fletcher and K. Santoro, Department of Fisheries, Western Australia, pp. 54-61.

Johnston, D., Harris, D., Warmbrunn, A. and Coloper, M. (2011). West Coast Blue Swimmer Crab Fishery Status Report. In: State of the Fisheries and Aquatic Resources Report 2010/11 eds. W.J. Fletcher and K. Santoro, Department of Fisheries, Western Australia, pp. 68-75.

Johnston, D., Harris, D., Fissioli, J. and Walshe, K. (2012). West Coast Blue Swimmer Crab Fishery Status Report. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2011/12: The State of the Fisheries eds. W.J. Fletcher and K. Santoro, Department of Fisheries, Western Australia, pp. 68-75.

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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 assess the reasons for the stock collapse and monitor the recovery of the fishery. The causes of the collapse and description of the recovery have been described in the scientific paper (Johnston *et al.*, 2011)¹. The stock status of the Cockburn Sound crab fishery, a description of the stock-recruitment-environment relationship for the Cockburn Sound crab stock, and a summary of the crab fisheries in Warnbro Sound and the Swan River have been presented (Johnston *et al.*, 2011)². Reports on the population status of the Peel-Harvey Estuary crab stock, and the 2007/08 recreational crabbing survey in the Peel-Harvey Estuary, are being finalised. A new 3 year project funded through the Recreational Fishing Initiatives Fund will commence in July 2013 to obtain data on recreational catch and effort and crab stocks in the important recreational fisheries of Swan-Canning River, Geographe Bay and Leschenault Estuary.

Retained Species

Commercial landings (season 2011/12):

Total 186 tonnes

Cockburn Sound 46 tonnes

Peel-Harvey Estuary 81 tonnes

Other west coast commercial fisheries 59 tonnes

The total commercial catch from the West Coast Bioregion in 2010/11 was 186 t, a 16% increase on the 161 t taken in 2010/11. This increase was primarily due to significant increases in crab catch from Warnbro Sound and the Peel-Harvey Estuary, and slight increases in catch from the Mandurah to Bunbury trap fishery. This catch accounted for 53% of the state commercial blue swimmer crab catch of 352 t for 2011/12 (West Coast Blue Swimmer Crab Figure 1).

The commercial catch from the Cockburn Sound Crab Managed Fishery for 2011/12 was 46 t, a 13% decrease from the 53 t caught during the 2010/11 season (West Coast Blue Swimmer Crab Figure 2).

The commercial catch from the Peel-Harvey Estuary (Area II of the West Coast Estuarine Managed Fishery) for 2011/12 was 81 t. This represents a 31% increase on the 62 t in 2010/11 (West Coast Blue Swimmer Crab Figure 4).

The Mandurah to Bunbury Developing Crab Fishery reported an annual catch for 2011/12 of 15 t, representing a 36% increase on the 11 t reported for the 2010/11 financial year

(West Coast Blue Swimmer Crab Figure 5).

Recreational boat-based catch estimate:

West Coast Bioregion (boat-based)

(Feb 11-Mar 12) 87 tonnes

Recreational catch estimate:

Peel-Harvey Estuary (boat and shore)

(Nov 07 - Oct 08) 107-193 tonnes

An integrated survey of boat-based recreational fishing in WA was conducted between 1 March 2011 and 29 February 2012. Most of the recreational blue swimmer crab fishing in Western Australia occurs in the West Coast Bioregion, with 92% of the recreational crab catch reported in a state-wide survey of boat-based recreational fishing in 2011/12 coming from this area (Ryan *et al.*, 2013)³. Catch data were recorded in numbers of animals, and have been converted to weight for this report using a mean state-wide estimate of 229 g/animal (based on 382 crabs weighed during boat ramp surveys). The survey provided a boat-based recreational estimate of retained blue swimmer crabs for the 12-month period for the West Coast Bioregion of 87 t.

This compares with total commercial landings for this bioregion of 174 t over the same period.

The total recreational catch and effort in the Peel-Harvey Estuary which covered fishing from boats, shore, canals, and houseboats was estimated from November 2007 to October 2008 as to be between 107-193 t. This was lower than a similar recreational catch estimate of 251-377 t for this region undertaken in 1998/99.

Within Cockburn Sound, recreational crabbing surveys in 1996/97 and 2001/02, and in the 2002, 2003 and 2004 calendar years, produced relatively consistent recreational catch estimates of 24 t, 25 t, 18 t, 23 t and 18 t respectively for catches made in daylight. The estimated recreational catch for the 2005/06 financial year of only 4 t reflects this was just before the closure for this area was introduced. The portion of Cockburn Sound south of a line drawn between Woodman Point and the northern end of Garden Island was closed to recreational crabbing in 2006 to protect crab stocks that were significantly depleted due to fishing pressures and environmental conditions that resulted in poor recruitment. The whole of Cockburn Sound was re-opened to recreational crabbing for the 2009/10 season from December 15th 2009 to March 31st 2010. A survey quantifying recreational catch and effort in the West Coast Bioregion was conducted over a two-year period between July 2008 and June 2010. The survey provided a recreational catch estimate for the 3½ months of the 2009/10 season of 15.4 t (S.E.±3.3 t) of blue swimmer crabs, for an area covering Cockburn Sound (south of latitude 32°05'S), Shoalwater Bay and the northern half of Warnbro Sound (north of latitude 32°20'S). However, the survey covered only the period during the day between 9am and

1 Johnston, D., Harris, D., Caputi, N. and Thomson, A. (2011). Decline of a blue swimmer crab (*Portunus pelagicus*) fishery in Western Australia—History, contributing factors and future management strategy. Fish. Res. 109(1), 119-130 doi:10.1016/j.fishres.2011.01.027

2 Johnston, D., Harris, D., Caputi, N., de Lestang, S. and Thomson, A. (2011). Status of the Cockburn Sound Crab Fisheries. Fisheries Research Report No. 219. Department of Fisheries, Western Australia. 104 pp.

3 Ryan, K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. and Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia. 162 pp.

5pm. As there is a significant level of early morning recreational crabbing in Cockburn and Warnbro Sounds, an additional survey was conducted between 5.30 am and 9am during the 2009/10 crabbing season. This survey provided an additional recreational catch estimate for this area of 18.8 t (S.E.±5.5 t) of blue swimmer crabs for the 3½ months of the 2009/10 season.

All of Cockburn Sound was again re-opened to recreational crabbing for the 2010/11 season from December 15th 2010 to April 30th 2011.

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 specifically in the Swan-Canning Estuary.

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

Fishing effort/access level

After three years of closure due to declining crab stocks, the Cockburn Sound (Crab) Managed Fishery partially re-opened for the 2009/10, 2010/11 and 2011/12 fishing seasons. Commercial fishers in Cockburn Sound reported a total of 76,190 trap lifts for the 2011/12 season, a 38% increase on the 55,294 trap lifts reported during the 2010/11 season (West Coast Blue Swimmer Crab Figure 2) as a result of extending the season by 2.5 months.

Commercial fishers in the Peel-Harvey Estuary reported 48,263 trap lifts during the 2011/12 season – a 17% decrease on the 58,119 trap lifts reported the previous year (West Coast Blue Swimmer Crab Figure 3).

Commercial effort in the Mandurah to Bunbury Developing Crab Fishery increased 61% in 2011/12, with a total of 21,172 trap lifts reported compared to 13,186 trap lifts the previous year (West Coast Blue Swimmer Crab Figure 4), primarily because the Mandurah to Bunbury fisher resumed operations.

Stock Assessment

Assessment complete: Yes

Assessment method and level:

Cockburn Sound Level 4 - Direct survey

Peel-Harvey Level 2 - Catch rate

Other West Coast fisheries Level 2 - Catch rate

Breeding stock levels:

Cockburn Sound Adequate

Peel-Harvey Adequate

Other West Coast fisheries Adequate

Catch rates from crab 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. In addition, direct surveys generating recruit, residual and breeding stock indices, along with data on the general crab population, have been conducted in Cockburn Sound for about 10 years and in the Peel-Harvey for five years.

Cockburn Sound: Historically, natural variations in stock abundance resulted in large fluctuations in the annual commercial blue swimmer crab catch from Cockburn Sound. This fluctuation related 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 effective effort and mean annual crab landings. Following the second highest annual catch on record in 2000 (340 t) the catch began to decline over the next few years to the point where low stock abundance required closure of the fishery in December 2006 for two seasons.

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.

Fishery-independent trawl and commercial monitoring surveys conducted during 2009 suggested the strength of both recruitment and breeding stock in Cockburn Sound had improved sufficiently to re-open the crab fishery for the 2009/10 fishing season.

The catch in 2011/12 of 46 t was lower than the previous year's catch of 53 t, despite an increase in effort (~80,000 pot lifts in 2011/12 compared to 55,000 potlifts in 2010/11) due to the 2½ month extension of the commercial fishing season to June 15th and a lowering of the minimum size for male crabs from 135 to 130 mm. This relatively low catch was generated by the very high proportion of undersize crabs present in Cockburn Sound resulting in a low proportion of legal sized crabs being present through the season. It appears that the majority of crabs did not moult during the December – January period, with the majority of the cohort remaining at sub-legal sizes for the remainder of the season. Historically, the majority of crabs moult to legal size between December and January, with a high proportion of crabs remaining legal size through the season. This lack of moulting during the 2011/12 season was only observed in Cockburn Sound; the proportion of legal sized crabs in Swan River, Warnbro Sound and Peel Harvey were all at normal or higher levels.

Recruitment index: Based on the juvenile (0+) catches sampled in the research trawls the recruitment of juvenile crabs within Cockburn Sound remained at acceptable levels in 2012. The index has now remained above 1.0 since 2010; substantially above the 0.15 value observed in 2006 (West

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Coast Blue Swimmer Crab Figure 5).

Residual index: The abundance of residual crabs (1+) was again strong in 2012 with the index having now been above 10 for the past three seasons (West Coast Blue Swimmer Crab Figure 5) as a result of the closure and conservative management approach since the resumption of fishing.

Breeding Stock index: The breeding stock (egg production) levels during 2011/12 remains above the proposed threshold breeding stock index of 1.5 (West Coast Blue Swimmer Crab Figure 6) which is based the level of egg production that produced adequate recruitment level during the productive years for the fishery (1989-2003) as determined from the relationship between egg production and recruitment. The levels of juvenile and residual abundance observed in 2012 suggest that the breeding stock in 2012/13 should be maintained at an acceptable level.

Peel Harvey: The mean annual catch rate for 2011/12 in the Peel-Harvey Estuary was 1.68 kg/trap lift, substantially higher than the 2010/11 catch rate of 1.07 kg/trap lift (West Coast Blue Swimmer Crab Figure 3), and representing the highest catch rate since the fishery converted from nets to crab traps in 1996/97.

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 therefore the trends in the recreational fishery can affect the stock status. This highlights the importance of having established fishery-independent surveys that will soon be able to complement the commercial logbook and monitoring data.

Mandurah to Bunbury: Mean annual trap catch rates in the Mandurah to Bunbury 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 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 2011/12 in the Mandurah to Bunbury fishery was 0.71 kg/trap lift – a 12% decrease on the 2010/11 catch rate of 0.81 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 byproduct 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 crab 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 2011/12, approximately 31 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 Geopraphe Bay region, where they dominate the inshore recreational catch.

Economic Effects

Estimated annual value (to fishers) for year

2010/11: Level 2 - \$1-5 million (\$1.65 million)

The commercial blue swimmer crab catch in the West Coast Bioregion for 2011/12 was valued at around \$1.65 million, a 43% increase on the \$1.15 million generated in 2010/11. Most of the catch from the West Coast Bioregion was sold through local markets.

The economic value of the total commercial blue swimmer crab catch for the State of Western Australia for the 2011/12

financial year was estimated to be \$2.53 million – a 58% decrease on the estimated \$6.35 million generated in 2010/11.

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 when the management arrangements are stabilised. 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 (2012/13)

As an outcome of a review into the management for Cockburn Sound, the following arrangements were implemented in December 2012 for this fishery:

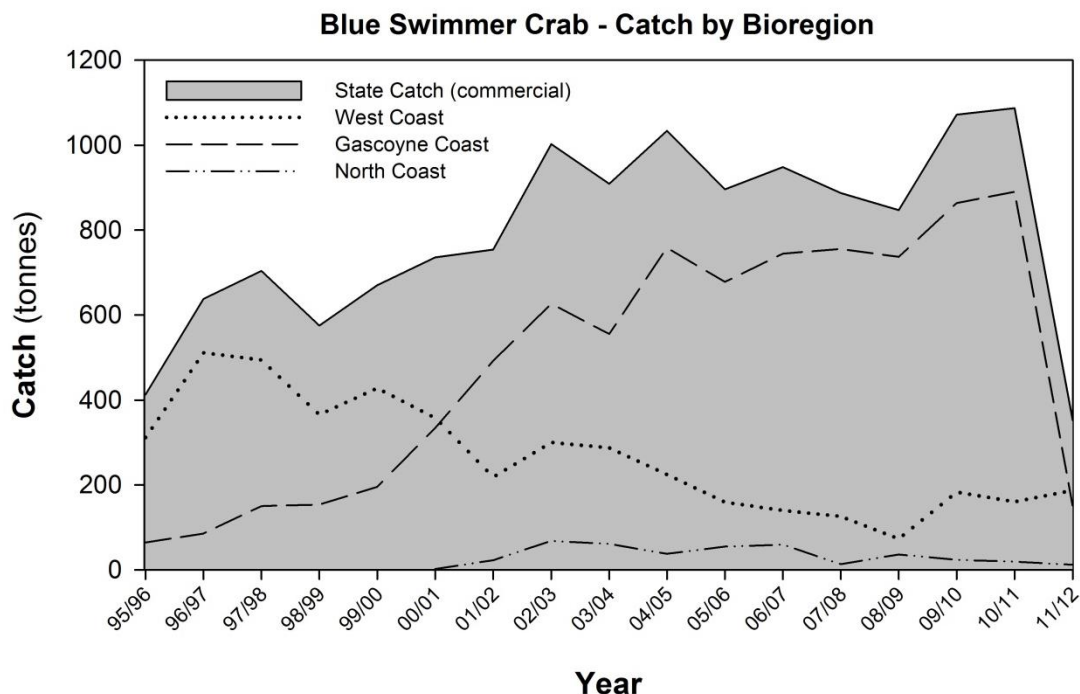
- Maintenance of the commercial fishing season from 15 Dec to 15 June;

- Maintenance of the recreational fishing season from 15 Dec to 30 July;
- A decrease in commercial size limit for female blue swimmer crabs from 135 to 130 mm CW;
- Retention of the commercial size limit for male blue swimmer crabs at 130 mm CW;
- Maintenance of the current 20% pot reduction in the commercial fishery.

The Mandurah to Bunbury Developing 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.

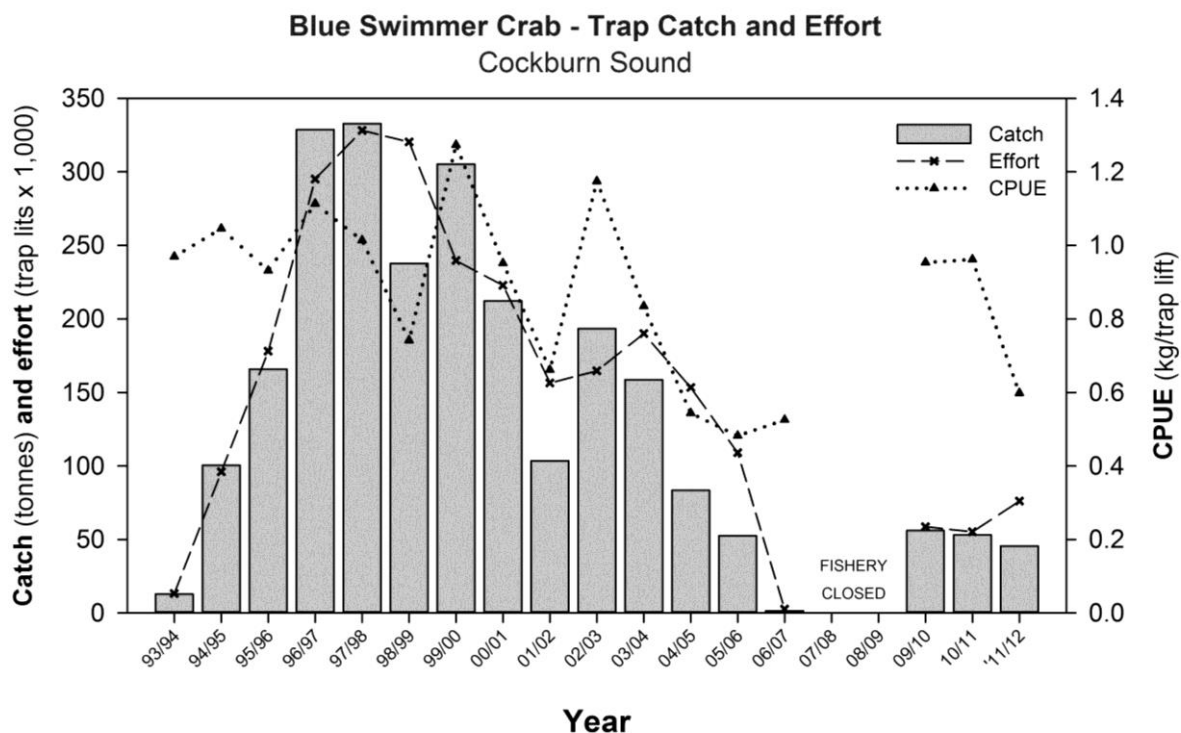
External Factors

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.

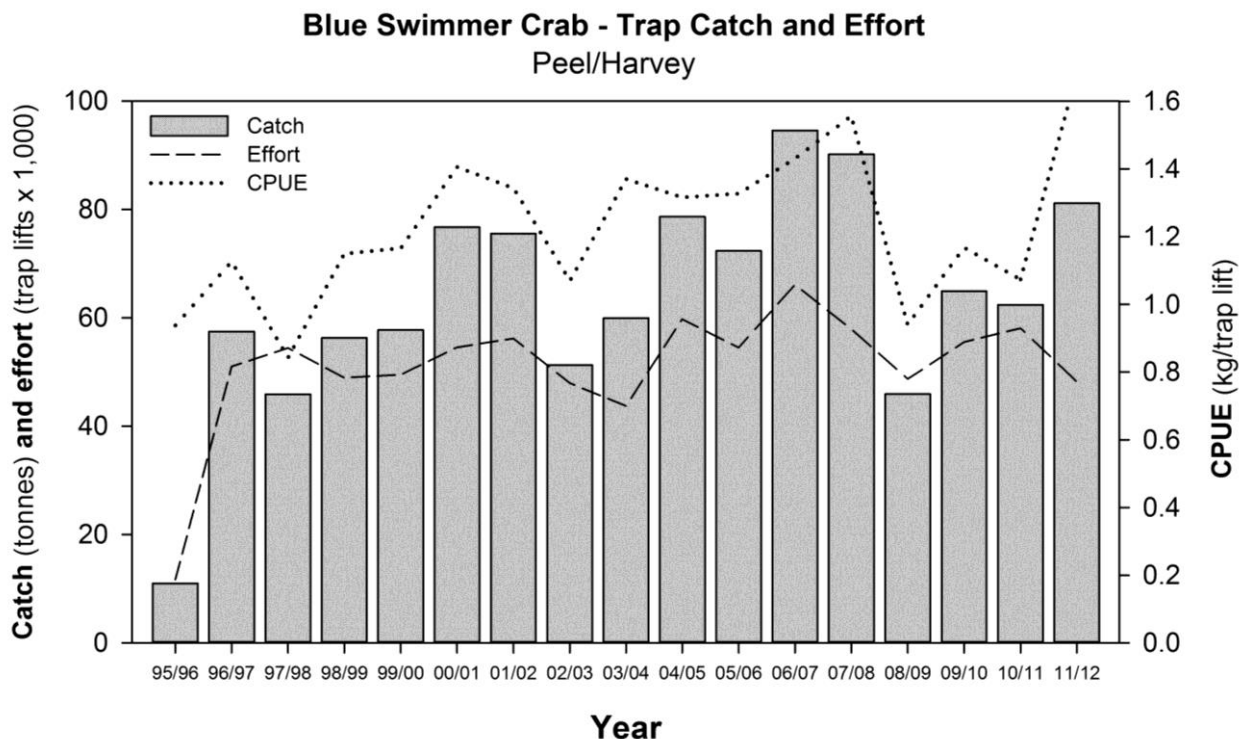


WEST COAST BLUE SWIMMER CRAB FIGURE 1

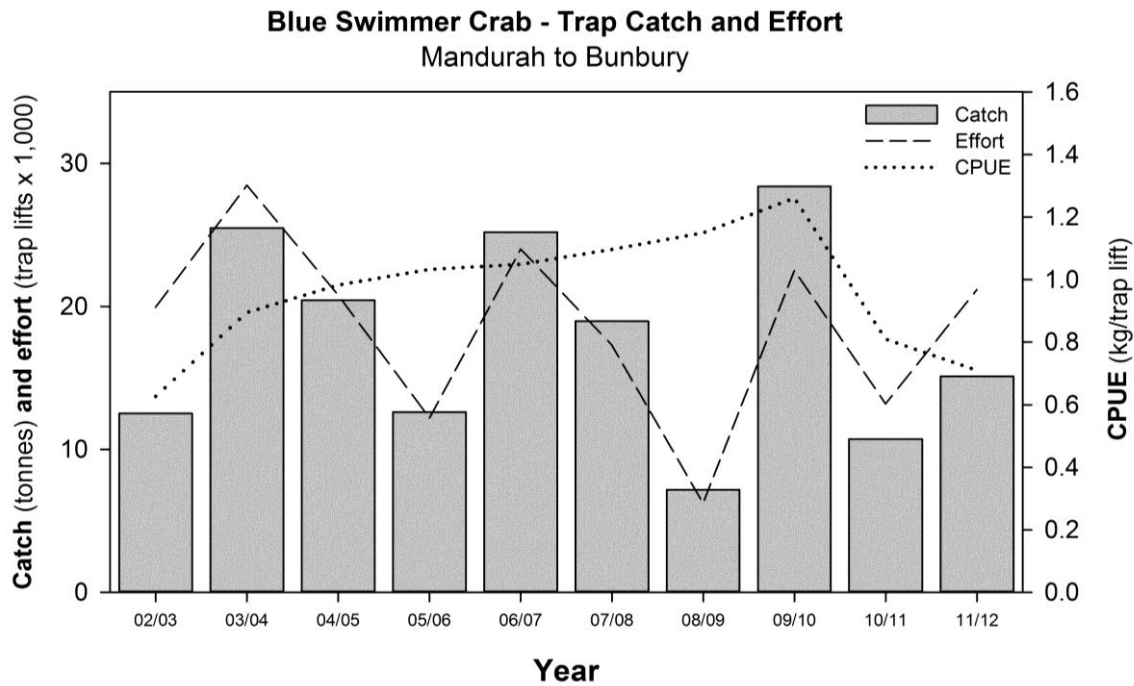
State and bioregion commercial catch history for the blue swimmer crab in Western Australia since 1995/96.

**WEST COAST BLUE SWIMMER CRAB FIGURE 2**

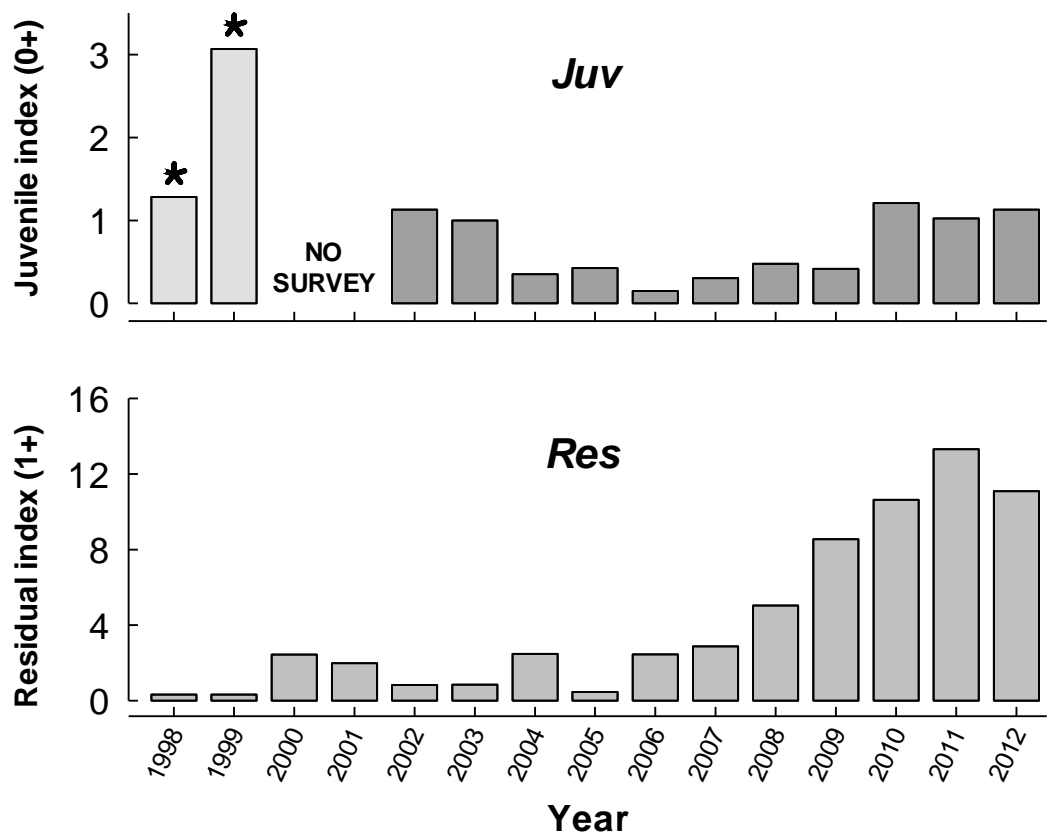
Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in the Cockburn Sound Crab Fishery using traps since 1993/94.

**WEST COAST BLUE SWIMMER CRAB FIGURE 3**

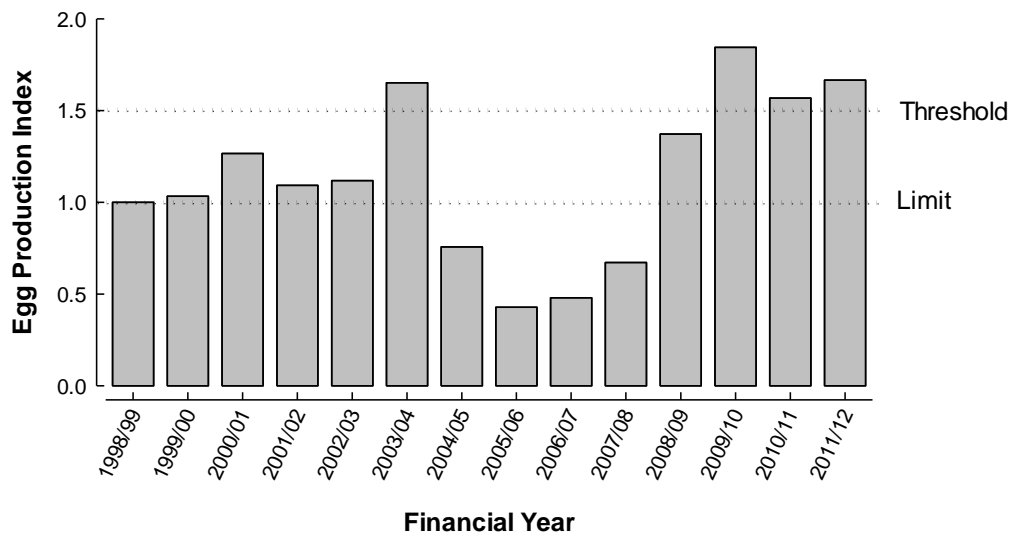
Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in Area 2 of the West Coast Estuarine Fishery (the Peel-Harvey Estuary) using traps since 1995/96.



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 Developing Crab Fishery since 2002/03.



WEST COAST BLUE SWIMMER CRAB FIGURE 5
Annual standardized index of juvenile (0+) recruitment and residual (1+) blue swimmer crabs in Cockburn Sound. Juvenile recruitment data was derived from juvenile research trawl conducted in April, May and June of each year, and residual data was derived from catch monitoring surveys aboard commercial crab vessels in August and September of each year. * Daytime trawling (conversion factor (5.84) used for comparison with night trawling).



WEST COAST BLUE SWIMMER CRAB FIGURE 6

Annual standardized egg production index based on numbers and carapace widths of sexually mature female blue swimmer crabs captured during all juvenile trawl surveys between 1996 and 1999, all trawl surveys aboard the Fisheries Research trawlers *RV Flinders* (1999 –2001) and *RV Naturaliste* (2001-2012), and all catch monitoring surveys aboard commercial crab vessels in Cockburn Sound (1999-2012). Proposed threshold (1.5) and limit (1.0) levels are indicated.

West Coast Nearshore and Estuarine Finfish Resources Status Report

K. Smith, A. Howard and J. Brown

Main Features

Status

Stock level:	
Australian herring	Unacceptable
Southern school whiting	Acceptable
Tailor	Acceptable
Southern garfish	Acceptable
King George whiting	Acceptable
Sea mullet	Acceptable
Whitebait	Acceptable
Black bream (Swan-Canning)	Acceptable
Cobbler (Peel-Harvey)	Acceptable

Fishing level:

Australian herring	Unacceptable
Other stocks	Acceptable

Current Landings (2012)

Commercial total	319 t (finfish only)
South West Coast Salmon Fishery	47 t (salmon only)
West Coast Beach Bait & South West Beach Seine Fisheries	83 t (whitebait only)
West Coast Estuarine Fishery	99 t (finfish only)
Recreational total	
Most recent survey 2000/01	940 t (key species only)
Recreational boat-based	
Most recent survey 2011/12	108 t (key species only)

Fishery Description

Commercial - Nearshore

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

The Cockburn Sound (Fish Net) Managed Fishery uses haul nets in Cockburn Sound. The main target species are southern garfish (formerly 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 western 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 southwards to Port Geographe Bay Marina. These seine net fisheries both target whitebait (*Hyperlophus vittatus*), but blue sprat (*Spratelloides robustus*), sea mullet (*Mugil cephalus*), yellowfin whiting (*Sillago schomburgkii*), southern garfish and yelloweye 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, yellowfin whiting and southern 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 armatus*) 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*), southern school whiting (*Sillago bassensis*), southern 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 Fish Net Managed Fishery Licence

Cockburn Sound (Line and Pot) Management Plan 1995

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

West Coast (Beach Bait Fish Net) Managed Fishery Licence

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

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

Salmon and Snapper Purse Seining Prohibition Notice 1987

Directions to Licensing Officers

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Recreational Net Fishing Licence

Recreational Fishing From Boat Licence

Consultation processes

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual Management Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

Boundaries

Commercial - Estuarine

WCEF: The management plan encompasses all estuaries in

the West Coast Bioregion between 27° S and 33°11' S. Complex closures exist for both the Swan/Canning and Peel/Harvey commercial fisheries (refer to management plans, related legislation and regulations).

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 – 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 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 WA. A Recreational Fishing from Boat Licence 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 has selected several key species as indicators for monitoring and assessing the status of the

finfish resources in the West Coast Bioregion (DoF 2011¹). Australian herring, tailor, southern garfish, southern school whiting and whitebait are indicators for this Bioregion's nearshore finfish suite and black bream, Perth herring (*Nematalosa vlaminghi*) and cobbler (*Cnidogobius macrocephalus*) are indicators for the estuarine finfish suite. Although not indicator's, the status of sea mullet and King George whiting (*Sillaginodes punctata*) is also reported here because they are significant components of nearshore fishery landings in this Bioregion.

Research summary

The status of the fish resources in nearshore and estuarine waters of the West Coast Bioregion is assessed by monitoring the status of indicator species (see DoF 2011 for details). Level 2 assessments of indicators are based on trends in commercial catch and effort obtained from compulsory monthly fisher returns, trends in recreational catch and effort obtained from voluntary fisher logbooks (the 'Research Angler Program') and recreational fishing surveys, and trends in juvenile recruitment obtained from fishery-independent surveys. Level 3 assessments of indicators include all of the above information plus information about rates of fishing mortality (F) estimated from the age composition of fishery landings. Fish collected from recreational and commercial fishers are used to determine age structure. Where available, any archived biological samples have been used to estimate historical F levels.

A 4-year State NRM-funded research project designed to provide more rigorous monitoring and assessment of the status of West Coast Bioregion nearshore indicator species (Australian herring, tailor, whiting species and southern garfish) was completed in 2012/13. Stock assessments were completed for all species (see 'Stock Assessments' below). New monitoring strategies developed during this project are now being implemented for each indicator species.

As part of the above project, the species composition of all whiting landings within the West Coast Bioregion was investigated. With the exception of King George whiting, a significant proportion of whiting taken recreationally, and a small proportion taken commercially, were found to be misidentified. The vast majority (~90%) of whiting (excluding King George whiting) taken recreationally were found to be southern school whiting, while the majority of whiting taken commercially were found to be yellowfin whiting.

A pilot tagging study of Australian herring was conducted in the West Coast Bioregion in 2012 to develop another method of estimating of fishing mortality. Approximately 4,500 fish were tagged. Tagging was scheduled to continue in 2013 and 2014 but was ceased due to the low availability of herring in the West Coast Bioregion. Some tagged fish have been recaptured. An eventual recapture rate of about 2-3% is anticipated, which may provide information about movement within the Bioregion to aid interpretation of other data and assist spatial management for Australian herring.

A tagging study of tailor involving volunteer recreational

fishers commenced in 2012 and is ongoing. Recaptures will provide information about tailor movement and stock structure in WA.

A state-wide survey of boat-based recreational fishing was conducted in 2011/12 (Ryan *et al.* 2013²). During this survey, nearshore species including southern school whiting and Australian herring were the most common species caught in the West Coast Bioregion. This survey provided information on catches from boat-based recreational fishers. Catches from shore-based fishers, who take the majority of nearshore species, were not estimated.

Retained Species

Total commercial finfish landings (2012)³:

198 tonnes in nearshore waters

121 tonnes in estuarine waters

Commercial landings by fishery (2012):

South West Coast Salmon: 47 tonnes (salmon)

**WC Beach Bait + SW Beach Seine: 66 tonnes
(whitebait only)**

West Coast Estuarine: 99 tonnes (finfish only)

Catches (West Coast Nearshore and Estuarine Table 1) are taken by commercial estuarine and beach-based fisheries using gill nets, haul nets and beach seines. The minor quantities of the same species taken by other methods (e.g. purse seine, demersal gill nets and long-lines) are not included in Table 1 but the total catch by all methods and fisheries is used for stock assessments.

In 2012, the total commercial catch of finfish by estuarine and beach-based fisheries in the West Coast Bioregion comprised approximately 30 species with the majority consisting of sea mullet (32% by weight), whitebait (21%), western Australian salmon (15%) and Australian herring (9%).

Commercial landings of key finfish species:

Many of the key species listed here have a stock distribution that extends beyond the West Coast Bioregion. Therefore, in addition to the West Coast landings, the catches of each species taken in other Bioregions and/or at a state level are also given here in order to provide information about the total commercial harvest of the stock.

Australian herring: Australian herring comprise a single stock across southern Australian waters. This species is targeted commercially in WA and South Australia (SA). Negligible quantities are also taken commercially in Victoria.

In WA, 80-90% of total annual commercial landings of Australian herring have been taken in the South Coast

¹ Department of Fisheries (2011) Resource Assessment Framework for Finfish Resources in Western Australia. Fisheries Occasional Publication. No. 85. 24 pp.

² Ryan, K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. & Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia. 162 pp.

³ Note: Values in overview table were from 2011/12

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Bioregion, with the remaining 10-20% taken in the West Coast Bioregion. Consistent with this pattern, the 2012 South Coast Bioregion catch share was 83% with the majority of commercial landings taken by the ocean beach-based herring trap net fishery (see South Coast Nearshore and Estuarine Finfish Resources Report). In 2012, this fishery reported 67% of the total commercial herring catch in WA and 81% of the total commercial herring catch in the South Coast Bioregion. In 2012, the remainder of the South Coast commercial catch was taken in estuaries (12%) and in nearshore ocean waters (7%). The proportion of commercial landings taken by the trap net fishery has been steadily declining since the late 1990s, when the fishery contributed 95% of the South Coast annual catch.

Within the West Coast Bioregion, 50% of landings in 2012 were taken in the Geographe Bay/Bunbury area, 36% taken in Cockburn Sound and 11% taken in the Peel-Harvey Estuary.

In the South Coast Bioregion, the total annual commercial catch reached an historical peak of 1,427 t in 1991 and then steadily declined to an historical low of 110 t in 2011 with landings in 2012 of 135 t. Recent low catches in the South Coast Bioregion reflects declining catches by the trap net fishery due to a combination of factors – reduced availability of fish from declining stock level and multiple recent years of low recruitment plus lack of targeting in response to low market demand.

In the West Coast Bioregion, the total annual commercial catch of Australian herring reached an historical peak of 211 t in 1988 and attained a similar level of 191 t in 1992. Annual landings have steadily declined to reach an historical low of 28 t in 2012. The downward trend in the West Coast Bioregion mainly reflected declining catches in the Geographe Bay/Bunbury area, where the majority of West Coast landings are taken. These declines were partly due to a substantial decline in fishing effort (i.e. decline in targeting) attributable to the reduced availability of fish.

Nationally, commercial landings of Australian herring peaked at approximately 1800 t per year in the late 1980s and early 1990s and steadily declined thereafter (West Coast Nearshore and Estuarine Figure 1). National landings were approximately 262 t in 2012, the lowest level since the start of reliable catch records in 1950. Commercial landings within WA and in SA each followed this downward trend. In WA, landings peaked at 1,537 t in 1991 and reached an historical low of 147 t in 2011. In 2012, total WA landings were 163 t. In SA, landings peaked at 498 t in 1987/88 and reached an historical low of 99 t in 2011/12 in SA¹. The proportion of total commercial landings taken in South Australia was relatively constant, typically 20-30% per year, from the early 1970s until 2008. However, since 2008 SA annual landings have comprised about 42% of the national catch.

Whiting: The total annual commercial catch of ‘whiting’ in the West Coast Bioregion has been gradually declining due to

an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of various Voluntary Fishery Adjustment Schemes (VFAS) (licence buy-backs) operating since 1990. The vast majority of ‘whiting’ (excluding King George whiting) landed by commercial fishers in this Bioregion are yellowfin whiting with 19 t taken commercially in 2012.

Relatively low quantities of southern school whiting are taken commercially in the West Coast Bioregion (6 t in 2012).

Tailor: In WA, tailor is found in coastal waters from Onslow to Esperance and is likely to constitute a single stock over this range. Incomplete records prior to 1976 suggest the total WA annual commercial catch of tailor probably peaked in 1965 at approximately 90 t. Since 1976, annual landings have fluctuated between 19 and 59 t but with an overall stable trend (West Coast Nearshore and Estuarine Figure 2). In 2012, the total WA commercial catch of tailor was 26 t, the majority of which was taken in the Gascoyne Coast Bioregion (64% by weight), with the remainder from the West Coast Bioregion (34%) and South Coast Bioregion (2%).

In the Gascoyne Coast Bioregion, total landings of tailor were typically 20-30 t per year during the period 1976-1990. Annual landings were markedly higher (>30 t per year) during the period 1990-2000, including an historical peak of 49 t in 1999. Elevated catches in this period probably reflect a higher availability of fish due to strong recruitment. After 2000, annual landings returned to levels similar to those reported prior to 1990. In 2012, the Gascoyne catch was 16 t, all of which was taken in Shark Bay.

In the West Coast Bioregion, total commercial landings of tailor declined from 28 t in 1976 to reach an historical minimum of 2 t in 2008. Subsequent landings have increased slightly, reaching 9 t in 2012. The majority (84%) of West Coast landings in 2012 were taken in the Peel-Harvey Estuary.

Southern garfish: There are possibly five species of garfish landed in southern WA waters with the vast majority believed to be southern garfish (*Hyporhamphus melanochir*) with small quantities of river garfish (*H. regularis*) and robust garfish (*H. robustus*) also landed. In 2012, 52% of total WA commercial landings of southern garfish were taken in the West Coast Bioregion, with the remainder in the South Coast Bioregion.

In the West Coast Bioregion, total annual southern garfish landings peaked at 44 t in 1999. Subsequently, annual landings have been variable with downward trend with a historic minimum of 6 t taken in 2012. The long-term decline in catch was partly due to a reduction in commercial effort but the decline in catch in 2012 probably reflected a decline in the availability of fish.

Since 1995, 82% of total commercial landings of southern garfish in the West Coast Bioregion have been taken in Cockburn Sound. The historical peak in annual landings within Cockburn Sound was 37 t in 1999. Since 1999, annual landings of garfish in Cockburn Sound have gradually declined, following the same trend as total West Coast Bioregion landings (including reaching an historic minimum level in 2012).

¹ Fowler, A.J., McGarvey, R., Steer, M.A. & Feenstra, J.E. (2012). South Australian Marine Scalefish Fishery. Stock Status Report 2011/12. Report to PIRSA Fisheries and Aquaculture South Australian Research and Development Institute (Aquatic Sciences), Adelaide. F2007/000565-7. SARDI Research Report Series No. 681. 44 pp.

King George whiting: King George whiting occurs in coastal waters in the West Coast and South Coast Bioregions with majority of landings occurring in estuaries. There is likely to be high connectivity between Bioregions due to adult migration and larval dispersal, but additional research is required to determine whether King George whiting should be managed as a single stock.

Annual landings of King George whiting are typically highly variable, mainly reflecting variations in juvenile recruitment due to environmental factors. In 2012, 4 t of King George whiting was taken commercially in the West Coast Bioregion, representing 26% of the total annual commercial catch in WA with the remainder taken in the South Coast.

Sea mullet: Sea mullet occurs in coastal waters in all WA Bioregions with high connectivity due to adult migration and larval dispersal. There may also be connectivity between sea mullet along the south coast of WA and in SA.

The total WA annual catch of sea mullet peaked at 694 t in 1988 but has gradually declined mainly due to widespread reductions in commercial fishing effort in nearshore and estuarine waters. In 2012, the WA total catch was 175 t. In 2012, 58% of the total WA catch was taken in the West Coast Bioregion, 24% in the Gascoyne Coast Bioregion, 17% in the South Coast Bioregion and 1% in the North Coast Bioregion.

In the West Coast Bioregion, commercial landings of sea mullet were highest during the 1970 and 1980s, including an historical peak of 429 t in 1988 (West Coast Nearshore and Estuarine Figure 4). Between 1988 and 2004, the total annual catch in the West Coast Bioregion steadily declined. The decline was partly due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of VFAS (licence buy-backs) operating since 1990. From 2004 to 2012, total landings were stable at 100-120 t per year, with the exception of 2011 when landings declined to 77 t. In 2012, the catch was 102 t. In 2012, 54% of total commercial landings of sea mullet in West Coast Bioregion were taken in the Peel-Harvey Estuary and the remainder taken from ocean waters near Jurien Bay (latitude 30-31°S).

In the Gascoyne Coast Bioregion, the vast majority (>90% per year) of commercial sea mullet landings are taken by the Shark Bay Beach Seine and Mesh Net Managed Fishery. Refer to the *Inner Shark Bay Scalefish Fishery Status Report* for details of the catch and effort in this fishery.

In the South Coast Bioregion, commercial landings of sea mullet have been stable since 1976 with the annual catch having averaged 36 t (range 11-94 t per year). In 2012, the catch was 30 t (West Coast Nearshore and Estuarine Figure 3). The vast majority (>90%) of annual landings of sea mullet in the South Coast Bioregion have been from estuaries. In 2012, 37% of total commercial landings of sea mullet in the South Coast Bioregion were taken in Oyster Harbour, 23% in Wilson Inlet, 15% in Beaufort Inlet, 7% in Stokes Inlet and 6% in Princess Royal Harbour. Minor sea mullet landings were also reported in 4 other estuaries in 2012.

Whitebait: In WA, whitebait occurs from Kalbarri southwards but is relatively rare along the south coast. All commercial landings of whitebait in WA are taken in the West Coast Bioregion, between Perth and Busselton. Fishing has historically occurred in two areas: Area 1 (Tim's Thicket to Busselton) is fished by the South West Beach Seine Fishery and Area 2 (Perth to Tim's Thicket) is fished by the

West Coast Beach Bait Managed Fishery. Total landings have declined since the 1990s when an historic peak of 302 t occurred in 1996/97 (West Coast Nearshore and Estuarine Figure 4). The decline in total landings mainly reflects declines in Area 2. In 2011/12, the total catch was 83 t, all of which was landed in Area 1.

In Area 2, declines in landings since the 1990s were partly due to effort reductions, particularly between 2002/03 and 2003/04 when the number of vessels operating in this area declined from 8 to 2 per year. Since 2003/04, low (or zero) catch levels in Area 2 are attributed to a low availability of fish.

Since 2004/05, virtually all (98%) whitebait landings have been in Area 1. Annual landings in this area have followed a relatively stable trend (i.e. non-directional over the long term) since the late 1980s. The decline in landings in Area 1 after 2000/01 was due to a decline in effort.

In 2010/11, the total commercial catch of whitebait was 38 t, virtually all of which was landed in Area 1. This was the lowest total whitebait catch since the commencement of the fishery in the early 1970s. It coincided with very unusual oceanographic conditions associated with a 'heatwave' event along the west coast (Pearce *et al.* 2011¹). Substantial variations in whitebait landings appear to occur in response to environmental factors including El Niño-Southern Oscillation (ENSO) and Leeuwin Current fluctuations (Gaughan *et al.*, 1996)².

Perth herring: Perth herring is endemic to the West Coast Bioregion of WA and constitutes a single stock over this range. 'Perth herring' previously reported from the Gascoyne Coast Bioregion are now believed to be a different species. 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. Since 2000, <3 t of Perth herring per year has been reported from the Peel-Harvey Estuary.

Recent landings of Perth herring are very low compared to historical landings. Total West Coast Bioregion landings peaked at 239 t in 1978. From the late 1970s to the early 1990s, Perth herring was captured by various netting fisheries in ocean and estuarine waters (including purse seine, gill and haul net fisheries). The species is now infrequently caught in ocean waters. From 1963 to 1988, annual commercial catches of Perth herring in the Swan-Canning Estuary were consistently >40 t, including a historical peak of 178 t in 1968. Declining landings were partly due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of VFAS (licence buy-backs) operating since 1990. However, deteriorating environmental conditions

1 Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. & Gaughan, D. (2011). The 'marine heat wave' off Western Australia during the summer of 2010/11. Fisheries Research Report No. 222. Department of Fisheries, Western Australia. 40 pp.

2 Gaughan, D.J., Fletcher, W.J., Tregonning, R.J. and J. Goh. (1996) Aspects of the biology and stock assessment of the whitebait, *Hyperlophus vittatus* in south western Australia. Fisheries Research Report, Fisheries Department of Western Australia 110, 1-115

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in West Coast Bioregion estuaries and historical overfishing are believed to be the main factors contributing to the current low stock level.

Cobbler: In WA, commercial targeting of cobbler is restricted to estuaries. Each estuary hosts a discrete stock of cobbler, which is genetically distinct to other estuarine populations and also distinct to cobbler populations in adjacent ocean waters. Since 2000, 95% of commercial landings of cobbler have been caught in estuaries of the South Coast Bioregion, with the remaining 5% in estuaries of the West Coast Bioregion. Virtually all West Coast landings over this period were in 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, annual 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 2012, 5 t of cobbler was reported in this estuary.

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 on catching cobbler in the Swan-Canning Estuary was introduced on 6 July 2007 and is in effect until 2017 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 landings of cobbler ranged from <1 t to 6 t.

Declining landings were partly due to an ongoing reduction in commercial effort in estuaries since 1990. However, deteriorating environmental conditions in West Coast Bioregion estuaries and historical overfishing are believed to be the main factors contributing to the current low stock levels.

Black bream: Black bream is a true estuarine species, spending its entire life cycle in these waters. Each estuary hosts a discrete stock of black bream, which is genetically distinct to other estuarine populations. Most estuaries and coastal lagoons in south-western WA host a black bream population. In 2012, 97% of commercial landings of black bream were in the South Coast Bioregion, with the remaining 3% from the West Coast Bioregion.

In the West Coast Bioregion, commercial landings of black bream have always been relatively low compared to landings of other estuarine target species. Historically, the Swan-Canning Estuary and Hardy Inlet contributed the vast majority of commercial black bream landings. Landings peaked at 8 t in 1996 in the Swan-Canning Estuary and

peaked at 4 t in 1983 in Hardy Inlet. Occasional landings were taken in the Leschenault Estuary (<2 t per year), prior to the closure of that fishery. Annual landings of black bream in the Peel-Harvey Estuary have always been negligible. 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 black bream fishery in the West Coast Bioregion. Since 2000, total West Coast Bioregion commercial landings of black bream have ranged from <1 to 5 t per year.

Recreational catch estimate (2012): N/A

Nearshore + estuarine catch (most recent estimate 2000/01): 940 tonnes (key species only)

Boat-based nearshore + estuarine catch (most recent estimate 2011/12):

108 tonnes (key species only)

The recreational catch levels of finfish in nearshore and estuarine waters of the West Coast Bioregion were not completely estimated for 2012. A Statewide recreational fishing survey in 2011/12 estimated boat-based catches of finfish in nearshore and estuarine waters. However, shore-based catches were not included in this survey and so total recreational catches are not known.

The most recent complete estimates are from the National Recreational and Indigenous Fishing Survey conducted in 2000/01 (West Coast Nearshore and Estuarine Table 2). In 2000/01, the most abundant species in the retained catch of nearshore and estuarine finfish (combined) were Australian herring (48% by number), whiting (various species, excluding King George) (24%), tailor (9%), southern garfish (3%), King George whiting (2%) and trevally (*Pseudocaranx* spp.). In nearshore waters, the regions contributing the highest catches were southern Perth, Mandurah and Geographe Bay/Bunbury, each of which contributed about 20% of all retained nearshore fish in the Bioregion. During the 2000/01 survey, 61% of fish retained in West Coast nearshore waters were taken by shore-based fishers and 39% by boat-based fishers.

While the dominant nearshore/estuarine species in the current catch are probably similar to those caught in 2000/01, the current catch and effort levels by recreational fishers may have changed substantially since this survey. Although several surveys of boat-based fishing have been conducted since 2000/01, no subsequent surveys of shore-based fishing have been undertaken. Shore-based fishers are believed to take the majority of nearshore and estuarine finfish. The current total recreational catch level in nearshore and estuarine waters cannot be estimated without current information about the shore-based catch.

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.* 2011¹). During this three-month

1 Smallwood, C. B., Pollock, K. H., Wise, B.S., Hall, N.G. and Gaughan, D.J. 2011. Quantifying recreational fishing catch and effort: a pilot study of shore-based fishers in the Perth Metropolitan area. Fisheries Research Report No. 216.

pilot study, the most frequently retained species were Australian herring, southern garfish and whiting (combined species).

Surveys of boat-based recreational fishing in the West Coast Bioregion were conducted in 1996/97, 2005/06, 2008/09 and 2009/10, and a state-wide survey of boat-based recreational fishing was conducted in 2011/12. During the 2011/12 survey, total of 174 finfish species were taken by boat-based fishers in the West Coast Bioregion with nearshore species dominating the catch. The most common were southern school whiting (20% of the West Coast catch by number), Australian herring (16%), silver trevally (5%), King George whiting (5%), pink snapper (5%), black bream (4%), tailor (3%), West Australian dhufish (*Glaucosoma hebraicum*) (3%) and western king wrasse (*Coris auricularis*) (3%).

Between 1996/7 and 2011/12 there was a decline in the annual catches of Australian herring, southern school whiting and southern garfish by boat-based fishers in the West Coast Bioregion. The annual catch of tailor initially declined but then increased over the same period (West Coast Nearshore and Estuarine Table 3).

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 usually calculated as the number of days fished by each method. Fishing effort is sometimes reported as the number of units of access (vessels, licensees, teams, etc). This measure is sometimes the only type of effort data available throughout the history of the fishery and provides a general indication of effort changes over time.

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: A substantial proportion of fishing effort in this estuary is directed towards the capture of blue swimmer crabs (50-60% of method days per year since 2000). The vast majority of crabs are taken by crab pots, whereas finfish are taken by gill and haul nets. Since 2000, the effort spent targeting finfish in this estuary (i.e. days spent gill and haul netting) has been stable, fluctuating between 600 and 1200 method days per year. Since 2000, the mean number of active fishing units per month has been about 8. There are currently 11 licences in the fishery.

Swan-Canning Estuary: The mean number of active fishing units per month declined from about 25 in the mid-

1970s to 1 in 2009 and subsequent years. A majority of total commercial effort in 2012 (and other recent years) was targeted towards 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 2012. Virtually all commercial effort in recent years was spent targeting a limited number of finfish species.

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 2012 was 303. In 2012, 6 licensees reported finfish landings by netting methods in this region.

South West Coast Salmon Fishery: From 1997 to 2005, 15 teams were licenced to capture western Australian salmon in the West Coast Bioregion. This number was reduced via VFAS to 12 teams in 2006 and then to 8 teams in 2010 and subsequent years. Only 3 of the 8 teams reported salmon catches in 2012.

West Coast Beach Bait and South West Beach

Seine Fisheries: In 2012, 7 licensees reported landings of whitebait.

Recreational

Current estimates of total recreational effort expended on targeting nearshore or estuarine finfish in the West 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 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 (nearshore and estuarine combined) 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.

Surveys of boat-based recreational fishing in the West Coast Bioregion were conducted in 1996/97, 2005/06, 2008/09 and 2009/10, and a state-wide survey of boat-based recreational fishing was conducted in 2011/12. 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 specifically targeting nearshore finfish during these surveys is unknown. In 2011/12, 52% of total annual boat-based fishing effort (boat days) in the West Coast Bioregion was estimated to have occurred in nearshore habitats (i.e. bottom depth <20m) and 18% in estuaries.

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 a recent pilot study of shore-

based fishing (Smallwood *et al.* 2011¹) 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.

Stock Assessments

Assessments complete: Not all

Assessment level and method:

Level 3 - Fishing mortality

Breeding stock levels:

Australian herring Inadequate

Southern school whiting Adequate

Assessment level and method:

Level 2 - Catch rates

Breeding stock levels:

Tailor Adequate

Southern garfish (Cockburn Sound) Adequate

King George whiting Adequate

Sea mullet Adequate

Whitebait Adequate

Black bream (Swan-Canning) Adequate

Cobbler (Peel-Harvey) Adequate

Perth herring Not assessed

Indicator species - nearshore

Australian herring: A level 3 assessment of the stock was completed in 2012 (Smith *et al.* 2013a²). The assessment found evidence of a substantial decline in stock abundance since the late 1990s and a steady increase in fishing mortality (F) over the same period. The estimated current F level is approximately two times higher than natural mortality (M) which is well above the limit reference point for this species. Relatively low annual recruitment was also observed in most years over the past decade. The fishery presently catches predominantly young fish, with >50% of total landings (commercial and recreational) now comprised of young fish that are yet to spawn for the first time. An independent review of this assessment was conducted, and supported the conclusion that the stock level is currently inadequate (DoF 2013³). The assessment recommended a reduction of at least

50% in the total catch of Australian herring.

Low recruitment over the past decade may partly be a consequence of the declining breeding stock level due to overfishing but is also likely to be partly due to environmental factors, including the fluctuations in the strength of the Leeuwin Current. Low recruitment along the southern coast of WA tends to occur in years of weak current. In 2011, extremely unusual oceanographic conditions occurred along the south-western coast of WA, including summer temperatures >3°C above average in some areas (a 'heatwave' event, Pearce *et al.* 2011⁴). These conditions were believed to be unfavourable for spawning by herring. Recruitment was relatively low in 2011. Recruitment improved in 2012 and was the highest level observed in 13 years.

Southern school whiting: A level 3 assessment of the West Coast Bioregion component of the stock was completed in 2012 (Brown *et al.* 2013⁵). The stock level was assessed as adequate. The current rate of fishing mortality (F) was estimated from the age structure of recreational landings in the West Coast Bioregion. The estimated current F level was around the target reference level for this species. In the West Coast Bioregion, the majority (>90%) of the catch is comprised of mature fish.

Tailor: A level 2 assessment of the stock was completed in 2012 (Smith *et al.* 2013b⁶). An independent review of this assessment was conducted, and supported the conclusion that the stock level is currently adequate (Department of Fisheries 2013).

Catch rates from a volunteer fishing program in the Swan-Canning Estuary have provided an indicator of the strength of annual recruitment by juvenile (age 0) tailor to the West Coast Bioregion since 1996. Annual recruitment has been relatively strong since 2006/07 (West Coast Nearshore and Estuarine Figure 5). Increasing recreational catch rates of adult tailor throughout the West Coast Bioregion over the past 3 or 4 years are consistent with higher recruitment. Catch and catch rates of tailor in the main commercial fishery, the Shark Bay Beach Seine and Mesh Net Fishery, are within the historical range and are considered acceptable.

Review of Western Australian Department of Fisheries Report, NRM Project 09003. Status of near-shore finfish stocks in south-western Western Australia: Australian herring and tailor. Fisheries Occasional Publication No. 116. Department of Fisheries Western Australia. Perth.

4 Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. & Gaughan, D. (2011). The 'marine heat wave' off Western Australia during the summer of 2010/11. Fisheries Research Report No. 222. Department of Fisheries, Western Australia. 40pp.

5 Brown, J., Dowling, C., Hesp, A., Smith, K. & Molony, B. (2013). Status of nearshore finfish stocks in south-western Western Australia. Part 3: Whiting. Final NRM Report - Project No. 09003. Fisheries Research Report No. 248. Department of Fisheries Western Australia. Perth.

6 Smith, K., Brown, J., Lewis, P., Dowling, C., Howard, A., Lenanton, R. & Molony, B. (2013b). Status of nearshore finfish stocks in south-western Western Australia. Part 2: Tailor. Final NRM Report - Project No. 09003. Fisheries Research Report No. 247. Department of Fisheries Western Australia. Perth.

1 Smallwood, C. B., Pollock, K. H., Wise, B.S., Hall, N.G. and Gaughan, D.J. (2011). Quantifying recreational fishing catch and effort: a pilot study of shore-based fishers in the Perth Metropolitan area. Fisheries Research Report No. 216. Final NRM Report - Project No. 09040. Department of Fisheries, Western Australia. 60pp.

2 Smith, K., Brown, J., Lewis, P., Dowling, C., Howard, A., Lenanton, R. & Molony, B. (2013a). Status of nearshore finfish stocks in south-western Western Australia. Part 1: Australian herring. Final NRM Report - Project No. 09003. Fisheries Research Report No. 246. Department of Fisheries, Western Australia.

3 Department of Fisheries (DoF). (2013). Independent

Southern garfish: Southern garfish are distributed across southern Australia from Kalbarri (WA) to Eden (NSW), and Tasmania. Southern garfish populations on the west and south coasts of WA are genetically distinct (Donnellan *et al.* 2002¹) and are managed as separate stocks. Population structuring at finer scales has not been examined in WA, but evidence from elsewhere indicate that garfish populations are comprised of numerous sub-populations which are separated by small (<60 km) distances (Steer *et al.* 2009², 2010³). On this evidence, garfish caught in Cockburn Sound are assumed to belong to a distinct sub-population and treated as a discrete management unit.

Cockburn Sound provides the majority of commercial landings of southern garfish. Recreational landings in this area are also believed to be substantial, although the total recreational catch is unknown due to lack of information about the shore-based component of the catch. Southern garfish are dependent on seagrass and other marine vegetation for reproduction and feeding. Seagrass area in Cockburn Sound has declined by around 80% since the 1950s and continues to be under threat due to ongoing development (e.g. dredging) (Cockburn Sound Management Council 2005⁴). For these reasons, the sustainability of garfish in Cockburn Sound is at higher risk than other populations in WA.

A level 2 assessment of the Cockburn Sound stock was completed in 2012 (Smith *et al.* in prep). Commercial catch rates suggest the abundance of garfish in Cockburn Sound has been declining gradually since 1996 (West Coast Nearshore and Estuarine Figure 6). The majority (~95%) of the current catch (commercial and recreational) is comprised of mature fish. However, the average size of fish in the commercial catch has declined since the late 1990s (the trend in the recreational catch is unknown). A level 3 assessment (fishing mortality) of the stock is planned for 2013.

King George whiting: A level 2 assessment of the stock was completed in 2012 (Brown *et al.* 2013). Juvenile King George whiting occur in inshore marine waters, whereas adults mainly occur in offshore waters. A high proportion of immature fish in current landings reflects the predominantly

inshore distribution of current fishing effort spent targeting this species. The majority (79%) of King George whiting taken recreationally in the West Coast Bioregion (and 94% in the South Coast Bioregion) are immature fish that are yet to spawn. The majority (>95%) of the commercial catch in both Bioregions also consists of immature fish. Presently, limited targeting in offshore waters is allowing the stock level to be maintained at an acceptable level. An increase in targeting of King George whiting in offshore waters would be a risk to the sustainability of the stock.

Sea mullet: 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. Given this behaviour, trends in catch rates of sea mullet in the Peel-Harvey Estuary and Oyster Harbour, which are both permanently open to the sea, are assumed to be indicative of abundance trends in the West Coast and South Coast Bioregions, respectively. Catch rates of sea mullet in seasonally closed estuaries are not suitable for this purpose because they can vary according to the extent of connectivity to the sea (i.e. sand bar openings) rather than regional abundance.

The annual commercial catch rate of sea mullet in the Peel-Harvey Estuary suggests a stable long-term trend in the availability of sea mullet in the West Coast Bioregion since 1980 (West Coast Nearshore and Estuarine Figure 7). The annual commercial catch rate in Oyster Harbour suggests an increase in the availability of sea mullet in the South Coast Bioregion since 2000. In the Gascoyne Coast Bioregion, catch rates in Shark Bay are assumed to be indicative of local abundance trends. Refer to the *Inner Shark Bay Scalefish Fishery Status Report* for details of the catch rate in this fishery.

Whitebait: Highly variable annual catches and catch rates 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 (Gaughan *et al.* 1996⁵). The total commercial catch of 35 t in 2011 was the lowest since the commencement of the commercial whitebait fishery in the early 1970s. Highly unusual oceanographic conditions, resulting in a 'heatwave' event along the west coast of WA (Pearce *et al.* 2011), occurred in 2011 and are likely to be the main reason for the low catch level.

Anecdotal reports and fishery-independent recruitment surveys by the Department in the Perth area are in agreement with local commercial catch and catch rate trends, all suggesting low abundance of whitebait in the Perth area in recent years due to poor juvenile recruitment (West Coast Nearshore and Estuarine Figure 4). An increase in juvenile recruitment was observed in 2011/12, which is expected to result in an increase in adult abundance in the Perth area in the following year. The annual catch and catch rate trends of whitebait in the Bunbury area suggest relatively stable long term abundance of whitebait in this area (West Coast Nearshore and Estuarine Figure 8).

1 Donnellan, S., Haigh, L., Elphinstone, M., McGlennan, D. & Ye, Q. (2002). Genetic discrimination between southern sea garfish (*Hyporhamphus melanochir*) stocks of Western Australia South Australia, Victoria and Tasmania. In: Fisheries Biology and Habitat Ecology of Southern Sea Garfish (*Hyporhamphus melanochir*) in Southern Australia (Jones GK, Ye Q, Ayvazian S & Coutin P, eds), pp. 9-34. FRDC Project 97/133. Canberra: Fisheries Research and Development Corporation.

2 Steer, M., Fowler, A.J. & Gillanders, B.M. (2009). Age-related movement patterns and population structuring in southern garfish, *Hyporhamphus melanochir*, inferred from otolith chemistry. Fisheries Management and Ecology. 16:265–278.

3 Steer, M., Halverson, G.P., Fowler, A.J. & Gillanders, B.M. (2010). Stock discrimination of Southern Garfish (*Hyporhamphus melanochir*) by stable isotope ratio analysis of otolith aragonite. Environmental Biology of Fishes 89:369–381.

⁴ Cockburn Sound Management Council. (2005). Environmental Management Plan for Cockburn Sound and its Catchment. Department of Environment, Perth.

5 Gaughan, D., Fletcher, W.J., Tregonning, R.J., and Goh, J. (1996). Aspects of the biology in stock assessment of the whitebait, *Hyperophus vittatus*, in south western Australia. Fisheries Research Report No. 108. Department of Fisheries, Western Australia. 127pp.

Indicator species - estuarine

Black bream (Swan-Canning only): 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 2006¹). Voluntary recreational logbook fisher catch rates suggest stable availability of black bream in this estuary from 2004 to 2012 (West Coast Nearshore and Estuarine Figure 9). Black bream in other West Coast estuaries are not assessed.

Cobbler (Peel-Harvey only): Commercial catch rates suggest fluctuating availability of cobbler in the Peel-Harvey Estuary since 1990. The long term trend from 1990 to 2012 was stable (i.e. non-directional) (West Coast Nearshore and Estuarine Figure 10). 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 reported from the lower part of the Swan-Canning Estuary are likely to belong to a separate oceanic 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 fishery-independent 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 West Coast 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 finfish 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 negligible. Estuarine birds have been known to interact with fishing nets, but none have been reported in recent years and the risk to their populations is negligible. 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 Perth 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 partly contributed to poor breeding success by these penguins in recent years (Cannell *et al.* 2012²).

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 2012, 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 2012, there were 3 licensees (involving up to 8 fishers) operating within the West Coast Salmon Fishery during the western Australian salmon season. There were 4-21 commercial fishers per month employed in various fisheries targeting Australian herring during 2012. Australian herring and western Australian salmon fishers in the West Coast Bioregion supply local bait and human consumption markets.

Commercial - estuarine

¹ Smith, K.A. (2006). Review of fishery resources and status of key fishery stocks in the Swan-Canning Estuary Fisheries Research Report 156. Department of Fisheries, Perth.

² Cannell, B.L., Chambers, L.E., Wooller, R.D. & Bradley, J.S. (2012). Poorer breeding by little penguins near Perth, Western Australia is correlated with above average sea surface temperatures and a stronger Leeuwin Current. Marine and Freshwater Research 63:914-925.

In 2012, there was an average of 11 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.

Economic Effects

Estimated annual value (to fishers) for 2012:

Level 2: \$1 to 5 million (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	Under review
Whitebait (West Coast Beach Bait + South West Beach Seine Fisheries)	Acceptable

Target commercial catch range:

West Coast Estuaries (Peel/Harvey only)

75 – 220 tonnes (finfish only)

Cockburn Sound (Fish Net) Fishery

30 – 112 tonnes (finfish only)

Salmon (South West + South Coast Fisheries)

1200 – 2800 tonnes

West Coast Australian herring fisheries

70 – 185 tonnes

Whitebait fisheries

60 – 275 tonnes

With the completion of the State NRM funded research into the assessment and status of nearshore finfish species in the West Coast, and the planned MSC pre-assessment for all West Coast and South Coast Bioregion fisheries scheduled in 2014, management arrangements, governance, and catch ranges will be reviewed. However, the 2012 catches are reported (below) against their current governance arrangements.

In the Peel-Harvey Estuary, the commercial catch of finfish in 2012 was 99 t, which was within the target range.

In the Cockburn Sound Fish Net Fishery the total catch of finfish in 2012 (19 t) was below the target range. The Cockburn Sound finfish catch has been below the target range for 5 of the past 7 years. Effort declined in this fishery during the 2000s and only a single operator has fished since

2009.

The total catch of western Australian salmon (West Coast and South Coast landings combined) in 2012 (122 t¹) was well below the target range and was the lowest recorded since the commencement of these fisheries in the 1940s. The catch has now been below the target range for 6 consecutive years.

The West Coast herring catch by all fisheries in 2012 (28 t) was below the target range. The West Coast herring catch has been below the target range for 8 of the past 9 years (similar to the trend in the South Coast herring catch, which has been below the target range for 10 consecutive years). Recent research outcomes regarding stock status are being used as a basis for reviewing management arrangements to ensure ongoing sustainability for this iconic species.

In 2012, the commercial catch of whitebait (66 t) was within the target range.

Recreational

Current Fishing (or Effort) Level

NA

Target catch range:

Not developed

New management initiatives

New state-wide recreational fishing rules (bag limits, size limits and total possession limits) were introduced in February 2013. This single set of state-wide rules replaced the various Bioregion-specific rules that previously applied to recreational fishers in WA.

The Department will be considering the results of recently completed research on the status of key nearshore species stocks and examining their implications for current management arrangements.

West Coast fisheries are scheduled to undergo MSC pre-assessment in 2014.

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.* 2008²). 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 western Australian salmon and thus their subsequent

¹ Australian salmon catch reported in Annual Report is lower than that reported here, due to the submission of additional 2012 catch and effort data by commercial fishers after publication of the Annual Report. The latest data are included here.

² Hobday, A.J., Poloczanska, E.S. & Mearns, R.J. (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.

WEST COAST BIOREGION

recruitment into each fishery (Lenanton *et al.* 2009¹).

In 2011, a very strong Leeuwin Current resulted in unusually warm ocean temperatures in coastal waters of the southern West Coast Bioregion and the western South Coast Bioregion. This 'heatwave' event caused widespread fish kills in the West Coast Bioregion. During and after this event there were reports of atypical distributions of various species (e.g. tropical species occurring in temperate waters) and unusual fish behaviour. The event altered the distribution and behaviour (eg. spawning activity, migration) of many nearshore finfish species, which is likely to have affected the catch levels of these species in 2011 and may continue to affect them in subsequent years.

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 garfish abundance. Since the 1950s, approximately 80% of the seagrass meadows in Cockburn Sound have been lost as a result of environmental degradation (Cockburn Sound Management Council 2005²). 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). 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 yelloweye 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.

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

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

WEST 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 West Coast Bioregion, 2008 to 2012.

Species	Scientific name	Catch (tonnes)				
		2008	2009	2010	2011	2012
Western Australian salmon	<i>Arripis truttaceus</i>	333.4	494.6	69.0	6.3	47.1
Sea mullet	<i>Mugil cephalus</i>	96.2	103.0	102.1	77.7	102.9
Whitebait	<i>Hyperlophus vittatus</i>	57.9	139.6	100.6	34.8	65.7
Australian herring	<i>Arripis georgianus</i>	34.7	34.6	30.6	36.3	28.3
Yelloweye mullet	<i>Aldrichetta forsteri</i>	26.2	26.1	24.7	16.2	17.5
Whiting species	<i>Sillago</i> spp.	21.7	23.9	22.5	24.6	19.0
Southern garfish	<i>Hyporhamphus melanochir</i>	11.0	15.7	15.8	19.2	5.8
Cobbler	<i>Cnodoglanis macrocephalus</i>	6.9	9.2	5.4	7.4	5.2
Tailor	<i>Pomatomus saltatrix</i>	1.5	7.1	4.8	7.2	8.8
King George whiting	<i>Sillaginodes punctata</i>	5.1	2.0	5.9	5.1	3.7
Blue sprat	<i>Spratelloides robustus</i>	13.7	7.1	0.1	0.3	0.3
Hardyheads/Silversides	Atherinidae			4.1	4.7	3.5
Trevally	Carangidae	0.9	2.1	3.5	2.4	2.3
Black bream	<i>Acanthopagrus butcheri</i>	1.0	1.1	2.6	0.7	1.4
Yellowtail scad	<i>Trachurus novaezelandiae</i>	2.5	1.2	0.9	1.2	0.9
Scaly mackerel	<i>Sardinella lemura</i>			0.9		3.0
Perth herring	<i>Nematalosa vlamingi</i>	0.7	1.6	0.1	0.4	1.0
Trumpeters/Grunters	Teraponidae	0.2	0.0	0.5	1.0	1.6
Other finfish	Teleostei	1.1	0.2	0.2	0.3	0.1
TOTAL		614.7	869.0	394.3	245.6	318.2

WEST COAST NEARSHORE AND ESTUARINE TABLE 2

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

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

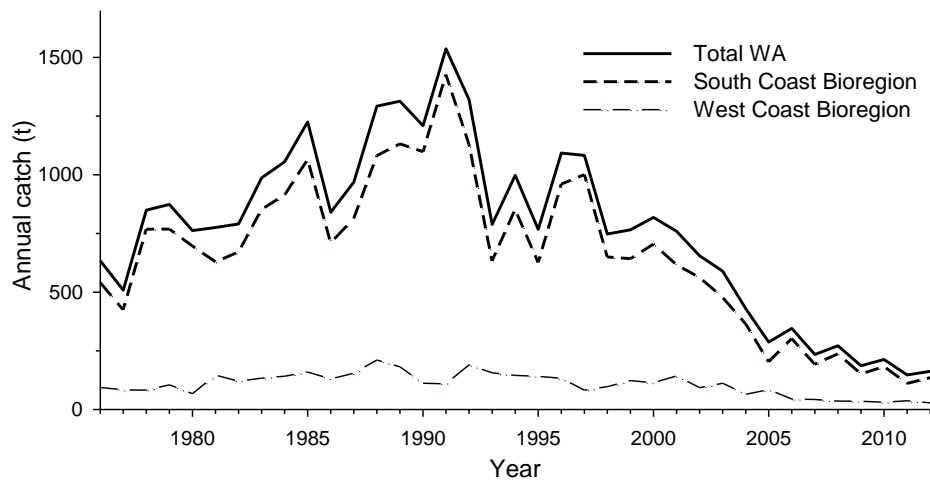
WEST COAST NEARSHORE AND ESTUARINE TABLE 3

Annual catches of key nearshore finfish species in the West Coast Bioregion by boat-based recreational fishers, estimated by various surveys conducted by the Department of Fisheries.

Species		Catch (tonnes)				
		1996/97	2005/06	2008/09	2009/10	2011/12
Australian herring	<i>Arripis georgianus</i>	40	35	33	35	23
Whiting species*	<i>Sillago</i> spp.	50	40	41	38	27
Tailor	<i>Pomatomus saltatrix</i>	11	3	3	2	12
King George whiting	<i>Sillaginodes punctata</i>	31	17	9	7	15
Silver trevally	<i>Pseudocaranx dextex</i>	42	32	28	26	26
Black bream	<i>Acanthopagrus butcheri</i>	n/a	n/a	n/a	n/a	3
Southern garfish	<i>Hyporhamphus melanochir</i>	6	2	4	3	2

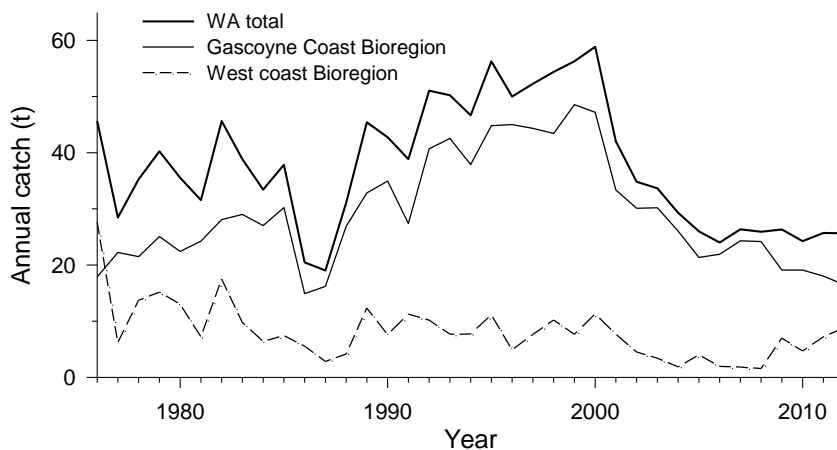
*estimated to be ~90% southern school whiting

1 Henry, G.W. & Lyle, J.M. (2003). The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.



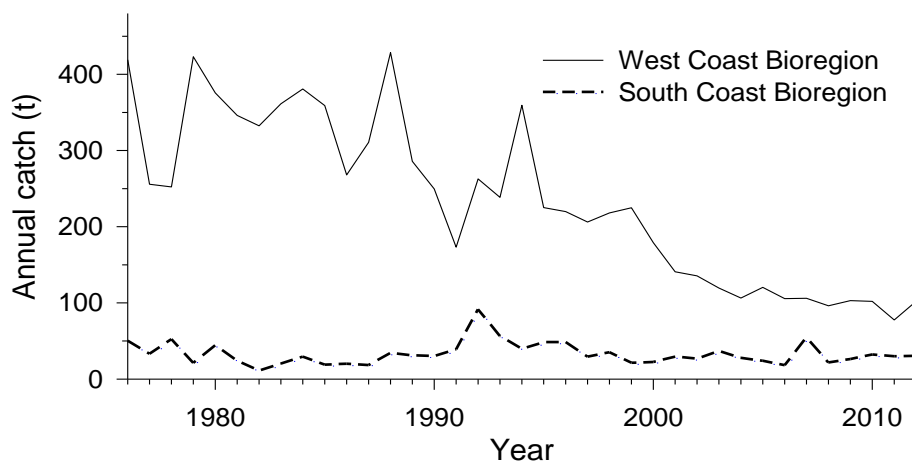
WEST COAST NEARSHORE AND ESTUARINE FIGURE 1

Annual commercial catches of Australian herring, by Bioregion, 1976 –2012.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 2

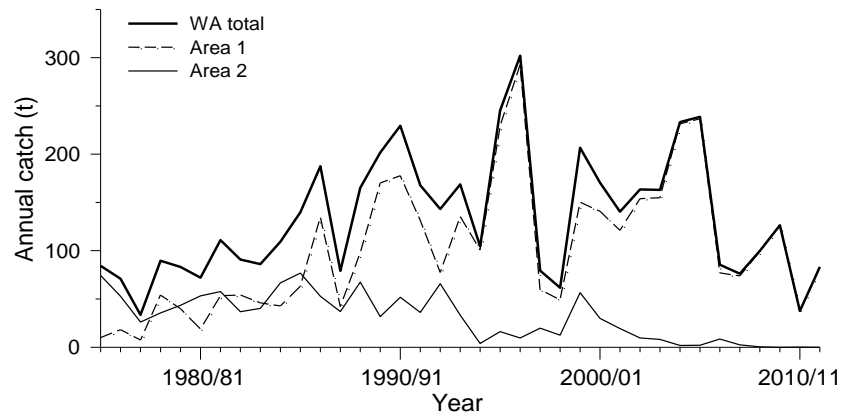
Annual commercial catches of tailor, by Bioregion, 1976 –2012. Minor catches in South Coast Bioregion are not shown, but are included in WA total.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 3

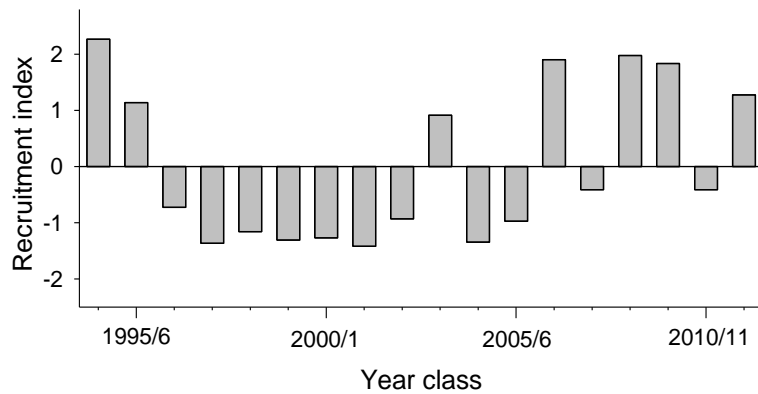
Annual commercial catches of sea mullet, by Bioregion, 1976 –2012. Minor catches in North Coast Bioregion are not shown, but are included in WA total.

WEST COAST BIOREGION



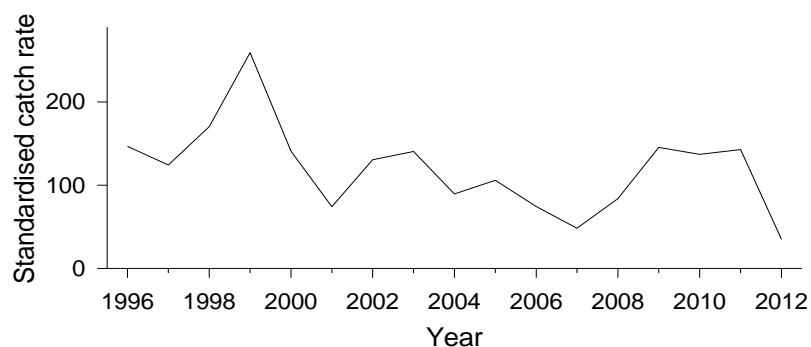
WEST COAST NEARSHORE AND ESTUARINE FIGURE 4

Annual commercial catches of whitebait in West Coast Bioregion, by fishing area, 1975/76 –2011/12. Area 1 = Bunbury; Area 2 = Perth/Mandurah.



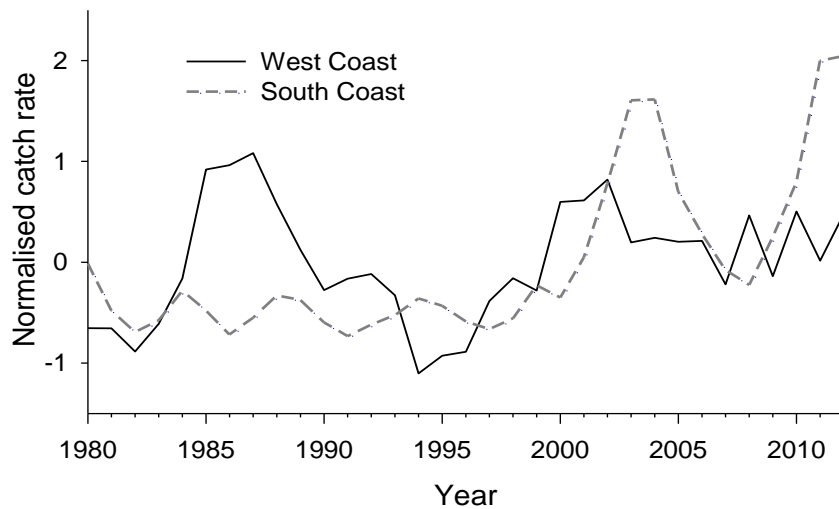
WEST COAST NEARSHORE AND ESTUARINE FIGURE 5

Annual recruitment index for tailor in the West Coast Bioregion, 1996 – 2012, derived from volunteer fisher catch rates of age 0+ juveniles in the Swan-Canning Estuary. Data represent annual deviations from the long-term average. e.g. bars above the line Indicate better than average number of recruits



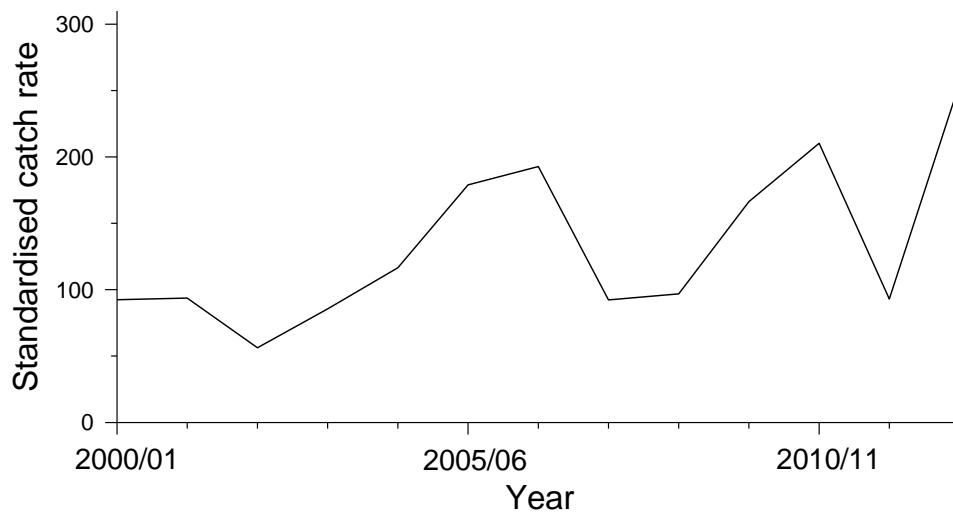
WEST COAST NEARSHORE AND ESTUARINE FIGURE 6

Annual commercial catch rate of southern garfish in Cockburn Sound, 1996 – 2012.



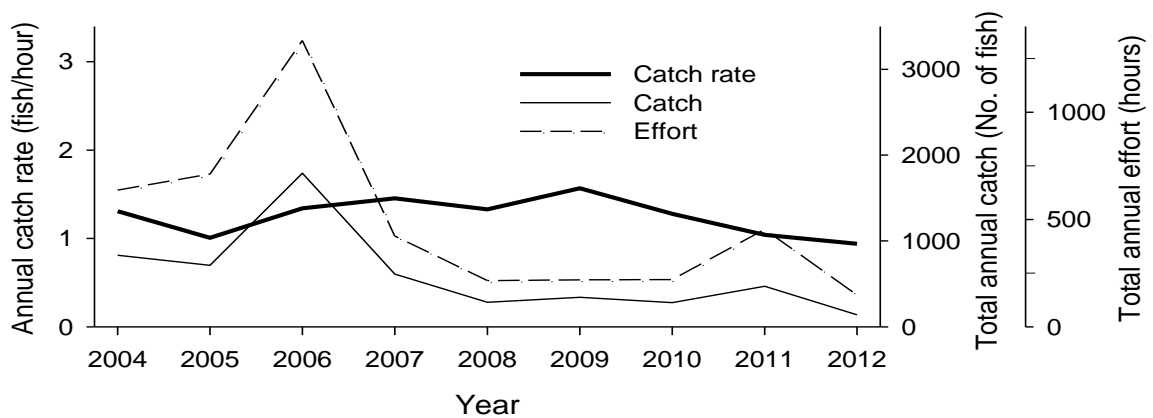
WEST COAST NEARSHORE AND ESTUARINE FIGURE 7

Annual commercial catch rates of sea mullet in West Coast and South Coast Bioregions, 1996 – 2012.



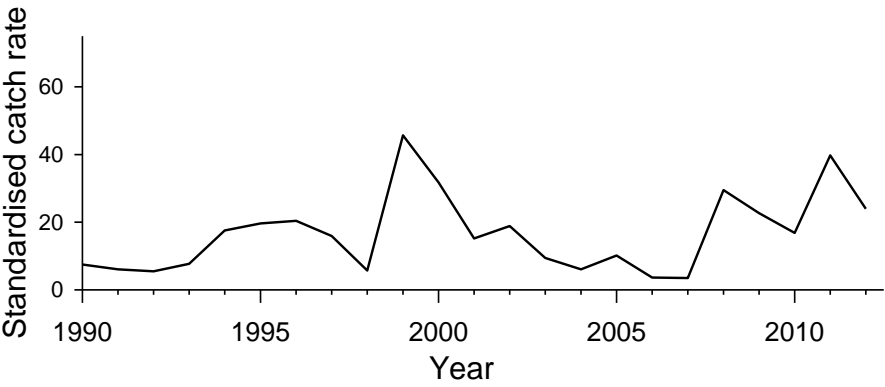
WEST COAST NEARSHORE AND ESTUARINE FIGURE 8

Annual commercial catch rate (kg/method day) of whitebait in Area 1 (Bunbury) 2000 – 2012.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 9

Total annual catch, effort and catch rate of black bream by voluntary recreational logbook fishers in the Swan-Canning Estuary, 2004 – 2012.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 10
Annual commercial catch rate of cobbler in the Peel-Harvey Estuary, 1990 – 2012.

West Coast Purse Seine Fishery Report: Statistics Only

B. Molony, E. Lai, M. Holtz and R. Jones

Fishery Description

The West Coast Purse Seine Fishery mainly captures pilchards (*Sardinops sagax*) and the tropical sardine (or scaly mackerel) *Sardinella lemuru* (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*), maray (*Etrumeus teres*) and other species are also reported.

Boundaries

There are three defined fisheries. The Perth metropolitan fishery operates between 31° S and 33° 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 22° S and 31° S.

Management arrangements

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

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 2010/11 licensing period (1 April 2010 – 31 March 2011) 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 notional 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

Commercial Landings: **19 tonnes**

Effort levels again increased in 2012 to 269 fishing days undertaken by six vessels. Total catches of pilchards and sardinella exceeded 219 t in 2012 (2010 ~ 10 t; 2011 ~ 175 t). The 2012 catch was the highest reported since 2006 but remains well below catches recorded in the mid to late 1990s

and early 2000s (West Coast Purse Seine Figure 2).

Catches were dominated by sardinella (scaly mackerel, 178.2 t) with approximately 41 t of pilchards landed.

Approximately 1.3 t of other species were landed, mainly comprising yellowtail scad and trumpeters.

Fishery Governance

Target commercial catch range: 0 – 3,000 tonnes

Current Fishing (or Effort) Level: Acceptable

Total effort and catch have been relatively low 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 surveys to estimate pilchard spawning biomass are scheduled for West Coast 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. A recent national assessment (Ward *et al.* 2012¹) concluded that the stock was being fished at sustainable levels with current exploitation rates being very low. Less information is available for the sardinella stock but it too has been fished in recent years at low levels.

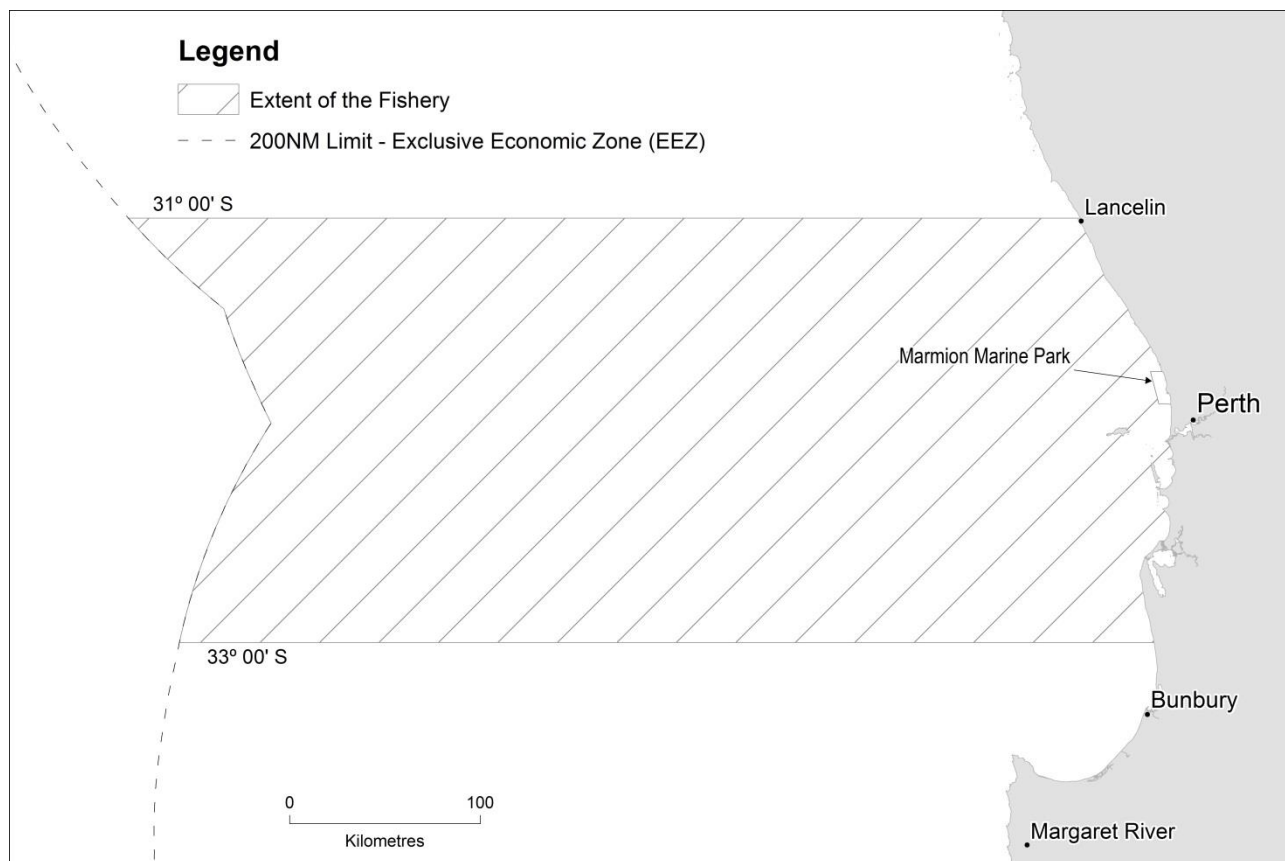
New management initiatives (2012/13)

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 more than ten years. However the implementation of quota for this fishery is 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, 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.

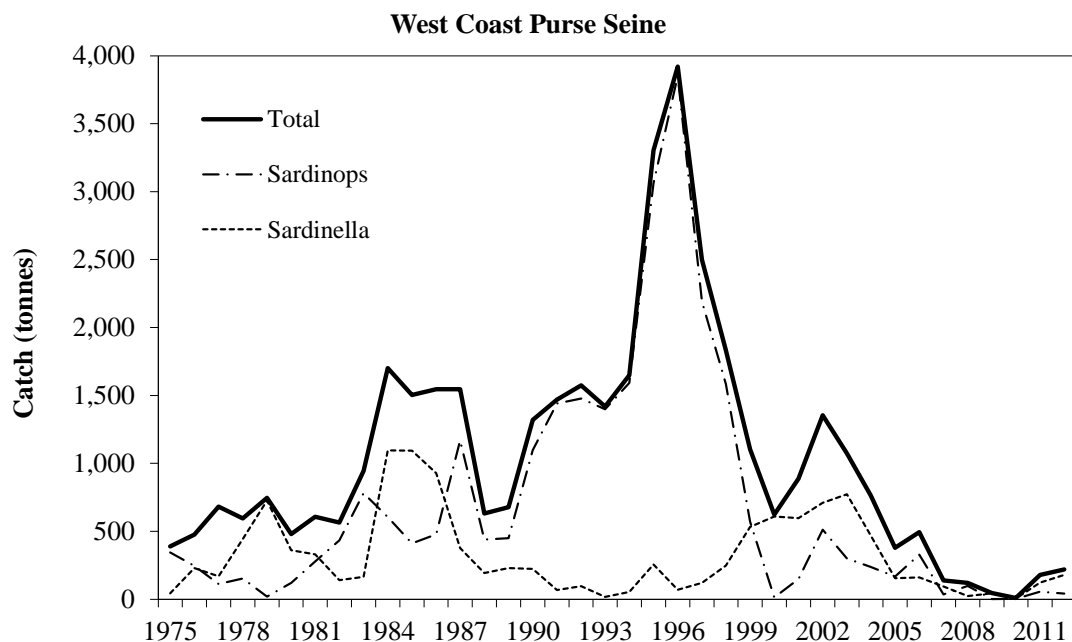
This fishery is scheduled to undergo MSC pre-assessment in 2014.

¹ Ward, T., Molony, B., Stewart, J., Andrews, J. and Moore, A. (2012). Australian sardine *Sardinops sagax*, in M. Flood, I. Stobutzki, J. Andrews, G. Begg, W. Fletcher, C. Gardiner, J. Kemp, A. Moore, A. O'Brien, R. Quinn, J. Roach, K. Rowling, K. Sainsbury, T. Saunders, T. Ward & M. Winning (eds), Status of key Australian fish stocks reports 2012, Fisheries Research and Development Corporation, Canberra, pp 272-279.



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 –2012.

West Coast Demersal Scalefish Resource Status Report

D. Fairclough, E. Lai, M. Holtz, T. Nicholas and R. Jones

Main Features

Status

Stock level	Recovering
Fishing Level	
Commercial:	Not Acceptable (Pink snapper only)
Recreational:	
	Not Acceptable (Pink snapper and baldchin only)

Current Landings

Commercial sector		
All scalefish:		
WCDSIMF (2012)		389 t
Demersal suite:		
WCDSIMF (2012)		361 t
Other (DGDLF, WCRLF, CSLPF, SWTMF; 2012 or 2011/12)		46 t
Total demersal suite		407 t
	WCDSIMF	Other
	(2012)	(2012 or 2011/12)
Indicator species		
West Australian Dhufish	64 t	9 t
Pink snapper	170 t	10 t
Baldchin Groper	16 t	1 t
Recreational sector (2011/12)		
Top 15 species:		159 t
Indicator species:		
West Australian Dhufish		74 t
Pink snapper		33 t
Baldchin Groper		29 t
Charter sector (2011/12)		
Top 15 species		41 t
Indicator species:		
West Australian Dhufish		13 t
Pink snapper		10 t
Baldchin Groper		9 t

Fishery Description

The West Coast Demersal Scalefish Resource comprises inshore and offshore suites of demersal scalefish species that are exploited by different commercial fisheries and recreational and charter fishers that operate in the West Coast Bioregion (WCB). The West Coast Inshore Demersal suite occurs in waters 20-250 m deep with approximately 100 species of this suite caught by these fisheries. The most important species are the West Australian Dhufish (*Glaucosoma hebraicum*) and Pink snapper (*Pagrus auratus*) with other species captured including Redthroat Emperor (*Lethrinus miniatus*), Bight Redfish (*Centroberyx gerrardi*) and Baldchin Groper (*Choerodon rubescens*). The West Coast Offshore Demersal suite, which occurs in waters > 250 m deep, 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 may take a small amount of demersal species in the WCB include, when exempted, the Cockburn Sound Line

WEST COAST BIOREGION

and Pot Managed Fishery (CSLPF) 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

Commercial

West Coast Demersal Scalefish (Interim) Management Plan 2007

West Coast Demersal Interim Managed Fishery Permit

West Coast Demersal Gillnet and Demersal Longline Interim Management Plan 1997

West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery Permit

Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992

Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery Licence

Cockburn Sound (Line and Pot) Management Plan 1995

Cockburn Sound (Line and Pot) Managed Fishery Licence

South West Trawl Management Plan 1989

South West Trawl Managed Fishery Licence

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation.

Consultation process

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department

undertakes 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 Status Reports of the Fisheries and Aquatic Resources of Western Australia.

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 a number of species that are under specific State or Commonwealth management) and are not permitted to take sharks and rays.

Access to the Fishery is restricted to 59 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 five 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 current harvest strategy objective for the WCDSIMF is to maintain catches of all scalefish and the suites of demersal species below 50 % of those recorded in the WCB during

2005/06 to reduce fishing mortality to a level that will enable recovery of all of these stocks. The status of the three indicator species (Pink snapper, Western Australian Dhufish and Baldchin Groper) is used to indicate the status of the entire West Coast Inshore Demersal Suite of scalefish species.

The catch in each management area should also not exceed 50 % of the 2005/06 catch in that area. The average annual catch for each indicator species in the WCDSIMF and in each of the areas where they are an indicator should also remain below 50 % of their 2005/06 level.

The other commercial fisheries that take demersal scalefish in the WCB (DGDLF, WCRLF, CSLPF 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. These other fisheries land only a small proportion (~10%) of the overall catches of demersal scalefish in the WCB.

The detailed management arrangements for each of the other fisheries that catch demersal species in the WCB are given in their separate sections of this *Status Reports of the Fisheries and Aquatic Resources of Western Australia*.

From 2008 until Aug 2011, fishers in the WCRLF were permitted by exemption to retain demersal scalefish caught in rock lobster pots for personal consumption only (i.e. not permitted to be sold). The Exemption expired in Aug 2011 and has not been renewed.

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 catch levels and stock status of indicator species. Level 3 stock assessments based on a weight of evidence approach, which now incorporate estimation of fishing mortality rates and spawning potential ratios, are conducted at periodic intervals for each of the indicator species within the West Coast Inshore Demersal Suite. Along with the existing indicator species for that suite, West Australian Dhufish, Pink snapper and Baldchin Groper, two new indicator species (Redthroat emperor and Bight redfish) are also being used. Annual Level 1 assessments of catch are also used to monitor these species and the indicator species for the West Coast Demersal Offshore Suite¹ (Hapuku, Blue-eye Trevalla, Bass Groper). To enable the Level 3 assessments, fish frames of the indicator species are collected from recreational and commercial fishers across the different areas of the WCB (West Coast Demersal Scalefish Figure 1). Otoliths obtained from these frames are used to determine age compositions for species in relevant management areas, from which estimates of fishing mortality and subsequently spawning potential ratios are calculated and stock status determined. A stock assessment for West Australian Dhufish, Pink snapper and Baldchin Groper will be reported in 2013.

Catch and effort data both for the WCDSIMF and charter fisheries are obtained 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 catch of demersal species in this Bioregion by other commercial fisheries (DGDLF, WCRLF, CSLPF, SWTMF) are determined annually from compulsory logbook data. Full details are reported in the relevant fisheries reports.

An integrated survey of boat-based recreational fishing in WA was conducted during 2011/12.

WA Marine Science Institute-funded research on the stock structure of West Australian Dhufish, Pink snapper and Baldchin Groper in the WCB is now complete. This was a

¹ See Fisheries Occasional Publication No. 85
http://www.fish.wa.gov.au/Documents/occasional_publications/fop085.pdf.

collaborative project between the Department of Fisheries, Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Murdoch University. Scientific papers have been published on the stock structures of West Australian Dhufish, Pink snapper and Baldchin Groper, based on both genetic and otolith microchemistry techniques plus an examination of oceanographic influences on larval dispersal of West Australian dhufish.

Acoustic telemetry is being used to investigate site-fidelity of adult Pink snapper to Cockburn Sound spawning aggregations. Data on the movements of tagged Pink snapper will be collected by remotely deployed receivers until the end of 2013. These data will be used to assess the risks associated with targeting Pink snapper that are either migrating to and from, or aggregating in, Cockburn Sound.

Annual surveys of the numbers of Pink snapper eggs in Cockburn Sound have been conducted consecutively since 2008. These data may in the future be capable of producing estimates of spawning stock biomass using a daily egg production model, similar to that used to monitor Pink snapper stocks in Shark Bay. However, a study of rapid genetic methods to validate the visual identification of Pink snapper eggs (given other visually similar eggs are present in this region) needs to be completed before spawning stock biomass can be robustly estimated.

A State Natural Resource Management-funded project, focused on small juvenile West Australian Dhufish (< 150 mm in length), has identified the habitat types that juvenile dhufish occupy. A final report will be published in 2013.

A collaborative FRDC-funded project (FRDC 2010-004) between Curtin University and the Department of Fisheries was completed in 2013. This project used passive-acoustic techniques and biological examination of fish samples to demonstrate that West Australian dhufish can produce sound, while this is not the case for Pink snapper. Further studies would be required to identify whether sound production in W.A. dhufish is associated with its reproductive behaviour, stress or both.

A collaborative FRDC-funded project (FRDC 2011-016) between CSIRO and the Department of Fisheries was completed in 2012 to survey the occurrence of West Australian dhufish eggs and larvae in the South-west and Metropolitan Areas of the WCB. The study used plankton collection and analysis of samples using rapid DNA screening. The project successfully conducted real-time modelling of ocean currents to guide the plankton sampling. Phytoplankton and nutrient concentration were also examined to correlate with egg/larval abundance. A final report can be downloaded from <http://frdc.com.au/research/final-reports/Pages/2011-016-DLD.aspx>.

Further studies are being conducted to determine the comparability of data for catch and effort of boat-based recreational fishers derived from the integrated survey of boat-based recreational fishing in WA 2011/12 with previous boat ramp surveys (i.e. creel surveys).

Retained Species

Commercial production

All scalefish

WCDSIMF (2012) **389 tonnes**

Demersal suite

WCDSIMF (2012) **361 tonnes**

DGDLF, WCRLF, CSLPF, SWTMF

(2012 or 2011/12) **46 tonnes**

Total **407 tonnes**

Indicator species

WCDSIMF (2012)

West Australian Dhufish **64 tonnes**

Pink snapper **170 tonnes**

Baldchin Groper **16 tonnes**

DGDLF, WCRLF, CSLPF, SWTMF

(2012 or 2011/12)

West Australian Dhufish **9 tonnes**

Pink snapper **10 tonnes**

Baldchin Groper **1 tonnes**

Total

West Australian Dhufish **73 tonnes**

Pink snapper **180 tonnes**

Baldchin Groper **17 tonnes**

Landings

Catches are reported from the most recent complete season of logbook data for each commercial fishery that catches demersal species in the WCB. This includes 2012 for the WCDSIMF, CSLPF and SWTMF and 2011/12 for the DGDLF and WCRLF.

Catches of all scalefish by the WCDSIMF decreased by 22 t from 411 t in 2011 to 389 t in 2012, as a result of a decrease in catch of demersal species from 382 t to 361 t. In 2012, catches comprised 352 t of inshore demersal species and 9 t of offshore demersal species.

The respective catches of demersal species in the Kalbarri, Mid-west and South-west areas in 2012 of 133 t, 176 t and 43 t decreased from those in 2011 of 144 t, 50 t and 180 t. The 9 t of demersal species landed in the offshore area in 2012 is a slight increase from 7 t in 2011.

The WCDSIMF catch in 2012 comprised 78 scalefish species or species groups. Fifty four species are from the inshore and offshore demersal suites and 24 from the pelagic and nearshore suites. Six species/species groups comprised 86 % of the total catch of the WCDSIMF, i.e. Pink snapper (170 t), West Australian Dhufish (64 t), Redthroat Emperor (46 t), Redfish species (*Centroberyx* spp., 24 t), Baldchin Groper

(16 t), and Samson Fish (15 t). Catches of offshore demersal species were low, i.e. Eightbar Grouper, 4 t; Hapuku, 3 t and Bass Groper, Blue-eye Trevalla and Ruby Snapper, each ≤ 1 t.

Catches of demersal scalefish by the DGDLF in the WCB decreased from 53 t in 2010/11 to 45 t in 2011/12. Less than 1 t was taken by the WCRLF, CSLPF and SWTMF combined.

West Australian Dhufish: The total catch of West Australian dhufish by the WCDSIMF in 2012 of 64 t changed little from the 67 t in 2011. The catch in the Kalbarri Area decreased from 5 t in 2011 to 4 t in 2012 and in the South-west Area from 19 t to 16 t. The catch of 44 t in 2012 in the Mid-west remained the same as in 2011 (West Coast Demersal Scalefish Figure 2). Catches of dhufish by the DGDLF decreased from 13 t in 2010/11 to 9 t in 2011/12 and by the WCRLF, SWTMF and CSLPF combined were negligible.

Pink snapper: The total catch of 170 t of Pink snapper by the WCDSIMF in 2012 declined from 182 t in 2011. In the Kalbarri area, the catch of 78 t of Pink snapper in 2012 decreased from 88 t in 2011 and in the Mid-west area it decreased from 91 t to 87 t. The catch of Pink snapper in the South-west Area increased to 4 t in 2012 from 3 t in 2011 (West Coast Demersal Scalefish Figure 3). Pink snapper catches of the DGDLF in the WCB increased from 7 t to 10 t between 2010/11 and 2011/12, and were < 1 t in the WCRLF, SWTMF and CSLPF combined, similar to previous years.

Baldchin Groper: The total catch of 16 t of Baldchin groper by the WCDSIMF in 2012 was similar to 2011 (West Coast Demersal Scalefish Figure 4). This was taken almost entirely in the Kalbarri and Mid-west Areas, with about 10 t of that being from the Abrolhos Zone A of the WCRLF. Only 1 t of Baldchin groper was caught by the DGDLF in 2011/12, similar to 2010/11. Reported Baldchin groper catches by the WCRLF, SWTMF and CSLPF combined were negligible (< 1 t).

Charter fishing (2011/12)

Top 15 demersal scalefish species **41 tonnes**

Indicator species

West Australian Dhufish **13 tonnes**

Pink snapper **10 tonnes**

Baldchin Groper **9 tonnes**

The total catch of 41 t of the top 15 demersal species/species groups by charter fishers in 2011/12 (based on 98 % of logbook returns at the time of this report) was the same as in 2010/11 (based on 97 % of logbooks returned; see West Coast Demersal Scalefish Figure 5). The catches of each of the indicator species in 2011/12 were also similar to 2010/11, i.e. West Australian dhufish: 13 vs 12 t, Pink snapper: 10 t in both years, Baldchin groper: 9 t in both years. The West Coast Offshore Demersal Suite comprised 1 t of charter catches in 2011/12 compared with < 1 t in 2010/11.

Recreational fishing (boat-based, non-charter) (2011/12)

Top 15 demersal scalefish species **159 tonnes**

Indicator species

West Australian Dhufish **74 tonnes**

Pink snapper **33 tonnes**

Baldchin Groper **29 tonnes**

Approximately 159 t of the top 15 demersal species/species groups were estimated to have been caught by boat-based fishers in the WCB during 2011/12 (West Coast Demersal Scalefish Figure 5). Estimated catches of indicator species in 2011/12 were as follows: West Australian Dhufish 74 t, Pink snapper 33 t, Baldchin groper 29 t. These data are not directly comparable with estimates of catch from previous surveys, which were based on different survey methods.

Fishing effort/access level

Commercial

In 2012, 51 boats fished in the WCDSIMF. Seventeen vessels fished in the Kalbarri Area, 43 in the Mid-west, 9 in the South-west and 12 in the Offshore Area. 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 2012 (1,568) was almost the same as in 2011 (1,572) as was the amount of fishing entitlement (hours) consumed. The number of hours fished (hours searching + hours fishing) increased from 17,700 h in 2011, to 18,800 h in 2012. Entitlement consumed in the Kalbarri area increased by only 4 % and decreased in the Mid-west by 5 %. However, in the South-west and Offshore areas, 11 % and almost 50 % more entitlement was consumed in 2012 than 2011.

Effort recorded by other fisheries that catch demersal species in the WCB is given in their separate sections of this *Status Reports of the Fisheries and Aquatic Resources of Western Australia*. Note that the exemption to retain demersal scalefish caught in lobster pots by the WCRLF expired part way through their 2011/12 fishing season.

Recreational

Fishing effort by the recreational sector during the 2011/12 *iSurvey* of boat-based fishing in the West Coast Bioregion, was estimated as 179,000 boat days. These data are not directly comparable with estimates of effort from previous surveys, which were based on different survey methods.

Fishing and Aquatic Tour Industry (Charter)

Fifty four charter licenses were reported to have undertaken fishing operations in 2011/12, which is the same as in 2010/11. The number of fisher days decreased slightly from 22,000 to 21,500.

Stock Assessment

Assessment complete **Yes (2013)**

Assessment level and method:

Level 3 - Fishing mortality and spawning potential ratio (Periodic)

Level 1 - Catch by sector (Annual)

Breeding stock levels

West Australian Dhufish:	Recovering
Pink snapper:	Recovering
Baldchin Groper:	Recovering

Inshore Demersal: A level three assessment of the status of stocks of the inshore demersal indicator species (West Australian Dhufish, Pink snapper and Baldchin Groper) in the West Coast Bioregion (WCB) and its different management areas was conducted in 2013, based on fisheries-dependent age structure data collected from 2008/09-2010/11 for the first two species and 2007/08-2010/11 for the latter species. The methods for estimating fishing mortality rates (F) have previously been independently reviewed (O'Neill, 2009)¹. The review recommended using additional estimation methods that use fewer assumptions and as an alternative (Fisher, 2012)². The 2013 assessment also included assessments of spawning potential ratios (SPR) for the first time. Both the F and SPR estimates were compared with internationally accepted biological reference points in a weight of evidence approach to determine the change in status of stocks over time.

The assessment demonstrated that both F and SPR for West Australian dhufish and F for Pink snapper in the West Coast Bioregion have improved. Thus, F has decreased and SPR has increased, since the previous assessment period of 2005/06-2007/08. This indicates evidence of recovery in their breeding stocks. However, at that time, stocks had not recovered to an appropriate level, i.e. the threshold (Fairclough *et al.* (in press)), where F is equivalent to the rate of natural mortality and SPR is equal to 30% of reproductive potential. The recovery trend was consistent among management areas for both species. However, there has been less recovery for Pink snapper stocks in the northern management areas (Kalbarri and Mid-west) compared to those in the southern management areas (Metropolitan and South-west). This indicates better status of stocks in the southern half of the WCB.

The F and SPR for Baldchin groper were beyond the limit reference point and thus at unacceptable levels. Neither the SPR or F levels had changed since the previous available assessment period of 2000/01-2001/02.

The limited levels of recovery for each of the indicator species at the time of this assessment was expected because changes to management were only introduced between late 2007 and early 2010, which overlaps with the sampling period for age data used in this assessment. The precise rate at which the stocks for each indicator species will recover will also be influenced by their biological characteristics. Recovery to threshold management levels is estimated to take at least 10 years (i.e. 2020s).

Offshore Demersal: A Level 1 assessment using catch is

conducted annually for the offshore demersal suite, including Eightbar Grouper, Bass Groper, Hapuku, Blue-eye Trevalla and Ruby Snapper. These species are particularly vulnerable to overfishing, as their biological characteristics include being long-lived with associated low rates of natural mortality and productivity (Wakefield and Newman, 2008³; Wakefield *et al.*, 2010⁴; Wakefield *et al.*, 2013a⁵, b⁶). In addition, some aggregate to spawn 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 acceptable.

Using the assessments of indicator species, revised management actions have reduced the ecological risks to the suites of inshore and offshore demersal species in the WCB to acceptable levels (see Fletcher *et al.*, 2010⁷). 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 selective⁸ for demersal fishes. Other demersal species that are caught but not normally retained during demersal fishing

- 1 O'Neill, M. (2009). *Scientific review of the West Coast Demersal Scalefish Fishery, Western Australia*. Fisheries Occasional Publication, **66**. Department of Fisheries, Western Australia, 24 pp.
- 2 Fisher, E.A. (2012). *Tools for assessing data-limited fisheries and communicating stock status information*. Ph.D. thesis, Murdoch University, Perth, Western Australia. 238 pp. <http://researchrepository.murdoch.edu.au/14881/>

- 3 Wakefield, C.B., & Newman, S.J. (2008) Age estimation and reproductive status of an exceptionally large blue-eye trevalla (*Hyperoglyphe antarctica*, Centrolophidae) captured off the south coast of Western Australia. *Cybius*, **32**, 321-324.
- 4 Wakefield, C.B., Newman, S.J. & Molony, B.W. (2010) Age-based demography and reproduction of hapuku, *Polyprion oxygeneios* (Polyprionidae), from the south coast of Western Australia: implications for management. *ICES Journal of Marine Science*, **67**, 1164-1174.
- Wakefield, C.B., Newman, S.J. & Boddington, D.K. (2013b). Exceptional longevity, slow growth and late maturation infer high inherent vulnerability to exploitation for bass groper *Polyprion americanus* (Teleostei: Polyprionidae). *Aquatic Biology*, **18**, 161-174.
- 5 Wakefield, *et al.* (2013a). Contrasting life history characteristics of the eightbar grouper *Hyporthodus octofasciatus* (Pisces: Epinephelidae) over a large latitudinal range reveals spawning omission at higher latitudes. *ICES J Mar Sci*, **70**, 485-497
- 6 Wakefield, C.B., Newman, S.J. & Boddington, D.K. (2013b). Exceptional longevity, slow growth and late maturation infer high inherent vulnerability to exploitation for bass groper *Polyprion americanus* (Teleostei: Polyprionidae). *Aquatic Biology*, **18**, 161-174.
- 7 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
- 8 Bycatch interactions of the gillnet and longline sector are presented in the relevant report.

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 when caught in waters > about 30 m deep¹, and this is likely to be similar for many species caught but not retained in this fishery.

Protected species interaction

Negligible

As line fishing is highly selective for demersal fishes, interactions with protected species by commercial, charter and recreational fishers in the WCDSF are minimal. Commercial WCDSIMF and charter fishers are required to record protected species interactions in their logbooks. During 2012, no interactions were reported by the WCDSIMF. Two grey nurse sharks were caught and released alive by the Charter Fishery in the WCB during 2011/12.

Ecosystem Effects

Food chain effects

Low

An FRDC study² examined the last 30 years of catch data by commercial wetline, gillnet and longline fisheries in the WCB and found that the species composition in catches had changed over time. This may be a function of changes in targeting or differences in reporting methods but there was no evidence of a decline in the trophic level or mean size in catches representing a low risk to the ecosystem.

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 and hence negligible risk to benthic habitats.

Social Effects

Commercial

The total number of crew members (excluding the skipper) employed per trip on permitted vessels that fished in the WCDSIMF in 2012 ranged from zero to five, with the majority employing two. Approximately 150 people are therefore directly employed by this fishery.

Fishing and Aquatic Tour Industry (Charter)

In 2010/11, 111 charter operators were licensed to operate in the WCB via a Fishing Tour Operators Licence, compared with 125 in 2009/10. Twenty one held a Restricted Fishing Tour Operators Licence. The number of people employed in the charter industry has not been estimated.

Recreational Fishing

Over 123,000 Recreational Fishing from Boat Licenses have been issued in Western Australia as at 2nd March 2012.

Economic Effects

Estimated annual value (to fishers) for 2011:

Level 2 - \$1-5 million

The estimated economic value of the WCDSIMF in 2012 was in the range of \$1-5 million, as in 2011.

Fishery Governance

Commercial

Current Fishing (or effort) level

Not acceptable (Pink snapper)

Catch (or effort) limit range:

All scalefish

WCDSIMF

449-469 tonnes

Demersal suite

WCDSIMF

361 tonnes

All fisheries combined (WCDSIMF, DGDLF,

WCRLF, CSLPF, SWTMF)

< 407 tonnes

The primary management objectives for the WCDSIMF are to reduce total catch of all scalefish, of the demersal suites, including 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 2012, catches of all scalefish (389 t) and of the suite of demersal species (361 t) by the WCDSIMF remained below 50 % of those of 2005/06, i.e. 449-469 and 408 t, respectively. The total catch of demersal species in a full year of fishing (either 2011/12 or 2012) by the WCDSIMF, DGDLF, WCRLF, CSLPF and the SWTMF was 407 t which is below the 450 t benchmark. WCDSIMF catches of West Australian Dhufish (64 t) and Baldchin Groper (16 t) also remained below 50 % of the 2005/06 level (i.e. 72 and 17 t, respectively). However, the catch of Pink snapper in 2012 (170 t), which was taken almost exclusively in the Mid-west and Kalbarri Areas, was above the relevant benchmark (120 t) for the fishery.

As the entitlements available to permit holders in 2012 were not fully acquitted, there is potential for further increases in effort and catch in subsequent years if catch rates remain similar or increase. Catches of Pink snapper and the other indicator species will need to be monitored closely in coming years to determine whether this trend continues and further management intervention becomes necessary.

Charter/recreational

Current Fishing level

Demersal suite

Acceptable

¹ see Fisheries Research Report No. 191

http://www.fish.wa.gov.au/Documents/research_reports/fr191.pdf

² 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. 112 pp.

Catch (or effort) limit range:**250 tonnes (adjusted IFAAC value)**

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 sector in the WCB should remain below 50 % of 2005/06 catches (adjusted to 250 t by the Integrated Fisheries Allocation Advisory Committee, IFAAC, 2013).

The latest available catch data for recreational fishers in 2011/12 was estimated via a phone diary survey of boat-based fishers. This is not directly comparable to the previous estimates of recreational catch of demersal species from 2005/06, which was determined from a boat ramp survey of boat-based fishers and is an under-estimate of the total recreational boat-based catch. Therefore, an increased adjusted estimate of catch in 2005/06 of the top 15 demersal species and of the indicator species was estimated by the IFAAC. These values (plus those from charter fishers) for 2005/06 will now be used for comparison.

The estimated catch of the top 15 species/species groups by the charter/recreational sector in 2011/12 was 200 t, which was below the adjusted 250 t IFAAC value. The total catch of West Australian Dhufish (87 t) was less than 50 % of 2005/06 catches of 126 t. The catches of 43 t of Pink snapper and 38 t of Baldchin groper were greater than 50% of 2005/06 catches of 37 t and 33 t, respectively.

New management initiatives**Commercial**

A new management plan for the WCDSIMF is to be progressed during 2013-14, which will include a review of the fishery's management arrangements and the management objectives for the demersal scalefish resource in the WCB and will incorporate the outcomes of the stock assessment of key indicator species completed in 2013. This review will also include an evaluation of the management arrangements of the other relevant commercial fisheries (DGDLF, WCRLF, CSLPF and SWTMF) as they relate to those fisheries' take of demersal species in the WCB and the development of a formal harvest strategy and catch control guidelines designed to accommodate any recognised variations in recruitment levels.

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.

Recreational/Charter

The Department of Fisheries undertook its first Statewide Recreational Boat Fishing Survey in 2011/12 and has commenced the second survey in mid-2013. The Department is now able to estimate the quantity of fish retained and released by the boat based sector for each WA marine Bioregion. This information will assist the Department in managing the State's fisheries and aquatic ecosystem resources.

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 and the outcomes of the stock

assessment of indicator species.

On 1 February 2013 a simplified statewide set of recreational fishing rules were implemented. The major changes being a reduction from 13 to 4 categories of finfish species and, where possible, single bag limits for each species across the State.

Integrated Fisheries Management

Integrated Fisheries Management (IFM) is one of the policies aimed at making sure that Western Australia's fisheries continue to be managed in a sustainable and equitable manner into the future. The IFM process has been completed for the demersal scalefish resource in the WCB. Two Fisheries Management Papers relevant to the implementation of IFM for the demersal scalefish resource in the WCB were released in July 2010¹. The Minister for Fisheries has now made a determination in relation to the sectoral allocations for the West Coast Demersal Scalefish Resource. The overall allocation of shares in the total suite of species being 64% to the commercial fishing sector and 36% to the recreational sector. In addition catch proportion guidelines (rather than specific fixed proportional shares) for WCB indicator species were also determined. These were as follows:

West Australian Dhufish – recreational sector 60%, commercial sector 40%

Pink Snapper – recreational sector 20%, commercial sector 80%

Baldchin groper – recreational sector 65%, commercial sector 35%

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 are dominated by 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. Juveniles also 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; thus these developments may increase the risks to sustainability of Pink snapper in 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. Currently, catches by these Commonwealth fisheries

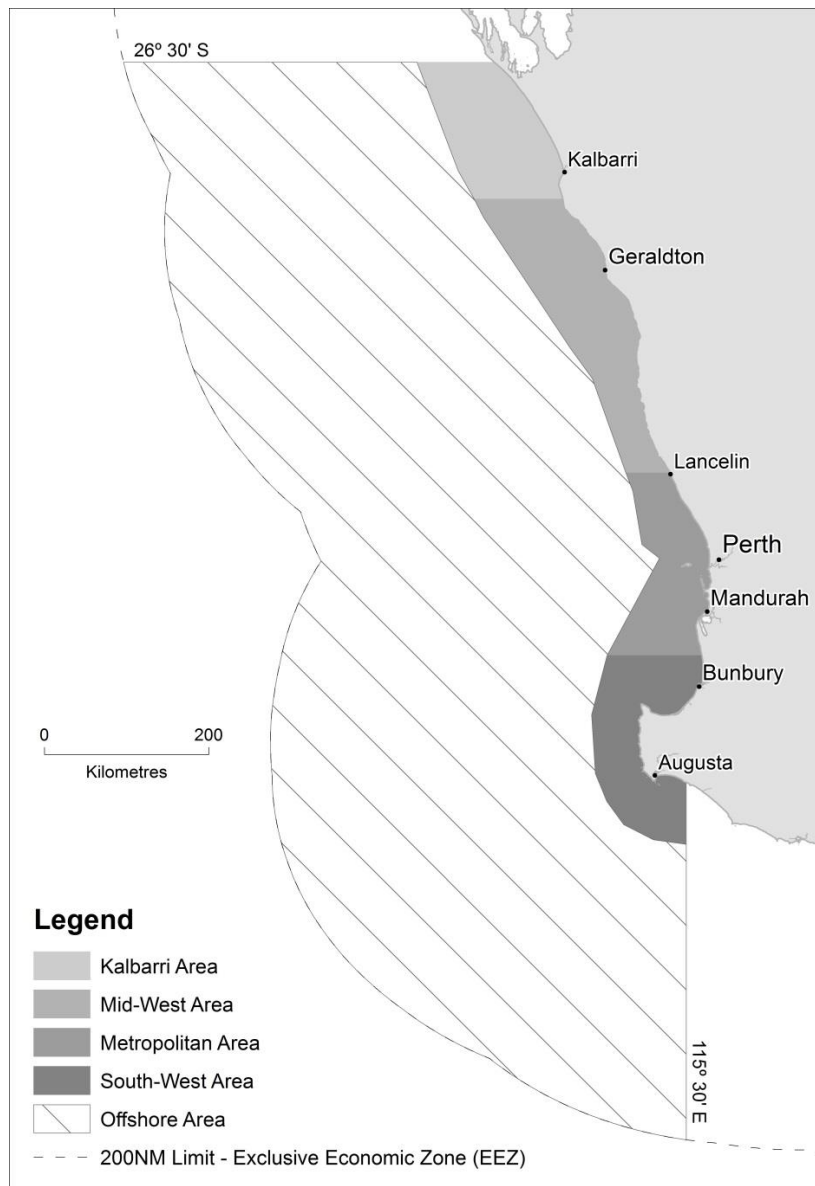
1 See Fisheries Management Papers 237 and 247
<http://www.fish.wa.gov.au/About-Us/Publications/Pages/Fisheries-Management-Papers.aspx>.

are very small in the WCB. A current project is focussed on the status and connectivity of Bight Redfish in the SCB and WCB and will include Commonwealth fishery catches in the assessment of stock status and risks to sustainability.

The Commonwealth's South-West Marine Bioregional Plan incorporates areas closed to fishing. These will restrict access to fishing in parts of the WCB to all sectors, i.e. commercial, recreational and charter. The management plans for this will come into effect on 1 July 2014. A compensation package will be offered to fishers for losses associated with closure to fishing in different areas. A public consultation period

requesting comment on the guidelines for the operation of the package closed on July 1 2013. It is proposed that effort removal will be complete by the 2016/17 financial year.

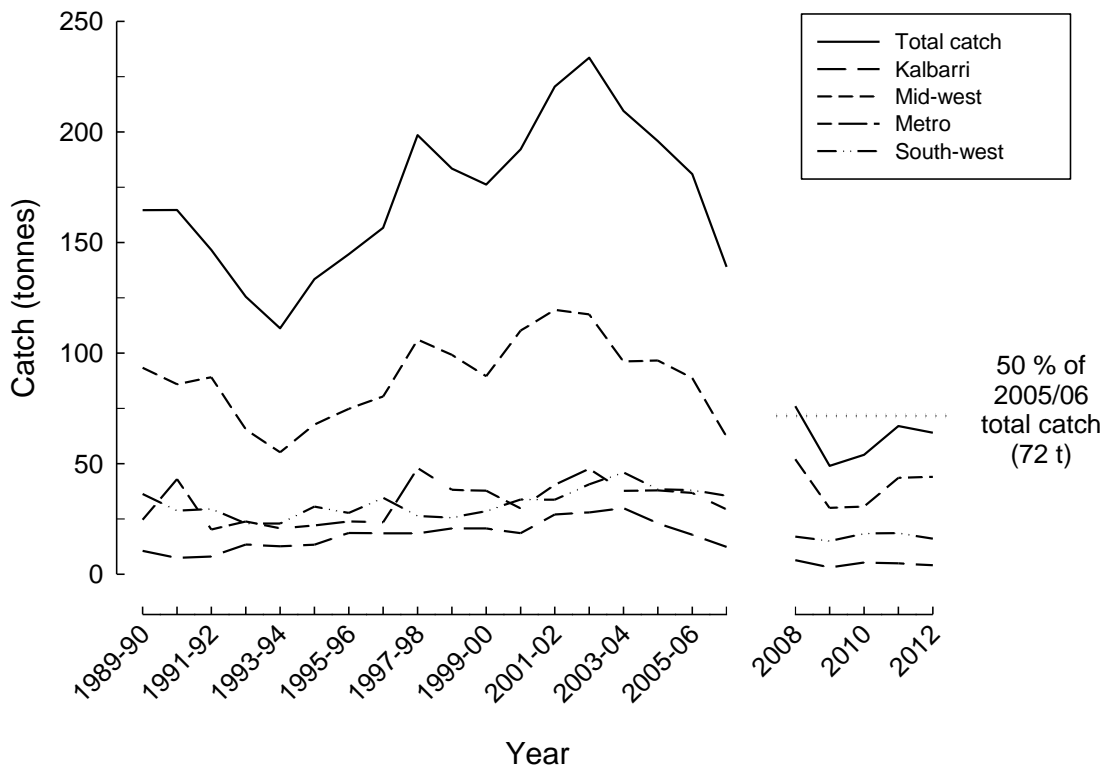
Climate change may lead to a range of impacts (e.g. increased water temperatures, acidification) which may influence aspects of the biology of demersal species, such as spawning success and thus recruitment patterns. Extreme events, such as the marine heatwave recently reported¹, may have severe negative effects, including increased mortalities.



WEST COAST DEMERSAL SCALEFISH FIGURE 1

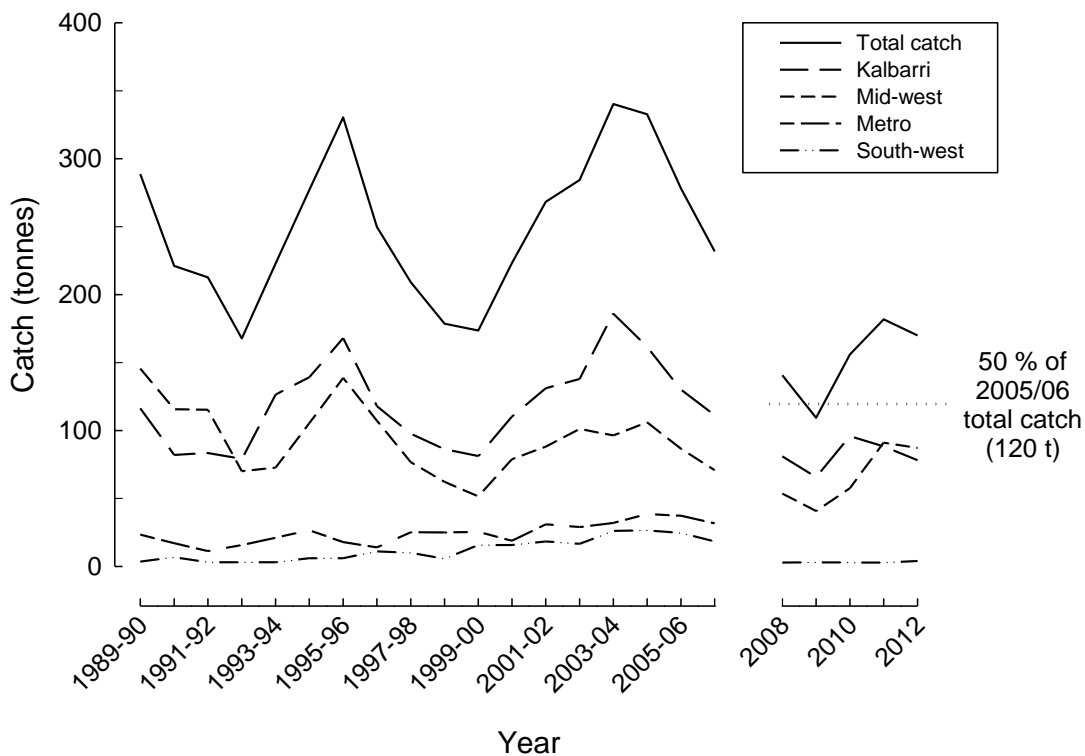
Map of the boundaries of the West Coast Demersal Scalefish Fishery extending from 26°30' S to 115°30' E. The northern boundary shown applies to the West Coast Demersal Scalefish (Interim) Managed Fishery (WCDSIMF) and is the proposed future boundary for the charter and recreational fishery. The Kalbarri, 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.

1 See http://www.fish.wa.gov.au/Documents/research_reports/frr222.pdf.



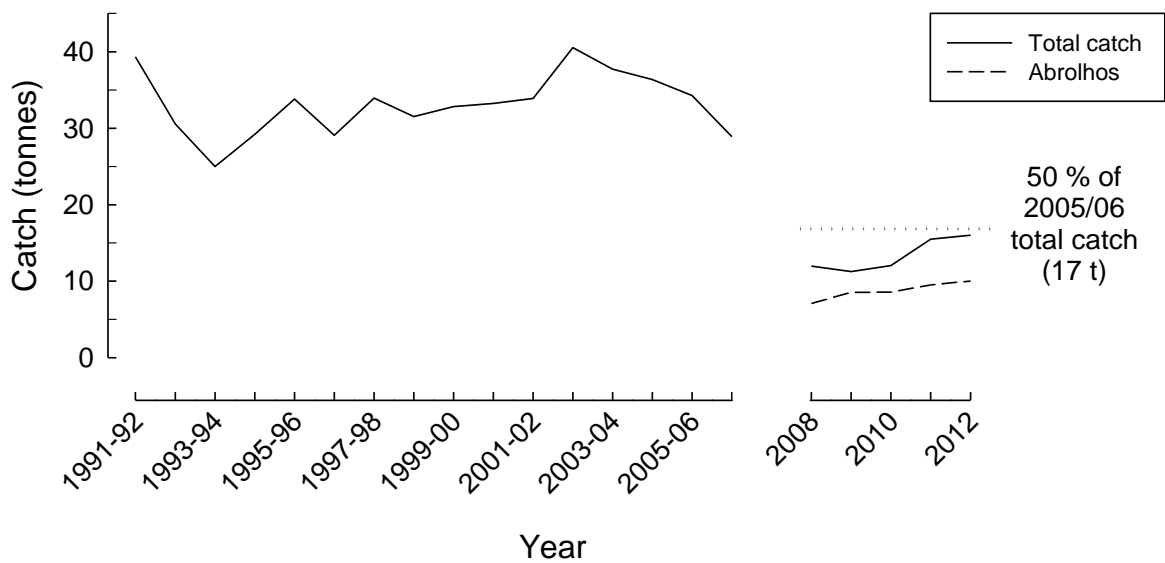
WEST COAST DEMERSAL SCALEFISH FIGURE 2

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 2012.



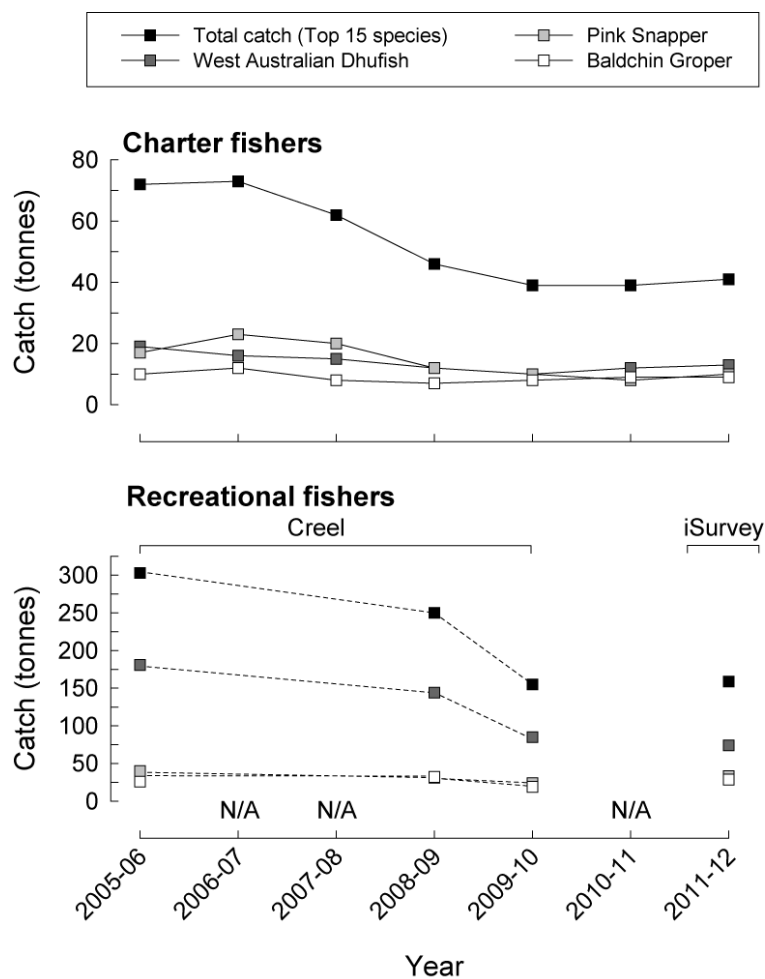
WEST COAST DEMERSAL SCALEFISH FIGURE 3

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 2012.



WEST COAST DEMERSAL SCALEFISH FIGURE 4

Total catch of Baldchin Groper *Choerodon rubescens* by commercial wetline fishers in the West Coast Bioregion (WCB) between 1991/92 and 2006/07 and by the West Coast Demersal Scalefish (Interim) Managed Fishery in the WCB and the Abrolhos Zone A of the Western Rock Lobster fishery between 2008 and 2012.



WEST COAST DEMERSAL SCALEFISH FIGURE 5

Catch of the top fifteen demersal species and of West Australian Dhufish, Pink snapper and Baldchin Groper by charter and recreational fishers in the West Coast Bioregion between 2005/06 and 2011/12. N/A, catch estimates not available.

Octopus Fishery Status Report

A. Hart, D. Murphy, S. Leporati, L. Joll

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial – Statewide	208 t
Fishing level	Acceptable	Recreational – Statewide (2011/12 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 byproduct, 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 bycatch from recreational lobster 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 byproduct.

specific issues.

Boundaries

Recreational octopus fishing is permitted to operate throughout Western Australian waters, with the exception of areas closed to recreational fishing such as reserves and sanctuaries. Each of the four commercial fishing sectors are 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 the Kalbarri Cliffs (26°30'S) in the north and Esperance in the south. Within the DOF there is also spatial separation of the areas fished by "Exemption holders".

Management arrangements

For the WCRLF, the keeping of octopus as a byproduct is permitted without catch restrictions or size-limits. The catch rate of octopus within the fishery is monitored as a performance indicator to ensure it is maintained within historical levels (see WCRLF status report).

The CSLPF is managed through input controls in the form of limited entry and gear restrictions. The DOF is also managed through limited entry (currently only 5 exemption holders) and limits on octopus pot allocations 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.

For the recreational sector, the current bag limit is 15 octopus, with a boat possession limit of 30 octopus.

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 the assessment of annual catch and effort statistics from commercial fisheries which are generally reported on a monthly basis. In the DOF, additional

Governing legislation/fishing authority

Commercial

Cockburn Sound (Line and Pot) Management Plan 1995

Cockburn Sound (Line and Pot) Managed Fishery Licence

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

West Coast Lobster Management Plan 1993

West Coast Rock Lobster Managed Fishery Licence

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation.

Consultation process

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on

reporting of daily catch and effort statistics by spatial location is also undertaken. The daily 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 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.

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 expansion of the DOF and project completion is scheduled for March 2014.

Retained Species

Commercial landings (season 2012):

208 tonnes (live weight)

Recreational catch estimate (season 2011/12):

2 tonnes (live weight)

Landings

Commercial: In 2012 the total commercial octopus catch was 208 t live weight, a 25% increase over last year's catch of 166 t (Octopus Figure 1).

On a sector-specific level, octopus catch from the WCRLF was relatively stable between 2009 and 2012, averaging 30 tonnes. Catch from the CSLP has also been stable since 2009, averaging around 22 tonnes. Catch from the DOF has increased by 380% between 2009 (33 t) and 2012 (160 t; Octopus Figure 1). The 2012 DOF catch represents the highest on record.

The DOF has steadily risen from 4% of the total catch in 2001 to 76% in 2012 (Octopus Table 1). At the same time, share of catch from the lobster fishery has declined from 86% to 13%, primarily as a result of effort reductions, which have occurred in that fishery.

Recreational: In 2001, the national recreational and indigenous fishing survey¹ estimated a total catch of 25,600 octopus in WA. Using an average weight of 0.7 kg, this amounts to a total catch 17 tonnes. Annual estimates of recreational catch by boat-based fishers at both the state-wide and bioregional levels were recently calculated for 2011/12 (Ryan *et al.*, 2013). The estimated total number of octopus captured during this period for all bioregions was 1,982 (90% in the West Coast Bioregion) which equates to a total weight of 1.4 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 2012 was 5,875 days,

a 17% reduction from 7,063 days in 2011 (Octopus Table 1). Days fished in the CSLP and DOF were 230 and 927 respectively, an increase of 6% and 77% respectively, from 2011 (Octopus Table 1). The 2012 DOF effort represents the highest on record. The fishing efficiency of the days fished in the DOF has also increased with the move to trigger traps.

Stock Assessment

Assessment complete:

Preliminary

Assessment level and method:

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 indicators of abundance of octopus.

The CPUE for octopus from the WCRLF was 4.6 kg/day, which was similar to the 2011 (Octopus Figure 2). The large increases in WCRLF CPUE from 2009 to 2011 may reflect changes in efficiency during this period when large reduction in fishing effort occurred for this fishery generated by changes in the management of rock lobster (see Western Rock Lobster report). In the case of the DOF it is due to gear efficiency increases.

The CPUE for octopus in the CSLPF and DOF sectors was 91 and 180 kg/day respectively. CPUE decreased slightly for both these sectors over the last year (Octopus Figure 2).

A standardised CPUE (SCPUE) analysis for the CSLPF and DOF was also undertaken, based on daily catch and effort logbook data which provide more precise estimates of effort, and standardised for month, soak time, and depth effects. This methodology is still under development, however preliminary trends have been estimated and are compared with the raw CPUE.

SCPUE for both shelter and trigger pots showed a slight declining trend between 2011 and 2012 (Octopus Figure 3). SCPUE for trigger pots was similar in 2008 and 2009, then there was a sharp increase up to 1.9 kg / pot. This was the first year of major development of the fishery, with catch increasing from 30 to 110 t as the fishery expanded into areas which previously had little effort applied to them and the experience of operators with new gear increased. However it may also have correlated with environmentally favourable conditions for octopus, as 2012 also saw a significant expansion of the fishery with new operators working in new grounds, but SCPUE did not increase. Future year's trends should reveal whether this is the case.

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 were met.

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

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.

Non-Retained Species

Bycatch species impact: **Negligible**

Octopus are a bycatch for the WCRLF, the impacts of this fishery on other components is discussed in the specific report for this fishery. The selective method of fishing used for the CSLPF and DOF results in a minimal level of bycatch of other species.

Protected species interaction: **Low**

In 2012 there were three reported whale entanglements (Humpback whale: *Megaptera novaeangliae*) in octopus fishing gear. All whales were successfully disentangled.

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, is likely to 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 the hard nature of the bottom substrate (see WCRLF report for full details).

In the CSLPF and DOF, octopus-specific pots are set in similar habitats to those fished in the WCRLF, as well as sandy and seagrass areas, particularly in Cockburn Sound. These are not expected to impact on benthic habitats as the soak times are at long intervals, averaging 11 days in the DOF and 25 days in the CSLP.

Social Effects

Each dedicated octopus fishing vessel employs between 2 and 3 people. In 2012, ~ 200 vessels caught octopus, although the vast majority of these landings were small (< 100 kg), as they were bycatch in the WCRLF. Within the octopus specific fisheries, 8 vessels fished in the CSLP, and 17 vessels in the DOF. 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 2012:

Level 2 - \$1 - 5 million (\$1.48 million)

The estimated annual value for 2012 was \$1.48 million based on the total catch of 208 t. and an average product price of \$7.11 /kg live weight.

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 208 tonnes is within the target range.

New management initiatives (2013/14)

The DOF moved into a new phase in its management arrangements during 2012. While one operator had pioneered the development and usage of trigger traps, the opportunity to use this gear was provided to other Exemption holders in the fishery during the year. In conjunction with this change the spatial management framework of the fishery was also modified to align it with the northern and southern zones of the West Coast rock lobster fishery. Permitted gear usage levels (both trigger traps and shelter pots) were set at levels designed to ensure sustainability while exploring the scope for an increased level of catch.

The CSLP management plan is currently under review and discussions are being held between Industry and the Department of Fisheries on the octopus fishing gear usage and entitlement levels. It is likely that changes to this plan will be made in 2013/14.

On 13 March 2013, the Department introduced an Exemption to commence a two year trial of the recreational use of octopus trigger traps. Under the conditions of the trial, recreational fishers can use a maximum of six octopus trigger traps when fishing for octopus. Any trigger trap used under the exemption needs to conform to a number of specific conditions. This is in addition to restrictions on where and when the traps can be used as well as bag and boat limits. In 2015 the Department intends to conduct a review of the trigger trap trial as well as the ongoing use of shelter pots in the recreational fishery. The outcomes of these reviews will be used to develop more permanent management arrangements for the recreational take of octopus.

External Factors

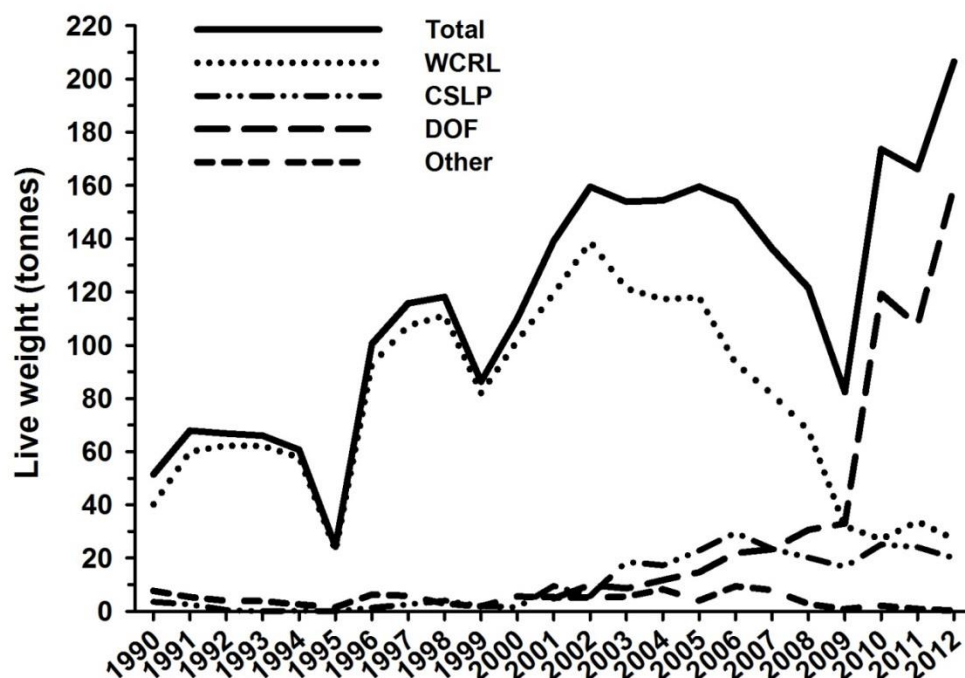
Cephalopods in general, including octopus, are known to be subject to large environmentally-driven fluctuations in abundance. If the fishery expands to reach a catch level approaching maximum sustainable yield, this year-to-year variability in abundance may prove a significant issue for the fishery. In particular, a "marine heatwave" experienced on the West Coast in the summer of 2010/11, where water temperatures reached 3 degrees C above average, may have been the cause of the elevated catch rates during the first year of expansion in the fishery.

The move of the rock lobster fishery from an effort-controlled fishery to a catch quota fishery, coupled with significant effort reductions will ensure the octopus catch in the WCRLF fishery remains a low % of the overall catch.

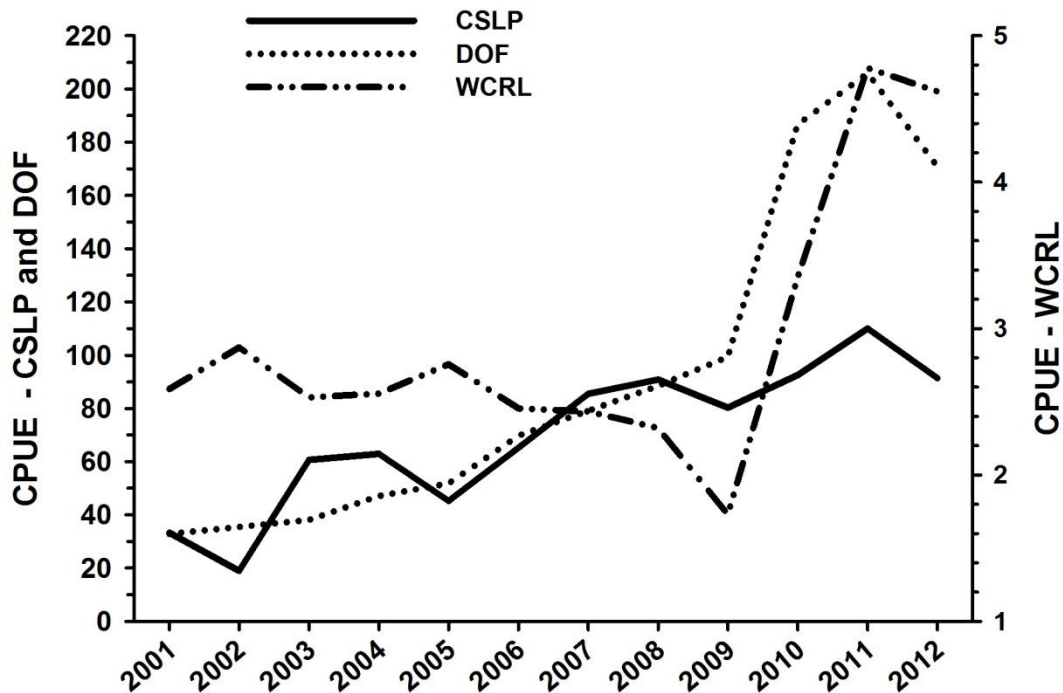
OCTOPUS TABLE 1

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 bycatch from trawl and miscellaneous pot fisheries.

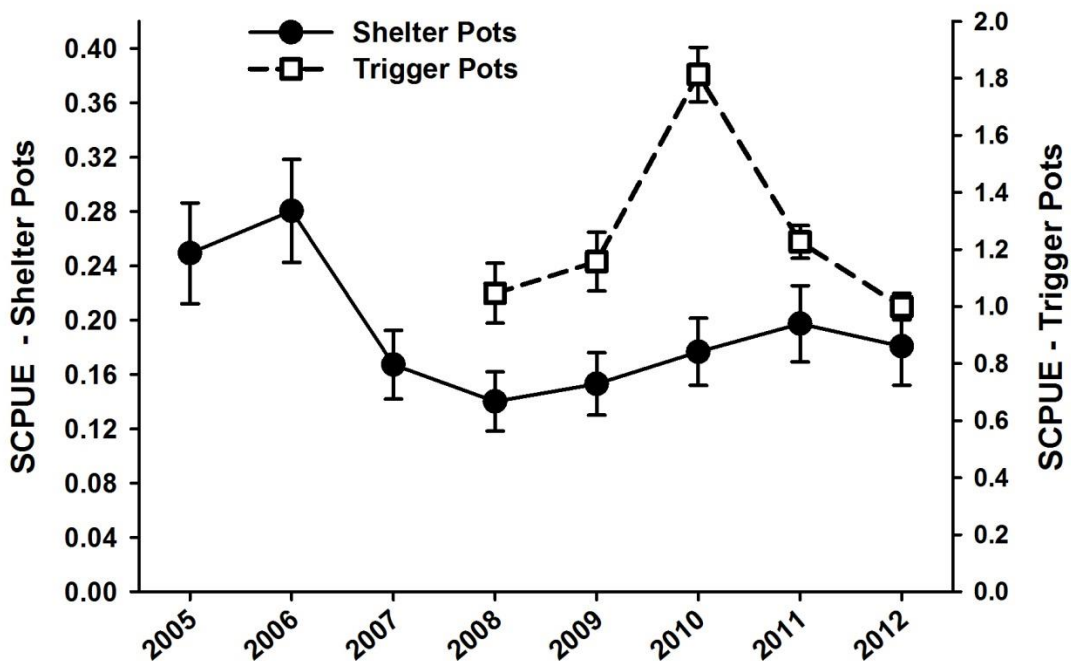
Year	WCRLF	CSLPF	DOF	Other	WCRLF	CSLPF	DOF
	Percentage of total catch				Effort (total days fished)		
2001	86	6.9	3.5	3.8	46,100	287	149
2002	87	3.6	6.2	3.2	48,300	300	278
2003	79	12.1	5.6	3.6	47,900	306	225
2004	76	11.1	7.6	5.3	45,900	273	249
2005	74	14.3	9.2	2.5	42,800	505	284
2006	62	19.7	11.6	6.3	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
2011	20	14.5	64.7	0.5	7,063	218	522
2012	13	11	76	0.1	5,875	230	927

**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 bycatch 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) ($\pm 95\%$ CL) in kg / pot (kg in live 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 *Fish Resources Management Act 1994* now 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.

The Department of Fisheries is now responsible for the environmental management of aquaculture in WA waters under the terms of a Memorandum of Understanding it has executed with the Department of Environment Regulation (DER). 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 (MEMP). In June 2013, the Department expects to provide relevant licence holders a guidance statement and template to assist in the preparation of their MEMPs.

A focus of the Department of Fisheries in the Abrolhos Islands area is the regulation of the pearling industry which is 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. More recently, attention has focused on the naturally-occurring Akoya oyster (*Pinctada imbricata*). A recent project, initiated by industry partners, demonstrated Akoya pearls can be produced successfully and provided the industry sector with the information it needs to continue to improve production strategies, reduce production costs, improve pearl quality and enhance the market value of the cultured Akoya pearls.

In addition to the production of pearl oysters, in the vicinity of the Abrolhos Islands there is increasing interest in the aquaculture of species that include coral and live rock. The Department of Fisheries has therefore started the development of an aquaculture policy to ensure the proper management and regulation of the aquaculture industry in the

Abrolhos Islands. The policy development process will involve substantial communication and consultation with stakeholders.

Through its Fish Health Unit, the Department of Fisheries has 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. The project demonstrated the technical feasibility of offshore marine finfish aquaculture in WA coastal waters. Information generated by the project will underpin the future growth of the industry in the Mid-West region.

An FRDC project, developed in collaboration with a commercial octopus fishing and processing company, is continuing with research on ranching wild-caught juvenile octopus and seeking to close the life cycle through larvae rearing. This project has made a number of advances in rearing mechanisms for this species.

To assist in addressing the regulatory and approvals issues concerning aquaculture development in WA coastal waters, the Department of Fisheries has received Government funding of \$1.85 million to establish two aquaculture zones in the Kimberley and Mid-West regions. The aquaculture zones will comprise defined areas of water selected for their suitability for the commercial production of marine finfish. Through this project, the Department of Fisheries will secure strategic environmental approvals for the zones from the Environmental Protection Authority, thereby streamlining the approvals processes for commercial projects within zoned areas and providing an “investment ready” platform for prospective investors. The establishment of the Mid-West zone is in its early stages.

The Department’s review of aquaculture licence conditions is scheduled to start in the 2012/13 fiscal 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.

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, Hillary's, Lancelin, Jurien, Dongara and Geraldton offices, statewide mobile patrol units and officers aboard the large ocean-going patrol vessels *P.V's Houtman 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 Hillarys 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. Marine park education and compliance functions are also undertaken in the Ngari Capes Marine Park (South West), and Shoalwater and Marmion Marine Parks (Metropolitan). These functions are primarily related to the integrity of management arrangements for Sanctuary Zones within the Parks.

Activities during 2011/12

During 2011/12, Fisheries and Marine Officers delivered a total of 25,354 hours of compliance and community education services in the field (West Coast Bioregion Compliance Table 1). This represents a 4% increase in field compliance over the previous year. A continuing emphasis was placed on employing risk- and intelligence-based approaches to compliance planning and prioritisation.

The West Coast Rock Lobster Managed Fishery is the largest commercial fishery in the state and within the bio region and therefore much of the compliance focus is in this fishery. 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 and estuarine fisheries.

The West Coast Rock Lobster Fishery entered its second season under a Quota Management System. Due to the transitioning of the fishery to a full year regime the season commenced on 15 November 2011 and extended into 2013

ending on 14 January 2013. The fishery will now commence on 15 January each year.

A focus for the second quota year for the rock lobster fishery was the introduction of Integrated Voice Response (IVR) reporting of catch returns. An extensive education program was conducted to support this new system, including a number of preseason education sessions and a high level of field education over the first few months.

Other new regulatory changes included a prohibition on bait bands, and introduction of the requirement of Sea Lion Exclusion devices (SLED's) in pots at the Abrolhos. Attention was given to education, and monitoring compliance, with these new requirements.

The focus of compliance activity for the West Coast Rock Lobster Managed Fishery reflected the outcomes of the Compliance Risk Assessment process. Routine compliance operations targeted black market operations, catch disposal records, quota weight declarations, container security, and over potting. There were a number of cases of fishers exceeding quota that required investigation.

One contentious matter that arose during the season was the quantum of water loss in a consignment between the time of weighing by the Master and the weighing by the Receiver. Field staff undertook investigations to provide quantitative data on this matter to assist policy formulation and subsequent Management Plan changes for the following season.

Overall, compliance in the West Coast Bioregion by commercial fishers was good, however there were increases in the number of prosecutions from 41 to 56, infringements from 16 to 21 and infringement warnings from 36 to 53 compared to 2010-11.

Recreational fishing compliance and education is a very large part of the compliance and education activity and primarily revolves around the prize species of demersal scalefish, rock lobster, abalone and marron and also blue manna crabs and minor finfish species. Demersal scalefish closures and fishing within the bio region is supported by statewide recreational mobile patrol units.

Field contacts with the recreational fishing community increased from 71,257 to 82,685. Overall compliance was good however there were increases in prosecutions from 267 to 306, infringements from 903 to 1004 and infringement warnings from 1,405 to 1,471.

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.

Throughout the year FMOs undertook joint patrols with other agencies including the 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 in both rock lobster and octopus fishing gear.

In the bioregion, the Department has had a growing role in shark response as part of the whole of government approach to the shark hazard program. During the year, FMO's provided support to incident responses and other program activities.

Initiatives in 2012/13

The third year of the Quota Management System commencing on 15 January 2013 in the West Coast Rock Lobster fishery will see the introduction of electronic catch reporting – FishEye – at some point in the season. The

significant move from a paper to an electronic system will involve a high level of industry liaison and education. A key management priority will be to ensure integrity with catch balances.

The increased focus on recreational fishing compliance will continue, particularly with the ongoing operation of the recreational mobile patrols operating within the Bio Region. 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.

The Department's role in the management of the Ngari Capes Marine Park will also be expanded and staff will be working closely with the Department of Conservation and Environment and the community, in planning both compliance and educational activities.

WEST COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the West Coast Bioregion during the 2011/12 financial year.

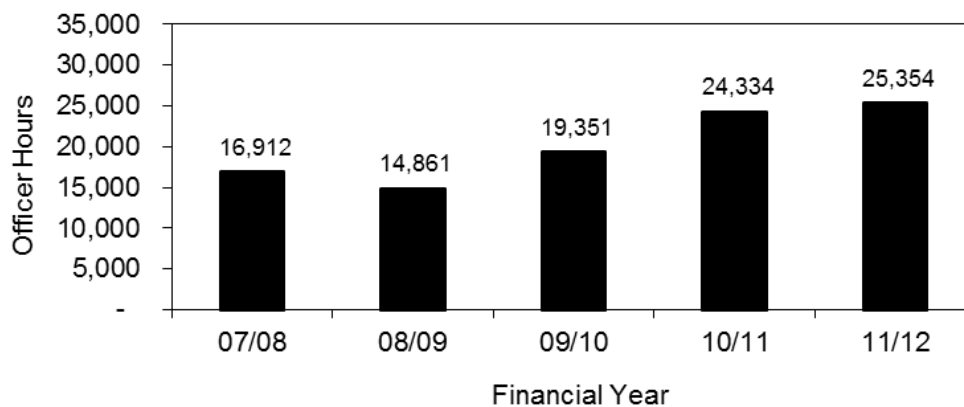
PATROL HOURS DELIVERED TO THE BIOREGION	25,354 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY ¹	
Field Contacts by Fisheries & Marine Officers	2044
Infringement warnings	53
Infringement notices	21
Prosecutions	56
Fishwatch reports ²	20
VMS (Vessel Days) ³	19,011
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	82,685
Infringement warnings	1,471
Infringement notices	1004
Prosecutions	306
Fishwatch reports	409
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY	
Field Contacts by Fisheries & Marine Officers	6,666
Fishwatch reports	208

1 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 Houtman. Contacts made by PV Walcott are included in North Coast Compliance Table 1.

2 Fishwatch reports are allocated to the District Offices relevant to the Bioregion. It is not possible to distinguish between calls relating to Inland Bioregions.

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

West Coast Bioregion Compliance Patrol Hours

**WEST COAST COMPLIANCE FIGURE 1¹**

“On Patrol” Officer Hours showing the level of compliance patrol activity delivered to the West Coast Bioregion over the previous 5 years. The 11/12 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.)

¹ These figures do not include 1,460 “on-patrol” hours delivered in 2011/12 by PV Houtman.

The total on-patrol hours for each of the Department’s 3 large patrol vessels are reported in the compliance summary of the most relevant bioregion: PV Walcott in North Coast, PV Houtman and PV Hamelin in West Coast.

GASCOYNE COAST BIOREGION

ABOUT THE BIOREGION

The marine environment of the Gascoyne Coast Bioregion (Figure 1) represents a transition between the fully tropical waters of the North West Shelf of the North Coast Bioregion and the temperate waters of the West Coast Bioregion.

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 in Shark Bay.

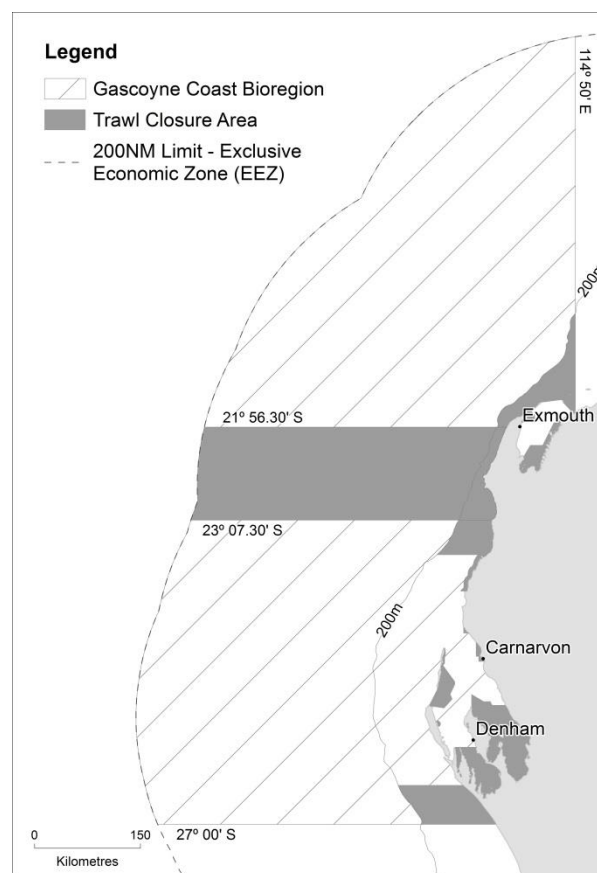
The coastline is characterised by high cliffs in the southern half changing to fringing coral reefs in the north. Coastal waters are generally high-energy in terms of wave action due to the strong trade wind system. The Exmouth Gulf section of the Gascoyne Coast Bioregion is seasonally influenced by extreme tropical summer cyclones, while the Shark Bay end of the Bioregion receives 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, it supports the highly diverse Ningaloo Reef marine ecosystem.

The outer area of the large marine embayment of the World Heritage-listed 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 terrestrial desert areas. 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 Coast Bioregion has been identified as one of 18 world ‘hotspots’ in terms of tropical reef endemism and the second most diverse marine environment in the world in terms of tropical reef species.

The Ningaloo reef in the north of the Bioregion is the largest continuous reef in WA and is one the most significant fringing reefs in Australia. The Bioregion also has some areas of mangroves, mostly in Exmouth Gulf, while seagrass beds are located in a number of areas.



GASCOYNE OVERVIEW FIGURE 1

Map showing the Gascoyne Coast bioregion and areas closed to trawling. The areas permanently closed to trawling are consistent with IUCN marine protected area category IV.

SUMMARY OF ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

Commercial fishing

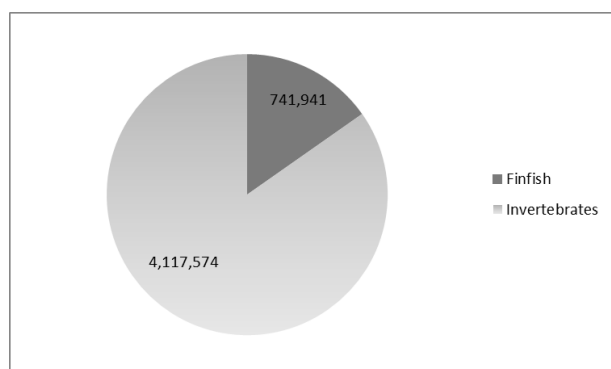
Commercial fishing is a significant industry in the region, with three of the State’s more valuable fisheries – the Shark Bay Prawn, Exmouth Gulf Prawn and Shark Bay Scallop fisheries – landing combined catches valued in the range of \$40 – \$50 million annually. These trawl based fisheries have operated sustainably in the region since the mid-1960s and are internationally recognised as ‘best practice’ in terms of both management and research. Only a relatively small number of the approximately 1,400 species of fish inhabiting this bioregion are targeted by commercial fishing activity.

The Gascoyne Demersal Scalefish Fishery (GDSF) and Shark Bay Beach Seine and Mesh Net Fishery have operated in the bioregion since the 1960s, and provide a significant proportion of the snapper and whiting catch for the State. The GDSF originally only targeted pink snapper but has developed over the past decade into a broader fishing sector

GASCOYNE COAST BIOREGION

taking other demersal finfish species including emperors, cods and deeper water species such as goldband snapper. The Gascoyne includes part of the Mackerel Managed Fishery (which extends the NT border and is reported on in the North Coast Bioregion chapter) with this area having lower annual catches compared to more northern areas. The region also includes some other small commercial fishing activities for finfish including the marine aquarium fishery which collects small numbers of a wide variety of species but is not permitted within the Ningaloo Marine Park or any waters closed to fishing. There is also a small beach seining fishery within Exmouth Gulf.

The main invertebrate species captured by fisheries in the Gascoyne Bioregion include a number of penaeid prawns, scallops, blue swimmer crabs within the two main embayments of Shark Bay and Exmouth Gulf plus deep sea crabs in the offshore region. The fishery for blue swimmer crabs which operates throughout the waters of Shark Bay had grown in the last decade to be the largest Australian crab fishery until recently affected by environmental issues. Other minor commercial fishing activities for invertebrates operating in the bioregion include collecting silver lipped pearl oyster which is used in pearl culture, though most effort is focused in the North Coast Bioregion.



GASCOYNE OVERVIEW FIGURE 2

Relative contribution of finfish and invertebrates to the total commercial wild fishery catch originating from the Gascoyne Bioregion. Numbers represent total catch (in kg) based on all major assessed fisheries identified in the Overview section of this report (Gascoyne Overview Table 1).

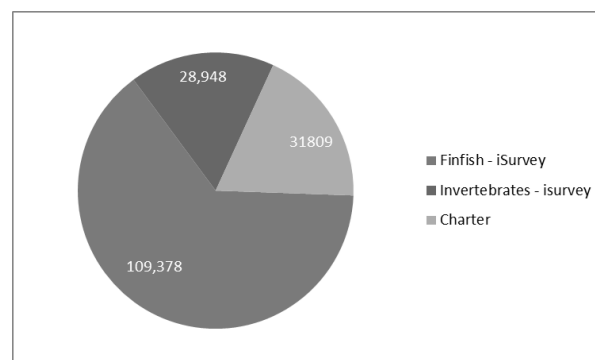
Recreational Fishing

The special features of the Gascoyne Coast Bioregion, 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 during this season 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.

Improved infrastructure (e.g. sealed roads) has led to increasing levels of domestic and international tourism to the Gascoyne. Enhanced access to coastal waters via new boat ramps (e.g. Bundegi, Coral Bay, Tantabiddi) and camping sites/facilities and the sustained popularity of recreational fishing also contribute to pressure on local fish stocks. This trend of increasing levels of recreational fishing effort and catches is also related in part to the recently increased levels of regulation and constraint on recreational fishing in the West Coast Bioregion south of the Gascoyne Coast Bioregion.



GASCOYNE OVERVIEW FIGURE 3

The Gascoyne Bioregion recreational catch as assessed in the integrated survey of boat-based recreational fishing in WA 2011/12, and the charter boat catch for the same period.

Aquaculture

Aquaculture development in the Gascoyne Coast Bioregion 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.

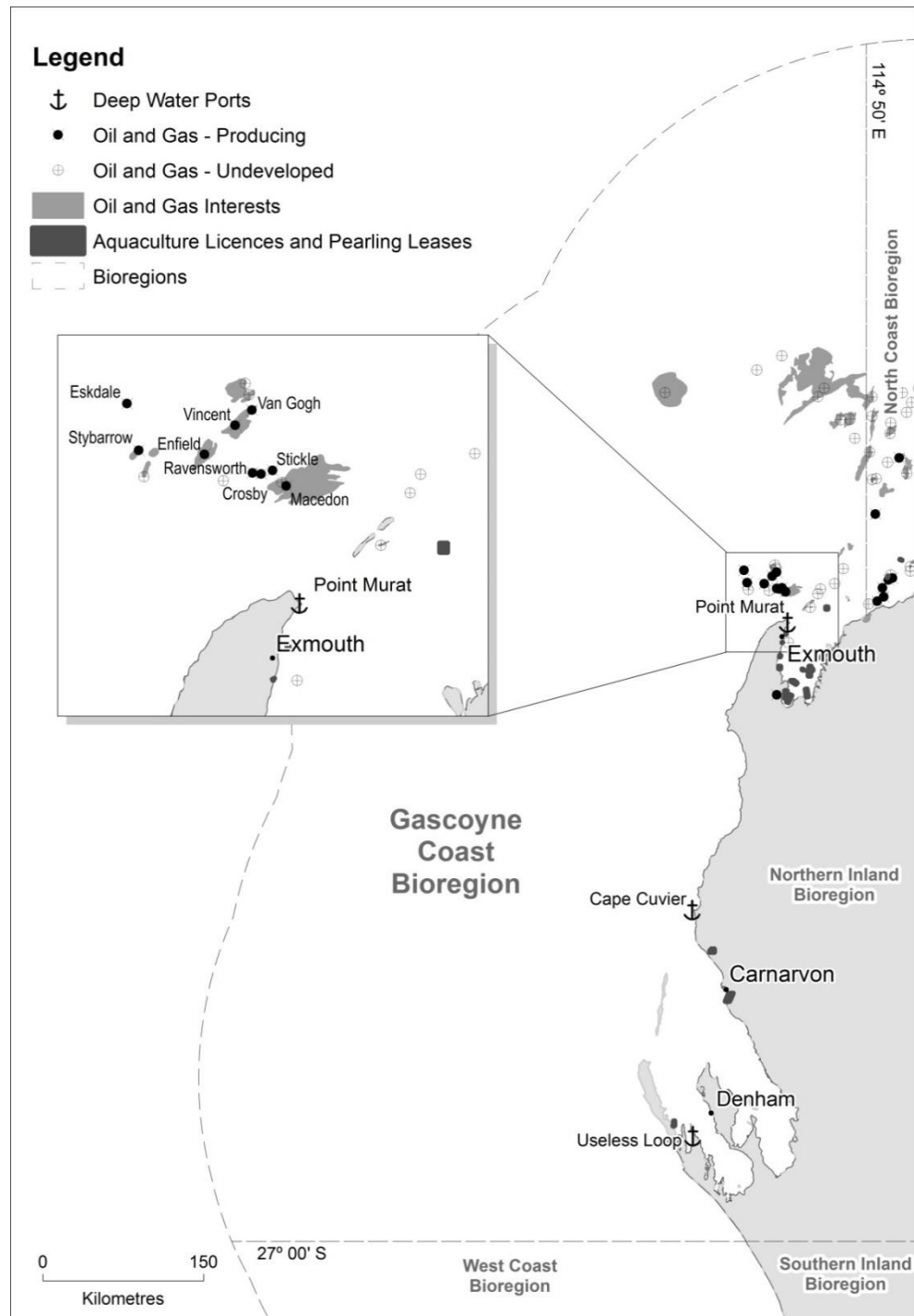
Tourism

The Gascoyne Coast Bioregion is a focal point for winter recreation by the Western Australian community. Apart from its scenic beauty, the main attraction of the coastline for tourists is the quality of marine life. The region supports extensive scuba diving and snorkelling activities, particularly inside the coral lagoons of Ningaloo. Specialised eco-tourism activities include whale shark and manta ray observation at Ningaloo and dolphin and dugong viewing in Shark Bay. Fishing is a key component of many tourist visits, and a full range of angling activities is available

Oil and Gas Activity

Exploration and appraisal drilling has occurred mainly in the northern part of the Gascoyne Coast Bioregion (Gascoyne Overview Figure 4). There is significant oil and gas mining activity offshore of North West Cape in the Exmouth Sub-basin, and the Australian Government has also recently released two areas offshore of Carnarvon in the Southern Carnarvon Basin for further exploration.

The main disturbances associated with oil and gas exploration and production include noise pollution from seismic surveys, potential for fish movement/impact arising from seismic surveys, disturbance to the marine habitat through drilling and/or dredging activities, release of produced formation water, shipping and transport activities and oil spill accidents.



GASCOYNE OVERVIEW FIGURE 4

Exmouth Sub-basin offshore oil and gas production sites and Aquaculture Licences and Pearling Leases (Source G DC 2010a).

Shipping and Maritime Activity

There are three deepwater port facilities currently operating in the Gascoyne Coast Bioregion: Useless Loop and Cape Cuvier (both private facilities servicing salt fields) and Point Murat, a naval port facility at Exmouth. The majority of shipping movements involve coastal cargo vessels, shipping associated with the two salt fields in the region and fishing vessels operating out of the numerous small ports along the coast.

Other harbours and maritime facilities of the Gascoyne Coast Bioregion include Denham, Carnarvon, Coral Bay and Exmouth, all of which largely service local fishing and charter vessels, as well as the private vessels of local residents and tourists. The expansion of oil and gas, along with increased recreational, charter and eco-tourism activities, in the area has led to the expansion of many of these facilities.

The impacts from vessels and ships tend to be concentrated around ports and favoured anchorage areas. Impacts include physical damage to the habitat and the potential to introduce and spread marine pest species.

ECOSYSTEM MANAGEMENT

A variety of measures have been implemented to manage the potential impact of activities on the ecosystem within the Gascoyne Coast Bioregion. These include:

Spatial Closures

The Department of Fisheries has established a comprehensive set of spatial management closures within the Gascoyne region that are equivalent to a number of IUCN categories for marine protected areas. Extensive trawl closures inside the 200 m 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, 2008¹; Gascoyne Ecosystem Management Table 1). The effective area that is not trawled is, however, much greater such that over 90% of the waters less than 200 m depth are not trawled (Gascoyne Ecosystem Management Table 1).

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. Commercial and

recreational fishing activities are restricted in these regions.

The Commonwealth 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 federal minister for the environment has recently announced the final reserve network proposed for the north-west which spans the Gascoyne and North Coast Bioregions.

Management of Commercial Fisheries

There is a high degree of ecosystem management and protection for the ecological assets that are located within the Gascoyne Coast Bioregion. Each of these fisheries operates under a specific management plan, the arrangements of which are implemented through the legislative framework provided by the *Fish Resources Management Act 1994* (FRMA). The FRMA and the management plan for each Fishery adhere to arrangements established under relevant Australian laws, with reference to international agreements that require conservation of all 'fish' and fisheries resources (which through the definition of fish includes nearly all aquatic organisms).

In WA, comprehensive controls on fishing were first introduced in the 1960s and now apply to all commercial fisheries. These controls are designed to ensure that all catches are kept at sustainable levels, which in turn requires that the annual catch is a relatively small proportion of the overall stock biomass. This approach maintains relatively high biomass levels for all harvested species compared to their unfished situation and therefore ensures that all trophic levels are being kept at relatively high levels of abundance. These management requirements have significantly reduced the risk of such trophic flow-on effects from occurring, and none are evident in the long-term trends in fish catches.

Strict limits on the use of fishing gear that can result in unwanted interactions with non-targeted species provide similar protection for bycatch and protected species and thus, biodiversity generally.

Examples of controls that operate in at least one fishery within the bioregion include:

- Limited entry;
- Variable spawning/size season closures (areas closed or opened depending upon catch rates and sizes);
- Permanent and seasonal area closures to preserve sensitive habitats that are essential nursery areas;
- Specific regulation to preclude use of gear types with high bycatch potential (eg large, mesh gillnets and long-lines)
- Temporal general closures;
- Primary and secondary bycatch reduction devices (BRDs);
- Total Allowable Catch limits;
- Target catch ranges;
- Minimum commercial size limits;
- Protection of berried females; and

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

- Monitoring of fishing activities using the Vessel Monitoring System (VMS).

Management of Recreational fisheries

Recreational fishing in the Gascoyne has been managed via a bioregional-specific management strategy since 2003. This strategy consists of a set of bag, possession and size limits, permitted gear types and seasonal and area closures implemented under the Fish Resources Management Act 1994. For inner Shark Bay (pink) snapper stocks, more complex arrangements are used within the Eastern Gulf, Denham Sound and Freycinet Estuary, where these stocks are managed separately and have explicit Total Allowable Catches (TACs). All recreational fishing activities, including those of the charter sector, are subject to the closures associated with the Ningaloo and Shark Bay Marine Sanctuary Areas, Nature Reserves and Conservation areas. In 2010, a state-wide recreational 'fishing from boat' license was also introduced.

A number of recreational fishing surveys have been undertaken in the region, including a recent state-wide recreational fishing from boat survey in 2011. The results of such surveys are used to estimate recreational catch and effort of targeted finfish and crustaceans. The results of such surveys are used to maintain a sustainable bioregional-specific management strategy.

Compliance and Community Education

Significant effort is put into ensuring adequate compliance with commercial and recreational fishing regulations. This includes at sea and aerial patrols to ensure closed seasons, closed areas, and operational rules are being adhered to. The use of VMS on commercial vessels also helps the Department monitor vessel location and speed, thus increasing compliance with closures while decreasing the need for untargeted patrol activities.

Biosecurity Risk Management

The International Maritime Organisation has identified the introduction of invasive marine species into new environments by ship's ballast water and biofouling as one of the four greatest threats to the world's oceans. Introduced marine pests can predate on native and farmed species, out-compete natives for space and food, alter nutrient cycle, lead to a loss of diversity in local species, cause human health impacts, negatively affect commercial fish and seafood species, negatively affect amenity and recreational activities and reduce the fuel efficiency for all vessel types. With increasing human population and associated travel, transport and trade, the risk of introducing new species is likely to grow.

Biosecurity risks associated with commercial vessel movements are managed through the routine monitoring of ports for marine pest species and management of risk associated with biofouling on commercial vessels utilizing state waters. Oil and gas related developments in the region have their own ministerial guidelines to ensure marine and coastal resources are protected. These developments undertake 'proof of freedom' pest monitoring to ascertain they have no pests present.

Management of Aquaculture Activities

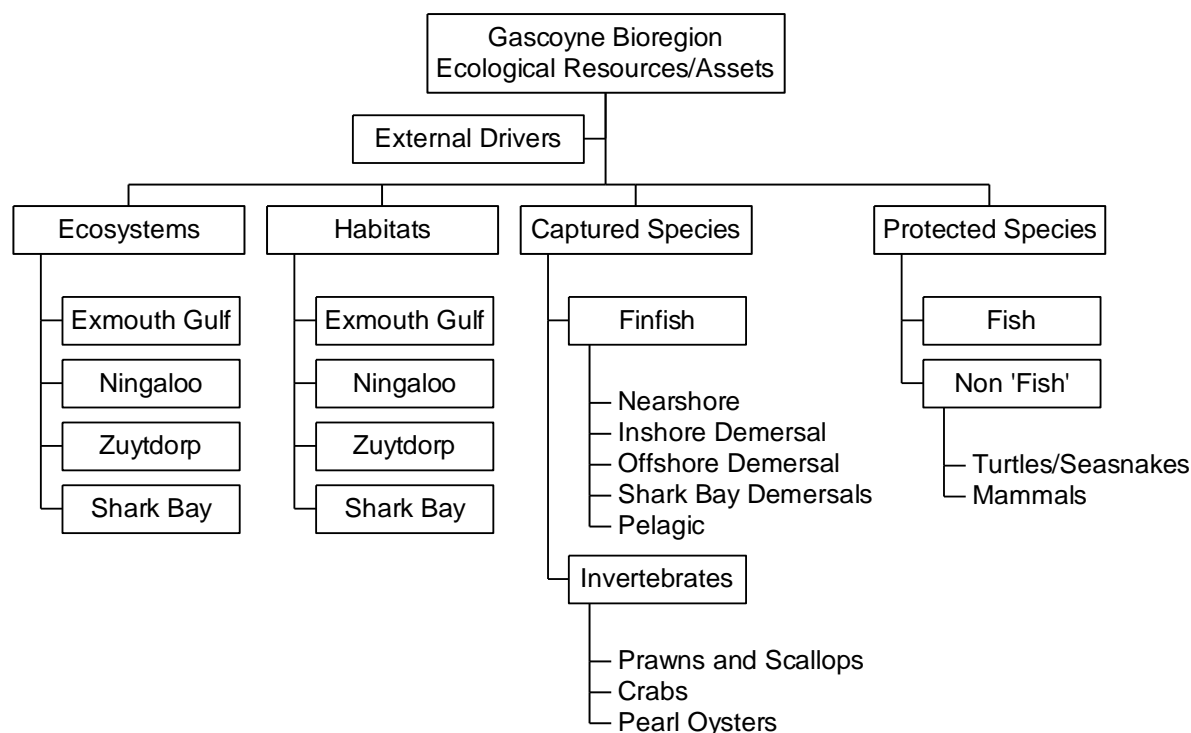
The main focus of the Department of Fisheries in the Gascoyne continues to be on the regulation of the regional pearling industry, including the blacklip oyster *Pinctada margaritifera*, which now complements the major State industry sector built on the silver lip pearl oyster (*Pinctada maxima*). A local aquaculture sector is emerging, focusing on the production of aquarium species, including coral and live rock. This developing sector is regulated according to the policy entitled *The Aquaculture of Coral, Live Rocks and Associated Products*.

ECOSYSTEM MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the Gascoyne Coast Bioregion, the Department must identify and monitor trends in the condition of these resources. This is achieved through application of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, *et al.*, 2010)¹ (see How to Use section for more details) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment.

These key ecological assets identified for the Gascoyne Bioregion are identified in Figure 3 and their current risk status reported on in the following sections.

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



GASCOYNE OVERVIEW FIGURE 5

Component tree showing the ecological assets identified and separately assessed for the Gascoyne Coast Bioregion. Under the integrated marine and coastal regionalisation for Australia scheme, the bioregion has been divided into 4 meso-scale regions (See Introduction Fig. 1): Zuytdorp, Shark Bay, Ningaloo, and Exmouth Gulf (imcra, v 4.0, 2006) which have been adopted for sub-regional management within an EBFM framework.

External Drivers

External factors include factors impacting at the bioregional-level that are likely to affect the ecosystem as whole and may not fall within the direct control of Fishery legislation (e.g. climate change). An understanding of these factors, which are typically environmental (cyclones, ocean currents) is necessary to fully assess the performance of the ecological resource. The main external drivers identified with potential to affect the Gascoyne Coast Bioregion include climate and introduced pests and diseases.

Climate

External Driver	Current Risk Status
Climate	MODERATE in short term HIGH in medium term

Being a transitional zone between tropical and temperate regions, the biota of the Gascoyne Bioregion is at enhanced risk of being affected by climate change. Climate change can influence fisheries and biological systems by affecting the timing of spawning, range and distribution, composition and interactions within communities, exotic species invasions and impacts, community structure and productivity.

Waters off the Gascoyne coast are strongly influenced by the Leeuwin current which brings warm low salinity water southward. After experiencing a weakening trend from the 1960's to the early 1990's, the strength of the Leeuwin Current has rebounded in the past two decades which has been driven by changes in frequency of El Niño/La Niña Southern Oscillation (ENSO) patterns. During the summer of 2010/11, a significant warming event took place off the coast of Western Australia, with widespread reports of fish kills and of tropical species being found further south than their normal range. Sea-surface temperatures were $> 3^{\circ}\text{C}$ above the normal summer averages in some regions. The "marine heat-wave" was associated with extremely strong La Niña conditions, leading to a record strength Leeuwin Current for that time of year, which resulted in record high summer sea levels along the mid-west and Gascoyne coast. The heat wave resulted in what is considered to be the first WA regional-scale coral bleaching event, affecting corals south to Rottnest Island and north to the Montebello and Barrow Islands (MBI). This warming event may also have contributed to a significant decline in blue swimmer crab and scallop stocks in Shark Bay and a subsequent recruitment failure for both of these species in 2011.

A preliminary assessment of fisheries-dependent indicators of climate change in WA was undertaken in 2010. This work continues as part of a three-year FRDC-funded project (2010/535) that will assess the effects of climate change on the marine environment and key fisheries, as well as

management implications. The first phase of the project is to understand how environmental factors, such as water temperature and salinity, affect fish stocks in Western Australia based on available historical data. The second phase will look at historical trends and possible future scenarios of Western Australian marine environments using climate model projections. Lastly, existing management arrangements will be reviewed to examine their robustness to climate change effects and new management policies will be developed in consultation with stakeholders to deal with climate change effects of fish stocks.

Introduced Pests and Diseases

External Driver	Current Risk Status
Introduced Pests and Diseases	LOW

The Department is the lead agency with responsibility for managing the threat posed by introduced marine species to our marine environment. As such it implements a range of risk-based policy, research, monitoring and compliance measures aimed at preventing introduction and establishment of marine pests in State waters.

The Gascoyne represents a transition between tropical and temperate regions and is an increasing focus of oil and gas exploratory activity. As such, there is an increasing risk of introduction and establishment of numerous nationally listed pest species to inhabit this region. Currently, recreational vessel movements, practices and the fouling present on these vessels represents one of our biggest gaps in marine biosecurity knowledge. Ongoing Departmental research includes an assessment of the likelihood of a marine pest being introduced into ports and quantification of the risk associated with recreational vessels for the introduction and translocation of marine pests into this Bioregion. Further detail may be found in the Appendix section entitled “Activities of the Marine Biosecurity Research Unit during 2012/13”.

Ecosystems and Habitats

A high level of protection of the ecosystems and habitats within the Gascoyne Coast Bioregion is ensured based on the limited area of the Bioregion that is available to commercial fishing activity.

If the areas that are not trawled is taken into account, more than 90 % of state-wide benthic habitats out to the 200 m depth contour are, in practical terms, fully protected and may never have been trawled (Table x). There are extensive trawl closures inside the 200 m depth zone in both Shark Bay and Exmouth Gulf that provide protection to sensitive benthic habitats including coral reef, seagrass and sand flats. These areas also provide significant nursery, breeding and feeding habitats for many retained and protected species. There is

also a large area from Point Maud to Tantabiddi Well off the Ningaloo Coast (23° 07.30' S to 21° 56.30' S) that is closed to all commercial fishing activities (Gascoyne Overview Fig. 1).

The Department identifies and monitors trends in the condition of ecosystems and their associated habitats to ensure the long term sustainability of both these key ecological assets and the fisheries that depend on them. Utilising the Integrated Marine and Coastal Regionalisation for Australia (IMCRA) scheme, the bioregion has been divided into four meso-scale ecosystems; the Ningaloo Coast, Shark Bay and Zuytdorp and Exmouth Gulf ecosystem (Introduction Fig. 1).

The key habitats occurring in depths of less than 40 m (where the vast majority of relevant fisheries resources are located and fishing activities are undertaken in this bioregion) include:

- **Coral reefs:** the Ningaloo ecosystem has the only major coral reef system in the bioregion. The Ningaloo Reef the largest continuous reef area in Western Australia and is considered one of Australia’s most significant fringing coral reef systems.
- **Mangroves:** The eastern coast of Exmouth Gulf supports one of the largest areas of mangroves in the region. These areas are thought to be significant sources of nutrients that contribute to the prawn fishery of the Gulf and provide nursery areas for juvenile fish and invertebrates.
- **Seagrasses:** The central Gascoyne coast and Shark Bay support major seagrass communities, which play important roles in sedimentary processes, food chains and nutrient cycling. Smaller seagrass beds also occur in the eastern and southern sections of Exmouth Gulf. Seagrass beds provide important nursery habitats for many finfish and invertebrate species, such as spangled emperor.
- **Sand banks:** Extensive sand areas support seagrasses and provide substrate for microalgae in all areas, particularly Ningaloo Reef. In both Exmouth Gulf and Shark Bay, shallow sand banks provide productive habitat and nursery areas for local prawn and finfish stocks. Within the deeper central areas of Shark Bay and Exmouth Gulf, bare sandy/muddy bottom habitats provide the main habitat for juvenile and adult prawns within the trawl areas.
- **Other habitats** that are located in the ecosystems within the Gascoyne Coast Bioregion include algal communities, rocky shore communities, hard- and soft-bottom benthic communities, and pelagic mid-water communities.

In depths beyond 40 m, ecosystems include hard- and soft-bottom benthic communities, sand banks and pelagic communities. Given the low levels of activities in these depths, there is little detailed information on these environments.

GASCOYNE ECOSYSTEM MANAGEMENT TABLE 1

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

Total Area of shelf	Area of shelf equivalent to IUCN marine protected area <= IV	Maximum area of trawl activity	Total area of habitat effectively protected from direct damage
15,800 sq nm	5,600 sq nm (35%)	1,100sq nm	14,700sq nm (93 %)

Exmouth Gulf

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Exmouth Gulf ecosystem	Marine	LOW
Exmouth Gulf benthic habitat	Sand, Mud, Sponge	LOW

Ecosystem

There is significant protection in place for all sensitive habitats and restrictions on the level of impacts that can occur in less sensitive habitats. Approximately 29 % (335 nm²) of Exmouth Gulf is trawled. Trawling is prohibited in a designated nursery area in the southern and eastern section of the Gulf. The nursery area covers 344 nm² and represents 28 % of Exmouth Gulf. 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, indicating that the current level of trawling activity does not affect overall biodiversity and cannot be distinguished from other sources of variation in community structure. The ecosystem in this region could be at increased risk if a number of proposed developments are implemented.

Habitat

There is a large permanent closure to trawling on the eastern and southern sides of the Gulf which protect sensitive habitats that operate as 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.

Trawling effort is focused in the deeper central and northwestern sections of the Gulf which is primarily mud. The mud substrate in Exmouth Gulf is generally comprised of coarse and heavy sediments, which are more resistant to disturbance by trawling. Seagrass beds are spatially separated from trawling activities and are protected within the permanent nursery area closure along the southern and

eastern sections of the Gulf. Current estimates of the amount of soft coral and sponge habitat within Exmouth Gulf suggest that there are only relatively small amounts and that trawling, given that the target prawn species prefer mud substrate, does not impact these areas. Macroalgal beds are predominantly located in the southern reaches and on the periphery of Exmouth Gulf in the shallow subtidal and low intertidal limestone pavement regions. The majority of these areas are a permanent nursery closures therefore trawling does not impact these habitats.

Ningaloo

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Ningaloo ecosystem	Marine	LOW
Ningaloo benthic habitat	Sand, Coral	LOW

Ecosystem

The Ningaloo ecosystem is protected via establishment of the Ningaloo Marine Park (NMP) which was established in 1987 and expanded in 2004 to cover and protect the entire Ningaloo Reef. The NMP covers a total area of 4,566 km² from the shoreline to continental slope. No commercial fisheries operate in the waters of the NMP and 34% of the park is zoned as no-take sanctuary areas. A significant level of research and monitoring is being undertaken in the Ningaloo marine park region by DEC, CSIRO, AIMS and universities. This reflects the main pressures on the ecosystem which are largely not fishing-related. 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, 2011)¹. The Department is a contributor and

1 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. 112 pp.

supporter of the extensive ecological research and monitoring that has been undertaken in the NMP, much of which was funded by the recently completed WAMSI Node 3 (see www.WAMSI.org.au for full details).

Habitat

Protection of habitats within Ningaloo occurs mainly through the use of spatial zoning throughout the Ningaloo Marine Park. There are no trawl activities conducted in this area. Corals are the most important reef building organisms within the NMP and provide food, shelter and settlement substrate for a variety of other marine flora and fauna. The main risk is to coral habitat results from tourism and other boating related activities. No major pressure on seagrass communities, which are general small, patchily distributed in this region have been identified (CALM 2005).

Zuytdorp

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Zuytdorp ecosystem	Marine	LOW
Zuytdorp benthic habitat	Sand, Reef	NEGLIGIBLE

Ecosystem

The Zuytdorp ecosystem is largely protected due to the lack of trawling that occurs in this area. The effects of the various scalefish fisheries (handline, dropline, longline and gillnet) on the Gascoyne Coast Bioregion ecosystem have been investigated by Hall and Wise (2011). This study used detailed statistical analyses on over 30 years of commercial catch data to determine if any major changes in community composition have occurred.

Results suggest there is no evidence of a decline in the mean trophic levels or mean maximum lengths of catches taken in the Gascoyne Coast Bioregion. Total catches of the three retained species of deep sea crabs represent a very small biomass, and any impact of crab fishing on the general food chain is expected to be minimal. There is also a large commercial closure between Point Maud and Tantabiddi Well, which limits the spatial extent of commercial fishing activities within the Gascoyne Coast Bioregion.

Habitat

The benthic habitats of the Zuytdorp ecosystem are dominated by mud/sand bottoms, likely to support a relatively sparse invertebrate community. The majority of non-trawl based fishing takes place over sand habitats in depths of 20-250 m, depending on which species is being targeted. Underwater video work, in 20-250m, has shown that the habitat is dominated by sponges, soft corals and gorgonians (DoF 2002)¹. The Gascoyne Demersal Scalefish

Fishery operates in this ecosystem and is based on using hook and lines, meaning that there is virtually no impact on benthic habitats. Fishing typically occurs over harder patches of hard bottom around the entrance to Shark Bay and the adjacent ocean. Fishing does not normally occur over sensitive seagrass or hard coral habitats. The West Coast Deep Sea Crustacean Fishery operates in this area in depths from 150-1200m. Crab traps in the Zuytdorp are mainly set over mud bottom areas and occasionally bring up solitary corals or sponges that get entangled in the pot. The footprint of the pots and effort levels are both extremely small in relation to the extent of this habitat. There are thus few direct impacts of fishing activity to these habitats

Shark Bay

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Shark Bay Gulfs	Marine	LOW
Shark Bay Gulfs	Sand, Sponge	MODERATE
Shark Bay Gulfs	Seagrass	NEGLIGIBLE

Ecosystem

Shark Bay is considered to be a highly productive system with protection for all sensitive habitats and restrictions on the level of impacts that can occur in less sensitive habitats. Benthic habitats and communities of Shark Bay have been described and mapped (CALM 1996). The current level of fishing by all methods does not appear to have noticeably affected the trophic/community structure in Shark Bay. A study of biodiversity in Shark Bay has found that no significant difference in the fish and invertebrate abundance, species richness, evenness or diversity between trawled and untrawled areas (Kangas *et al.* 2007)². Therefore, the closed areas provide protection to those species more vulnerable to trawling (Kangas *et al.* 2007).

Habitats

The extent of various habitat types, such as seagrasses and corals, has been described and mapped (CALM 1996). Seagrass is extensive throughout the eastern and western gulfs, and corals can be found primarily along the eastern coast of the western gulf, and the eastern coasts of Dirk Hartog, Dorre and Bernier Islands. Almost all of these areas are part of the Shark Bay Marine Park and are permanently closed to trawling activities.

The majority of sponge/coral habitats and other sensitive habitats are also contained within specific trawl closures and there are limits to the trawled area to less than 40% of the

¹ Department of Fisheries, (2002). Fisheries Environmental Management Plan for the Gascoyne Region. Fisheries Management Paper No. 142

² Kangas, M.I., Morrison, S., Unsworth, P., Lai, E., Wright, I. and Thomson A. 2007. Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia. Final FRDC Report 2002/038. Department of Fisheries, Western Australia, Fisheries Research Report No. 160. 333 pp.

sand habitats. The few unprotected areas where coral occur (e.g. Egg Island and Bar Flats) are not part of the actively trawled areas. The main areas where trawling occurs, in the central bay, north Cape Peron and in the northern area of Denham Sound, are sand/shell habitat, which is the preferred substrate of the main targeted species.

There are permanent closures include the Sanctuary and Special Purpose Zones of the Shark Bay Marine Park and the Hamelin Pool Marine Reserve. In addition, specific areas of the Bay are closed to certain fishing methods. Permanent trawl closures protect the majority of seagrass and coral habitats in the eastern and western gulfs.

Captured Species

Finfish

The Gascoyne supports a diverse fish fauna and is noted for its high quality of both commercial and recreational fishing (Shaw 2000). Approximately 1400 species of fishes could be expected to inhabit this region. Of these only a relatively small number are targeted by commercial fishing activities with demersal finfish species (e.g. Pink Snapper) captured in the Zuytdorp region and nearshore finfish species (e.g. Whiting) within the Shark Bay region. DoF manages commercial and recreational fishing in the State coastal waters (generally 3 nm). By way of the *Offshore Constitutional Settlement 1995* (OCS) agreement between the State and Commonwealth Governments, control is also given to WA for most fisheries which operate out to 200 nm from the coast (except for trawling where WA's jurisdiction is limited to the 200 m isobath).

Due to the broad spatial distribution of both species and fisheries, the majority of finfish species in this area are managed at the Bioregional scale within four recognized aquatic zones. Indicator species which reflect the characteristics of the broader exploited stocks are monitored in order to assess ecological risk to the range of species targeted. The major fishery operating at the bioregional level is the Gascoyne Demersal Scalefish Fishery. This is a line fishery that originally targeted pink snapper has been developed over the past decade into a broader fishing sector targeting other demersal finfish species including emperors, cods and deeper water species and is managed as the Gascoyne Demersal Scalefish (Managed) Fishery.

The Gascoyne Coast Bioregion also has the Shark Bay-based beach seine fishery (the Shark Bay Beach Seine and Mesh Net Managed Fishery) since the 1960s, which respectively provide most of the pink snapper and whiting catch for the state.

Nearshore (0-20m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Nearshore (0-20m depth)	MODERATE

The indicator species for this suite (e.g. whiting) are all considered to have adequate breeding stocks, fishing catch and effort has been occurring at the same acceptable levels for over 40 years and there are no additional risks that have

been identified. Annual catch and effort monitoring is continuing.

Inshore demersal (20-250 m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Inshore demersal (20-250m depth)	MODERATE

The main fishery operating in this region is the Gascoyne Demersal Scalefish Fishery, for which a detailed status report is provided at the end of this chapter. 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 (but the overall stock is at an acceptable level). (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 2012). 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 (>250 m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Offshore demersal (>250 m 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

Captured Species	Aquatic zone	Ecological Risk
Finfish	Pelagic	MODERATE

The stock status and fishing levels of these species (e.g. Spanish mackerel) are both at acceptable levels

Shark Bay Gulf Demersal

Captured Species	Ecosystem	Ecological Risk
Finfish	Shark Bay Gulf Demersal	MODERATE

The main fishery operating in this ecosystem, is the Inner Shark Bay Scalefish Fishery, for which a detailed status report is included at the end of this chapter.

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. These inner gulf stocks are monitored using 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

Commercial fishing for invertebrates is a very significant industry within the Gascoyne Coast Bioregion; three of the State's most valuable fisheries (the Exmouth Gulf Prawn, Shark Bay Prawn and Shark Bay Scallop Managed Fisheries) land combined catches valued in the range of \$AUD 40-50 million annually. These trawl-based fisheries have operated in the region since the mid-1960s and are internationally recognised as 'best practice' in terms of both management and research (Fletcher and Santoro 2012). A fishery for blue swimmer crabs (the Shark Bay Crab [Interim] Managed Fishery), based primarily in Carnarvon but operating throughout the water of Shark Bay, has grown in the last decade to be the largest Western Australian crab fishery. The Gascoyne also supports the majority of the catch of deep sea crabs off the coast of Western Australia as part of the West Coast Deep Sea Crustacean Managed Fishery.

Nearshore (0-20 m depth)

Captured Species	Aquatic zone	Ecological Risk
Crabs	Nearshore (0-20 m depth)	MODERATE
Pearl Oysters	Nearshore (0-20 m depth)	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 recent (2011 stock assessment) concluded that there was conflicting evidence about the level of impact the current catch levels were having on the stock. Subsequent to this review, the relative abundance of all size classes of crabs in Shark Bay declined significantly. The reasons for this unexpected and substantial decline appear to be linked to several adverse extreme environmental events and this has already had a significant impact on the 2011/12 fishing season.

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.

Exmouth Gulf

Captured Species	Aquatic zone	Ecological Risk
Prawns	Exmouth Gulf Ecosystem	MODERATE

The only commercial fishery that operates continuously in the Exmouth Gulf ecosystem is the Exmouth Gulf Prawn Managed Fishery (EGPMF). The Exmouth Gulf Beach Seine Fishery, which only has one license holder, is very small scale and does not operate every year. The EGPMF is the second largest prawn trawl fishery in WA, with a landed value in 2011 of around \$ 11 million. The Fishery is located in the north/northwest waters of Exmouth Gulf. Currently, the two main target species of this fishery are the brown tiger prawn and western king prawn. A status report summarizing the condition of the EGPMF is included at the end of this chapter.

Management of the prawn 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. In the Exmouth Gulf Prawn Managed Fishery, of the 4000 km² waters contained within the fishery boundary, 1100 km² is closed to trawling but a further 900 km² is not trawled. All the stocks of prawns are at acceptable levels.

Zuytdorp

In addition to the bioregional fisheries, the Zuytdorp ecosystem is also utilized by the West Coast Deep Sea Crustacean Managed Fishery which has been operating since the late 1990s.

Shark Bay

Captured Species	Aquatic zone	Ecological Risk
Prawns and Scallops	Shark Bay Ecosystem	MODERATE

Four commercial fisheries targeting invertebrates operate within the waters of Shark Bay which include trawl (Shark Bay Prawn Managed Fishery for which a detailed status report is provided at the end of this chapter) and Shark Bay Scallop Managed Fishery (both also target crabs)), trap based fisheries (Shark Bay Crab (Interim) Managed Fishery) and beach seine fisheries (Shark Bay Seine and Mesh Net Managed Fishery)

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

GASCOYNE COAST BIOREGION

tiger prawn breeding stocks above the threshold abundance level.

For the Shark Bay Prawn and Scallop Managed Fisheries, 41,500 km² waters are legislated within the fisheries' boundaries. Prawn trawling only occurs in 4,500 km² leaving 37,000 km² untrawled (7,600 km² of which is closed to the Fishery). Scallop trawling occurs over even less of the area (3,400 km²), leaving 38 100 km² untrawled and 9,700 km² closed to the Fishery.

To ensure that sufficient stock remained for spawning, the fishing arrangements provide a threshold catch rate limit for the scallop fleet to cease fishing. All the stocks of prawns are at acceptable levels. The stock of scallops, however, declined significantly after the 2011 season had ended and this is likely to have been generated by the same set of environmental conditions that affected the crab stocks

Protected Species

A variety of endangered, threatened and protected¹ (ETP) species can be found within the Gascoyne Coast Bioregion, including cetaceans, dugongs, marine turtles, sea snakes, elasmobranchs, seahorses and pipefish and sea/shore birds. These species are protected by various international agreements and national and state legislation. Primary pieces of legislation include the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, the *Western Australian Wildlife Conservation Act 1950*, and the *Fish Resources Management Act 1994*.

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. 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 all trawl nets in this bioregion have further increased the protection for sharks, rays and any turtles encountered on the trawl grounds. In a further effort to protect sharks and rays, line-fishery vessels are not permitted to use wire snoods.

Fish

Protected Species	Risk
Fish	LOW

There are no protected fish species (including syngnathids) at risk in this region.

Non-Fish

Protected Species	Ecological Risk
Turtles/seasnakes	LOW
Mammals	LOW

While protected species including dugongs, turtles and sea snakes occur in the Gascoyne region area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both of these 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.

There are no recorded captures of mammals by the trawl fisheries in this bioregion.

¹ It must be noted that merely being on the protected species list does not automatically indicate that a species is either threatened or endangered.

FISHERIES

Shark Bay Prawn and Scallop Managed Fisheries Status Report

E. Sporer, M. Kangas S. Brown and L. Pickles

Main Features

Status		Current Landings	
Stock level		King Prawns	1075 t
Prawn	Adequate	Tiger Prawns	494 t
Scallop	Inadequate (non-fishing)	Endeavour Prawns	23 t
Fishing level		Scallops	Nil
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 incorporate in-season real time management to ensure sustainability and maximise economic efficiency.

Both the area and timing of operation of the two fisheries overlap and vessels that operate within the prawn fishery are entitled to retain scallops.

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

The Department is responsible for the statutory management plan consultation and undertakes consultation directly with licensees on operational issues and processes. The West Australian Fishing Industry Council (WAFIC) is also responsible for statutory management plan consultation under a Service Level Agreement with the Department. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council

Boundaries

The boundaries of the Shark Bay Prawn Managed Fishery and the Shark Bay Scallop managed Fishery are located in and near the waters of Shark Bay as presented in Shark Bay Prawn and Scallop Figures 1 & 2. These diagrams outline the boundaries of the two fisheries plus show all the area closures (both temporary and permanent) and the specific areas trawled in the 2012 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. Both fleets undertake trawl fishing using otter trawl systems. Each fleet has a separate standard net size and gear configuration. This system has specific effort controls based on maximum headrope length and the maximum fishing days (season duration). These controls have allowed fleet rationalisation to occur in response to improvements in vessel and gear efficiency.

The maximum headrope allocation for the prawn fleet was set at 790 m (or 432 fathoms of headrope). This headrope allocation was originally for use in the twin trawl configuration using nets of maximum size equal to 2 x 14.63 m (8 ftm), but has been reduced by 8.3 % to 724 m (396 ftm), when the change to the more efficient quad gear configuration was approved. Scallop boats are authorised to operate with two 12.8 metre nets (7 fathoms) and boat units no greater than 375, but the scallop fleet also operates under an exemption from the 375- hull unit rule. The total net headrope capacity for the scallop fleet was 358.4 metres (196 fathoms).

Within the Shark Bay Scallop Managed Fishery in 2011 the Minister adopted a formal catch share management objective for the annual scallop catch between A Class (scallop only) and B Class (scallop and prawn) boats of 70% and 30% respectively.

Bycatch reduction devices ('grids') are mandatory for all prawn and scallop trawl nets. In addition, secondary bycatch reduction devices (fish escape devices) are mandatory for nets of prawn boats because they fish with small size mesh codends. Dedicated 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 Fish Resource Management 1994 (FRMA) is the overarching legislation for the Shark Bay Prawn Managed Fishery (SBPMF). The key object of the FRMA is to conserve develop and share the fish resources of the State for the benefit of present and future generations. The delivery of this management outcome is supported by the use of a sophisticated system of seasonal, spatial and temporal closures (nursery and spawning area). These management controls, in particular, the spatial and temporal closures are designed to ensure the maintenance of breeding stocks for all prawn species, maximise the size of the prawns at capture and minimize environment impacts of the fishery.

The key strategy for these fisheries is the use of real time management of spatial and temporal fishing effort. This is supported by the Research Division of the Department of Fisheries who carry out surveys and regular monitoring of the catch by the fleet to provide advice on when to close areas based on the threshold catch rates. The Vessel Monitoring System (VMS) monitors the location of all activities by licensed fishing boats in these fisheries.

The Commonwealth Government's Department of Sustainability Environment Water Populations and Communities (SEWPaC), has assessed the fisheries under the provisions of the EPBC Act 1999 and has accredited these 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 material 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.

For the 2012 prawn season, the fishing arrangements included an opening date of 14 March and closing date of 23 October, providing a total of 175 nights fishing. During this season the fishing strategy involved flexible arrangements and voluntary rolling area openings, based on assessments of the sizes of king and tiger prawns obtained through fishery-independent surveys. The tiger prawn spawning area (TPSA) was closed on 29 June.

The 2012 scallop season did not open because of environmentally induced low scallop abundance.

Research summary

Research and monitoring activities in the Shark Bay region is separated into two regions - Northern Shark Bay and Denham Sound. Research activities continue to focus on stock assessment and annual monitoring of the target stocks, particularly tiger prawns and scallop stocks.

Prawns

The seasonal operations of the prawn fishery are dynamic because they depend on the strength and timing of recruitment which, in turn, affects the opening and closing dates for the fishing seasons. These dates 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.

The fishery uses moon closure periods because king prawns are sensitive to light, 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. In 2012, the moon closures ranged from five to nine days and were set out in the season arrangements.

From early August onwards, the Extended Nursery Area (ENA) is closed to protect smaller prawns (primarily king prawns) and provide protection as a buffer to the remaining tiger prawns during the key spawning period before 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 smaller prawns early in the season allowing a higher spawning biomass in this region.

All prawn boats completed detailed daily log books, and these, together with pre-season fishery-independent recruitment surveys and in-season surveys of size composition and spawning stock, provide the information 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.

Scallops

The opening date of the scallop fishing season is determined based on 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.

A minimum estimated scallop catch availability level for Denham Sound and northern Shark Bay has also been set to determine if commercial fishing can commence each season. Based on the catch prediction from the annual pre-season survey in November 2011 which indicated very low landings would be generated, the fishery remained closed for the 2012 season.

Retained Species

Commercial production (season 2012)

Prawns	1592 tonnes
Scallops	Nil

Landings

Prawns

The total landings (whole weight) of major prawn species for this fishery was 1592 tonnes, comprising 1075 tonnes of king prawns, 494 tonnes of tiger prawns and 23 tonnes of endeavour prawns (Shark Bay Prawn and Scallop Figure 3). In addition, 200 t of coral prawns (various species, but mainly *Metapenaeopsis crassissima*) were landed. The total landings of major prawn species were within the interim target catch range set in 2009 (1350 – 2150 t) and the historical target catch range (1501 to 2330 t). The interim catch range reflects the change in the expected level king prawn landings (950 to 1350 t) which are being reviewed to reflect current fishing/targeting strategies and effort levels under normal environmental conditions.

King prawn landings (1075 t) were within their interim catch range but slightly below their historical target catch range (1100 to 1600 tonnes). Tiger prawn landings (494 tonnes) were also within the historical target catch range (400-700 tonnes).

Scallops

Nil

Byproduct

Byproduct landings from the prawn fleet included 12.5 t of blue swimmer crab (*Portunus armatus*), 5.1 t of squid, 22.6 t of cuttlefish, 2.5 t of bugs (*Thenus australiensis* and *T. parindicus*), < 1 t of octopus and 3 t mixed finfish species.

The blue swimmer crabs total season landings by the prawn boats were low as retention of crabs was voluntarily ceased in April due to low stock abundance of crabs in Shark Bay (see Gascoyne Coast Blue Swimmer Crab report for more details).

Fishing effort/access level

Eighteen prawn boats operated in 2012. All boats fished with quad gear configuration (four, 10.1 m nets). The mean annual total effort recorded historically by 27 prawn boats between 1990 and 2004 inclusive is 44,864 hours, fishing with twin gear (prior to 1990, the fleet consisted of 35 boats). An adjustment was made to the nominal effort for the increased headrope (37.5% per boat) towed by the 18 quad boats with the 2012 adjusted effort being 33,198 hours (twin-gear equivalent). This adjusted effort is 8% lower than 2011 and the lowest seen since 1967 and well below the mean effort between 1990 and 2004. The impact of gear amalgamation means that effective effort has not reduced as much as nominal effort.

The increased cost of fishing (mainly high fuel prices and high value of the Australian dollar) has reduced effort. The 2012 prawn season arrangements provided 175 nights fishing, however, a maximum of 162 nights were fished, and only by some boats. Ten boats ceased fishing at the August moon closure (27 August to 5 September) for a total of 126 nights, with one additional boat ceasing fishing in late September with the remaining 7 boats fishing 16 of the 23 days left available to fish in that period.

Recreational component:

Nil

Stock Assessment

Assessment complete:

Yes

Assessment level and method:

Level 4 - Direct survey/catch rate

Breeding stock levels:

King prawns

Adequate

Tigers prawns

Adequate

Scallops:

Inadequate

Prawns

The catch per unit of effort for the prawn 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 commercial catch rate levels of tiger prawn spawning stock from logbook data. Conservative tiger prawn 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 stocks, which are monitored and assessed for size and catch rates from recruit surveys in March and April, king prawn surveys in Denham Sound in June and July, and tiger prawn breeding stock surveys in July and August.

Fishery-independent recruitment surveys are undertaken as fishery-dependent data on key recruitment grounds is no longer available. 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. The information is also used to forecast a predicted catch range for tiger and king prawns and to determine the extent of areas to be opened to fishing to meet prevailing market requirements. The spawning stock surveys are undertaken to verify tiger prawn catch rates after the TPSA is closed to fishing. Some of the king prawn breeding stock is also protected by this closure and their catch rates are also recorded during the surveys.

Catch rate assessment

The overall king prawn catch rate of 32.4 kg/hr (for adjusted effort equivalent to twin gear units) in 2012 was lower than in 2011 (36.2 kg/hr), however, it was relatively high when compared with the previous ten years mean catch rate (24.1 kg/hr). The overall tiger prawn catch rate of 14.9 kg/hr was also lower than 2011 but again higher than the previous 10 years mean catch rate (11.3 kg/hr). These catch rates show that the fishing fleet is fishing efficiently.

Survey assessment and breeding stock levels

For 2012, the king and tiger prawn mean survey catch rates (index) during the combined recruitment surveys (March and April) were 64.6 kg/hr and 43.7 kg/hr respectively and the catch predictions for king and tiger prawns were 950 t (760 to 1140 tonnes) and 485 t (390 to 580 tonnes) respectively. The actual landed catches of both species were within their predicted ranges. The relationship between survey indices and landings will continue to be reviewed.

To help maintain adequate tiger prawn breeding stock levels, fishing is delayed on the tiger prawn stock by not opening the Carnarvon/Peron line (CPL) at the commencement of the season. The aim for the Tiger Prawn Spawning Area (TPSA) within the CPL is to close this area at a target catch rate level of 25 kg/hr. The target catch rate (kg/hr) level was conservatively adjusted for use of quad gear (four 10.1 m nets) in 2007 (up from 20 kg/hr). For 2012, the daily catch rate in the TPSA was difficult to assess due to the sporadic fishing effort by boats in this area once the CPL was opened. Two standard spawning stock surveys were undertaken around the third moon phase in July and August 2012 and the catch rates for tiger prawns were 6.6 kg/hr in July and 5.9 kg/hr in August with a mean catch rate of 6.2 kg/hr, well below the target level. The mean catch rate was also below the proposed limit level.

Analysis of the spatial catch and catch rates of tiger prawns in 2012 using daily logbooks showed that most of the tiger prawn stock was caught well south of the TPSA in 2012 and only a very low abundance was present in the TPSA. Therefore the survey catch rates within this area during 2012 may not have been fully indicative of the overall spawning stock level. The effect of this apparent low level of spawning stock within the TPSA on recruitment for the 2013 season (as measured by the survey in March-April 2013) was closely monitored and found to have generated an acceptable level.

If the migration pattern in 2013 results in a similar low spatial distribution of tiger prawns within the TPSA this would suggest that the use of the TPSA closure may no longer be the appropriate strategy for the protection of spawning stock. Such an outcome would generate the need to review the strategy including identifying additional or different areas in order to protect a sufficient proportion of the tiger prawn spawning stock.

The king prawn catch rates during the spawning stock survey were 20.5 kg/hr and 12.9 kg/hr respectively with a mean catch rate of 16.7 kg/hr, which is within the historical range for this species (16-29 kg/hr). King prawn spawning stock remains above the level where it significantly affects the recruitment and it is therefore adequate. 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.

Projected prawn catch range next season (2013):

King prawns 700-1050 tonnes

Tiger prawns 400-600 tonnes

The main performance measures for the prawn fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2012, the breeding stock indicator for tiger prawns was well below the target level of 25 kg/hr. However, the 2013 tiger prawn recruitment index was average and provided a catch prediction within the target catch range and it appears that overall there was an adequate spawning stock during the key spawning period in 2012. Examination of the 2012 logbook data for the spatial distribution and abundance of tiger prawn spawning stock indicates the stock was concentrated well south of the TPSA. This shift in their distribution pattern may have been related to the previous year's flood and heatwave events. The king and tiger prawn annual landings were within the historical target range.

Scallops

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 2012 catch predictions included was 42 t meat weight for northern Shark Bay and 11 t for Denham Sound. These low overall catch predictions for the fishery meant that all the available stock needed to remain as spawning stock and the fishery remained closed. This low recruitment appears due to the extreme environmental conditions in late 2010/early 2011 in Shark Bay due to the very strong La Niña, strong Leeuwin Current and higher than average sea water temperatures.

The performance measure is to ensure adequate breeding stock levels. This is normally achieved by cessation of fishing at the appropriate catch rate target as the catch predictions were below the minimum abundance level for fishing, the fishery remained closed for the 2012 season to allow all scallops to contribute to the spawning stock.

Projected scallop catch next season (2013):

Nil tonnes (whole weight)

The catch projection for the 2013 season was based on the 2012 annual survey results. In northern Shark Bay, observed recruitment was very low. The catch prediction for this area was 20 t meat weight but this was predominantly comprised of recruits with few residual scallops. In Denham Sound, both recruitment and residual levels were low and provided a low overall index giving a predicted catch of 10 t meat weight. Therefore the catch prediction for the fishery was at very low levels such that all the available stock should again remain for spawning with no scallops to be taken. These two consecutive years of low recruitment also means that the spawning stock in 2013 will be well below average. A small area where some recruit scallops were identified in Denham

Sound was closed to prawn trawling in 2013 as an additional protective measure for the scallop spawning stock.

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 sea 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 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

Generally the total bycatch of fish and other fauna is minimal 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. No fishing occurred in 2012.

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 (~90%) returned to the sea alive. There has been a focus on improved reporting of interaction and fate of protected species. 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 nets so this performance measure is no longer valid. For the 2012 season 6 turtles were recorded as caught in nets in the prawn fishery and were recorded as being returned to the sea alive. With improved reporting of protected species interactions, 431 seasnakes were reported as caught with 90% returned to the sea alive, 9 syngnathids and 1 dolphin were reported with status unknown.

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 trawl fisheries. 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

Nil

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 2012 the performance measure was met as the total area trawled within inner Shark Bay by the prawn fleet was approximately 746 square nautical miles or 16% of inner Shark Bay.

Social Effects

These industries are a major contributor to regional employment. During 2012, approximately 100 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.

Economic Effects

Estimated annual value of major prawn and scallop for 2012:

Prawns Level 5 - > \$20 million (\$20.9 million)

Scallops Level 0 - Nil

The value of the fishery including crabs, coral prawns, scallops, squid and bugs to the prawn fleet is \$21.12 million.

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time, and average ex-boat prices were as follows:

King prawns	\$12.60/kg
Tiger prawns	\$13.40/kg
Coral prawns	\$3.50/kg
Scallops	\$0.00/kg
Crabs	\$5.50/kg

Fishery Governance

Target catch range:

Prawns (Historical range) 1501 – 2330 tonnes

Prawns (New interim range) 1350 – 2150 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 current focus of industry is to target larger size prawns which has resulted in a shift in effort shift which has reduced the expected range of total landings (under normal environmental conditions) for king prawns to 950 -1450 t compared to historical catch ranges. Because of the change to the king prawn catch range, an interim overall range has been calculated as 1350 -2150 tonnes. This interim range will be reviewed over the next three years (2012 to 2015) with a new target catch range developed for the combined prawn catch and individual target species.

The scallop target catch range, under normal environmental conditions, 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 scallop catch for 2013 (150 t) whole weight, based on a pre-season survey, is below the target catch range and the fishery remains closed.

New management initiatives (2013)

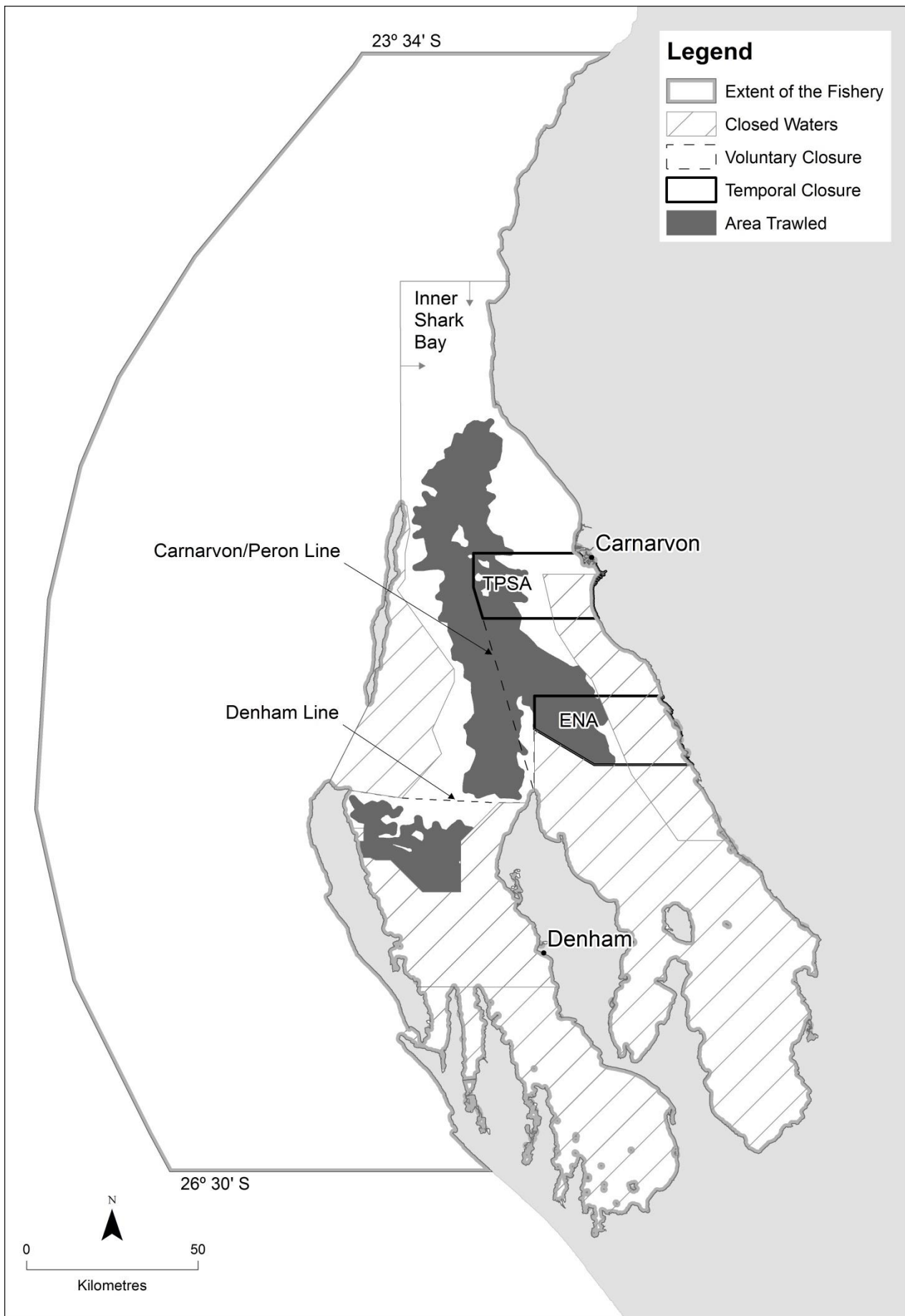
Pre-assessment phase for the Marine Stewardship Council approval system has been initiated for these two fisheries.

External Factors

Increasing costs of fishing and lower returns due to the global economic climate and competition from imported and locally aquaculture small prawns, has focussed harvesting practices on targeting larger prawns during efficient catch rate periods and shifting the emphasis to domestic markets rather than export markets. This has also lead the prawn industry maximise the return from all species taken in the fishery where possible particularly scallops and blue swimmer crabs.

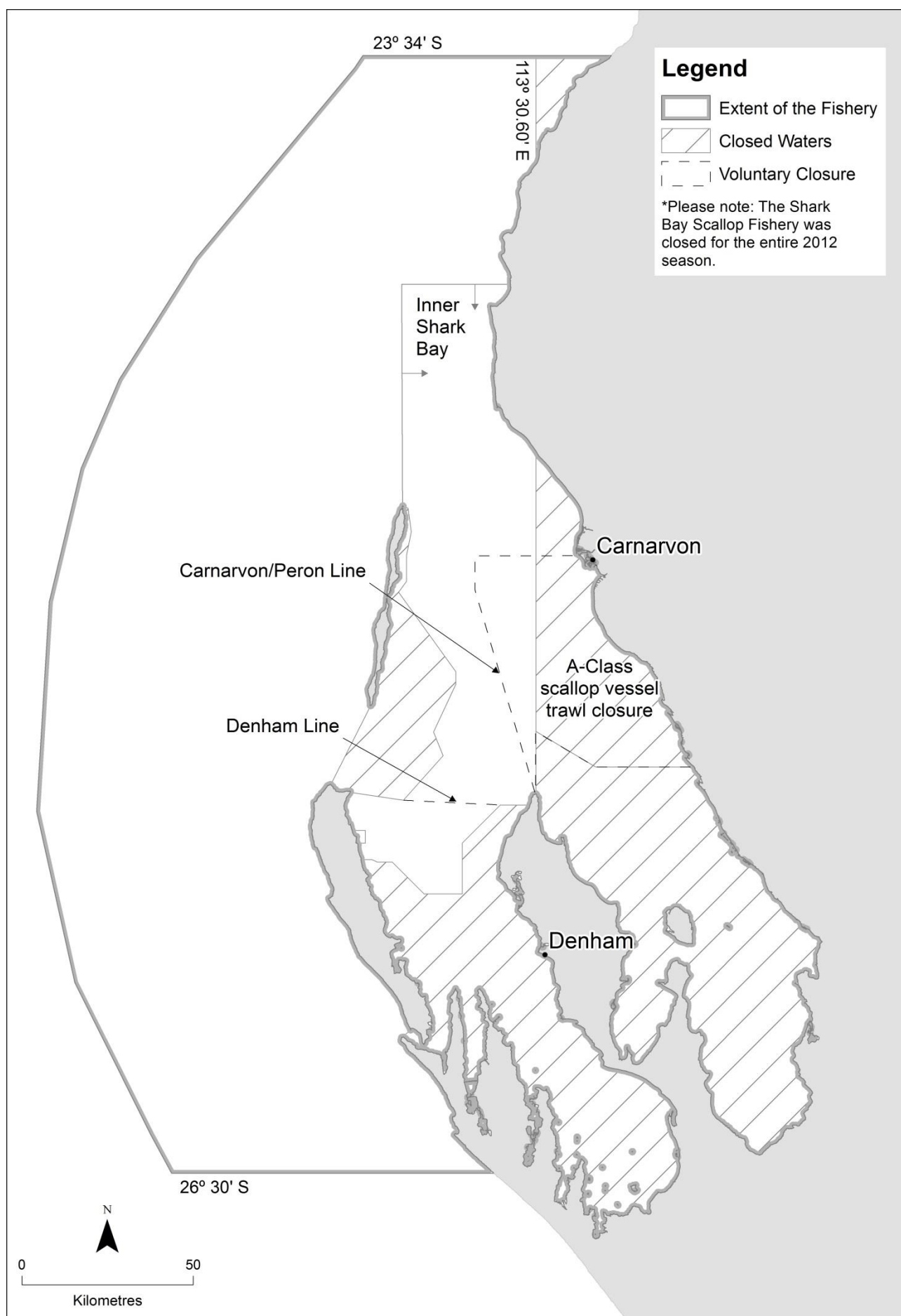
The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment. A relationship between current strength (as measured by Fremantle sea level) and king prawn catches has been identified and may be used to indicate broad catch trends. The theory is that higher current flows increase water temperatures, which may increase the growth and catchability of the prawns. A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay, particularly in the Red Cliff area. Generally, high sea levels corresponding to strong Leeuwin Current correlate with poor recruitment.

The Department of Fisheries is currently examining the mechanisms that control recruitment success in greater detail, in order to explain more of the inter-annual variation that occurs.

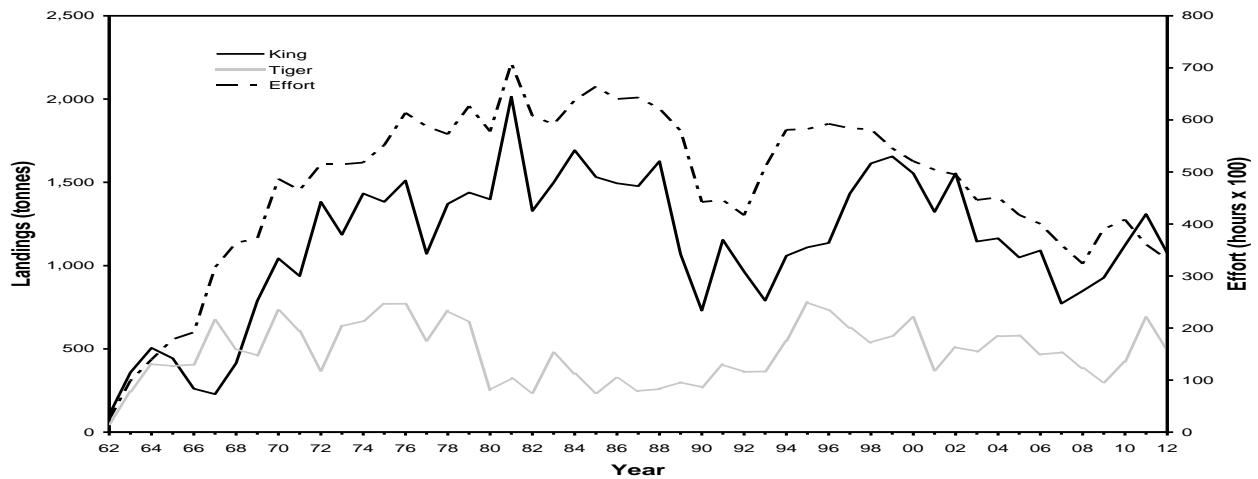


SHARK BAY PRAWN AND SCALLOP FIGURE 1

The main boundaries of the Shark Bay Prawn Fishery, Inner Shark Bay, TPSA, ENA, trawl closures, permitted trawl area (extends out to the 200m isobath) and area trawled in 2012.

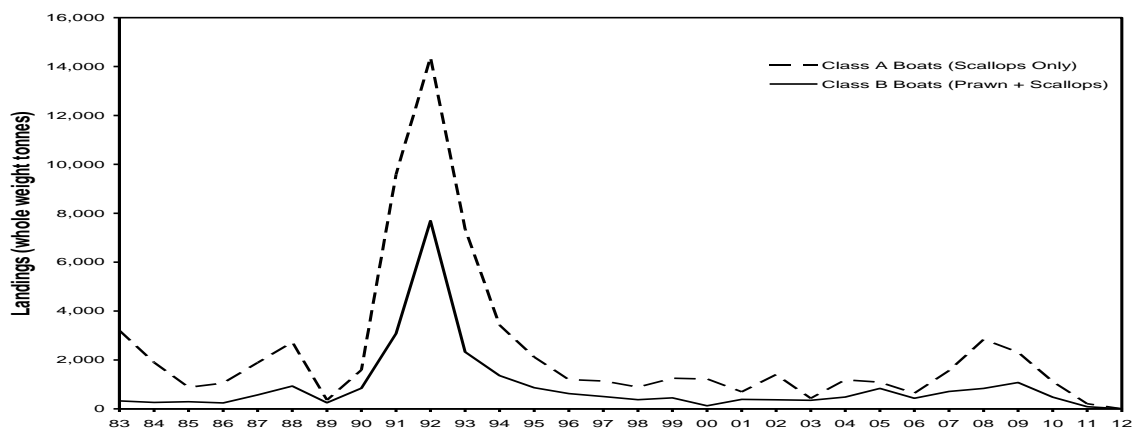
**SHARK BAY PRAWN AND SCALLOP FIGURE 2**

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



SHARK BAY PRAWN AND SCALLOP FIGURE 3

Shark Bay Prawn Managed Fishery annual landings and effort (adjusted to twin gear units) 1962 – 2012.



SHARK BAY PRAWN AND SCALLOP FIGURE 4

Shark Bay Scallop Managed Fishery annual landings 1983 – 2012.

Exmouth Gulf Prawn Managed Fishery Status Report

E. Sporer, M. Kangas, S. Brown

Main Features

Status		Current prawn Landings	
Stock level	Adequate	Tiger	46 t
		Kings	157 t
Fishing level	Acceptable	Endeavours	51 t
		Banana	33 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 merguensis*).

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

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department. For statutory management plan processes, the Director General consults with licensees.

Boundaries

The main boundaries for the Exmouth Gulf Prawn Managed Fishery are shown in Exmouth Gulf Figure 1. This diagram outlines the boundaries of the fishery, the areas where trawling is permitted, the areas actually trawled in 2012, the Tiger Prawn Spawning Area (TPSA) which is closed for part of the season, and the areas permanently closed to trawling.

Management arrangements

Management of this fishery is based on input controls, including limited entry, seasonal and area openings and closures, moon closures and gear controls. Management arrangements are designed to keep fishing effort at levels that will maintain a sufficient spawning biomass of prawns (particularly tiger prawns). The process for in-season fishing area opening/closing is dynamic and involves real-time management between the Department's Research Division and the industry. Opening and closing dates vary each year,

depending on environmental conditions, moon phases and the results of fishery-independent pre-season surveys that provide a catch prediction. The Department's Vessel Monitoring System (VMS) monitors the activities of all boats during the season.

The primary control on the fishery effort is through the maximum headrope units in the fishery and the duration of the season. The maximum headrope allocation for the fleet is set at 394.8 m (or 216 fathoms of headrope), which is a 10% reduction of the original headrope when the change to the more efficient quad gear configuration was approved. This has resulted in a reduction in the number of boats with the headrope allocation being redistributed among the remaining boats. The reduction of boat numbers and overall net allocation is continuing with the aim of maximizing economic efficiency, whilst maintaining overall catches in this fishery as well as stock sustainability.

For the 2012 season the boat numbers were reduced from 9 to 6 and all the boats were fitted with freezer storage capacity for processing at sea. Prior to 2012 all the boats were wet boats and landed retained product ashore for processing at the Learmonth processing factory.

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 during the period. For the 2012 season, official opening and closing dates were set at 2 April and 28 November respectively, providing a maximum of 200 nights (allowing five nights closure each full moon) for fishing. The season actually commenced on 11 June, based on results from pre-season surveys and it closed at 0800 hrs on 28 October. Although the season commenced later than normal (usually April or May) there were also some spatio-temporal closures in June and July to avoid fishing on small size prawns prior to the closure of the key tiger prawn spawning area to maximise the value of the limited tiger prawn stock available in 2012.

Stringent measures are in place to ensure that spawning stock levels for tiger prawns are maintained at adequate levels and that the prospects of both recruitment and growth over-fishing are avoided. These measures will continue to be applied, while incorporating a flexible fishing regime to optimise size and value of prawns.

Bycatch reduction devices (BRDs) are mandatory 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 and was re-certified in 2012, with a review of the conditions, of its BRD-compliance, for reducing the potential for turtle captures. Because of the increase in the size of the net headrope and the body of the net to accommodate the reduction of boat numbers the grids actual size and the grid escape opening were also required to be increased in line with the U.S standards. 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 Commonwealth Government's Department of Sustainability Environment Water Populations and Communities (SEWPaC), assessed the fishery in 2008 as being sustainable under the provisions of the EPBC Act 1999. This has provided the export accreditation for the fishery for a period of five years and re-assessed in 2013. 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, spawning stock levels and a pre-season survey of king prawn sizes to assist with harvesting strategies (these are detailed above in the management arrangements). An annual catch prediction for both tiger and king 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 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.

King prawn breeding stock levels in the fishery are maintained at adequate levels during normal environmental conditions through controls on fishing effort, their extended breeding period and lower catchability of the species compared to tiger prawns. Pre-season surveys for king prawns have been established since 2002 to provide an index of recruitment into the fishery and as of provide a catch prediction and understanding of prawn movement in this fishery. In 2012 two pre-season recruitment surveys were undertaken and a catch prediction provided for the season.

Retained Species

Commercial production (season 2012):

288 tonnes

Landings

The total landings of major penaeids for the 2012 season were 288 t, comprising 46 t of tiger prawns, 157 t of king prawns, 51 t of endeavour prawns and 33 t of banana prawns. The tiger prawn landings were well below the normal catch range (250-550 t) and the lowest recorded since 1965. The king prawn landings were also well below the target catch range (350-500 t). The king prawn landings remain low, a trend that is consistent with other prawn fisheries in the northern bio-region. Endeavour prawn landings were below the normal catch range of 120-300 t. Banana prawn catches were the highest since 2000.

Recorded landings of byproduct were: 2 t of blue swimmer crab (*Portunus armatus*), 3 t of squid, <1 t of bugs (*Thenus australiensis*), 12 t of coral prawns and <1 t of octopus.

Recorded landings of blue swimmer crabs were extremely low this season and the lowest since 2002 and below the historical range (8 to 58 t). The low effort and spatial distribution of fishing where crabs are abundant, were reflected in the low catches. Crabs and other byproduct are taken incidentally and are variable depending on abundance available on the trawl grounds each year. Fishers retain crabs at a minimum size of approximately 137 mm spine to spine measurement (compared to the recreational minimum size of 127 mm). The larger minimum size was introduced on a voluntary basis into this fishery in 2007. Because of the low trawl effort this season all retained recorded annual landings of by product was the lowest recorded since 2002 (recorded byproduct).

Fishing effort/access level

In 2012 six boats operated towing a total of 292.6 m (160 fathoms) of net headrope, well below the maximum allocation of 395 metres (216 fathoms). There were two different net headrope sizes towed, four boats towing 10.97 m (6 fathom nets) and two boats towing 14.63 m (8 fathom nets), because four of the six boats cannot tow the larger 14.63 m nets.

Total nominal effort for the 2012 season was 7042 hours. The adjusted effort (to twin gear) was 12,592 hours, which is 39% lower than last year and the lowest since 1967. Fishing effort (in adjusted hours) in 2012 was extremely low but at the expected level because of the low prawn abundance. Generally the effort on king prawns is targeted at the latter part of the season when their abundance peaks during August and September. Fishing effort normally continues into November, however, because of low catch rates of king prawns this year fishing ceased on 28 October with 117 days actually fished.

Stock Assessment

Assessment complete: **Yes**

Assessment level and method:

Level 4 - Direct survey/catch rate

Breeding stock levels: **Adequate**

Projected catch next season (2013):**210 (170-250) tonnes tiger prawns****315 (250-380) tonnes king prawns**

The standardised catch per unit effort (CPUE) 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. Because of the reduced number of boats in the fleet and the focus on size and quality of prawns the reference catch ranges may need to be reviewed in the future and adjusted for the fishing harvesting strategy, if required. The tiger and king prawns stocks are also assessed each year using standardised recruitment and breeding stock surveys.

Catch assessment

The adjusted catch rate of 3.7 kg/hr for tiger prawn is below the reference catch rate of 10 kg/hr. This significant decline in the annual landings has not been previously observed since the early 1980's except after cyclone Vance when severe environmental conditions destroyed inshore habitats that caused the decline in the landings. The higher than normal water temperature spike in 2010/11 may have caused a decline in inshore structured habitat causing recruitment failure for the tiger prawn and possibly the endeavour prawns as this species is also associated with the same type of juvenile habitat. In addition, the low effort in those areas where endeavour prawns are primarily found (due to low abundance of tiger prawns) also contributed to poor landings. Fishing ceased according to the target catch rate level for tiger prawns.

The adjusted catch rate of 12.5 per kg/hr, for king prawns is slightly above the reference catch rate level of 11.7 kg/hr. The king prawn total landings were below the acceptable catch range and there is some concern for the king prawn stock, however, fishing effort does not appear to be the cause of the decline in annual landings at current effort levels. Fishery-independent surveys are undertaken to measure the recruitment strength and logbook spatial and catch and effort information is used during the spawning phase to review the stock status and to understand the distribution of king prawns in the gulf.

The season commenced on 11 June, which was later than previous seasons and king prawns were fished conservatively because fishing in the northern area (key king prawn fishing grounds) was limited. In the early part of the season total effort was reduced because of the later opening date and areas of small prawns were closed to fishing to ensure that size and quality were maintained. Overall, fishing ceased in 2012 because of the fishing protocol set out in the season arrangements related to king prawn size composition.

Survey assessment

The tiger and king prawn stocks are assessed each year using standardised surveys, which permits variations to the management plan using flexible real-time arrangements within the season to optimise catch and size grades and ensure sustainability.

For tiger prawns, this process involves analysis of survey-based indices of recruitment and spawning stock, which are assessed against the spawning stock recruitment relationship. 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 recruitment survey recorded a very low abundance and predicted tiger prawn catch range for 2012 was 140 to 210 tonnes. For the 2012 season the annual total landings were below the prediction range which is probably due to the very low effort. The tiger prawn breeding stock levels are maintained at adequate levels by monitoring the tiger prawn catch rates 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 target catch rate is 25 kg/hr based on 6-fathom nets in quad gear configuration (which is reduced to 19 kg/hr after 1 November).

During 2012, tiger prawn catch rates were monitored during July and the central Tiger Prawn Spawning Area (TPSA) and Eastern Area closed on 21 July. For the 2012 season it was difficult to monitor the tiger prawn catch rates because of the intermittent nature of fishing between the tiger prawn area and the northern king prawn area and a number of boat breakdowns. The low number of boats in the fishery now does not provide a full coverage of all the fishing areas with only hot spots primarily being fished. When boats shift effort between areas, monitoring tiger prawn catch rates on a daily basis is difficult. For this reason a survey was undertaken on 19 July to obtain tiger prawn catch rate information in the spawning area. As a result the southern part of tiger prawn area was closed to fishing on 21 July because the tiger prawn catch rates were below the target level. The northern part of the tiger prawn area remained open so that boats could fish the available banana prawns in the northern area. The risk of leaving this part of the fishery open until the mandatory cease fishing date of 2 August to the tiger prawn stock was considered low to negligible because catch rates of tiger prawns were highest inside the closed area and with low tiger prawn catch rates in the northern part precluding any targeting of tiger prawns.

Three standardised tiger prawn breeding stock surveys are carried out from August to October each year. The 2012 survey results showed an average quad gear CPUE of 10.7 kg/hr and 23.9 kg/hr in the spawning areas (Q1 and Q2 respectively). The August, September and October Q1 area surveys showed a quad gear CPUE of 12.0 kg/hr, 11.4 kg/hr and 8.8 kg/hr respectively. The spawning stock survey extends to the central Gulf (Q2 area) and the mean spawning indices for the three surveys were slightly below the target level of 25 kg/hr at 23.9 kg/hr. The overall mean (combined Q1 and Q2) spawning stock catch rate was 17.3 kg/hr, below the target level but above the limit (15 kg/hr).

King prawn breeding stock levels in the fishery are maintained at adequate levels during normal environmental conditions through controls on fishing effort, their extended breeding period and lower catchability of the species compared to tiger prawns.

Recruitment surveys were also undertaken for king prawns in the northern part of the fishery that provided prawn size structure and catch abundance information. The time series for king prawns is limited and 2012 is the first season for a catch prediction to be provided. The April pre-season survey provided a catch prediction of 190 t with a range between 150 and 225 t. The annual landing of 157 t was within the catch prediction range.

There is no formal stock 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 stocks of endeavour prawns are considered to be at adequate levels 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 each year. In addition, endeavour prawns are also considered to be more resilient to fishing pressure due to their smaller size and lower catchability and less targeting than the tiger and king prawns.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. The strategy for tiger prawns is to maintain the spawning biomass above the historically determined biological reference points with the present target of 25 kg/hr with a limit of 15 kg/hr. The tiger prawn spawning stock catch rate of 17.3 above this limit. Stocks of king prawns are monitored using catch levels which were below the target catch range, however, there is a conservative harvesting strategy in place for this species and the annual landings were within the catch prediction. The higher banana prawn annual landings corresponded to the relatively higher rainfall experienced by this region over the summer months.

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. All boats used hoppers (in-water catch sorting systems), which add another level of improvement for bycatch survival and product quality. Fishing adjusted effort in 2012 was the lowest seen since 1970.

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 turtles or other large animals. In addition, secondary bycatch reduction devices (square mesh panels) were implemented in all nets in 2005. There has been a focus on reporting of interaction with protected species by fishers. Six turtles (5 green and 1 unidentified) were reported as captured in nets and returned to the sea alive. Seventy sea snakes (unidentified) were reported as captured and reported as returned to the sea alive. Three sawfish were reported as captured but their status was unknown and no syngnathids were reported.

Ecosystem Effects

Food chain effects:

Low

Although the prawn species are managed to 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 2012 the performance measure was met as the total area trawled, at approximately 273 square nautical miles (24%) per cent of Exmouth Gulf, was below the 40% level.

Social Effects

The estimated employment in the fishery for the year 2012 was 18 including skippers and other crew. Additional 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

2012: Level 2 - \$1 - 5 million
(\$3.2 million including byproduct)

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 prices quoted for prawns and byproduct are provided by the company based on an overall average price taking into account each grade abundance landed. The total estimated value of the fishery includes byproduct (\$3.2 million). This reflects an extremely low return from the fishery a decline of approximately \$8 million compared with the 2011 fishing season. Estimated prices for prawns were as follows:

King prawns	\$12.00/kg
Tiger prawns	\$12.50/kg
Banana prawns	\$ 9.50/kg
Endeavour prawns	\$6.00/kg
Coral prawns	\$3.00/kg

Fishery Governance

Target catch range: 721 – 1,410 tonnes

Current fishing level: Acceptable

Under current fishing effort levels, the target catch range for major penaeids is 721–1,410 t so the total catch of 288 t is well below the range. The long-term target catch ranges for individual species are king prawns 350–500 t, tiger prawns 250–550 t, endeavour prawns 120–300 t and banana prawns 1–60 t (noting that maximum or minimum catches do not occur for all species simultaneously). The catch ranges for individual species and a total for all major penaeids were developed (circa 1999) as a means of providing governance for the target ranges for prawns in the prawn managed fisheries. For Exmouth the initial individual species ranges were changed in 2000, but has not been reflected in the total for major penaeids. This has been amended for 2012, including banana prawns (1–60 tonnes)

These overall and individual figures are generally based on a 10-year average (1989–1998). Tiger prawns annual landings were well below the target catch range, however, the low catch prediction (140–210 t) indicated that the season landings could be below the target range and as such the low landings were not unexpected when you take into account the low effort because the target level triggered the cessation of fishing on tiger prawns. The king prawn survey catch rates were indicating low abundance, however, the annual landings (157 t) were within the predicted range (150 to 225 tonnes).

New management initiatives (2013)

The Department is still progressing a management plan amendment in consultation with the licensee to incorporate changes to gear arrangements in this fishery. The fishery will be undergoing Marine Stewardship Council pre-assessment during mid-2013.

External Factors

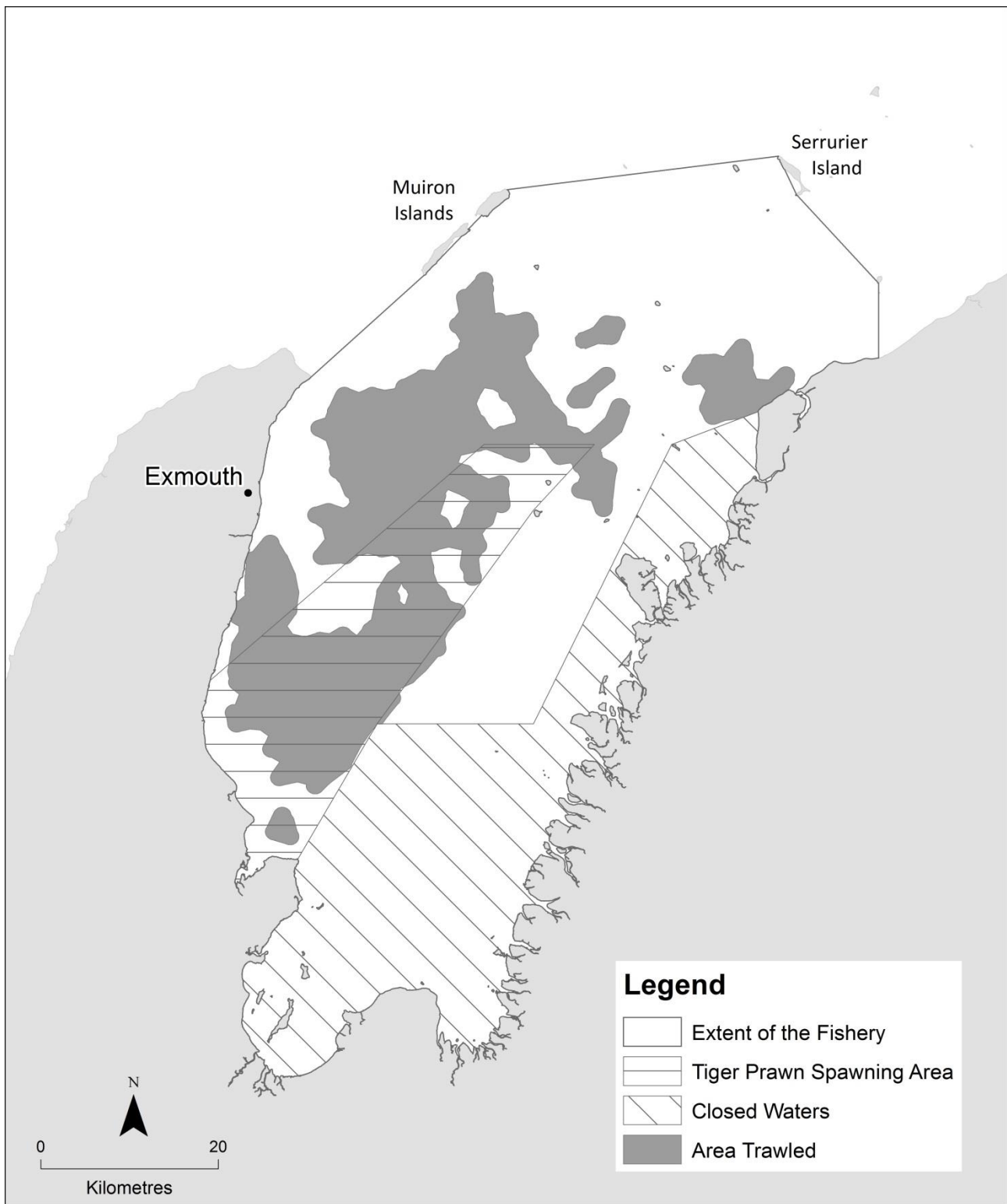
Increasing costs of fishing and lower returns due to the global economic climate, high value of the Australian dollar and competition from imported and Australian aquacultured small prawns, has focussed fishing harvesting strategies about targeting larger prawns during efficient catch rate periods and shifting the emphasis to domestic markets rather than export markets.

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 effects of cyclones, related to the destruction of shallow seagrass nursery areas. Other environmental factors, may also impact on recruit survival, but have yet to be fully investigated.

The heat wave event may have contributed to the recent extremes in abundance of brown tiger prawns in Exmouth Gulf. In 2011, the brown tiger prawn recruitment and landings were one of the highest recorded which led to a very high spawning stock abundance. However in 2012, the lowest recruitment was observed resulting in the lowest catch. This in turn has resulted in low spawning stock in 2012 although it is at levels that has historically resulted in moderate recruitment.

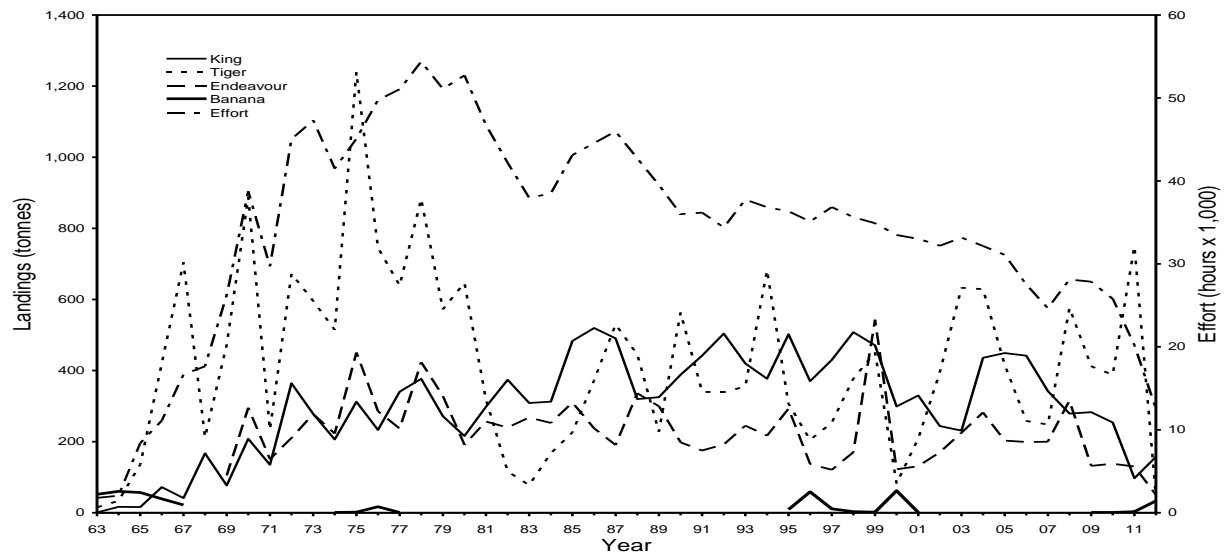
The hypotheses under investigation are that:

- The 2010/11 warmer summer temperatures may have been beneficial for recruitment in 2011.
- The warmer summer temperatures (which also occurred in the summer of 2012/13) may have had a direct negative effect on the spawning (timing/success) or transport/survival of larvae in the spring of 2011 leading to poor recruitment in 2012. This may be a short-term (1 year) effect as the spawning stock is not significantly affected.
- The warmer temperatures may have led to the loss of structured habitat (seagrass and/or algae) in the nursery areas that may have contributed to the poor recruitment. This may be a long-term (3–4 year) effect based on previous experience with loss of structured habitat.
- There was some other undetected perturbation in the region.



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 2012.



EXMOUTH GULF PRAWN FIGURE 2

Exmouth Gulf Prawn Managed Fishery annual landings and adjusted effort (twin-gear), 1963 – 2012.

West Coast¹ Deep Sea Crustacean Managed Fishery Status Report

J. How and K. Nardi

Main Features

Status		Current Landings	
Stock level	Adequate	Crystal Crabs	139 t
Fishing Level	Acceptable	Giant Crabs	0.8 t

Fishery Description

The West Coast Deep Sea Crustacean 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 waters (>150m) of the West Coast.

Governing legislation/fishing authority

West Coast Deep Sea Crustacean Managed Fishery Management Plan 2012

West Coast Deep Sea Crustacean Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation).

Consultation process

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

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 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 80 and 180 pots attached to a main line marked by a float at each end.

The Department of Fisheries has minimum size limit and specific regulations to protect breeding females (berried females must not be retained). A minimum carapace length of 120 mm 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 fishery transitioned from an interim managed fishery to a managed fishery on 1 January 2013. Within the new management plan, there was unitisation of the licenses (which replaced permits in the previous management plan). Unitisation allowed greater transfer of units between license holders. Catch of Giant and Champagne crabs were previously retained as 'byproduct' of a permit. They were now unitised as "B" class units which allowed these to be transferred onto a single license to permit these species to be specifically targeted while still retaining a "B" class quota of 14 t.

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 are now based on whether the quota is achieved and the standardised catch rate required to achieve quota.

Current research has focused on obtaining greater information on commercial catch through industry based sampling (FRDC TRF project, PI R. Melville-Smith), and remote video. Both projects are aimed at gaining a better understanding of the catches, particularly undersize and berried females which are currently only estimates by fishers recorded through the volunteer logbook program.

¹ Note: This is the official name of the fishery. Boundaries include Gascoyne, see above.

Retained Species

Commercial landings (season 2012):

Crystal crab	138.7 tonnes
Giant crab	0.8 tonnes
Champagne crab	0.01 tonnes

The catch of 138.7 tonnes of Crystal crab in 2012 was similar to all years since the introduction of quota in 2008 (Deep Sea Crab Figure 1). There was a very small catch of Champagne crab (13 kg) taken in 2012, compared to between 5-6 t in the previous three seasons which is likely due to low market demand. Minimal Giant crab has been landed since 2010 due to minimal targeted fishing. The catch records are based on mandatory monthly catch and effort returns prior to 2008, with the more accurate trip catch disposal records from 2008 onwards.

Recreational catch estimate (season 2012) Nil

Fishing effort/access level

Nominal commercial effort decreased by 8 % from an estimated 59,249 pot lifts in the 2011 season to 54,301 pot lifts in the 2012 season. The catch of the fishery (see above) is divided by the average logbook catch rates to provide an estimate of nominal effort for the fishery.

Stock Assessment

Assessment complete Yes

Assessment level and method:

Level 2 - Catch rate

Breeding stock levels Adequate

The fishery effectively achieved the quota for crystal crabs with landings of 138.7 t, which is within the target catch range (100-140 t). The standardised catch rate of legal crabs increased by 4% in 2012 to 1.96 kg/pot compared with 1.86 kg/pot in 2011 (Deep Sea Crab Figure 2). The 2012 standardised catch rate represents the highest standardised catch rate in a decade (Deep Sea Crab Figure 2), and is well above the current notional threshold reference point with a large degree of certainty.

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 standardised 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 2012. The standardized catch rate takes into account the soak period, location and depth of fishing, however does not take into account increases in fishing efficiency

The performance measures for the fishery were revised after the move to quota to:

a) whether the quota has been achieved, and

b) the standardised catch rate to achieve the quota is acceptable (above an 'informal' threshold value with a degree of certainty).

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

Total landings of the 3 species of deep sea crabs 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 in depths between 500 to 800 metres. An estimate of the amount of ground between 500–1,000 m over the distributional range of Crystal crabs is about 50,600 km². Assuming that all the ground is equally productive, at catch levels experienced in the past seasons 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 three vessels operating in 2012.

Economic Effects

Estimated annual value (to fishers) for 2012

Level 2 - \$1 - 5 million (\$2.8 million)

The beach value of the fishery was about \$2.8 million in 2012 with the majority of the catch sold live to Asian markets both locally and internationally.

Fishery Governance

Target catch range 100-140 tonnes

Effort range 50-80,000 pot lifts

Current fishing (or effort) level Acceptable

The TAC for the fishery has been set well below landings of which occurred in the early and mid 2000's and is at the lower end of the target catch range for the WTO assessments. A preliminary effort range to achieve the TAC had been generated as 70,000–100,000 pot lifts but with the current nominal effort (2009-12) of 76,370- 54,230 pot lifts all below this level. The effort range was subsequently revised to 50,000-80,000 pot lifts. A proposed harvest strategy is currently being considered by industry which will formalise

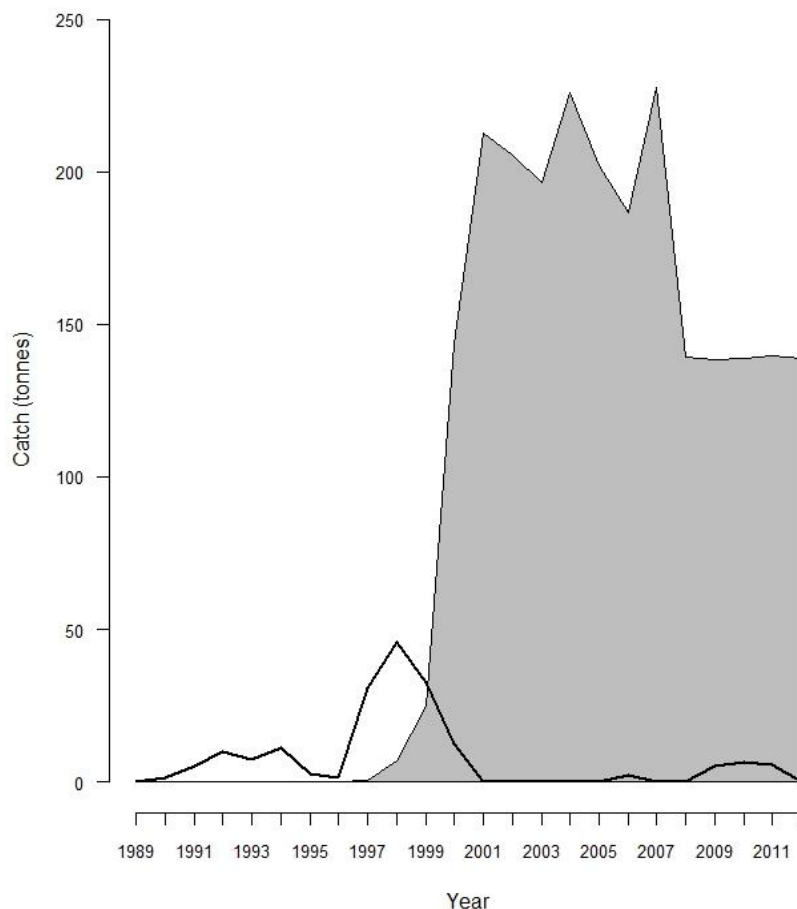
future effort levels under quota in line with the proposed target range for standardised catch rates.

New management initiatives for 2013

There are no new management initiatives planned for 2013 noting the new management plan for the fishery was introduced on 1 January 2013.

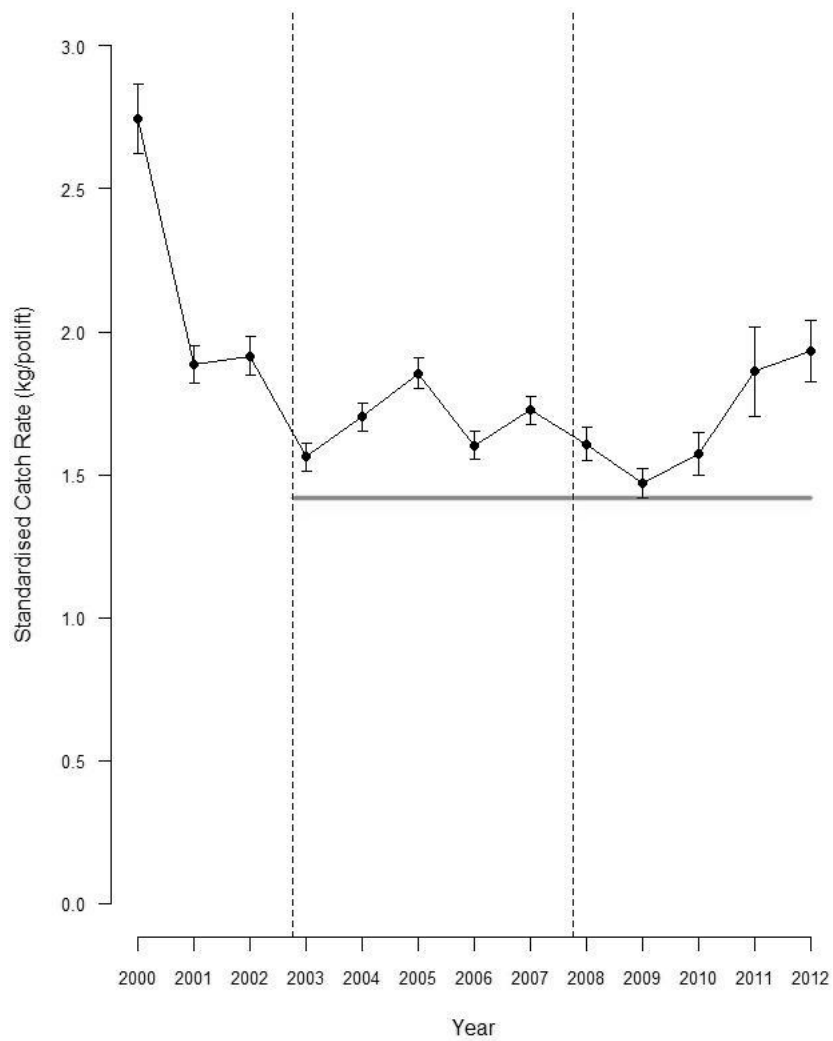
External Factors

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



WEST COAST DEEP SEA CRUSTACEAN FIGURE 1

Annual catches of Crystal (grey) and Champagne (heavy line) crabs since 1989. Annual giant crab catches have always been small, and they have therefore been excluded.



WEST COAST DEEP SEA CRUSTACEAN FIGURE 2

Standardised catch per unit effort ($\pm 95\text{CI}$) since 2000 for crystal crabs. Area between vertical dashed lines indicate period when management required fishing in all zones. Horizontal line represents the current notional threshold reference point for crystal crabs in the fishery.

Gascoyne Demersal Scalefish Fishery Status Report

G. Jackson, R. Marriott, E. Lai and H. Zilles

Main Features

Status		Current Landings	
Stock level		Pink snapper:	
Pink snapper	Adequate	Commercial	235 t
Goldband snapper	Adequate	Recreational	30 t
Spangled emperor	Adequate	Charter	11 t
Fishing Level		Goldband snapper:	
Pink snapper	Acceptable	Commercial	64 t
Goldband snapper	Acceptable	Recreational	7 t
Spangled emperor	Acceptable	Charter	11 t
		Spangled emperor:	
		Commercial	4 t
		Recreational	35 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 1 November 2010, the Gascoyne Demersal Scalefish Managed Fishery (GDSF) has incorporated the pre-existing pink snapper quota system from the Shark Bay Snapper Managed Fishery (SBSF) plus the previously open access area south of Coral Bay.

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 multidentis*), rosy snapper (*P. filamentosus*), ruby snapper (*Etelis carbunculus*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, including spangled emperor, *Lethrinus nebulosus*, and redthroat emperor, *L. miniatus*), cods (Serranidae, including Rankin cod, *Epinephelus multinotatus* and goldspotted rockcod, *E. coioides*), pearl perch (*Glaucosoma burgeri*), mullet (*Argyrosomus japonicus*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).

A limited number of licensed charter vessels and a large number of recreational vessels fish out of Denham, Carnarvon and around the Ningaloo area (Coral Bay, Tantabiddi and Exmouth) and catch a similar range of demersal species.

Governing legislation/fishing authority

Commercial

Gascoyne Demersal Scalefish Management Plan 2010

Gascoyne Demersal Scalefish Managed Fishery Licence

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

Recreational

Fish Resources Management Act 1994, *Fish Resources Management Regulations 1995* and subsidiary legislation

Consultation process

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are facilitated by Recfishwest under a Service Level Agreement although the Department undertakes 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). GDSF 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 Gascoyne 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 all demersal scalefish stocks in the Gascoyne Coast Bioregion. The 'open-access' wetline fishing operations that were previously undertaken in waters between 23°34'S and 23°07'30"S (Gascoyne Demersal Scalefish Fishery Figure 1) are also incorporated within the Plan (see Fisheries Management Paper No. 224 for further details).

Pink snapper within the GDSF are managed through the use of output controls based on an Individual Transferable Quota system. The 'quota-year' for pink snapper runs from 1 September to 31 August, with a total of 5,102 units in the fishery. There is a requirement to hold a minimum of 100 units of pink snapper entitlement to be able to operate within the fishery. This requirement was carried over from the previous *Shark Bay Snapper Management Plan*.

Demersal scalefish other than pink snapper are currently managed using an interim effort cap of 30 days per 100 units of pink snapper quota which restricts total fishing effort and is applied as a non-transferable licence condition. A dedicated non pink snapper demersal scalefish entitlement system is being developed by the Department in consultation with WAFIC and licensees.

An Environmental Protection and Biodiversity Conservation Act (EPBC Act) assessment for the SBSF was first completed in 2003, and the fishery was re-accredited in 2009 for a further 5 years (next scheduled review to be in 2014).

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 maximum and minimum legal lengths, daily bag and possession limits, and limitations on the use of certain fishing gears. All persons fishing from a powered boat anywhere in the state are required to hold a Recreational Fishing from Boat Licence or fish in the company of a licence holder (since March 2010).

Research summary

Catch and effort monitoring for this fishery includes analyses

of commercial 'daily/trip' returns for GDSF licensed vessels, catch-disposal records (only for pink snapper, to monitor individual quotas), 'monthly' catch and effort returns for charter vessels, and various recreational survey data.

The commercial catch and effort data reported here are for GDSF licensed vessels fishing between 23°07'30"S and 26°30'S. The reporting period used for commercial catches is the 2011-12 licensing period for the GDSF, i.e. 1 September 2011 – 31 August 2012 (referred to as 'season 2012'). Charter catches are reported for the calendar year. For recreational fishing, the most recent catch estimates for goldband snapper and spangled emperor were derived from data obtained from the first state-wide integrated survey of recreational boat-based fishing undertaken between 1 March 2011 and 29 February 2012 (Ryan *et al.* 2013)¹. Because the integrated survey only provides bioregional-level catch estimates, the catch estimates for pink snapper are also informed based on the second Gascoyne wide boat-fishing survey that was undertaken between April 2007 and March 2008 (Marriott *et al.* 2012)².

Research undertaken by the Department of Fisheries on the retained species in each bioregion is now focussed on selected indicator species. In the Gascoyne, these indicators were selected to represent the inshore (waters of 20-250 m depth) and offshore (greater than 250 m depth) demersal scalefish suites using a risk-based approach based on the relative vulnerability of the species/stock to fishing activities. In the Gascoyne Coast Bioregion, pink snapper, goldband snapper and spangled emperor are the indicator species for the inshore suite with ruby snapper and eightbar grouper (*Epinephelus octofasciatus*) the indicator species for the offshore suite (DoF 2011³).

Pink snapper: Detailed research on the oceanic 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 2012).

Goldband snapper: Comprehensive research on goldband snapper commenced in 2007 as part of a Gascoyne Integrated Fisheries Management (IFM) project. Goldband snapper in the Gascoyne Coast Bioregion are managed as a single stock. A 'weight of evidence' based assessment has been completed and externally reviewed. Results from this work have been independently reviewed and published (Marriott *et al.* 2012). Monitoring of commercial catches and age structure is ongoing and further research is planned to refine estimates of

1 Ryan K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. and Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia 162 pp.

2 Marriott *et al.* (2012). Biology and stock status of demersal indicator species in the Gascoyne Coast Bioregion. Fisheries Research Report No. 228, Department of Fisheries, Western Australia, Perth.

3 DOF (2011). Resource Assessment Framework (RAF) for Finfish Resources in Western Australia. Fisheries Occasional Publication No. 85, Department of Fisheries, Perth.

the key biological parameters.

Spangled emperor: Comprehensive research on spangled emperor commenced in 2007 also as part of the Gascoyne IFM project. Spangled emperor in the Gascoyne Coast Bioregion are managed as a single stock. A 'weight of evidence' based assessment has been completed and externally reviewed. Results from this work have been independently reviewed and published (Marriott *et al.* 2012). Limited monitoring of recreational catches landed at fishing tournaments is on-going.

Retained Species

Commercial landings (season 2012):

Total	389 tonnes
Pink snapper	235 tonnes
Goldband snapper	64 tonnes
Spangled emperor	4 tonnes
Other species	86 tonnes

The total commercial catch taken by the GDSF in the 2012 season was 389 t which is similar to the catch level in 2011 (Gascoyne Demersal Scalefish Fishery Figure 2). The catch comprised 235 t of pink snapper (oceanic stock, TACC = 277 t), plus 153 t of other species including 64 t of goldband snapper, 4 t of spangled emperor and 85 t of other scalefish species (Gascoyne Demersal Scalefish Table 1).

Recreational catch estimate (includes charter sector):

Pink snapper	ca. 40 tonnes
Goldband snapper	ca. 18 tonnes
Spangled emperor	ca. 40 tonnes

In 2012 the recreational catch of pink snapper (oceanic stock) reported by licensed charter boats was 11 t (12 t in 2011). In 2007/08, an estimated 31 t of pink snapper (oceanic stock) was taken by recreational vessels fishing in Gascoyne waters (excluding inner gulfs of Shark Bay). The total catch of this stock of pink snapper taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 40 tonnes.

The recreational catch of goldband snapper reported by charter boats in 2012 increased to 11 t (6 t in 2011). The recreational catch of goldband snapper in 2007/08 is estimated to have been approximately 7 t. The total catch of goldband snapper taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 18 tonnes.

The recreational catch of spangled emperor reported by charter boats in 2012 was 5 t (6 t in 2011). In 2011/12, an estimated 35 t of spangled emperor was taken by boat-based recreational fishers in Gascoyne waters, which is slightly higher than the recreational catch estimate for 2007/08 (30 t). The total catch of spangled emperor taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 40 tonnes.

Fishing effort/access level

Commercial

There were 55 licences with pink snapper quota in the 2012 season with 18 vessels actively fishing (17 in 2011). These vessels (all are required to hold a minimum of 100 units of pink snapper quota to be able to operate in the waters of the GDSF) fished for a total of 875 days. The level of overall effort in this fishery is approximately 50% of that in the early 2000s (Gascoyne Demersal Scalefish Fishery Figure 2). The level of effort targeted at pink snapper varies on a seasonal basis, historically peaking in June–July, when the oceanic stock aggregates to spawn. Pink snapper catch rates are assessed annually using 'standard boat days', i.e. days fished by quota-holding vessels that caught more than 4 t each of pink snapper by line during the period June–July. GDSF vessels fished for 223 boat days during June–July in 2012 (280 in 2011).

Recreational

Total recreational boat fishing effort across the entire Gascoyne between 1 March 2011 and 29 February 2012 was estimated at approximately 60,000 fisher days (Ryan *et al.* 2013).

Stock Assessment

Assessment complete:

Pink snapper	Yes
Goldband snapper	Yes
Spangled emperor	Yes

Assessment level and method:

Pink snapper	Level 2 - Catch Rates (annual)
	Level 5 - Composite Assessment (2011)
Goldband snapper	Level 1 - Catch (annual)
	Level 3 - Fishing Mortality (2007/08)
Spangled emperor	Level 1 - Catch (annual)
	Level 3 - Fishing Mortality (2007/08)

Breeding stock levels:

Pink snapper	Adequate
Goldband snapper	Adequate
Spangled emperor	Adequate

Pink snapper: An integrated stock assessment model was developed for this stock in 2003 and 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 (completed in 2012) indicated that the spawning biomass in 2011 was above the threshold level (30% of the unexploited spawning biomass). The model estimated that at 2011 harvest levels (total annual catch ca. 300 t) the target level (40% of the unexploited spawning biomass) would be reached by 2014–2015. The next assessment is scheduled to be completed in 2014.

Prior to the development of the integrated assessment model,

the breeding stock was assessed using a pink snapper annual threshold catch rate based on catch and effort information from the peak of the spawning season (June–July). 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 threshold level set at a minimum of 500 kg pink snapper/standard boat day. Since the reductions in quota were implemented in the mid-2000s, the pink snapper catch rate (GDSF vessels fishing in June–July only) has fluctuated around 550 kg/day. In the 2012 season, the pink snapper catch rate reached 650 kg pink snapper/standard boat day, its highest level since significant TACC reductions in 2004 (Gascoyne Demersal Scalefish Fishery Figure 3) (see also box below).

The current performance measure for the Gascoyne Demersal Scalefish Fishery is that the pink snapper catch rate for the peak months (June–July) should not fall below a minimum threshold level of 500 kg pink snapper/standard boat day.

The catch rates in the early 2000s declined to a low of 450 kg pink snapper/standard boat day. After the TACC was reduced significantly in 2004 and again in 2007, catch rates have increased to an average value of about 550 kg/day. In 2012, the catch rate was 650 kg pink snapper/standard boat day well above the threshold and the highest level since 2000.

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 minimum basis of a time series of catch rates for examining trends in relative stock biomass. A research project is underway to evaluate daily catch rate data for pink snapper and goldband snapper. A ‘weight of evidence’ approach, based on an assessment of fishing mortality (F), has been used to assess the stock. 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 was not having an unacceptable impact on the age structure of the population at that time. As the commercial targeting of goldband snapper has only occurred since ca. 2000, the flow through effects of these catches to its sampled population age structures used for 2008 stock assessments many not have been detectable. Therefore, ongoing monitoring was advised to confirm this low risk profile.

The total goldband snapper catch in 2012 was well below the maximum sustainable commercial catch limit recommended for this species in the Gascoyne Coast Bioregion (100–120 t, see Fisheries Research Report 228 for details). Breeding stock levels and fishing level are currently assessed as adequate.

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 to assess stock status 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 indicated, given the available evidence, that the current level of fishing on the spangled emperor population in the North Gascoyne exceeded sustainable levels. The spangled emperor breeding stock was 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 (see Fisheries Research Report 228 for details). A slightly higher estimate of Bioregion-wide catch for this species in 2011/12 indicates that estimates of F for spangled emperor may be at similar levels, or slightly higher, than those estimated for 2007.

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

As line fishing is highly selective, interactions with protected species by commercial, charter and recreational fishers in the GDSF are low. Commercial GDSF and charter fishers are required to record all protected species interactions in their logbooks. During 2012, commercial fishers in the GDSF reported no interactions with protected species. No interactions were reported in 2012 by the charter fishery in the Gascoyne Coast Bioregion.

Ecosystem Effects

Food chain effects

Low

Pink snapper and other species in this suite are generalist feeders and are just some of a number of such species inhabiting the continental shelf waters in this Bioregion. Food chain effects due to fishing for species within this suite are considered to be low because the quota system restricts overall GDSF catches to a relatively small percentage of the total biomass. The juvenile components of these stocks 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 GDSF vessels in 2012 was similar to previous years and reflects the focus on pink snapper during the peak season and fishing further offshore in deeper water for other species at other times of the year.

In 2012, 18 vessels fished during the entire season of which 8 vessels fished for more than 10 days during the peak season, typically with a crew of 2-3. Commercial 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) for

2012:

Level 2 - \$1 - 5 million

The gross value of production (GVP) of the commercial component of the Gascoyne Demersal Scalefish Fishery was in the range \$1-5 million in 2012. 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 Pink snapper (season 2012):

Acceptable

Current catch level Goldband (season 2012):

Acceptable

Target catch (and effort) range:

Pink snapper 277 tonnes/380-540 days

Goldband snapper 50-120 tonnes (preliminary)

In 2012, GDSF vessels with pink snapper quota required 362 boat days to catch 235 t of pink snapper (oceanic stock, TACC = 277 t). The available TACC was not entirely taken

due to quota being left in the water for a range of operational factors affecting a small number of vessels.

The average catch rate at 650 kg pink snapper/boat day during the peak season for the 2012 was well above the threshold level (500 kg/standard boat day). This catch rate-based performance measure will be re-assessed when results from analyses of higher resolution (daily/trip catch and effort returns) data become available. The catch of goldband snapper in 2012 was well within the preliminary acceptable commercial catch range.

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 outside of the sanctuary zones.

New management initiatives (2012/13)

The *Gascoyne Demersal Scalefish Management Plan 2010* (the Plan) was implemented on 1 November 2010, superseding the *Shark Bay Snapper Management Plan 1994*. The Plan provides the Department with the ability to manage all demersal scalefish stocks in the Gascoyne Coast Bioregion.

Phase one of the Plan has been implemented, and includes a formal entitlement system (in the form of individual transferable quota) for pink snapper. A second form of formal entitlement is required to be introduced into the Plan to explicitly regulate the take of other demersal scalefish (e.g. goldband snapper). The development of an entitlement framework with the capacity to regulate catches of other scalefish, in particular goldband snapper, that can work in combination with the existing ITQ system for pink snapper is currently underway.

All commercial fisheries in the Gascoyne Coast Bioregion, including the GDSF, underwent Marine Stewardship Council (MSC) pre-assessment in the first half of 2013.

External Factors

Under the Offshore Constitutional Settlement, commercial vessels licensed by the Commonwealth may operate in state waters off the Gascoyne coast, outside the 200 m isobath, as part of the Western Deepwater Trawl Fishery (WDWTF). In the 2010/11 season, total effort in this fishery was 258 trawl hours (628 in 2009/10), with 0.6 t of ruby snapper (the main component of the scalefish catch taken in this fishery) caught (15.6 t in 2009/10) (Woodhams *et al.* 2012)². Recent information on catches of pink snapper taken by WDWTF

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

² Woodhams, J., Vieira, S., Stobutzki, I. (eds) (2012). Fishery status reports 2011, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

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vessels fishing in waters off the Gascoyne coast is not available (last reported catch of snapper was <0.5 t in 2006).

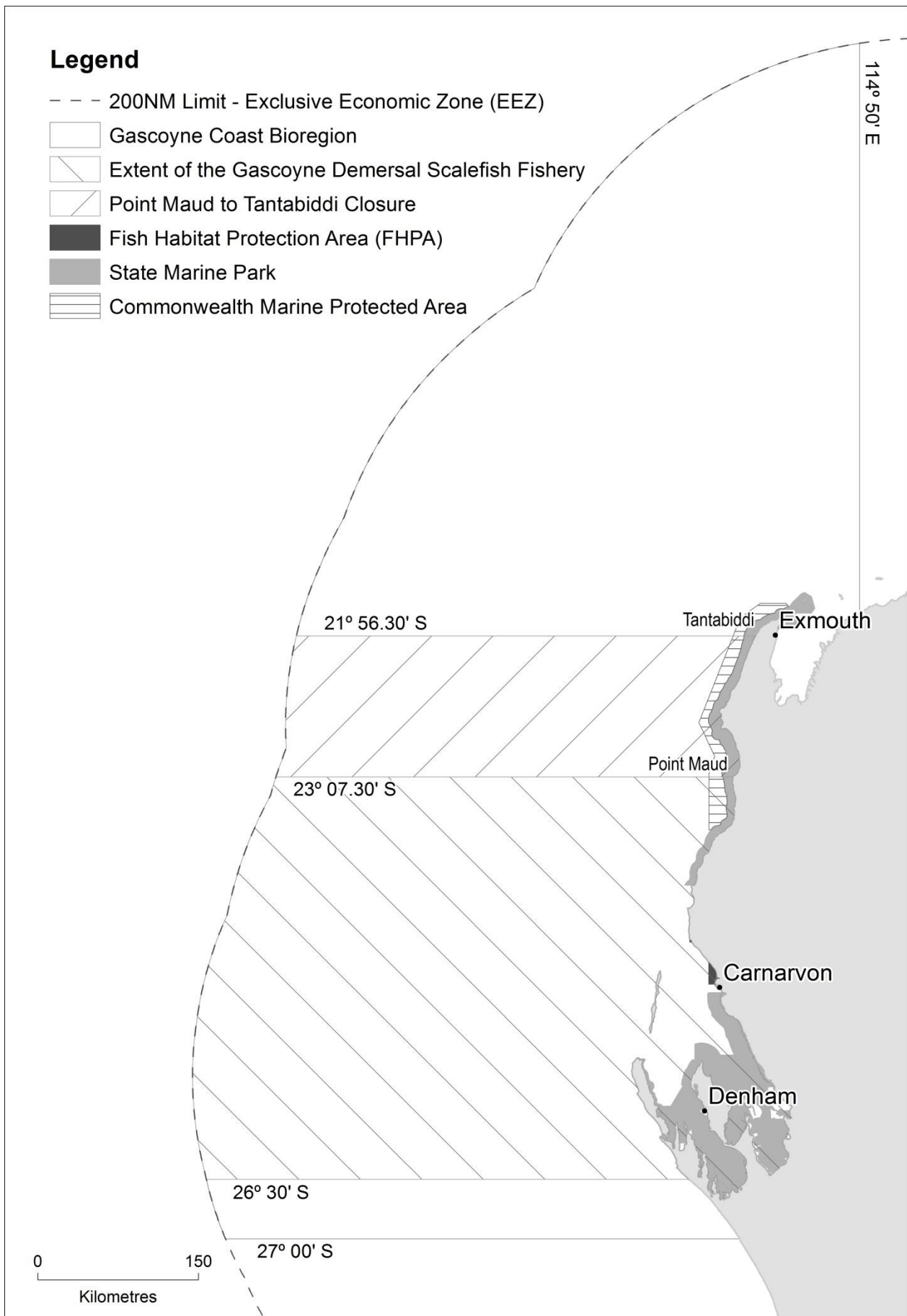
Climate change has the potential to impact fish stocks in range of ways including, with temperate species such as pink snapper, affecting spawning patterns and influencing their geographic distribution (latitude shift). A review of the impacts and responses to marine climate change in Australia has been undertaken by CSIRO (see www.oceanclimatechange.org.au). In addition, a 3-year

FRDC-funded project is currently assessing the effects of climate change on key fisheries in Western Australia. The key species that will be considered in relation to the consequences of climate change as part of this project include pink snapper, goldband snapper and spangled emperor. A recent collaborative study with CSIRO used modelling to investigate the potential influence of long-term increases in water temperatures and cyclone activity on spangled emperor in the Ningaloo Marine Park.

Species	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Goldband snapper	310.7	250.4	239.8	105.8	107.2	121.1	143.8	104.6	53.2	64.2
Red emperor	18.6	21.3	18.5	19.4	17.0	12.8	11.7	9.8	8.2	13.1
Spangled emperor	20.4	15.2	13.5	18.1	7.0	7.0	3.3	3.8	3.7	4.3
other emperors	25.8	37.4	31.8	29.2	34.3	26.8	13.8	9.2	10.4	11.6
Cods	38.0	39.2	27.9	21.9	21.5	15.0	9.5	13.4	11.4	21.1
Other	90.5	95.4	82.0	78.1	77.1	65.8	64.8	72.9	50.7	38.9
Total	504.0	458.9	413.5	272.5	264.1	248.5	246.9	213.7	137.5	153.0

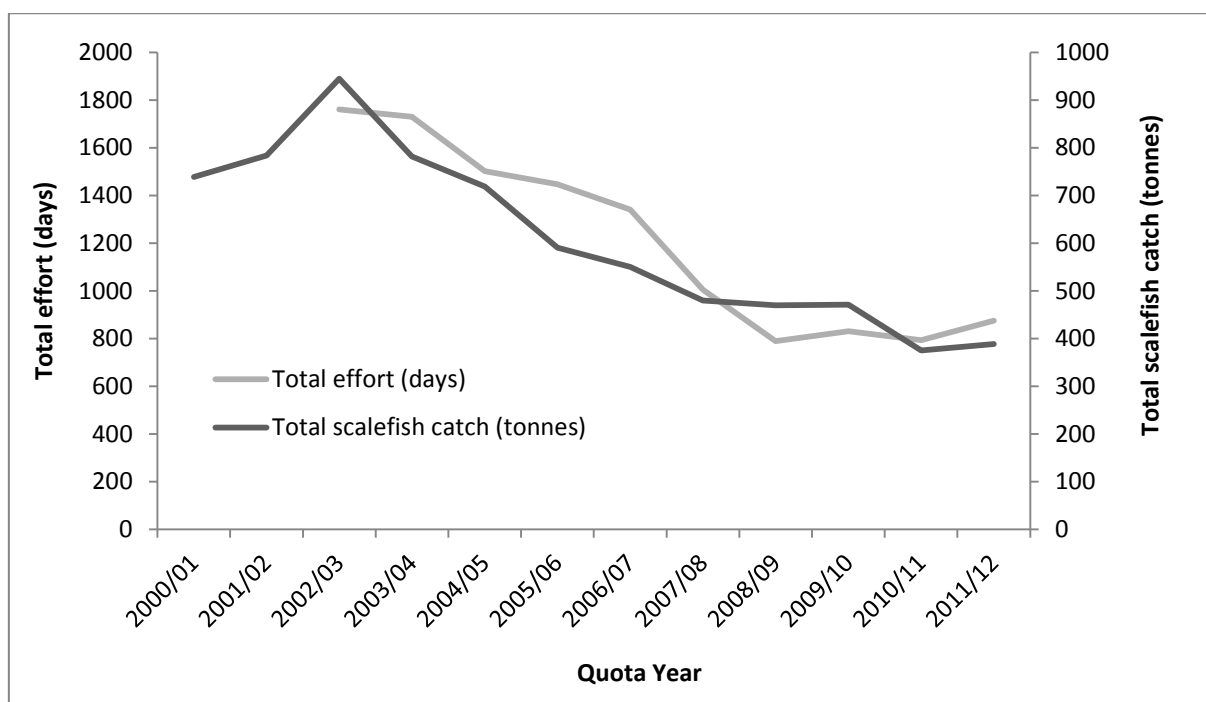
GASCOYNE DEMERSAL SCALEFISH FISHERY TABLE 1

Total commercial catch of demersal scalefish species other than pink snapper taken in Gascoyne waters between 2002/03 and 2011/12 (excludes mackerels, sharks and tunas). Units are tonnes.



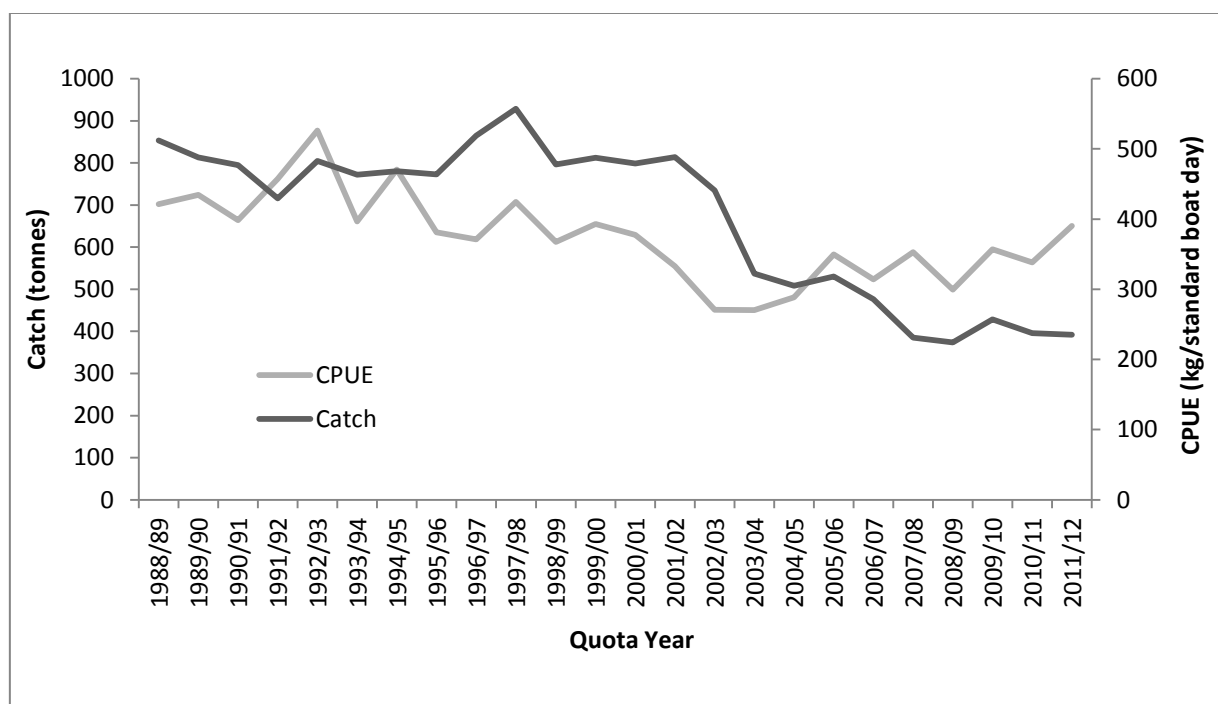
GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 1

Waters of Gascoyne Coast Bioregion including Gascoyne Demersal Scalefish Fishery and 'Point Maud to Tantabiddi Well' fishing closure.



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 2

Gascoyne demersal scalefish catch (all species including pink snapper, tonnes) and total fishing effort (days) from 2000/01 to 2011/12.



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 3

Gascoyne pink snapper catch and catch per unit effort by quota year from 1988/89 to 2011/12. Units are kg whole weight of pink snapper per standard boat day. The CPUE for vessels line fishing for snapper in June-July (peak season) is incorporated in the stock assessment model used to assess the oceanic pink snapper stock.

Inner Shark Bay Scalefish Fishery Status Report

G. Jackson, J. Norriss and H. Zilles

Main Features

Status		Current Landings	
Stock level:		Commercial (2012)	
Whiting	Adequate	Whiting	116 t
Sea mullet	Adequate	Sea mullet	40 t
Tailor	Adequate	Tailor	16 t
Western yellowfin bream	Adequate	Western yellowfin bream	9 t
Pink snapper	Eastern Gulf - Adequate	Pink snapper	1.5 t
	Denham Sound – Adequate		
	Freycinet Estuary – Recovering	Recreational (Pink snapper only)	
Fishing Level:		Eastern Gulf	4 t (2010)
Whiting	Acceptable	Charter	0.1 t (2012)
Sea mullet	Acceptable	Denham Sound	6 t (2010)
Tailor	Acceptable	Charter	1.0 t (2012)
Western yellowfin bream	Acceptable	Freycinet	1.5 t (2010)
Pink snapper	Eastern Gulf – Acceptable	Charter	nil (2012)
	Denham Sound – Acceptable		
	Freycinet Estuary – Acceptable		

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 mesh net gears to mainly take four species/groups: whiting (mostly yellowfin, *Sillago schomburgki*, with some goldenline, *S. analis*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and western yellowfin bream (*Acanthopagrus morrisoni*).

Most recreational fishing is boat-based using rod & line or handline with some netting for bait and sea mullet. The key recreational species are pink snapper (*Pagrus auratus*), grass emperor (black snapper or blue-lined emperor, *Lethrinus laticaudis*), western butterflyfish (*Pentapodus vitta*), whiting (*Sillago* spp.), Queensland school mackerel (*Scomberomorus queenslandicus*), tailor, blackspot tuskfish (bluebone, *Choerodon schoenleinii*) and goldspotted rockcod (estuary or slimy cod, *Epinephelus coioides*). A limited number of licensed charter vessels operate out of Denham and Monkey Mia.

Notice 1992

Shark Bay Beach Seine and Mesh Net Managed Fishery Licence

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Consultation process

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues (e.g. Shark Bay Inner Gulf Pink Snapper Working Group, convenes every 3 years).

Governing legislation/fishing authority

Commercial

Shark Bay Beach Seine and Mesh Net Limited Entry Fishery

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 or in sanctuary zones, recreational zones or special purpose zones within the Shark Bay Marine Park.

Management arrangements

Commercial

The SBBSMNF is managed through input controls in the form of limited entry, gear restrictions (e.g. vessel size, net length and mesh size) and permanently closed waters (e.g. Hamelin Pool, Big Lagoon, Denham foreshore). 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 snapper has not been permitted in these waters since 1996 (see 'Gascoyne Demersal Scalefish Fishery').

Recreational

The recreational fishery in Shark Bay is managed using a combination of daily bag, possession, size and gear limits and for boat-based fishing, by a Statewide recreational marine boat fishing licence, and for net fishing, by a Statewide recreational net fishing licence. For pink snapper more complex arrangements apply within the Eastern Gulf, Denham Sound and Freycinet Estuary (Inner Shark Bay Fishery Figure 1). These stocks are managed separately with explicit Total Allowable Catch (TAC) targets. In 2012, 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 in the inner gulfs were derived annually between 1998 and 2010 (no surveys in 1999 and 2009) using 'on-site' recreational fishing surveys involving interviews with boat crews returning to the Monkey Mia, Denham, and Nanga boat ramps (Wise *et al.* 2012)¹. An integrated survey of boat-based recreational fishing in WA was conducted during 2011/12 (Ryan *et al.* 2013)². This survey was developed to provide state-wide and

bioregional level catch estimates; estimates at the finer scale required for the management of inner gulf snapper stocks are not available from these survey data.

Catches of pink snapper taken by licensed commercial and charter vessels are derived from compulsory monthly catch returns. The status of the four SBBSMNF target species (whiting, sea mullet, tailor, western yellowfin bream) are monitored each year using data from commercial catch returns coupled with the extensive scientific knowledge gained from research dating back to the 1960s. Performance indicators for the SBBSMNF in the form of target catch ranges and threshold catch rates 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 years. At the most recent meeting of the Shark Bay Inner Gulf Pink Snapper Working Group (September 2011), 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 (2014).

Retained Species

Commercial landings (season 2012):

Whiting	116 tonnes
Sea mullet	40 tonnes
Tailor	16 tonnes
Western yellowfin bream	9 tonnes
Pink snapper	1.5 tonnes

The total catch taken by SBBSMNF licensed vessels in 2012 was 188 t which represents an approximate 28% decrease on the total catch taken in 2011 (see Stock Assessment for explanation). This total catch comprised 116 t of whiting, 40 t of sea mullet, 16 t of tailor, 9 t of western yellowfin bream and 6 t of other mixed scalefish species that included 1.5 t of pink snapper (taken as bycatch in net fishing gears).

Recreational catch estimates

(including charter, 2012)

Pink snapper	Eastern Gulf ca. 4-5 tonnes
	Denham Sound ca. 6-7 tonnes
	Freycinet Estuary ca. 1-2 tonnes
Grass emperor	ca. 10 tonnes

As a direct result of management intervention, including the introduction of TAC-based management in 2003, recreational catches of pink snapper in Shark Bay are much lower than were taken in the 1990s.

Based on results of the most recent 'on-site' recreational fishing survey in 2010, the estimated recreational catch of pink snapper was approximately 4-5 tonnes in the Eastern Gulf, approximately 6-7 tonnes in Denham Sound and approximately 1-2 tonnes in the Freycinet Estuary. The estimated recreational catch of grass emperor in 2010 was approximately 10 tonnes (all areas combined).

1 Wise et al. (2012) Long-term monitoring of boat-based recreational fishing in Shark Bay, Western Australia; providing advice for sustainable fisheries management in a World Heritage Area. *Marine and Freshwater Research* 63: 1129-1142

2 Ryan, K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H., Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia. 162 pp.

In 2012, approximately 1 t of pink snapper was taken in Denham Sound and approximately 100 kg in the Eastern Gulf by licensed charter vessels; no charter boat catches were reported from the Freycinet Estuary. A total catch of approximately 1 t of grass emperor (all three areas combined) was reported by charter vessels in 2012.

Fishing effort/access level

Commercial

In 2012, of the 12 SBBSMNF licenses, only six vessels were routinely involved in fishing. Total fishing effort declined significantly in 2012 (664 boat days) compared with 2011 (1,002 boat days) and 2010 (1,081 boat days). This approximate 34% decrease in overall effort can be mostly attributed to one particular vessel that had been highly active historically, that did not fish at all in 2012.

Recreational

In 2010, boat-based recreational fishing effort in the inner gulfs was estimated at approximately 37,000 boat fisher hours (compared to an estimated 33,000 fisher hours in 2007). No more recent estimates of recreational effort are available from the first state-wide integrated survey of recreational boat-based fishing.

Stock Assessment

Assessment complete

Whiting	Yes
Sea mullet	Yes
Tailor	Yes
Western yellowfin bream	Yes
Pink snapper	Yes
Grass emperor	Yes

Assessment level and method:

Whiting/Sea mullet/Tailor/Western yellowfin bream	Level 2 - Catch, Catch Rate (2012)
Pink snapper	Level 5 - Composite Assessment (2011)
Grass emperor	Level 3 - Fishing Mortality (2005) Level 1 - Catch (2010)

Breeding stock levels

Whiting	Adequate
Sea mullet	Adequate
Tailor	Adequate
Western yellowfin bream	Adequate
Pink snapper	Eastern Gulf - Adequate Denham Sound - Adequate Freycinet Estuary - Recovery

Grass emperor

Adequate

Whiting, Sea mullet, Tailor, Western yellowfin bream:

Assessment of the four main SBBSMNF target species is based on annual analysis of the commercial catch and effort data. Target catch ranges and threshold catch rates (CPUE) have been determined for the fishery overall and for each target species (Inner Shark Bay Fishery Table 1).

In 2012, while the total catch (all species) at 188 tonnes was below the lower limit of the target catch range (235–335 tonnes)(Inner Shark Bay Scalefish Fishery Figure 2), the overall CPUE at 283 kg/boat day (all species) was maintained above the average since 1990 (230 kg/boat day). The large decrease in total catch can be attributed to a decrease in overall effort and the large decrease in the sea mullet catch in particular (see below).

In 2012, the catch of whiting (116 tonnes) was within the target catch range and CPUE (175 kg/boat day) well above the threshold catch rate at the highest level observed since 1990 (Inner Shark Bay Scalefish Fishery Figure 3). This increase in catch rate can be attributed to an increase in availability of whiting and greater time spent targeting this species rather than other lower-value species such as sea mullet. The catch and CPUE of western yellowfin bream (9 tonnes, 14 kg/boat day) were also within the respective target catch range and above the threshold catch rate, respectively. Although the catch of sea mullet (40 tonnes) was the lowest on record (previous lowest catch was 57 tonnes in 1976), and well below the target range, the CPUE (61 kg/boat day) was maintained around the threshold level. The decrease in the sea mullet catch is explained by the non-participation in 2012 of a single vessel that had landed 24% of the total mullet catch in 2011 and contributed 22% of the total effort (see comment for whiting above).

While the tailor catch (16 tonnes) was again below the target range, the CPUE (25 kg/boat day) increased to above the threshold level. The low landings of tailor that have become a feature of the fishery in recent years are mostly attributed to local processing restrictions.

Pink snapper: DEPM surveys that directly estimate 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 the Eastern Gulf in 2012 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 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.

Grass emperor: 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 significantly 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 fish 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 (rarely) 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 is unlikely to have a lasting effect on the habitat.

Social Effects

Commercial

Currently around 20 fishers are employed in the SBBSMNF based on six 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 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) for

2012 **Level 2 - \$1 - 5 million**

Commercial

The gross value of production (GVP) of the SBBSMNF in 2012 was estimated in the range \$1-5 million.

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 (2012): **Acceptable**

Target catch range (2012):

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 the SBBSMNF declined to 664 boat days in 2012. This represents an approximate 34% reduction on effort in 2011 (1,002 boat days) and 38% reduction on 2010 (1,081 boat days). The large decrease between these two years is mostly explained by non-participation of one particular vessel in 2012 that historically had been a major operator in the fishery.

The total commercial catch (ex. pink snapper) in 2012 at 188 t was well below the lower limit of the target catch range (235–335 tonnes). At this time, this fishery is considered to present a low risk to the sustainability of the finfish and other ecological resources of inner Shark Bay, and as a consequence is a low research/management priority.

Commercial catches of pink snapper taken as bycatch by SBBSMNF vessels in 2011 were either nil or significantly below their allocation within the respective pink snapper TACs (1.5 tonnes in Denham Sound, nil catch in Eastern Gulf and Freycinet Estuary).

Recreational

Target catch range (2012):

Pink snapper **Eastern Gulf 12 tonnes**

Denham Sound 12 tonnes

Freycinet Estuary 3.8 tonnes

Recreational catches of pink snapper were assumed to be similar to those estimated in 2010 (no 'on-site' survey undertaken in 2011 or 2012) and therefore within the respective TACs in each area.

In 2012, a total of 561 applications (first and second rounds) were received for Freycinet Estuary management quota tags with a total of 914 tags (total available 1,050) allocated to recreational fishers.

New management initiatives (2012/13)

As an outcome of the 'Wetline Review' (see Fisheries Management Paper No. 224 for details), a management plan is being developed for a Gascoyne Inshore Net Fishery. The Plan will 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.

All commercial fisheries in the Gascoyne Coast Bioregion, including the SBBSMNF, underwent Marine Stewardship Council (MSC) pre-assessment in the first half of 2013.

External Factors

While the inner Shark Bay system has been considered relatively stable as a result of its typically low-rainfall, arid environment, the region is occasionally affected by cyclone-related flood events such as occurred in the Gascoyne and Wooramel Rivers in late 2010 and again in early 2011. Combined with this, the marine heatwave in the summer of 2010/11 had significant impacts on some marine habitats (e.g. temperate seagrasses) and invertebrate species (e.g. blue crabs, scallops) (see Fisheries Research Report 222)¹. The

impact of these events on key scalefish species in inner Shark Bay remains to be fully determined. 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. The key fishery species that will be considered in relation to the consequences of climate change as part of this project include pink snapper and tailor.

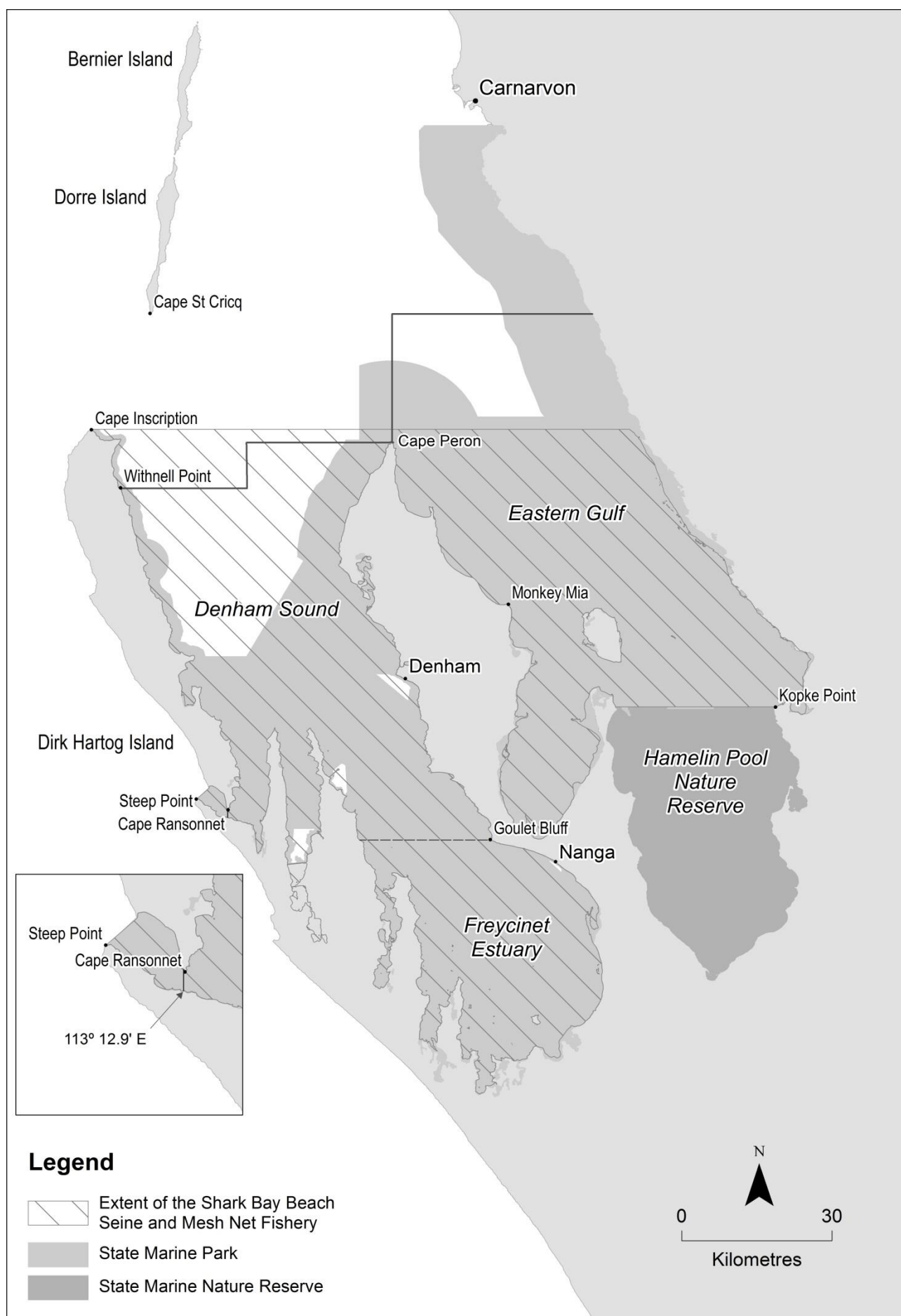
INNER SHARK BAY SCALEFISH FISHERY TABLE 1

Annual catch and target catch range (tonnes) (upper), and annual CPUE and threshold level (kg/boat day) (lower) for key species taken by Shark Bay Beach Seine and Mesh Net Managed Fishery vessels for the period 2003-2012.

Species	Acceptable catch range	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Whiting	93-127	107	119	116	113	102	117	115	118	105	116
Mullet	77-144	149	143	85	62	91	107	124	117	116	40
Tailor	25-40	28	24	19	21	23	23	19	19	17	16
Bream	7-15	24	27	27	23	14	8	8	10	9	9

Species	Trigger level	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Whiting	75	86	114	102	110	100	98	100	112	105	175
Mullet	62	120	137	74	60	90	89	106	107	116	61
Tailor	21	22	23	17	20	22	19	16	17	17	25
Bream	5	19	26	23	22	14	6	7	10	9	14

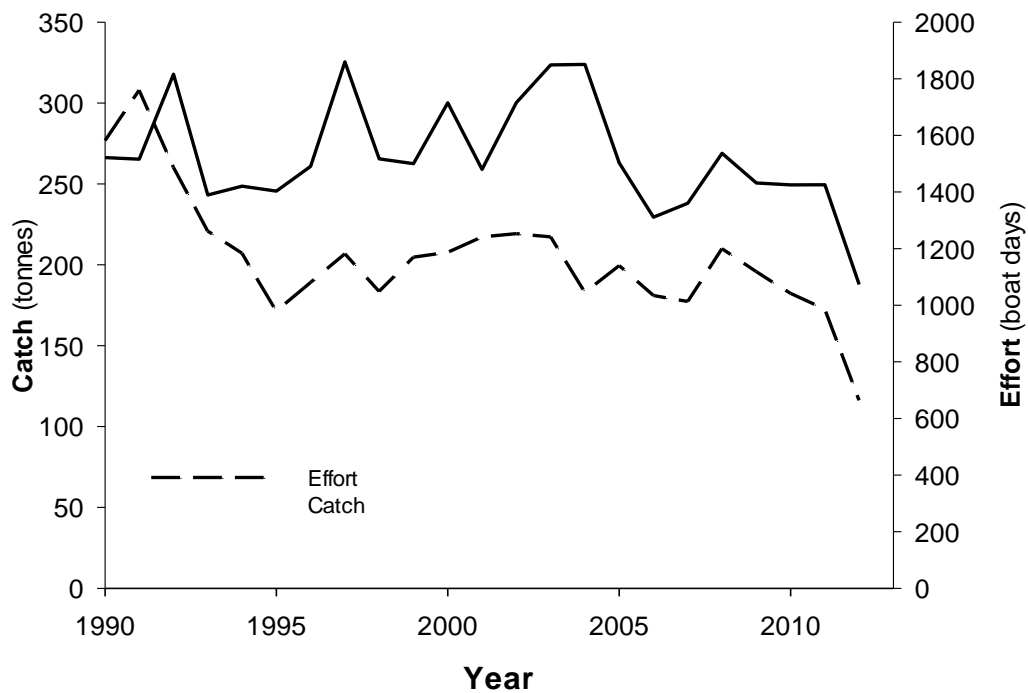
¹ Pearce et al. (2011). The "marine heatwave" off Western Australia during the summer of 2010/11. Fisheries Research Report No 222. Department of Fisheries, Western Australia, Perth.



INNER SHARK BAY SCALEFISH FISHERY FIGURE 1

The commercial (scalefish) and recreational fishing areas of inner Shark Bay.

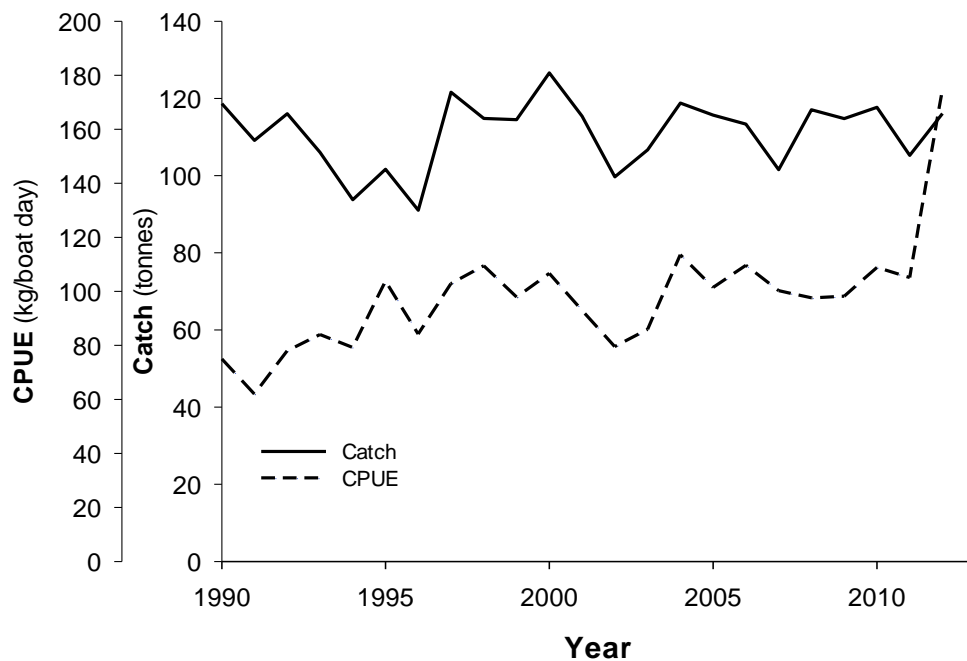
Shark Bay Beach Seine and Mesh Net Total Catch



INNER SHARK BAY SCALEFISH FISHERY FIGURE 2

The total annual catch and effort for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2012.

Shark Bay Whiting



INNER SHARK BAY SCALEFISH FISHERY FIGURE 3

The annual whiting catch and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2012.

Shark Bay Blue Swimmer Crab Fishery Status Report

A. Chandrapavan, D. Johnston, E. Sporer, S. O'Donoghue and C. Syers

Main Features

Status		Current Landings	
Stock level	Inadequate (non –fishing)	Commercial catch	113 t
		Shark Bay trap fleet	59 t
Fishing level:		Shark Bay trawl fleet	54 t
	Voluntary commercial closure since April 2012	Recreational catch	~ 1t

Fishery Description

The blue swimmer crab (*Portunus armatus*) resource in Shark Bay is harvested commercially by the Shark Bay crab trap and Shark Bay prawn trawl fisheries, with negligible amounts retained by the Shark Bay scallop fishery. This crab stock also supports a small (~1 t) but important recreational fishery. Prior to 2012, this was Australia's highest producing blue swimmer crab fishery. However between July and December 2011, commercial catch rates declined rapidly due to significantly low stock abundance across the region that appeared to be caused by environmental conditions generated by an unprecedented marine heatwave combined multiple flooding events during the summer of 2010/11. Commercial fishing for blue swimmer crabs in Shark Bay was voluntarily halted by industry in April 2012 to facilitate stock rebuilding.

Recfishwest under a Service Level Agreement although the Department continues to undertake direct consultation with the community on specific issues

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 (Shark Bay 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.

The boundaries of the Shark Bay Prawn and Scallop Managed Fisheries, which also retain blue swimmer crabs, are described in the relevant status reports specific to the trawl fisheries elsewhere within this document.

Governing legislation/fishing authority

Commercial

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

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order – Shark Bay Interim Managed Fishery only)

Recreational

Fish Resources Management Act 1994; *Fish Resources Management Regulations 1995* and subsidiary legislation.

Consultation process

Commercial

The Department of Fisheries undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are now convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Recreational consultation processes are now facilitated by

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 licence and trap (hourglass) numbers or length of headrope of trawl net. Supplementary controls cover what species can be retained, associated minimum size limits, gear specifications, and area, seasonal and daily time restrictions. The principal management tool employed to ensure adequate breeding stock involves having minimum size limits well above the size at sexual maturity. Male blue swimmer crabs in Shark Bay become sexually mature at 97 mm carapace width, while females become sexually mature below 92 mm carapace width. Setting the commercial minimum size at 135 mm carapace width is designed to ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

There are five crab trap licences each with 300 units of entitlement currently valued at 1 trap each 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. These licences are consolidated onto three active vessels. Two permit holders, who have a long standing history of crab fishing south of Cape Peron (south of the existing

waters of the Shark Bay Crab Interim Managed Fishery [SBCIMF]), have a Fishing Boat Licence (FBL) condition that allows them to fish in these waters but with no more than 200 traps. At no time, however, may they each use more than 300 traps in total across all of the waters of Shark Bay.

There are currently 28 trawl (18 prawn and 10 scallop) licenses authorized to take blue swimmer crabs in Shark Bay. Management controls for the trawl fisheries that retain blue swimmer crabs in the Gascoyne Coast Bioregion, namely the Shark Bay Prawn Managed Fishery and the Shark Bay Scallop Managed Fishery, are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices (grids) and these are fully described in the relevant status reports within this document. The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all trawlers in these fleets.

A third comprehensive ESD assessment of the Shark Bay fishery was completed in June 2011. The Federal Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) approved the fishery to export product for a further five years until September 2016, 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 is a minimum size limit 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. Recreational crab fishers mainly use drop nets or scoop nets.

Research summary

Data for the assessment of blue swimmer crab stocks in the Gascoyne bioregion are obtained from trap fishers' statutory monthly catch and effort returns and voluntary daily logbooks, and trawl fisher's statutory daily logbooks. In addition, Department of Fisheries' research staff conduct quarterly catch monitoring aboard commercial crab trap vessels in Shark Bay. A fishery-independent trawl survey, which covers the deeper water habitat, is conducted annually during late November/early December. Some base-line information on the biology and ecology of blue swimmer crabs has been generated by a number of FRDC funded projects conducted over the past decade both by the Department of Fisheries and Murdoch University. An FRDC project completed in early 2005 produced a preliminary stock assessment of the Shark Bay blue swimmer crab fishery.

An external scientific review (May 2011) of the blue swimmer crab stock in Shark Bay highlighted the need for rigorous fishery-independent data collection to address knowledge gaps in some of the biological parameters, discard information from trawling and models to determine sustainable harvest levels. An additional FRDC project (2012/015) to determine how to more accurately assess the stock status of crabs in Shark Bay commenced in July 2012. This will include completing a program of fishery-independent surveys to provide an understanding of the

annual life cycle.

Retained Species

Commercial landings (season 2011/12):

	113 tonnes (total)
Shark Bay trap fleet	59 tonnes
Shark Bay trawl fleet	54 tonnes

The total commercial crab catch from Shark Bay during 2011/12 was 113 t, representing a significant decrease (87%) compared to the 2010/11 catch of 860 t (Shark Bay Blue Swimmer Crab Figure 2). This catch only accounted for 33% of the state commercial blue swimmer crab catch of 347 t for 2011/12.

The annual catch from the Shark Bay crab trap fishery for 2011/12 was 59 t, an 88% decrease on the 2010/11 catch of 496 t (Shark Bay Blue Swimmer Crab Figure 2, 3). Landings from the Shark Bay trawl fleet were 54 t in 2011/12, an 85% decrease on the 2010/11 catch of 364 t. These low catches resulted from low stock abundance that appears to be caused by extreme environmental conditions in the summer of 2010/11 and the voluntary no take of crabs from April 2012.

Recreational catch:

Shark Bay	< 1 % of total
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Previous estimates of recreational crab catches from Shark Bay derived from a 12-month creel surveys of recreational boat-based fishing and as part of recreational surveys targeting pink snapper fishers and this estimate ranged between 0.3 and 1.9 t of blue swimmer crabs predominantly caught from the Eastern Gulf region. A more recent state-wide recreational survey found only 4% of the state's blue swimmer recreational catches came from the Gascoyne region.

Fishing effort/access level

Trap fishers reported a total of 76,940 traplifts for 2011/12 (Shark Bay Blue Swimmer Crab Figure 3) – a 73% decrease on the 284,400 traplifts reported for the previous year. This was driven by the extremely low catch rates of crabs by the end of 2011 and trap fishing ceasing in February 2012.

Effort in the Shark Bay Prawn fishery is described in the relevant status reports elsewhere within this document and is primarily directed at catching prawns not at crabs. The Shark Bay Scallop Managed Fishery was closed during 2011/12.

Stock Assessment

Assessment complete:

Shark Bay:	Yes
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Assessment level and method:

Level 3 - Catch rate/Size Distributions

Breeding stock levels:

Shark Bay:	Inadequate (non-fishing)
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The Shark Bay Crab Fishery (trap and trawl sectors) developed rapidly between 2000 and 2011 and was Australia's highest producing blue swimmer crab fishery. During the developmental phase of the commercial trap fishery, catches grew steadily in line with increases in fisher knowledge, gear development and fishing effort, from 87 t (1998) to 564 t (2005). In 2005, the trap fishery transitioned to interim managed status and trap catches have stabilized at around 500 t. The annual mean commercial trap catch rate was stable around 1.6 kg/traplift between 2000/01 and 2010/11, which was well above the performance measure of 1.0 kg/traplift. The Shark Bay trawl fisheries have retained crabs as a byproduct since the inception of this fishery. Their level of retained catch was relatively low (<100 t) up until 2001/02, but increased steadily to 364 t in 2010/11. An independent review of the status of the blue swimmer crab stocks in Shark Bay was completed in May 2011 which supported the conclusions on the risks to the stock and priorities for future research. Discussions were therefore being initiated to potentially cap overall catch levels until a better understanding of stock dynamics and knowledge gaps on the factors influencing recruitment, spawning, and other life-history traits were addressed.

The total crab landings in 2011 were approximately 690 t, which is similar to the catch levels taken over the past 6 years, however the monthly trend in crab trap landings was significantly different to that observed during the rest of this period. During 2011, crab catches during the early part of 2011 (peaking in April 2011) were higher than in previous years when catches usually peaked later in May-June and sometimes even in August. The early peak in catch rates may have been influenced by the large flooding events in the summer of 2010/11 that may have flushed the crabs from the inshore grounds of the Eastern Gulf region. For the trawl sector, catches declined rapidly from June 2011 (43 t), to 9 t in August 2011, to very low catch of 9 kg in October 2011. The trap sector experienced a similar trend with the catch rate falling from 1.75 kg/traplift in July 2011 to 0.5 kg/traplift by December 2011. The standard annual scallop survey, which also provides data on crab abundance, undertaken in November 2011 confirmed the collapse of the Shark Bay crab stock. Catches of legal biomass (>135mm) were 0.22 kg/nm compared to the previous years' average of 5.6 kg/nm and sublegal biomass (sexually mature) of 0.15 kg/nm compared to 3.9 kg/nm from previous years.

An exemption to fish was granted to one trap fisher in January and February 2012 to fish beyond the existing boundary of the fishery to determine if crabs had moved into areas that had previously not been fished. The results confirmed low stock abundance across all size classes. The trawl sector commenced fishing in March 2012 and a small amount of crabs (< 5 t) were retained in March and April 2012 until a voluntary no take of crabs was negotiated with trawl and trap sectors by the Fisheries Department in April 2012. Since this time the fishery has been in a rebuilding phase.

The reasons for this substantial decline while not fully understood are likely to be linked to several adverse extreme environmental events. Firstly, this part of the WA coast experienced an extreme "marine heat wave" event where sea surface temperatures were at record high levels, reaching 3-5°C higher than historical levels for December 2010 to March 2011. The increases in 2010/11 were part of the record

water temperatures that occurred in the Gascoyne and mid-west region and were associated with a very strong La Niña and Leeuwin Current. These conditions are known to have contributed to the mortality of a number of invertebrate and fish species (Pearce *et al.*, 2001)¹. Secondly, there were two major flood events over the 2010/11 summer months as a result of cyclone activity. Large amount of freshwater outflow into Shark Bay may have redistributed crab inshore stocks and/or caused some mortality in the following months.

It is suspected the extremely high water temperatures (and possibly combined with the flood events) may have also been responsible for high mortality of adult legal and sub-legal crabs due to thermal stress and possibly through increased susceptibility to predation &/or disease. This may explain the low residual spawning stock during the second half of 2011. The lack of small recruits during the November trawl survey suggests recruitment failure poor larval survival and settlement as the spawning stock had been within historic ranges. The flooding events over the summer of 2010/11 could also have affected the larval movement (flushing out of Shark Bay) and the salinity regime may have also affected mortality further reducing the level of juveniles now present in Shark Bay.

The water temperature during the winter 2010 was well below average and this may be a contributing factor as the winter period has been identified as the potential peak spawning period and there appears to be a positive correlation between winter SST and subsequent commercial catches. In addition, water temperatures have been above average in the summers of 2011/12 and 2012/13 and these may also be contributing to the continued low recruitment.

The performance measure for the Shark Bay crab fishery requires legal crab abundance be maintained above a performance measure of 1.0 kg/traplift. While the 2010/11 catch rate was well above at 1.74 kg/traplift, for 2011/12 the catch rate declined to 0.76 kg/traplift due to significant decline in overall stock abundance across Shark Bay. There are currently trap and trawl based research surveys programs in place to monitor the recovery of the Shark Bay crab stock.

Non-Retained Species

Bycatch species impact

Negligible

Hourglass traps are purpose-designed to minimise the capture of undersized blue swimmer crabs and 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.

On-board sampling by departmental staff has indicated low numbers of bycatch species of mainly finfish (eg. Snapper

¹Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. and Gaughan, D. 2011. The "marine heat wave" off Western Australia during the summer of 2010/11. Fisheries Research Report No. 222. Department of Fisheries, Western Australia. 40 pp.

spp.), and other invertebrates (e.g. starfish, cephalopods and other crab species). The low number of fish caught and returned by crab fishers is considered to pose a negligible risk to these stocks. Impacts from discarded bycatch from trawl fisheries that retain crabs as a byproduct 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

The closure of the Shark bay crab fishery has had a significant socio economic impact on both the trap and trawl sectors. The trap sector which once employed approximately 15 people as skippers and crew on vessels and additional employment for some 30-35 workers through the development of post-harvest processing of the crab catch, are all currently inactive.

Economic Effects

Estimated annual value (to fishers) for 2011/12

Level 1 - < \$1 million (\$565 000)

The beach price for uncooked crabs in the Gascoyne fisheries for the year varied between \$4-5.50/kg.

Based on an average of \$5/kg the blue swimmer crab landings from Shark Bay during 2011/12 were worth \$565 000, a significant decrease on the estimated \$5 million generated during 2010/11 (for the Gascoyne Coast Bioregion). While the majority of the product was sold through local and inter-state markets, several Shark Bay fishers have been developing markets in Asia.

Fishery Governance

Target catch (or effort) range:

Shark Bay: Under Development

Target ranges are currently under development including precautionary target levels for limited fishing once the stock has recovered to acceptable levels.

Current fishing (or effort) level:

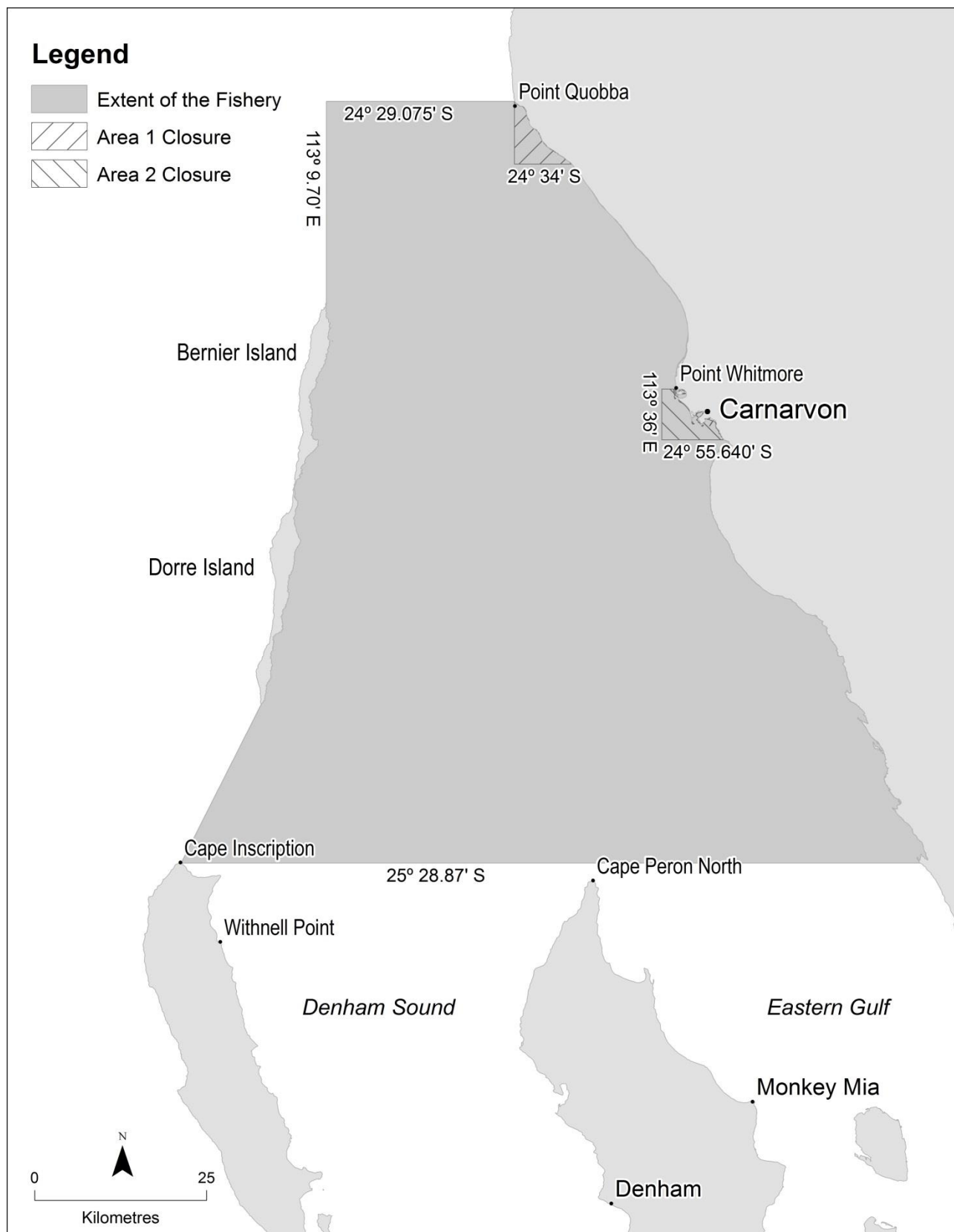
Not Applicable as fishery closed

New management initiatives (2012/13)

A ministerial decision on allocating catch shares within the commercial sectors was made in June 2012 (trap – 66%, prawn trawl 33.8%, scallop trawl sector 0.2%). Approval was also given by the Minister to develop a managed fishery management plan that would incorporate an Individual Transferable Quota system of entitlement to apply across all three commercial sectors in Shark Bay. The current Shark Bay Crab Interim Management Plan is extended to 31 August 2013.

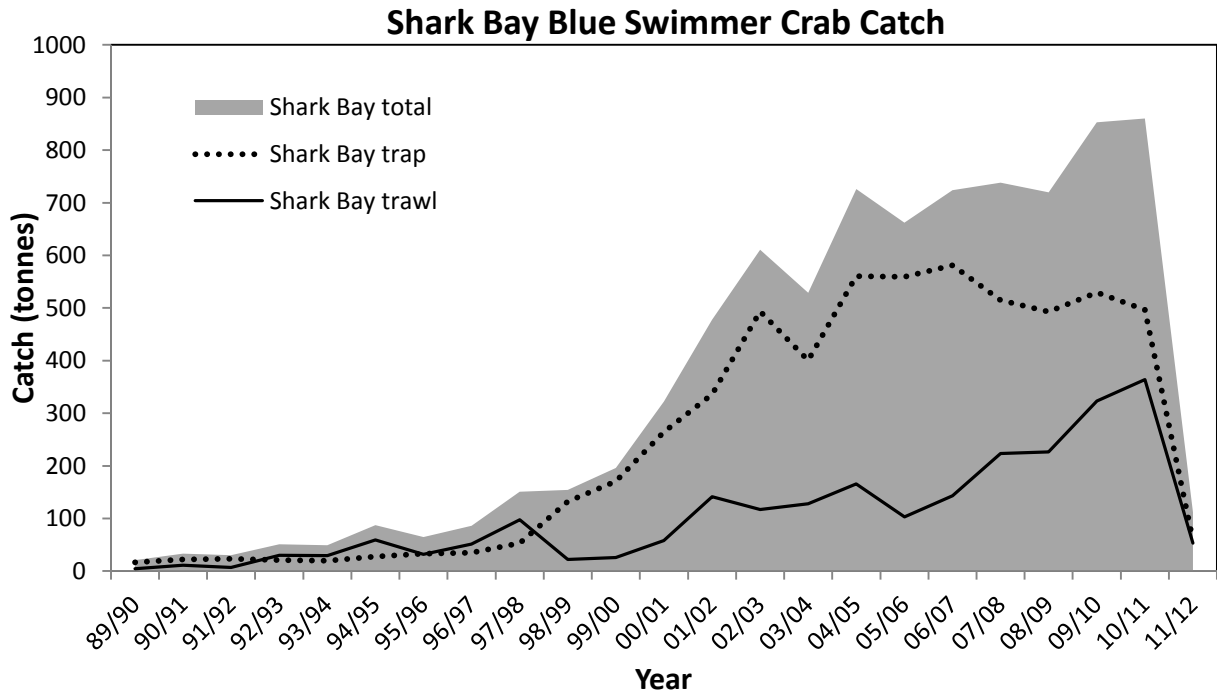
External Factors

The effect of the extreme environmental conditions in the summer 2010/11, winter temperatures and continued warm water temperatures in the summer of 2011/12 and 2012/13 are being assessed as part of the FRDC research project.

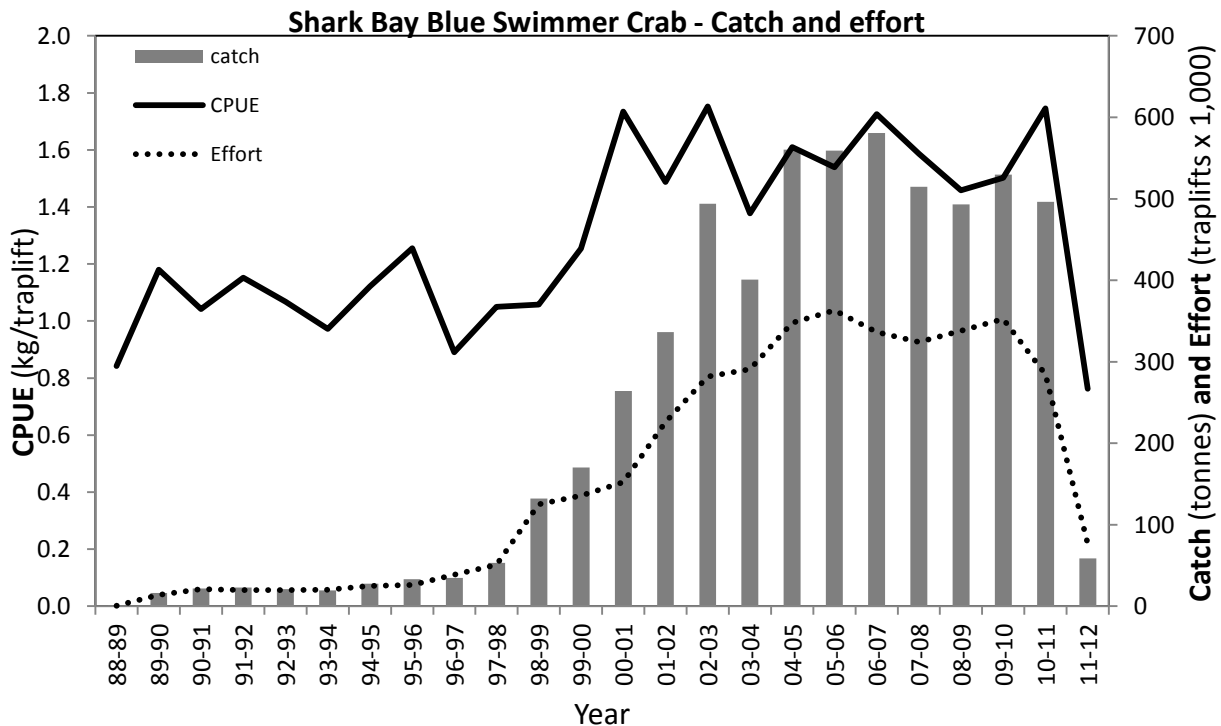


SHARK BAY BLUE SWIMMER CRAB FIGURE 1

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.

**SHARK BAY BLUE SWIMMER CRAB FIGURE 2**

Commercial catch history for the blue swimmer crab (*Portunus armatus*) between trap and trawl sectors since 1989/90.

**SHARK BAY BLUE SWIMMER CRAB FIGURE 3**

Blue swimmer crab trap catch (t), effort (traplifts x 1,000) and catch per unit effort (kg/traplift) in Shark Bay since 1988/89.

AQUACULTURE

Regional Research and Development Overview

For aquaculture in the Gascoyne, the Department of Fisheries continues to focus on the regulation of the regional pearling industry, including the blacklip oyster *Pinctada margaritifera* and Akoya pearl oyster *Pinctada imbricate*. These now complement the major State oyster industry sector which has been centred on the silver lip pearl oyster (*Pinctada maxima*).

The Department of Fisheries is also focusing on the management and regulation of an emerging local aquaculture

sector, which is producing aquarium species that include coral and live rock. This developing sector is regulated according to the policy entitled *The Aquaculture of Coral, Live Rocks and Associated Products*.

A start-up project is investigating the production of artemia (brine shrimp) and a small-scale project is growing limited quantities of diadromous and marine species for local markets.

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 2011/12 the three district offices supported a total of ten 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.

A significant aspect of the regions 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, 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 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. A high visibility Recreational Fishing Mobile Patrol has been added to the Gascoyne pool of resources. 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 Carnarvon and Denham use an 8 metre rigid inflatable boat

and a 7.3-metre rigid inflatable boat respectively. Both vessels are 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. Historically large patrol vessels (greater than 20 m in length) have assisted FMOs at various times of the year for offshore patrols, especially in the Shark Bay Prawn and Scallop Fisheries. In 2011/12 this process was changed and tactical operations were developed incorporating the large PV's and the days were increased to 22 at-sea patrols in 2011/12. This allowed FMOs to conduct patrols the length of the Gascoyne and target offenders in all of the recreational and commercial fisheries based on intelligence gathered by FMO's and also conduct aerial surveillance, at-sea and on-land catch, licence, gear and marine safety inspections, and attend community events as well as school education programs.

In mid-2011, commercial blue swimmer crab trap catches dropped to below economically viable levels. Investigation of research data, including commercial trawl and trap catch data, showed that the stock was severely depleted. It appears that a recruitment failure was caused as a result of major environmental factors, including severe flood events in late 2010 and early 2011, plus a marine heat wave event in early 2011 resulting in very high water temperatures in Shark Bay.

As a result of all these factors, the trap industry was provided access to waters north of the current fishery under exemption in late 2011/early 2012, so as to allow the commercial fishers to explore the possibility of crabs in other areas.

Unfortunately low numbers of crabs were found following surveys conducted by the DoF in February and March 2012. Research results included:

- Small size and low estimated standing stock of blue swimmer crabs
- Few crabs in traditional areas
- Majority of crabs were females with 50% being berried.
- Recent trends in trawl landings and survey data showed numbers rapidly declining between May and August 2011
- Research surveys aboard the departmental research vessel "Naturaliste" recorded very low numbers (4 crabs/nm trawled) that produced the lowest crab density on record

As a result the Department of Fisheries asked for industry to adopt a no take approach of crabs on a voluntary basis as of the 2nd of April, 2012. This method allowed for real time adaptive management throughout the season based on the outcomes of the scheduled surveys, whereas the legislative approach was unlikely to afford the same level of flexibility. A voluntary approach also demonstrated industry's continued responsibility and stewardship over the resource.

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 2011/12 year using this model. Several other OCPs were completed, including the Commonwealth Ningaloo Marine Park. 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 increased due to a more focused intelligence base of compliance. However, compliance overall is assessed as being at an acceptable level across all the fisheries. 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.

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 (81) was similar to 2010/11, however infringement notices issued (186) increased marginally. The real difference was the detection of offences that required the instigation of prosecutions (10) over 2011/12. This was achieved from a total of 14,092 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 20% higher than in 2010/11.

The addition of a Gascoyne Recreational Fishing Mobile Patrol based in Carnarvon allowed for a higher focus on education and enforcing management arrangements for Shark Bay Inner Gulf pink snapper, the Gnarraloo Bay area and Onslow town site and surrounds. Two Mobile Patrols from the Metro Region patrolled the Gascoyne Region increasing the effective contact rate at the peak of the season.

Three Recreational Fishing Mobile Patrols from outside the region were again active in the Gascoyne in 2011/12. "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.

Initiatives in 2012/13

For the 2012/13-year a number of initiatives across the Gascoyne Bioregion have been planned. These include: -

- Continue to monitor the management and compliance aspects associated with the Shark Bay Crab Fishery;
- Continue to focus on a more intelligence based and tactical approach to compliance delivery, especially in marine parks and recreational fishing;
- Provide information to the Marine Stewardship Council (MSC) for the pre-assessment of the Gascoyne Bioregion's commercial and recreational fisheries;
- Increase effort in terms of education and enforcement in the Coral Bay and Gnarraloo area
- Improve recruitment and retention practises to attract and retain staff in the Gascoyne;

GASCOYNE COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the Gascoyne Coast Bioregion during the 2011/12 financial year.

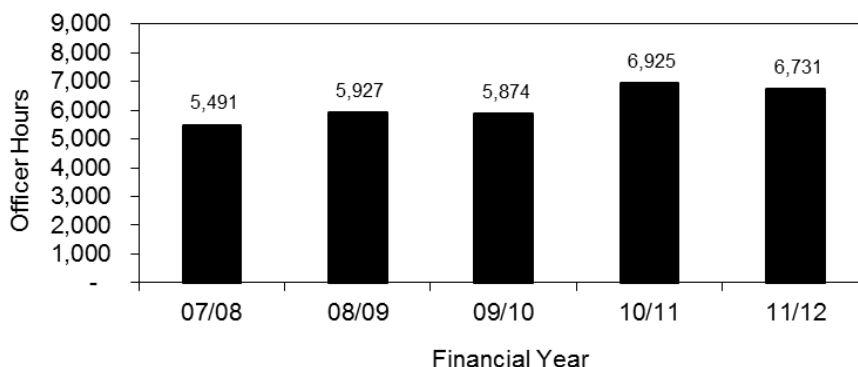
PATROL HOURS DELIVERED TO THE BIOREGION		6,731 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY		
Field Contacts by Fisheries & Marine Officers		157
Infringement warnings		18
Infringement notices		0
Prosecutions		13
Fishwatch reports**		1
VMS (Vessel Days)***		7,091
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY		
Field Contacts by Fisheries & Marine Officers		14,092
Infringement warnings		81
Infringement notices		186
Prosecutions		10
Fishwatch reports		13
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*		
Field Contacts by Fisheries & Marine Officers		786
Fishwatch reports		3

*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.

** Fishwatch reports are allocated to the District Offices relevant to the Bioregion. It is not possible to distinguish between calls relating to Inland Bioregions.

*** 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 Bioregion Compliance Patrol Hours

**GASCOYNE COAST COMPLIANCE FIGURE 1**

"On Patrol" Officer Hours showing the level of compliance patrol activity delivered to the Gascoyne Coast Bioregion over the previous 5 years. The 11/12 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 waters of Pacific origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian Throughflow and Holloway Currents which flow seasonally and interact with Indian Ocean waters. 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, 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 Coast 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 intertidal 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. Nearshore 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 the Dampier Peninsular. 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 and the Kimberley Training Institute 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 Commonwealth Government 'Guidelines for the Ecologically Sustainable Management of Fisheries' under the Environment Protection and Biodiversity Conservation Act 1999. The extent of these areas means that 41% of the entire shelf region of the North Coast Bioregion could be classified as a marine protected area with an IUCN category of IV (as per Dudley, 2008¹; North Coast Ecosystem Management Table 1).

In addition to these habitat related marine protected area closures, the bioregion has a number of other marine protected areas including the Montebello and Barrow Islands and the Rowley Shoals proclaimed under the *Conservation and Land Management Act 1984* (see North Coast Ecosystem Management Figure 2), and closures to fishing under section 43 of the Fish Resources Management Act 1994 at Point Samson and the wreck of the Kunmunya Samson II (Delambre Reef). The proposed Dampier Archipelago marine conservation reserves are still under consideration by Government.

The Department of Fisheries has participated in the marine conservation reserve planning process in this region. This has resulted in the recent establishment of the Lalang-garram Camden Sound Marine Park. 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 region, and the State Government has announced funding of further marine protected areas at Eighty Mile Beach, Roebuck Bay and the Horizontal Falls. The Department continues to work closely with relevant agencies and stakeholders to develop strategies to minimize environmental impacts in the marine environment. This includes participation in the Kimberley Science and Conservation Strategy developed with the Department of Parks and Wildlife (DPAW) and collaboration on relevant WAMSI Kimberley Marine Research Program (KMRP) projects.

The Commonwealth Government's Department of Sustainability, Environment, Water, Population and

Communities (SEWPaC) has also undertaken a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border. The federal minister for the environment has recently announced the final reserve network proposed for the North-West which spans the North Coast and Gascoyne bioregions.

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 Bioregion 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 extent of the impact of this incident on fishery resources and assets may not be known for some time.

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 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 the North Coast Bioregion:

Ecosystem structure and biodiversity;

Captured fish species

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

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.

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.

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 Commonwealth 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 is currently achieved through the Fish

Resources Management Act 1994 and the Biosecurity and Agriculture Management Act 2007.

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 Lalang-garram Camden Sound Marine Park (LGCSMP). This will focus on developing research and monitoring projects that provide information on the key ecological assets within the bioregion and contribute to the key management strategies of the LGCSMP management plan. Further initiatives are being developed as part of the broader Kimberly Science and Conservation strategy.

The Marine Biosecurity Research and Monitoring group have implemented a series of biosecurity related projects during 2012 – 2013. 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 Ports of Dampier and Port Hedland that have informed the Department of the status of IMPs in those Ports. Background monitoring programs are also continuing within Dampier and Port Hedland Ports waters with assistance from the Dampier Port Authority and Port Hedland Port Authority. Further detail may be found in the Introduced Pests Status Report at the end of this chapter. This work complements introduced aquatic organism incursion and fish kill incident response programs already in place in this bioregion.

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the North Coast Bioregion making up State Waters and continental shelf waters where habitats are protected from the physical disturbance of trawl fishing. The areas, 200 m depth which are formally closed to trawling would be equivalent to meet category IV of the IUCN criteria for classification as marine protected areas. The area effectively protected covers those areas of the shelf < 200 m depth where state managed trawling doesn't occur.

Total Area of Shelf	Area of shelf equivalent to IUCN marine protected area category IV (%)	Maximum area of actual trawling activity	Total area of habitat effectively protected (%)
98600 sq nm	40700 sq nm (41%)	10500 sq nm	88100 sq nm (89%)

**NORTH COAST ECOSYSTEM MANAGEMENT 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
Kimberley Nearshore	Estuarine	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.
	Marine	LOW	The current level of removal of all retained species is considered to have only minor impacts on the trophic structure.
Pilbara Nearshore	Estuarine	LOW (non-fishing)	See Kimberley Estuarine above.
	Marine	LOW	The current level of removal of all retained species is considered to have only minor impacts on the trophic structure.
Kimberley Inshore (shelf)	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 minor risk that the ecosystem will be altered measurably. 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.
Pilbara Inshore (shelf)	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 regional-level community structure to an unacceptable level. 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.
Offshore Oceanic Shoals	Marine	LOW (non-fishing)	There is a number of specific oil and gas related offshore developments that are proposed in this region, particularly around Scott Reef. At the overall ecosystem level, however, there is only a minor risk that the ecosystem will be altered measurably.

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Northern Pelagic	Marine	LOW	<p>Aside from shipping traffic, there are few other anthropogenic impacts to this system.</p> <p>A single fishery operates in the pelagic component of the North Coast Bioregion. 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.</p>

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Finfish	Estuarine/ Nearshore	MODERATE	The barramundi and threadfin salmon stocks are considered to be at acceptable levels.
	Inshore (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 in determining 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	Estuarine/ Nearshore	LOW	There is a small amount of fishing for mud crabs and blue swimmer crabs in some estuarine and inshore areas.
	Inshore (shelf)	MODERATE	There are a number of separate prawn stocks and fisheries within this bioregion that each has limited entry, seasonal and area closures. Annual recruitment to these stocks is variable, which combined with the higher costs of operating in this region, has resulted in fishing effort being much lower in recent years.
Molluscs	Nearshore	LOW	The North Coast Trochus Fishery in King Sound is an indigenous fishery targeting the commercially important gastropod shell <i>Tectus niloticus</i> , commonly known as trochus. It is a hand collection fishery open to nominated fishers from the community. No fishing took place in 2012. The pearl oyster fishery only targets a very small section of the pearl oyster stock both spatially and within the available size range. Recent catches have been well below the quota levels due to low market demand but are beginning to increase again.
Echinoderm	Nearshore	LOW	Bêche-de-mer, also known as 'sea cucumbers' or trepang, are commercially harvested echinoderms (sea slugs) processed and sold for medicinal purposes in Asia. The majority of the effort has been expended in the Kimberly region, although there have been several years with substantial effort directed into the Pilbara region.

Protected species

Protected species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Reptiles	LOW	<p>Sea snakes and occasionally turtles are encountered in trawl catches. Both of these species are typically returned to the sea alive. Grids are now compulsory on trawl nets, which has largely eliminated the capture of any turtle or other large animal.</p> <p>Crocodiles are occasionally captured in nearshore/ freshwater fisheries' nets and most often are released alive.</p>
	Mammals	MODERATE	Dolphins are captured by the Pilbara trawl fishery, but dolphin excluder devices have reduced this incidence to acceptable levels, with further refinements in net design currently being trialed.

Protected species	Species	Risk	Status and Current Activities
Protected 'Fish' Species	Sea/Shore Birds	LOW	Anecdotal information from Lake Argyle fishers suggests that interactions with birds are very low. Additionally, the fishery is closed from 1 November to 31 December each year, during a high-use period for protected migratory birds.
	Elasmobranchs	MODERATE	The sawfish (Pristidae), speartooth shark (<i>Glyphis glyphis</i>) or the northern river shark (<i>Glyphis garricki</i>) are captured in small numbers by net fishing and trawlers in some areas of the Kimberley region. The area of these fisheries in which sawfish are vulnerable to capture is small relative to the total range of each species, suggesting limited impacts on each population. However, elasmobranchs grow and reproduce slowly, and even low levels of fishing mortality may be unsustainable.
	Syngnathids and Solenostomids	LOW	Sea horses and pipefish are occasionally captured in trawl nets and fish/crab traps. The areas of each fishery in which syngnathids and solenostomids are vulnerable to capture is small relative to the total distribution of the species, which includes waters inshore of the fishery and fishery closed areas, as well as structured habitats where trawling does not occur.
	Other Fish	LOW	Recent video observations indicate that the potato cod is present in high numbers at discrete locations within the Kimberley region where the NDSF operates. Potato cod (<i>Epinephelus tukula</i>), a totally protected species, rarely enter fish traps due to their large size and girth limiting their capacity to pass through the entrance funnel into fish traps.

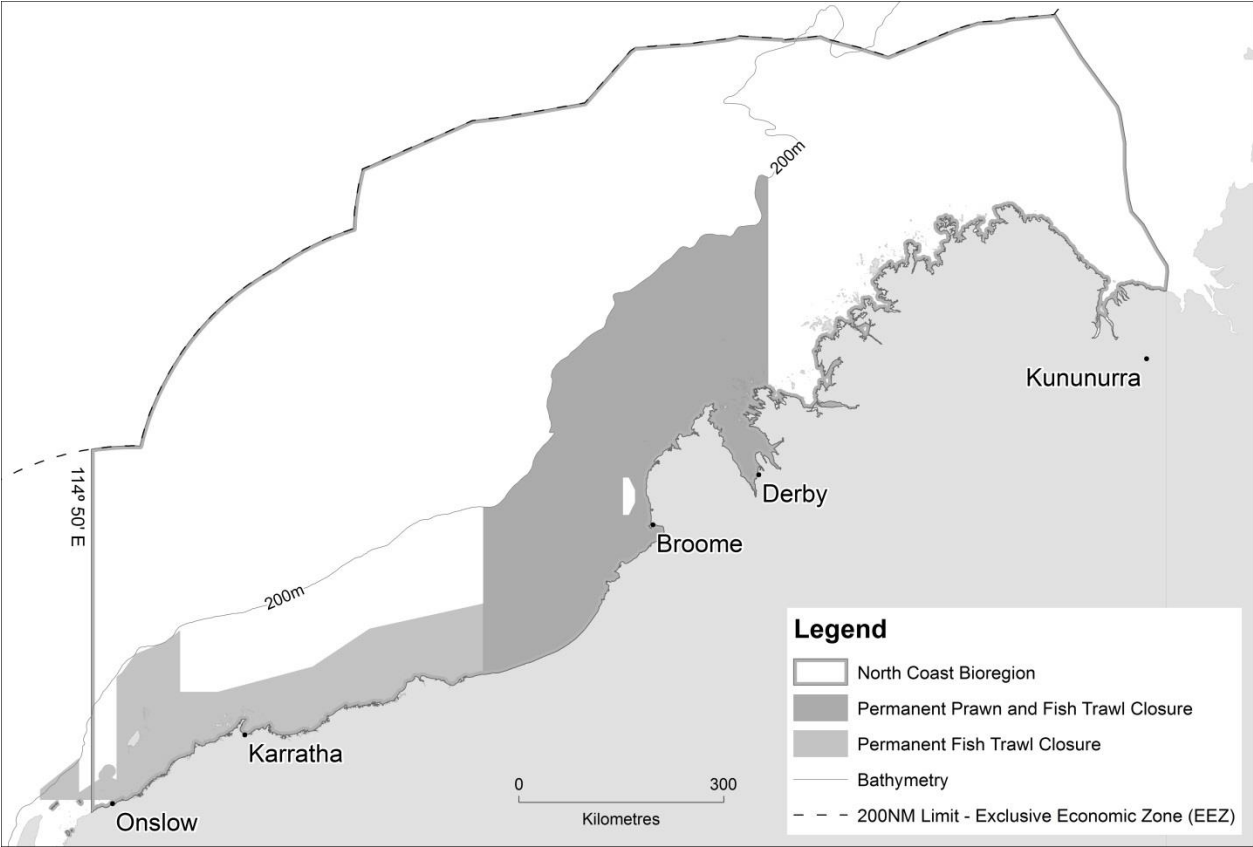
Benthic habitat

Benthic Habitat	Aquatic Zone	Category	Risk	Status and Current Activities
Kimberley Nearshore	Estuarine	Sand/Mud Mangroves	LOW (Non-fishing)	The main risks to nearshore habitats come from oil and gas resource development and the expansion of port facilities, plus periodic cyclones.
	Marine	Sand/Mud Sponge Reef Mangroves	LOW	The main fishing activities within the nearshore environment are hand collection fisheries, which actively avoid damaging benthic habitats in the fishing grounds.
Pilbara Nearshore	Estuarine	Sand/Mud Mangroves	LOW (Non-fishing)	See Kimberley Estuarine above.
	Marine	Sand/Mud Sponge Seagrass Reef	LOW	The majority of fishing activities in the Pilbara take place over mud and sand habitats. Prawn trawl activities are considered to have the highest impact of the methods used within the ecosystem; however, the spatial extent of trawling activities is small, and there are a variety of measures in place to manage any habitat impacts.
Kimberley Inshore (shelf)	Marine	Sand/Mud Sponge Reef	LOW	Except for some small areas where prawn trawlers operate for short periods each year, most of this region is closed to trawling. These activities may be examined in the future as part of the proposed Camden Sound Marine Park monitoring.

Benthic Habitat	Aquatic Zone	Category	Risk	Status and Current Activities
Pilbara Inshore (shelf)	Marine	Sand/Mud Sponge Seagrass Reef	MODERATE (fishing) LOW (non-fishing)	Although fish trawling occurs in these areas, trawl activities are 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. The most likely potential impacts to the habitat in this area are from oil and gas infrastructure development and operation.
Offshore Oceanic Shoals	Marine	Sand/Mud Reef	LOW (non-fishing)	The main threat to benthic habitats in this ecosystem is from oil and gas development at Scott Reef. A small amount of line fishing also occurs around these offshore shoals and reefs and is likely to have a negligible impact on the benthic habitat.

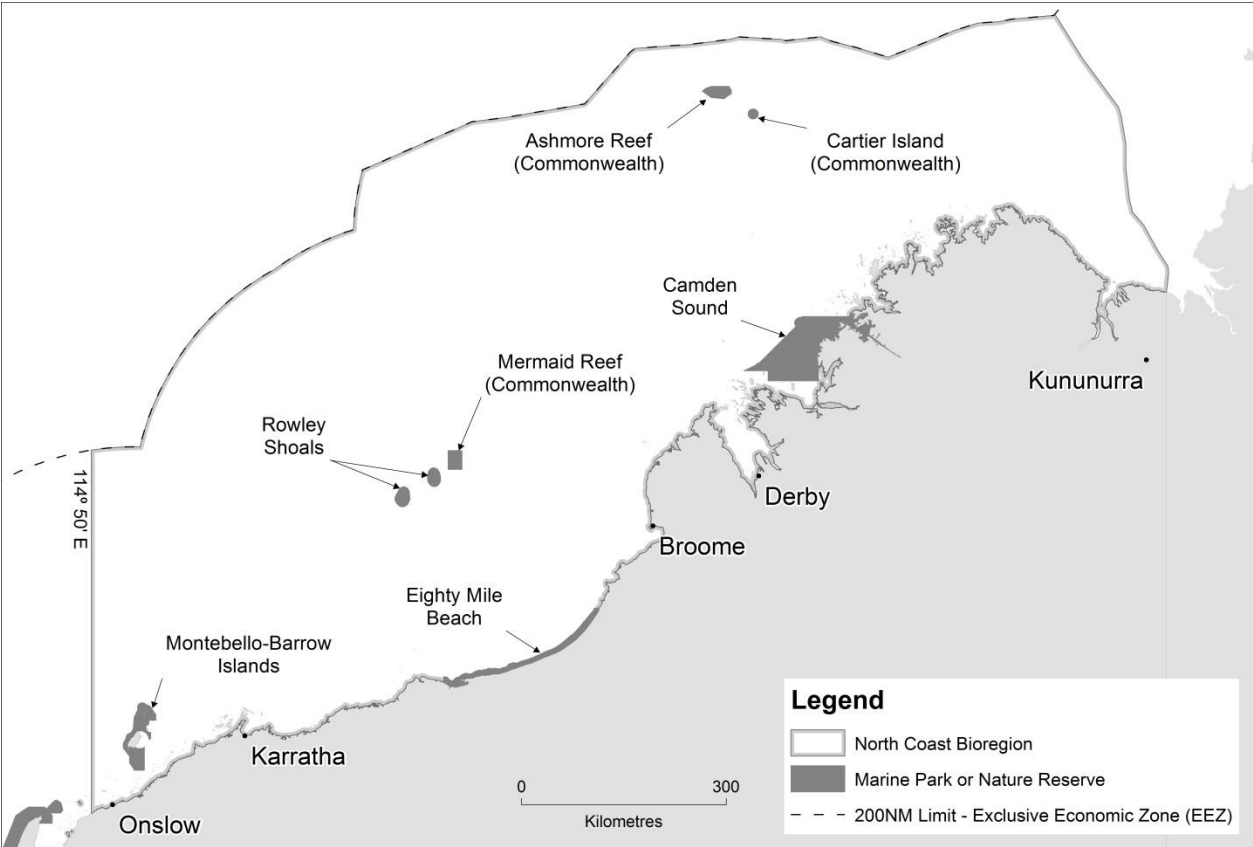
External Drivers (NON FISHING)

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 introduced. The Department has implemented a targeted IMP monitoring and inspection program. For more information please refer to External Factors.
Climate	LOW	This area is predicted to have relatively minor impacts from climate change, especially in the coming decade compared to more southerly locations. A number of research projects to examine potential impacts are planned.
Oil and gas development	LOW	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 low risk that the ecosystem will be altered measurably. Some of the risks identified (e.g. increased turbidity) are being examined under WAMSI 2 projects. In addition, State and Commonwealth marine parks, including totally protected zones, are currently in place (State) or will be in place by 2014.



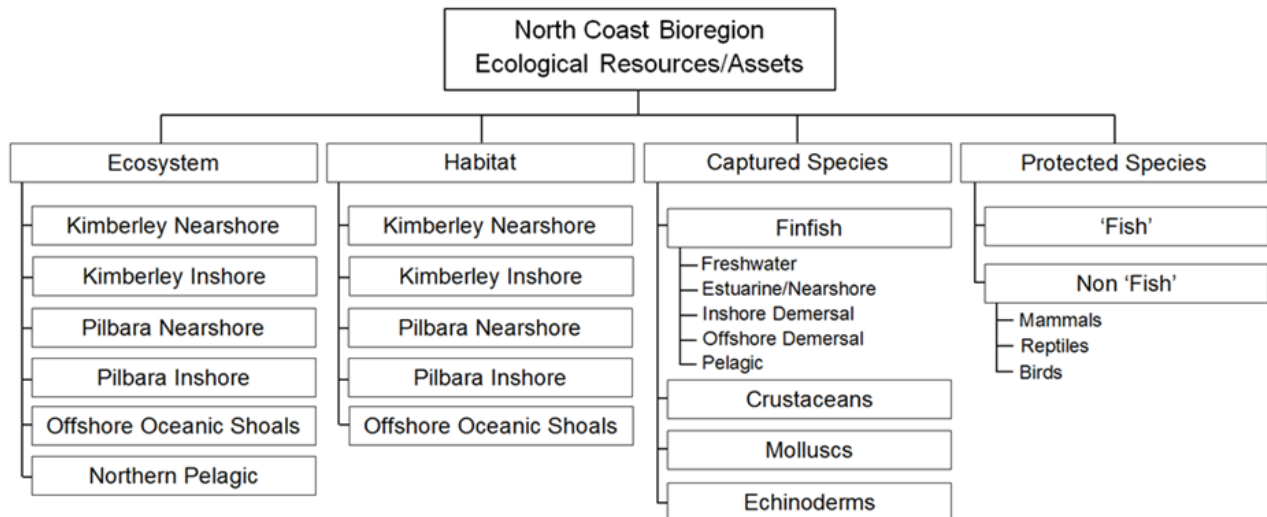
NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

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 areas of protected fish habitat in the North Coast Bioregion.



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 3

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

Introduced Pests Status Report

Regional Monitoring and Research Update

The introduction and spread of marine pests in WA waters poses a serious threat to native biodiversity and can have widespread effects on both our economy and health. To this end the Marine Biosecurity Research and Monitoring group continue to implement a series of biosecurity related projects initially developed in 2010 in two ports in the North Coast Bioregion. The aim is to detect the early presence of introduced marine pests (IMPs) using a suite of tools. Early detection of IMPs is vital if any attempt at eradication or other management strategies is to be successful. Large-scale, nationally approved surveys of Dampier and Port Hedland ports were completed in early 2013. These biennial programs adhered to the Australian Marine Pest Monitoring Guidelines and have been endorsed by the Commonwealth. In recognition of the risks IMPs pose to WA ports the Marine Biosecurity Research and Monitoring group have developed complementary monitoring to occur every alternate year to

National monitoring. These surveys are scheduled for mid 2014. This supplementary monitoring is a smaller more focussed version of the national approach designed to target select high risk sites in each port between the larger surveillance trips.

In addition the Marine Biosecurity Research and Monitoring group, with financial and *in-kind* assistance from Dampier and Port Hedland Port Authorities and stakeholders, is running an Early Warning System program using *in-situ* sampling arrays to aid in the early detection of marine pests in both ports.

Through this combined surveillance the species that have been detected in this region are reported in Introduced Pests Table 1.

INTRODUCED PESTS TABLE 1

Introduced marine species detected in this bioregion.

Common name	Scientific name	Type of organism	IMS/IMP listing
	<i>Theora fragilis</i>	Mollusc	Introduced species
	<i>Didemnum perlucidum</i>	Ascidian	Introduced species – likely pest

FISHERIES

North Coast Prawn Managed Fisheries Status Report

E. Sporer, M. Kangas, M. Shanks and N. Blay

Main Features

Status		Current Landings	
Stock level	Adequate	Onslow:	nil
		Nickol Bay:	129 t
Fishing level	Acceptable	Broome:	12 t
		Kimberley:	329 t

Fishery Description

There four prawn fisheries that operate in the North Coast Bioregion include the Onslow (OPMF), Nickol Bay (NBPMF), Broome (BPMF) and Kimberley (KPMF) Prawn Managed Fisheries. These are all otter trawl fisheries and extend from the north eastern boundary of the Exmouth Gulf Prawn Fishery to 126° 58' east longitude (Cape Londonderry – boundary of the Northern Prawn Fishery).

The OPMF and NBPMF operate along the western part of the North-West Shelf. The OPMF targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) whereas the NBPMF primarily targets banana prawns (*Penaeus merguensis*).

The 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 KPMF operates off the north of the state between Koolan Island and Cape Londonderry. It predominantly targets banana prawns (*Penaeus merguensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*).

Governing legislation/fishing authority

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Broome Prawn Managed Fishery Management Plan 1999

Broome Prawn Managed Fishery Licence

Kimberley Prawn Fishery Management Plan 1993

Kimberley Prawn Managed Fishery Licence

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

Consultation process

The Department undertakes consultation directly with licensees on operational issues. Industry Annual Management

Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), which is also responsible for statutory management plan consultation under a Service Level Agreement with the Department. For statutory management plan processes, the Director General consults with licensees.

Boundaries

The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114°39.9' on the landward side of the 200 m depth isobath'. The fishery is divided into three parts with associated size management fish grounds (SMFGs) and nursery areas 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'. The NBPMF incorporates the Nickol Bay, Extended Nickol Bay, Depuch and De Grey SMFGs. (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). The KPF has four inshore closures and two SMFGs in place (Northern Prawn Figure 4).

Management arrangements

Management of all the north coast prawn fisheries is based on input controls including limited entry, seasonal and area closures, and gear controls including bycatch reduction

devices. Fish Escape Devices are mandatory in all trawl nets. 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 10.98 metres (6 fathoms). These boats operate under an exemption to fish with larger size nets. In Areas 2 and 3 a maximum headrope length of 29.27 metres (16 fathoms) 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. Additionally, the fishery is exempt from the 375 boat unit rule.

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 (11MFLs, that are also Exmouth Gulf Prawn MFLs)
Class D	Area 3 (12 MFLs that are also Nickol Bay prawn MFLs)

The 2012 season officially opened on 13 April and closed on 12 October with subsidiary openings and closings of SMFG's. The specific SMFG openings were as follows:

Areas 1, 2, 3	13 April – 12 October
Fortescue SMFG	29 May – 30 September
Ashburton SMFG	13 May – 11 July
Weld Island SFMG	13 May– 31 August
Mangrove Island SFMG	13 May –12th October

NBPMF: The management arrangements in the NBPMF provide for authorised boats to tow any combination of standard otter trawl nets provided that the total headrope length does not exceed 29.27 metres (16 fathoms). Each licence has an equal allocation of headrope length and the maximum total headrope length for the entire fleet is 409.78 metres (224 fathoms). The 2012 season opened on 15 March and closed on 22 October with subsidiary openings and closings of SMFG's. The specific SMFG openings were as follows:

Nickol Bay	29 May – 30 September
(Day fishing only 29 May – 18 June)	
Extended Nickol Bay SMFG	29 May –22 October
Depuch SMFG	29 May – 30 September
De Grey SMFG	29 May – 30 September

BPMF: The BPMF management arrangements provide for the use of standard otter trawl nets not exceeding 73.16 metres (40 fathoms) in either twin or quad gear configuration. Each licence has an equal allocation and the maximum total headrope length for the entire fleet is 365.8 metres (200 fathoms).

The Fishery opened on 25 May and officially closed on 25 October, providing for 153 fishing nights. Two boats fished in the BPMF fishery this season for a limited time then left the fishery. Given the current economic conditions and high cost of fishing, other operators did not send boats to the Broome fishery to undertake commercial fishing in 2012.

KPMF: The KPMF Management Plan permits the use of two otter trawl nets where the total headrope length does not exceed 58.5metres (32 fathoms).

There are 124 boats licenced to fish in the KPMF, 45 of these also held an NPF licence.

Seasonal dates for the KPMF are generally aligned with those of the adjacent NPF. This strategy aims to prevent large shifts of fishing effort into the KPMF. There are permanent inshore closures and a total allowable effort cap system is in place that restricts the number of fishing days to a total of 1500 days, with 600 and 900 boat days allocated to the first and second part of the season respectively.

The 2012 season opened on 1 April with a mid-season closure commencing on 27 May. The fishery re-opened on 1 August, with a final season closure on 30 November.

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 Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) 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.

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.

In the OPMF a field-based consultative process is normally undertaken whereby industry and the Department's Research Division decide on the extent of an area to be fished within the areas that are officially opened, and to limit the fishing of small size prawns. For 2012 no commercial fishing was undertaken because of resource ventures in the region. The installation of the pipeline into the hinterland from platforms at sea and the construction of wharf facilities increased uncertainty of fishing viability in Area 1 the most productive area in this fishery. Area 3 was fished by one boat from the NBPMF, which has access to that part of the Onslow fishery.

For the NBPMF and KPMF rainfall records are also used to update the rainfall-catch relationship for banana prawns. For the BPMF a depletion analysis is undertaken when sufficient fishing activity occurs which assists in the assessment of the

king prawn stocks within the permitted fishing area. Insufficient effort has occurred in this fishery since 2008 precluding the use of this analysis.

Retained Species

Commercial production (season 2012):

Onslow:	Nil tonnes
Nickol Bay:	129 tonnes
Broome:	12 tonnes
Kimberley:	329 tonnes

Landings

OPMF: No commercial trawling occurred by the dedicated Onslow licenced fishing boats therefore, no landings of major penaeids or byproduct for the 2012 season were recorded (Northern Prawn Figure 5).

NBPMF: The total recorded landings of major penaeids for the 2012 season were 129.4t, comprising: 129 t of banana prawns (124 t from the Nickol Bay fishery, and 5 t from Onslow, Area 3), and no recorded landings of king and endeavour prawns and a very low amount of tiger prawns (approximately 10kgs) (Table 1). The recorded landings of banana prawns in 2012 from Nickol Bay (124 t) was lower than the predicted catch of 165 t and slightly below the predicted catch range (130 to 200 t). (Northern Prawn Figure 6).

BPMF: Recorded landings for target species were very low at 12 t for king prawns and 4 t of coral prawns. No byproduct species was recorded in 2012 (Northern Prawn Figure 7).

KPMF: The total recorded landings in the KPMF were 329 t, comprising 323 t of banana prawns, 4 t of tiger prawns and 2 t of endeavour prawns (Northern Prawn Figure 8). Banana prawn landings were the highest since 2004 and within their target catch range (200-450 t) and slightly above the projected catch range (210 to 315 t) calculated using the relationship between summer rainfall and annual landings. Both tiger and endeavour prawns were below their target catch ranges. Fishing occurred in both fishing periods for 2012 but effort was still low, possibly reducing total catches for these species. Negligible quantities of byproduct were reported.

Recreational component: Nil

Fishing effort/access level

OPMF: No boats fished in 2012

NBPMF: Six boats fished during the 2012 season for an aggregated total of 186 boat days. This is a relatively low total effort and within the expected effort levels reflecting the moderate banana prawn abundance this season.

BPMF: A total of twenty nine nights of fishing effort was expended by two boats in 2012.

KPMF: Fifteen boats fished during 2012 for an aggregated total of 362 boat days. This is an increase compared to the 200 boat days fished in the 2011 season reflecting the economic conditions and targeting banana prawns at high

catch rates. Boats left the fishery when banana prawn catch rates declined hence the low catches of other prawn species. The total days was well below the 1500 aggregated days allocated to fish and similar to 2008 to 2011.

Stock Assessment

Assessment complete: Yes

Assessment level and method: Level 1 - Catch (Rainfall-catch relationship for NBPMF and KPMF for banana prawns, depletion analysis for BPMF - when appropriate)

Breeding stock levels: Adequate

Projected catch next season (2013):

NBPMF: 150 t banana prawns

KPMF: 290 t banana prawns

For the prawn stocks in the North coast region 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 recent series of low annual landings of prawns is still a feature in many of these northern fisheries and are in part due to low effort caused by the current economic conditions including, high fuel and equipment prices and low market prices and variable market conditions. Catches of banana prawns are highly variable and related to the amount of rainfall recorded in the region with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment.

OPMF: No commercial fishing was undertaken in 2012, this was due to disturbance to the main fishing grounds in Area 1. This included construction of facilities on the hinterland for the delivery of gas via a pipeline from the offshore gas platforms, wharf construction and general boat movement in the area making fishing operations difficult. Since there was no effort or catch of tiger prawns in this part of the fishery adequate breeding stock would remain. This also applies for the king prawn stock. The dredging for the wharf facility and inshore disturbance for the construction of the pipeline facility is likely to cause short term loss of some nursery habitat and may change the hydrology for prawn movement in the immediate area. This disturbance may cause some loss of seagrass/algal habitats and may impact juvenile tiger prawns in the short term.

NBPMF: The landing of banana prawns 124 t overall (129 t overall) in 2012 was below the target catch range and slightly below the predicted catch range. All other species, tiger, king and endeavour prawn landings were well below the target range.

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 2012 and March 2013 (at Roebourne) was 234 mm and the predicted catch for 2013 is around 150 t with a range of 120 –180 t of banana prawns.

BPMF: The very low fishing effort that occurred was reflected in the low king prawn landings of 12 t. While no stock assessment was completed in 2012, the king prawn catch rates of 44 kg/hr were the highest seen since 1998, but reflect the very low catch and effort levels. Because of the low effort only part of the fishery was exploited to its potential total catch. Since the king prawn catch rates have returned to historical levels, there has been interest from Licensees to consider fishing in this fishery in 2013.

KPMF: Banana prawns were within the target catch range (200 to 450 t) and the highest since 2004 despite the relatively low level of effort. However both tiger and endeavour prawns were very low and below their target ranges which is likely to be effort related.

The relationship between the early season rainfall and catches of banana prawns (the dominant species taken in this area) is based on the rainfall in Kalumburu and Derby in January and February (451 mm). The good 2012 catch was expected given the high level of rainfall. This may be in part due to the slightly increased level of fishing effort due to the increased number of boats operating overall compared to the last three years. The predicted catch of banana prawns in 2013 is 290 t, with a range of 230 to 350 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 2012 the breeding stock indicators in the OPMF (catches within specified ranges, as set out in the 'Fishery Governance' section) were not able to be measured because no fishing effort was applied or catch taken in this fishery.

The breeding stock indicator for banana prawns in the NBPMF was met and the landings were within the target catch range. Banana prawns were slightly below the projected range. There were no recorded king or endeavour prawn landings, therefore, they were below the target ranges. The tiger prawns landings were negligible and below the target range. This is likely to be a result of limited targeting of these species.

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 as the landings were within the target range but slightly above the upper end of the projected range. Tiger and endeavour prawns were below the target range. This may be due to low levels of effort expended on these species as their behavior is quite different to that of the aggregating behavior of the banana prawns and generally are taken in the latter part of the season thus more effort or time on the fish grounds is required.

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: **Nil**
NBPMF, BPMF, KPMF: **Negligible**

The northern prawn fisheries have previously caught the occasional turtle and sea snakes 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.

OPMF: Nil

NBMF: Three sea snakes were reported as caught and released alive and no turtle captures were recorded.

BPMF: Three turtles were reported as captured but their status was not reported. Thirty sea snakes were reported of which 19 were released alive, 5 were dead and 6 reported as unknown status.

KPMF: One green turtle was reported as captured and the status was unknown. Thirty five sea snakes were reported as captured and 27 were returned to the sea alive whilst 1 was reported as dead and 7 status unknown. Four Saw fish were reported as captured, all with unknown return status.

Ecosystem Effects

Food chain effects: **Low**

For all the northern prawn fisheries and in particular the OPMF with no fishing 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:

OPMF, BPMF: **Negligible**
NBPMF, KPMF: **Low**

In 2012 the area fished in the three northern fisheries where fishing took place was less than 1-3% of the overall fishery (Northern Prawn Figures 1-4). The fisheries are generally restricted to clean sand and mud bottoms, where trawling has minimal long-term physical impact. Because there was no fishing in the OPMF the habitat effects was changed from low to negligible.

Social Effects

Estimated employment in these fisheries for 2012 was 45 to 65 including skippers and other crew with additional people involved in local processing.

Economic Effects

Estimated annual value (to fishers) for 2012:

OPMF/NBPF/BPMF:

Level 2 - \$1 - 5 million (\$1.5 million)

KPMF: Level 2 - \$1 - 5 million (\$3.1 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

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.

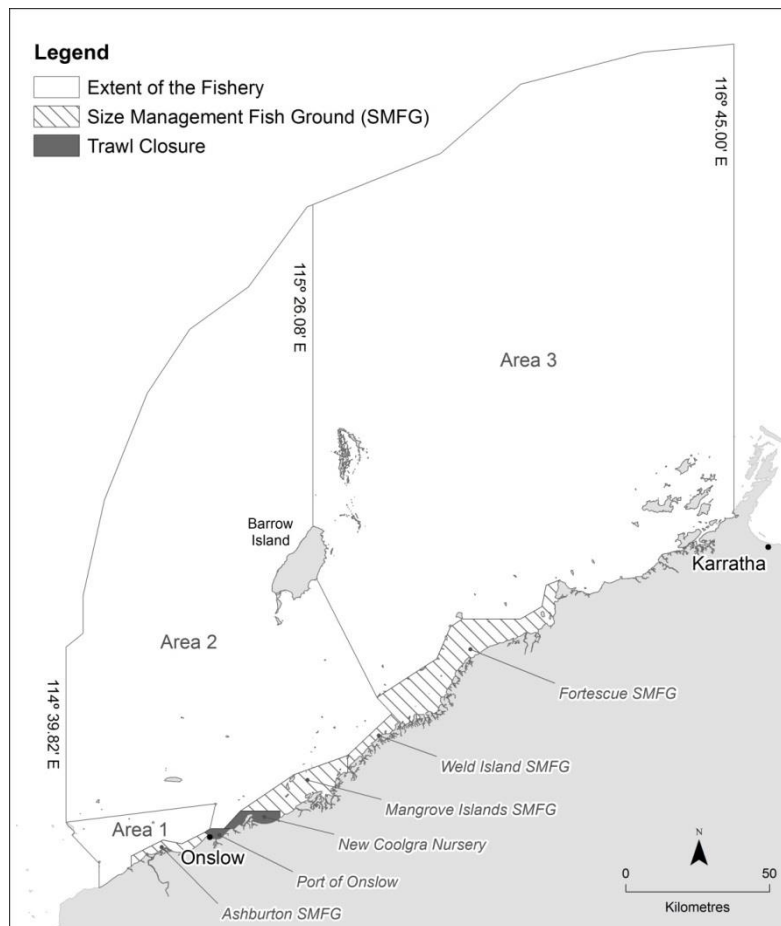
New management initiatives (2013): None

External Factors

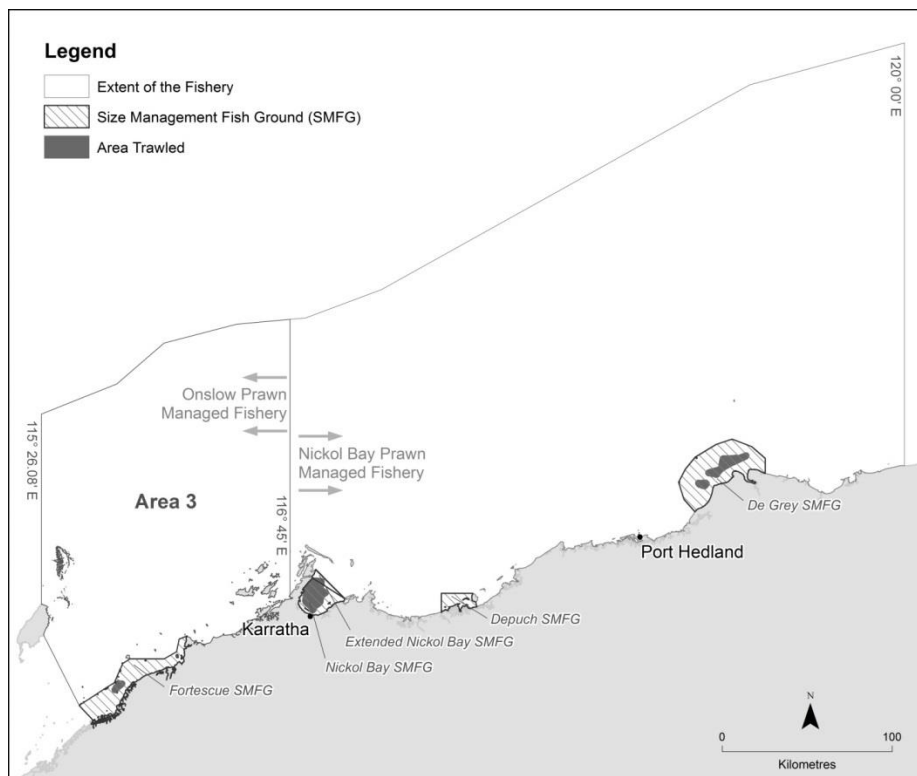
The resource industry developments in the OPMF during 2012 have created uncertainty about the access to prawn abundance in traditionally high catching fish grounds and overall viability of operations therefore no fishing took place in 2012.

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. There is also competition for boat crew with the oil and gas resource sector.

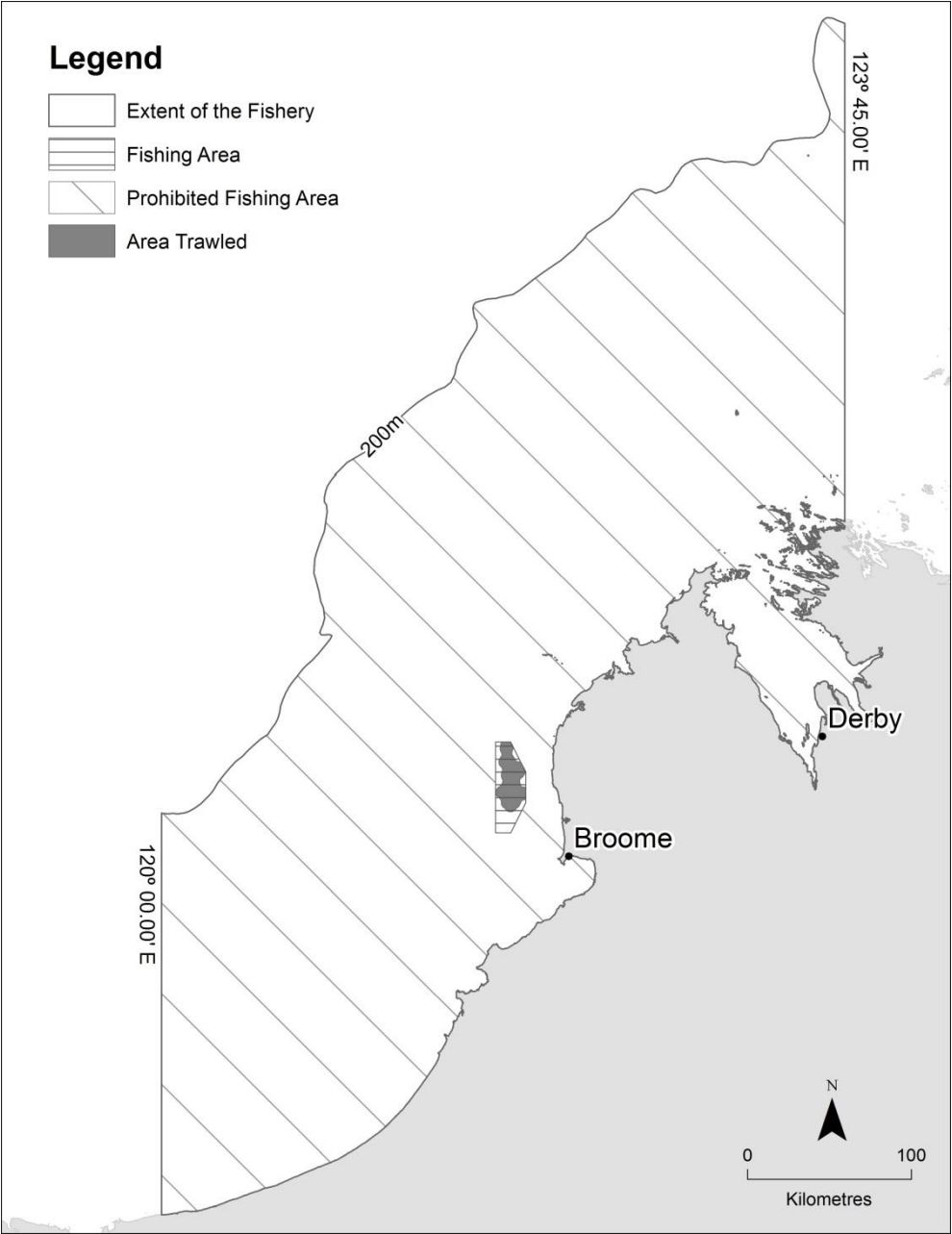
In the BPMF one factor influencing catches is the timing of the season which is set by the mid-season closure for the Northern Prawn Fishery, and, since the permitted fishing area is small, in some years the timing of prawn recruitment and the prawn migration patterns may not result in significant abundances in the permitted fishing area. The success of this fishery also depends on how the limited fishing season coincides with the king prawn recruitment and catchability, which is strongly influenced by the lunar period.

**NORTHERN PRAWN FIGURE 1**

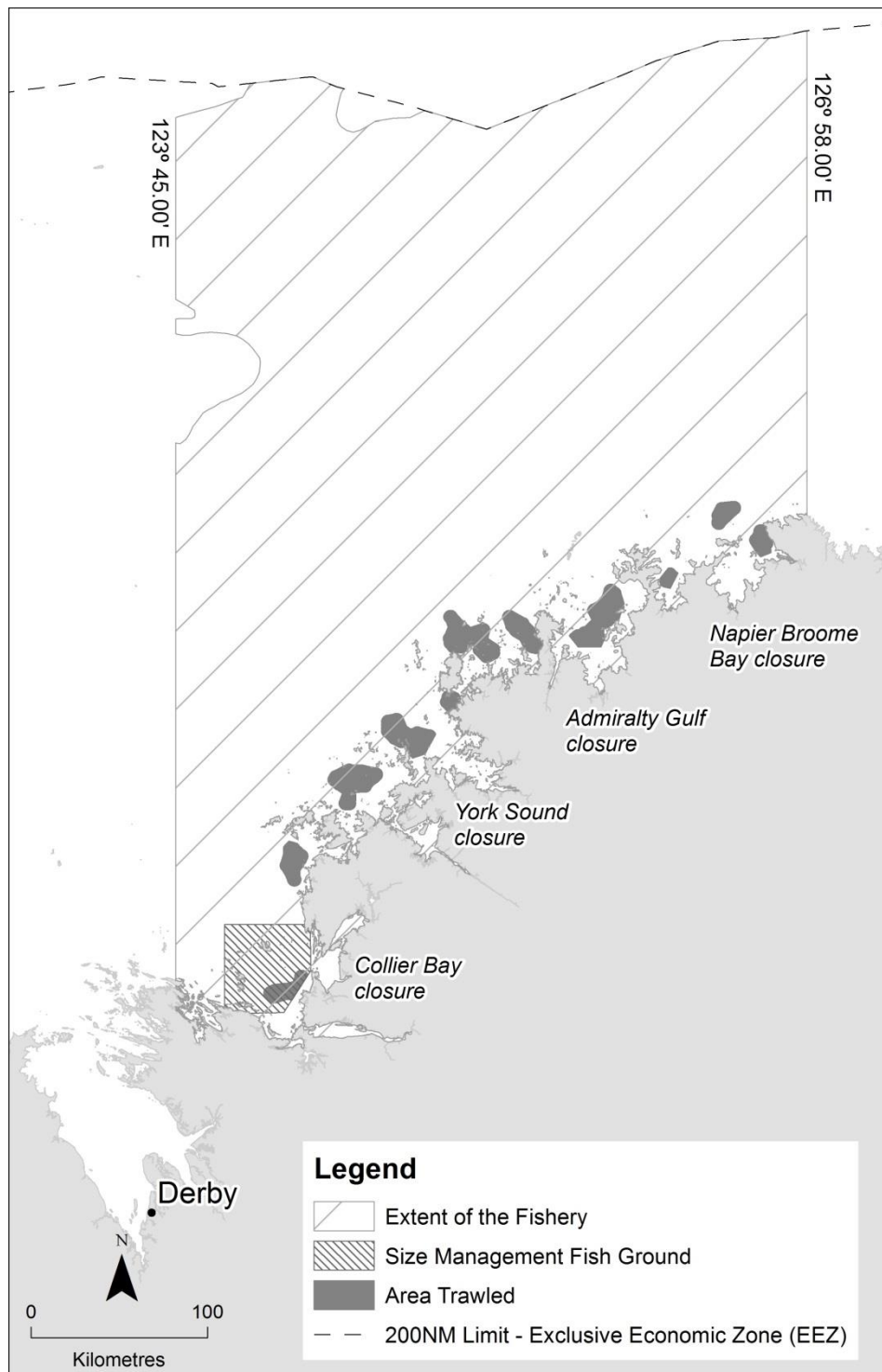
Boundaries of the Onslow Prawn Managed Fishery indicating trawl closures and size management fish grounds. No fishing took place in 2012.

**NORTHERN PRAWN FIGURE 2**

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2012.

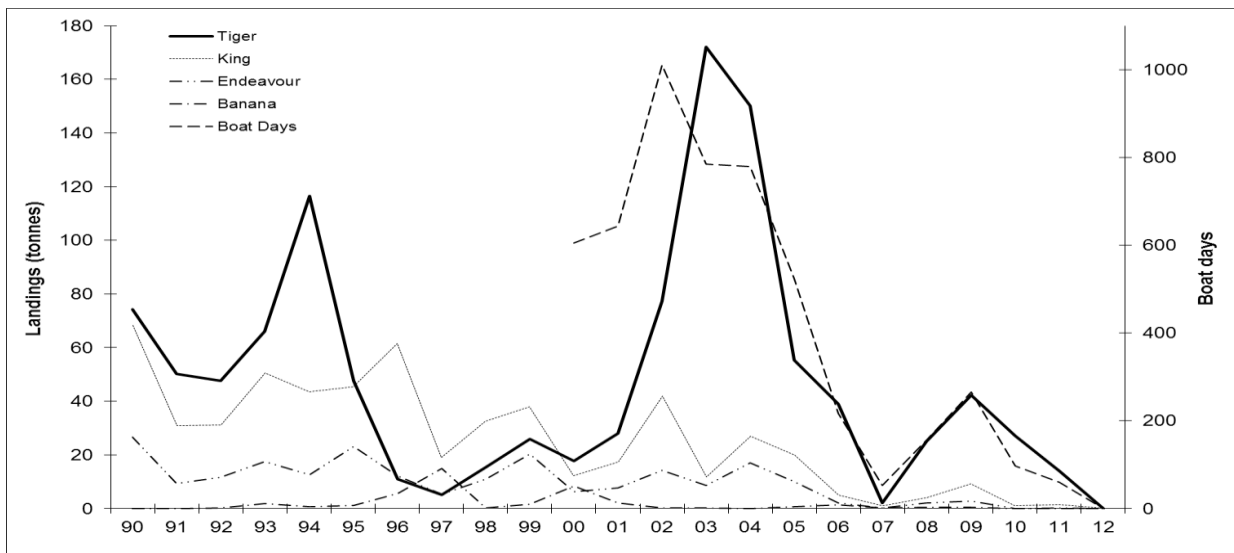


NORTHERN PRAWN FIGURE 3
Boundaries of the Broome Prawn Managed Fishery indicating area trawled in 2012.



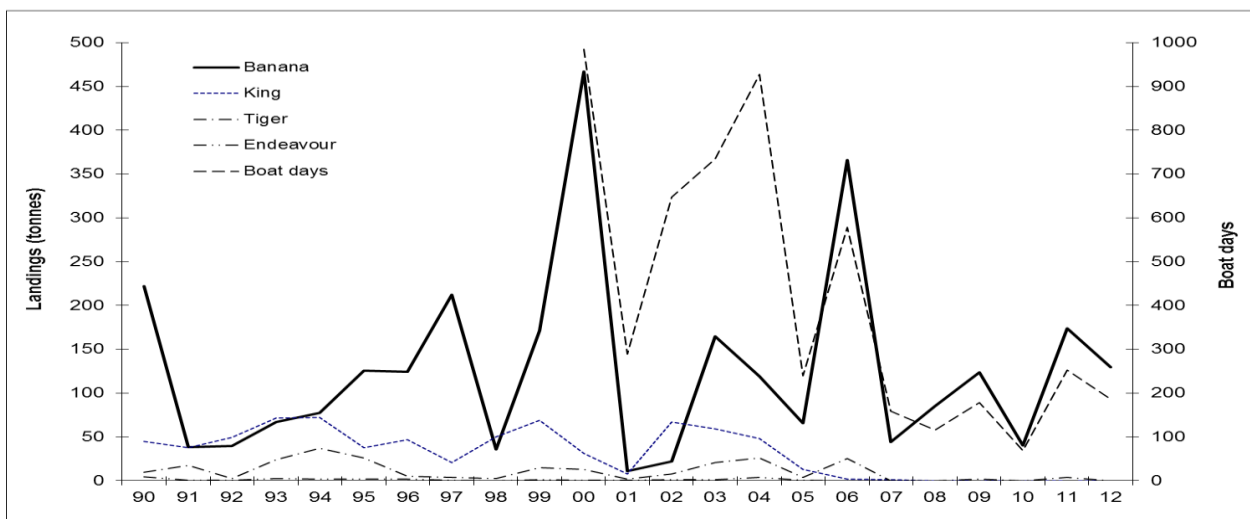
NORTHERN PRAWN FIGURE 4

Areas fished in the Kimberley Prawn Managed Fishery in 2012, Size Management Fish Grounds and the inshore trawl closures.



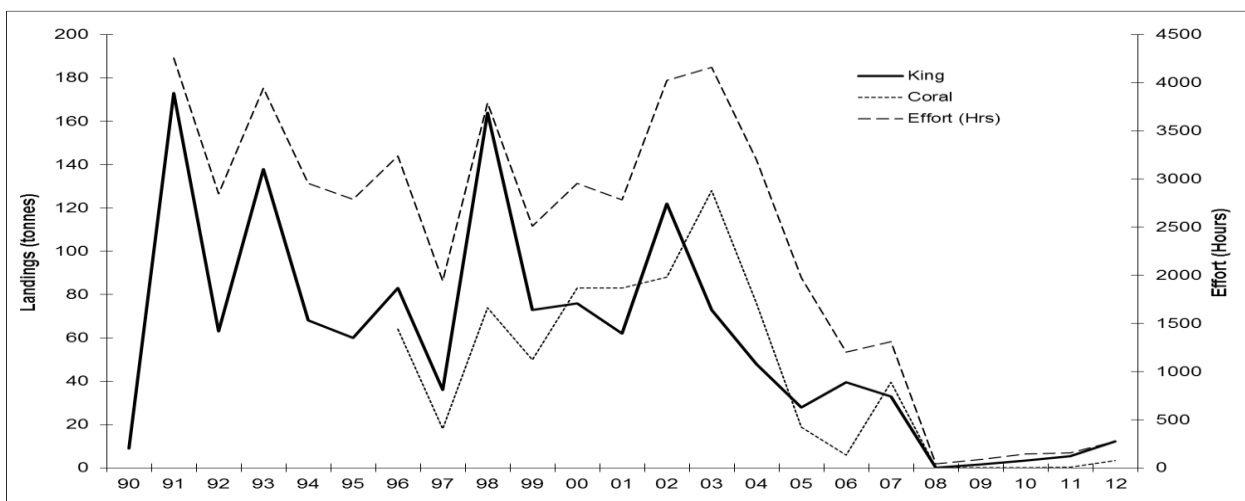
NORTHERN PRAWN FIGURE 5

Annual landings and number of boat days (from 2000) for the Onslow Prawn Managed Fishery, 1990 – 2012.



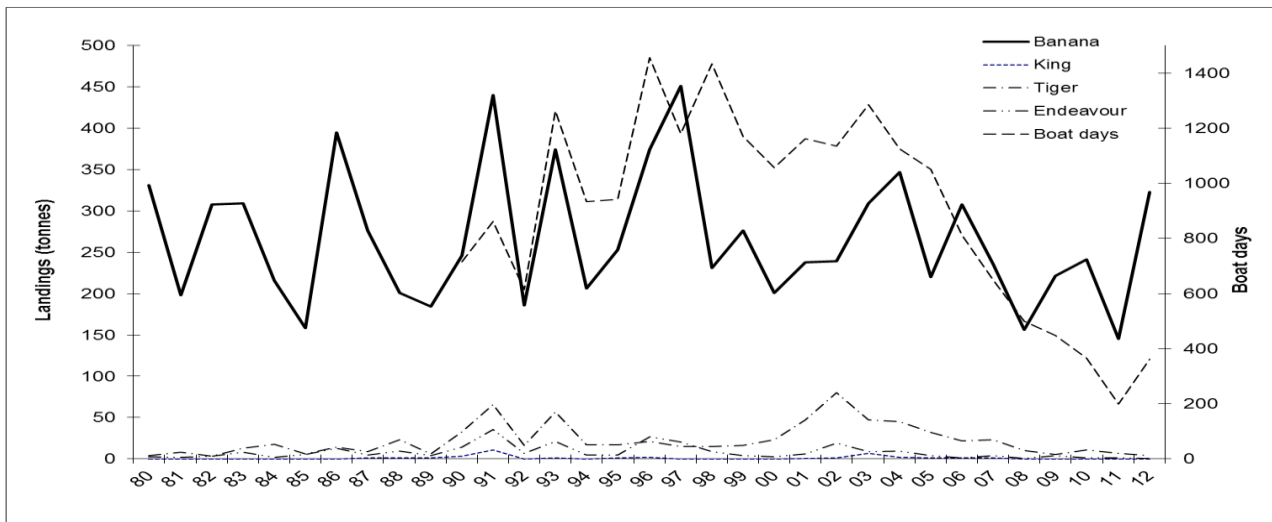
NORTHERN PRAWN FIGURE 6

Annual landings and boat days (from 2000) for the Nickol Bay Prawn Managed Fishery, 1990 – 2012.



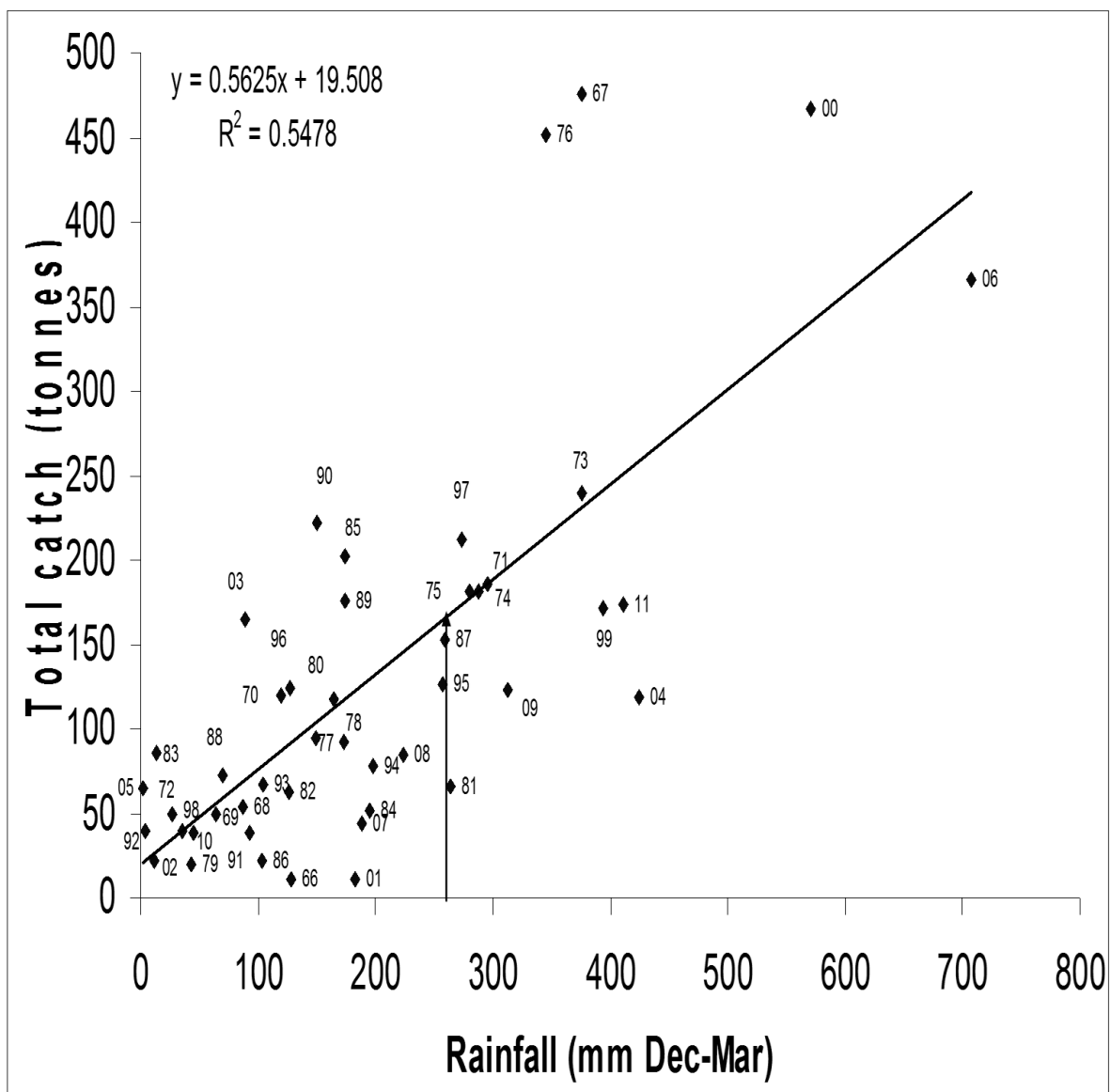
NORTHERN PRAWN FIGURE 7

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990 – 2012.



NORTHERN PRAWN FIGURE 8

Annual landings and number of boat days (from 1990) for the Kimberley Prawn Managed Fishery, 1980 – 2012.



NORTHERN PRAWN FIGURE 9

Relationship between banana prawn landings in Nickol Bay and rainfall between December and March for 1966 – 2011 with rainfall level for 2012 indicated.

North Coast Nearshore and Estuarine Fishery Status Report

S.J. Newman, C. Skepper, G. Mitsopoulos, A. Thomson, R. Marriott and P. Carter

Main Features			
Status		Current Landings	
Stock levels	Acceptable	Total	91.0 t
		Barramundi	39.7 t
Fishing Levels	Acceptable	Threadfin	46.2 t
		Recreational	20% of total (last estimate 2012)
		Charter	< 7 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 (129°E) to the top end of Eighty Mile Beach, south of Broome (19°S). It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi (*Lates calcarifer*) by any means.

The other species taken by the fishery are predominantly king threadfin (*Polydactylus macrochir*) and blue threadfin (*Eleutheronema tetradactylum*). The main areas of operation for the fishery are the river systems and tidal creek systems of the Cambridge Gulf, the Ria coast of the northern Kimberley, King Sound, Roebuck Bay and the northern end of Eighty Mile Beach to 19°S (Kimberley Gillnet Figure 1).

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 other subsidiary legislation.

Consultation processes

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are now convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

Boundaries

Commercial

The waters of the KGBF are defined as 'all Western Australian waters north of 19° south latitude and west of 129° east longitude and within three nautical miles of the high water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47' south latitude' (Kimberley Gillnet Figure 1).

Recreational

The North Coast Bioregion, which encompasses the Pilbara and Kimberley regions, extends from the Ashburton River south of Onslow to the WA/NT border (all land and water north of 21°46'S latitude and east of 114°50'E longitude).

Management arrangements

Commercial

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures and gear restrictions. Access to the KGBF is limited to seven licences.

There is a closed season in which fishing is prohibited in the KGBF. In the southern KGBF (west of Cunningham Point, 123°08.23' E longitude) the closure extends from 1 December to 31 January the following year, while in the northern section of the KGBF (east of Cunningham Point) the closure extends from 1 November to 31 January the following year (see Kimberley Gillnet Figure 1). 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 and the Broome coast (Roebuck Bay).

There are 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 and all its creeks and tributaries south of 17°27' S, Whistle Creek and Admiral Bay, and the lower Ord River upstream of Adolphus Island.

Recreational

Fish species in the North Coast Bioregion are assigned bag and size limits according to their aquatic environment (ecological suite) and risk to sustainability 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) to ensure that breeding stock levels are maintained. These bag and size limits have been revised and new simpler rules that apply across most bioregions will be effective in 2013. These new rules include the following: barramundi (individual daily bag limit and possession limit of 2 fish, minimum legal length (MLL) of 550 mm and a maximum size limit of 800 mm); black jewfish (individual daily bag limit of 2 fish, MLL 700 mm); king threadfin (individual daily bag limit of 2 fish, MLL 450 mm); other threadfin species (individual daily bag limit of 4 fish) and tripletail (individual daily bag limit of 2 fish, MLL 300 mm).

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 fisheries' management officers.

The biological characteristics required for fisheries management for both the threadfin species have been completed (Pember *et al.* 2005)¹. 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 previous Pilbara Coast fishing area was examined during 2002 and 2003 (McAuley *et al.* 2005)². The stock structure of both threadfin species was defined by

Welch *et al.* (2010)³ and will be considered in future monitoring and assessment programs. Estimates of recreational boat and shore based catches were assessed in 1999/2000 (Williamson *et al.* 2006)⁴ and an integrated survey of boat-based recreational fishing in WA was conducted during 2011/12 (Ryan *et al.* 2013)⁵.

Retained Species

Commercial landings (season 2012):

All species	91.0 tonnes
Barramundi	39.7 tonnes
Threadfin	46.2 tonnes

The principal species landed are barramundi and two species of threadfin (king threadfin and blue threadfin). 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 (Family Carcharhinidae), including pigeye sharks (*Carcharhinus amboinensis*), blacktip whalers (mainly *C. tilstoni*) and various species of rays. Sawfish (Family Pristidae) are totally protected under the *Fish Resources Management Regulations 1995* and may not be retained by this fishery, and are released alive wherever possible.

The total reported catch of all species in the KGBF in 2012 was 91t (Kimberley Gillnet Figure 2). The total landings of barramundi from the KGBF were 39.7 t for 2012 (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 3), an increase on the reported catch of 28.5 t in 2011. The 2012 landings of threadfin from the KGBF were 46.2 t (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 4), lower than that reported in 2011 (74.2 t) and represent the lowest catch level reported from the fishery over the last decade (Kimberley Gillnet Table 1). The composition of the KGBF catch in 2012 is summarised in Kimberley Gillnet Table 2.

1 Pember, M.B., Newman, S.J., Hesp, S.A., Young, G.C., Skepper, C.L., Hall, N.G. and Potter, I.C. (2005). Biological parameters for managing the fisheries for Blue and King Threadfins, Estuary Rockcod, Malabar Grouper and Mangrove Jack in north-western Australia. Final Report to the Fisheries Research and Development Corporation (FRDC) on Project No. 2002/003. Centre for Fish and Fisheries Research, Murdoch University, Murdoch, Western Australia, Australia. 172 pp.

2 McAuley, R., Lenanton, R., Chidlow, J., Allison, R. and Heist, E. (2005). Biology and stock assessment of the thickskin (sandbar) shark, *Carcharhinus plumbeus*, in Western Australia and further refinement of the dusky shark, *Carcharhinus obscurus*, stock assessment, Final FRDC Report – Project 2000/134, Fisheries Research Report No. 151, Department of Fisheries, Western Australia. 132 pp.

3 Welch, D.J., Ballagh, A.C., Newman, S.J., Lester, R.J.G., Moore, B.R., van Herwerden, L., Horne, J.B., Allsop, Q., Saunders, T., Stapley J.M. and Gribble, N.A. (2010). Defining the stock structure of northern Australia's threadfin salmon species. Final Report to the Fisheries Research and Development Corporation, Project 2007/032. *Fishing and Fisheries Research Centre Technical Report No. 10*, Fishing & Fisheries Research Centre, James Cook University, Townsville, Australia. 180 pp.

4 Williamson, P.C., Sumner, N.R. and Malseed, B.E. (2006). A 12-month survey of recreational fishing in the Pilbara region of Western Australia during 1999-2000, Fisheries Research Report No. 153, Department of Fisheries, Western Australia, 61 pp.

5 Ryan K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. and Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia 162 pp.

Recreational catch estimate (last estimate**2011/12): 20% of total catch**

The recreational catches from boat-based fishers in 2011/12 were estimated to be approximately 8.4 t of barramundi and approximately 7.0 t of threadfin.

The estimate that the recreational catch in 2011/12 was 20% of the total catch is not directly comparable to the 1999/2000 survey results (Williamson *et al.* 2006).

Estimates of the recreational catch by boat-based fishers for barramundi will be underestimated as shore-based fishers and boat-based fishers that fished only in freshwater were out of scope of the 2011/12 survey.

The reported charter vessel catches for the North Coast Bioregion in 2012 were estimated to be approximately 4.8 t of barramundi and approximately 1.4 t of threadfin.

As such, there is an estimated annual harvest of 13.2 t of barramundi (recreational + charter) reported in the North Coast Bioregion. In addition, there is an estimated annual harvest of 8.4 t of all threadfin (recreational + charter) reported in the North Coast Bioregion.

Even though these data underestimate the recreational catch, the recreational catch (i.e. recreational + charter) can be estimated at around 20% of the total (commercial and recreational) barramundi and threadfin catch in these areas in 2012. Separately, the recreational catch of barramundi can be estimated at around 25% of the total (commercial and recreational) catch in these areas in 2012; whereas the recreational catch of threadfin can be estimated at around 15% of the total (commercial and recreational) catch in these areas in 2012.

Fishing effort/access level**Commercial**

The effort reported in the fishery this year is kg per block day. The effort used in the fishery is currently being reviewed. Fishing practices vary across the industry and are not uniform. For example, some fishers actively fish there nets for a few hours while others leave there nets in the water for up to 24 hours. Furthermore, reporting practices are inconsistent across time. It is anticipated that effective effort in the fishery, once validated, will reflect the total length of net set and the time that net is set in the water. During 2012, the total effort across the fishery was 511 block days, a decrease on the 2011 effort figure of 598 block days and considerably below the effort reported from 2008 to 2010 (a range of 800-935 block days). This decrease in effort is linked to one vessel not operating in 2012, thus reducing the overall effort in the fishery and in particular the effort expended in Roebuck Bay. There is considerable latent effort in the KGBF.

Recreational

A summary of the key findings of the integrated survey of boat-based recreational fishing in regards to Barramundi, Blue and King threadfin by Ryan *et al.* (2013) are provided below.

- Recreational catches of Barramundi by RFBL holders aged five years or older occurred in the North Coast Bioregion. The majority of the boat-based recreational catch of barramundi was released or discarded (72%).

The majority of the catch was taken in estuary habitats (64%), but also in freshwater (21%) and nearshore areas (16%). Barramundi were harvested throughout the year, with higher catches observed in winter (38%), spring (29%) and autumn (20%). All the barramundi catch was taken by line-fishing.

- All recreational catches of Blue and King threadfin by RFBL holders aged five years or older occurred in the North Coast Bioregion. Similar proportions of the boat-based recreational catch of Blue threadfin were retained (54%) and released (46%). Catches were taken predominantly from nearshore habitat (86%), but also estuarine habitats (14%). Blue threadfin were harvested throughout the year, with higher catches observed in winter (71%) compared with spring (6%), summer (3%) and autumn (20%). All catches were taken by line fishing.
- The majority of the boat-based recreational catch of King threadfin was retained (66%). Catches were taken from estuary (51%) and nearshore (49%) habitats. King threadfin were harvested throughout the year, with higher catches observed in autumn (45%) and spring (42%) compared with winter (4%) and summer (9%). All catches were taken by line fishing.

Stock Assessment**Assessment complete:****Barramundi Yes****Threadfin Yes****Assessment level and method:****Level 2 - Catch Rate****Breeding stock levels:****Barramundi Adequate****Threadfin Adequate**

The level of catch of barramundi increased in 2012 due to an increase in catch and also effort levels along the Kimberley Coast and in the Cambridge Gulf area. Fishing effort in the Broome Coast and King Sound areas was substantially lower than that reported in recent years. The level of catch of threadfin was much reduced in 2012 due to a decrease in effort levels in the Broome Coast fishing area.

The commercial catch rates for barramundi in the KGBF increased in 2012 (77.7 kg/block day) to the highest level reported since 1990 (Kimberley Gillnet Figure 3). The catch rate for threadfin in 2012 (178.1 kg/block day) across the fishery was slightly lower than that reported in 2011 (184.7 kg/block day; Kimberley Gillnet Figure 4). The catch rate for threadfin in the Broome Coast area was similar between 2011 (205.1 kg/block day) and 2012 (204.1 kg/block day) despite effort (block days) being almost 50% less than that reported in 2011.

There is a need to update the stock assessments for both barramundi and threadfin and also a need to re-evaluate the effort measure used in the fishery (planned for 2015/16). 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. In 2012, protected species interactions were reported for both crocodiles and sawfish.

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 poses a minimal risk 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 and is typically mud flat areas.

Social Effects

Commercial

During 2012, six vessels fished in the KGBF with an average crew level of approximately 2.7 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 value (to fishers) for 2011-12:

Level 1 - < \$1 Million

The value of the North Coast Nearshore and Estuarine Fishery was reported using the 6 categories defined in Fletcher *et al.* (2010¹) that are used to assess the relative economic (based on gross value product, GVP) and social amenity value associated with each ecological asset. These values are based on GVP figures derived from the 2011-2012 financial year.

The KGBF principally targets the high-value species barramundi and threadfin. The fishery's score value in 2011-12 was estimated to be 1 (i.e. Risk level – Negligible; Economic value – <\$1 million). However, the social amenity definition for the KGBF is Important (this fishery is an important asset locally and/or the use or existence of the asset is important to the broader community).

Fishery Governance

Target commercial catch range:

Barramundi **32-45 tonnes**

Current Fishing (or Effort) Level: **Acceptable**

The target catch range for barramundi (32–45 t) represents a confidence interval that describes the general range of total catches during a stable time period for this fishery, 1989 through to 1999. This interval was calculated using the standard deviation of the observed catches over this period. For most years, the level of barramundi catch is within the target catch range. The barramundi catch in 2001 and from 2008-2010 was above the target range, as a result of increased effort levels in different areas of the fishery. In only 2 years (2007 and 2011) was the barramundi catch below the target catch range. This reduced catch was associated with reduced effort levels in the fishery. The 2012 catch is within the target range. However, there is no risk to the sustainability of the stocks.

A review of the fishery is planned for 2015/16 and will include reviews and updates of 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.

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

New management initiatives (2012/13)

The KGBF management plan was amended in June 2012 to modernise the fishery management arrangements. The next management review of the fishery is due after the 2015 /16 financial year.

External Factors

The barramundi stocks utilising the 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 risks of local depletion of barramundi and threadfin stocks.

The KGBF is planned to undergo MSC pre-assessment in late 2013.

KIMBERLEY GILLNET TABLE 1

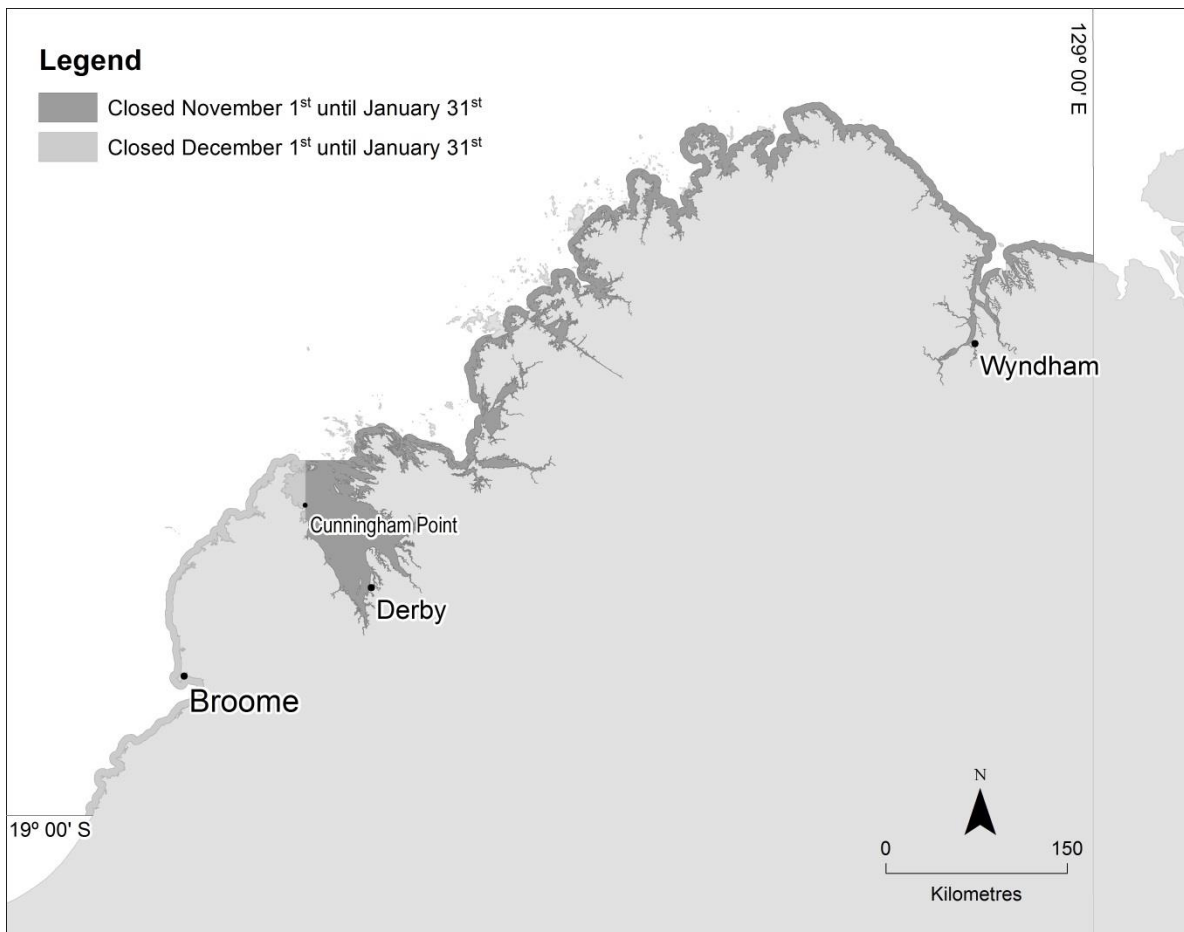
Annual catches of the major target species by the KGBF from 2000-2012.

Species	Kimberley Gillnet Annual Catch (tonnes)												
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Barramundi	42.9	38.8	39.5	45.0	53.5	35.6	36.3	27.2	54.8	59.6	57.1	28.5	39.7
Threadfin	66.7	50.9	76.4	94.1	75.8	70.6	67.7	78.5	101.2	89.9	83.3	74.2	46.2
Total	120.7	100.5	124.4	148.0	136.1	117.8	109.9	111.4	165.6	167.3	150.9	110.5	91.0

KIMBERLEY GILLNET TABLE 2

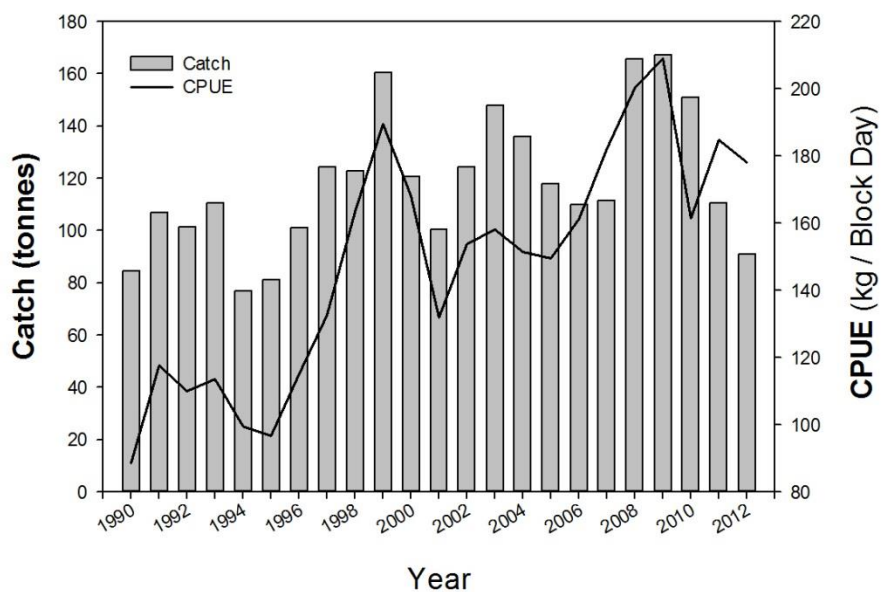
Summary of the reported catch (t) in the KGBF in 2012 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin	46.2	50.7
Barramundi	39.7	43.6
Tripletail	0.7	0.8
Black jewfish	1.5	1.6
Sharks and rays	0.9	1.0
Other fish	2.0	2.2
Total	91.0	100



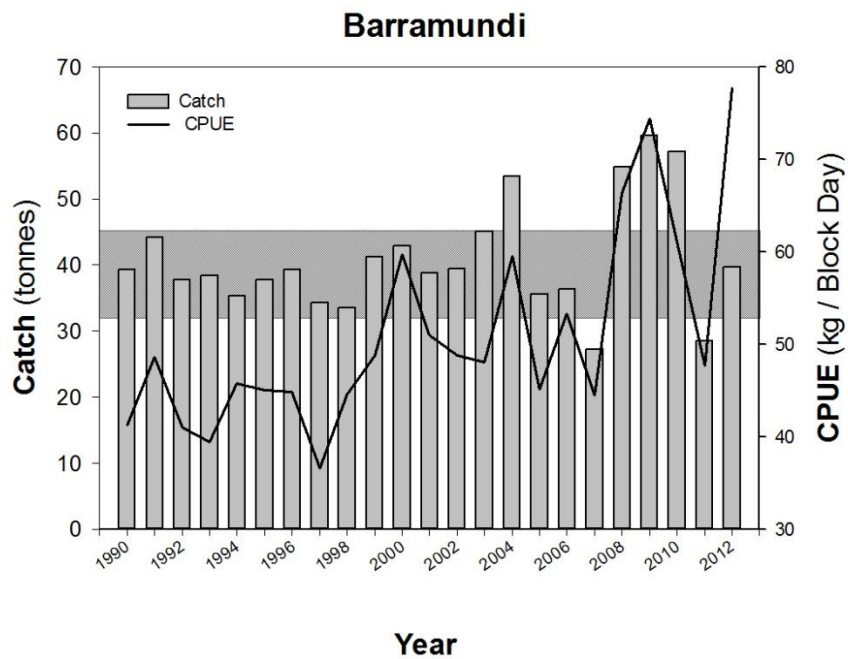
KIMBERLEY GILLNET FIGURE 1

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

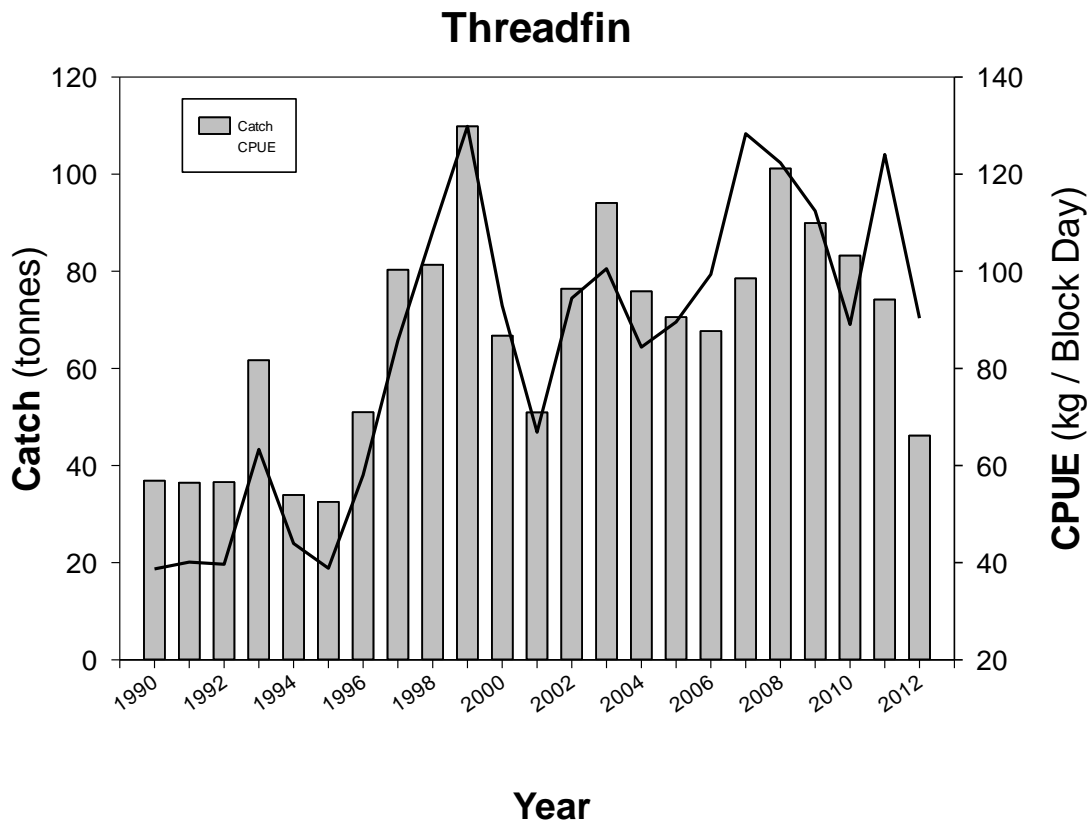


KIMBERLEY GILLNET FIGURE 2

The annual total catch and catch per unit effort (CPUE, kg block day⁻¹), from all areas of the KGBF including sharks and rays over the period 1990 to 2012.

**KIMBERLEY GILLNET FIGURE 3**

The annual catch and catch per unit effort (CPUE, kg block day^{-1}) for barramundi from the KGBF over the period 1990 to 2012. The upper and lower bounds of the target commercial catch range for barramundi are shown by the shaded catch area between 32 and 45 tonnes.

**KIMBERLEY GILLNET FIGURE 4**

The annual catch and catch per unit effort (CPUE, kg block day^{-1}) for threadfin from the KGBF over the period 1990 to 2012.

North Coast Demersal Fisheries Status Report

S.J. Newman, C. Wakefield, C. Skepper, D. Boddington and P. Dobson

Main Features

Status

Pilbara:

Stock level Adequate

Fishing Level

Trawl Fishery Acceptable

Trap Fishery Acceptable

Line Fishery Acceptable

Kimberley:

Stock level Adequate

Fishing Level Acceptable

Current Landings

Total North Coast Demersal landings 2,913 t

Recreational (top 10 demersal) 77 t (~3% of total)

Pilbara:

Total 1,806 t

Red emperor 122 t

Rankin cod 82 t

Bluespotted emperor 210 t

Pilbara Fish Trawl Fishery 1,312 t

Pilbara Fish Trap 416 t

Pilbara Line 77 t

Charter ~24.3 t (1.4% of total)

Kimberley (NDSF):

Total 1,107 t

Red emperor 134 t

Goldband snapper 487 t

Charter ~11.8 t (1.1% of total)

Fishery Description

There are a number of commercial and recreational fisheries that operate in the northern bioregion which target, to varying degrees, the following tropical, demersal fish species (in order of gross tonnage); goldband snapper (*Pristipomoides multidens*), bluespotted emperor (*Lethrinus punctulatus*), red emperor (*Lutjanus sebae*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), 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, effort allocations (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) comprising more than 50 scalefish species. In comparison, the trap fishery retains a subset of about 45 to 50 scalefish species, and while the Line Fishery catch comprises a similar number it also includes some deeper offshore species, e.g. ruby snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus*).

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

Pilbara Trap Managed Fishery Licence

Pilbara Fish Trawl Fishery (Interim) Management Plan 1997

Pilbara Fish Trawl Interim Managed Fishery Permit

Prohibition on Commercial Fishing for Demersal Scalefish (Pilbara Area) Order 1997

Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006

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Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order – Pilbara Fish Trawl)

Kimberley

Northern Demersal Scalefish Managed Fishery Management Plan 2000

Northern Demersal Scalefish Managed Fishery Licence

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

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

Boundaries

Commercial

Pilbara

The Pilbara Fish Trawl Interim Managed 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 (i.e. ~46% of Zone 2 is currently open to trawling). This represents less than 5% of the total shelf 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 120°E. The exact latitudes and longitudes delineating the Fishery are listed in the *Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006*.

Kimberley

The waters of the Northern Demersal Scalefish Fishery are defined as all Western Australian waters off the north coast of Western Australia east of longitude 120°E. These waters extend out to the edge of the Australian Fishing Zone (200 nautical miles) (North Coast Figure 1). The fishery is further divided into two fishing areas; an inshore sector (Area 1) and an offshore sector (Area 2; see North Coast Figure 1). Under a voluntary industry agreement (soon to be formalised in the *Northern Demersal Scalefish Managed Fishery Management Plan 2000*), the offshore sector (Area 2) has been further divided into 3 zones; A, B and C. Zone B comprises the area with most of the 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 (North Coast Figure 1).

Recreational

Recreational fishing in the North Coast Bioregion encompasses all waters in both the Pilbara and Kimberley regions, extending from the Ashburton River south of Onslow to the WA/NT border 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 input 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 within the boundaries of the Trawl Fishery is closed to trawling. Much of this has been closed since the implementation of the (Interim) Management Plan (1998) including Zone 1 of the Fishery and Area 3 of Zone 2 of the Trawl Fishery. 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 trawl 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.

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 Director General 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. Nine 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 Commonwealth Government's Environment Department, now called SEWPaC, in 2004 for both the Pilbara Trap and Trawl Fisheries to allow product to be exported. 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 was not renewed after December 2007 as the fishery was not exporting. The Pilbara Fish Trawl Interim Managed Fishery is exempt from export controls under the List of Exempt Native Species until November 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. The annual effort capacity is set by the Director General based on the available research advice in consultation with licensees. This effort capacity is then allocated among license holders through units of entitlement on Managed Fishery Licences, for use in Area 2 of the Fishery. In 2012 an Exemption provided 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 additional access to Zones A and C will be provided in the 2013 licensing period via units of entitlement on Area 2 Managed Fishery Licences.

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 2012, Zone B effort allocation was 985.6 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 2012, 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 2012, 9 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. While there is no restriction on the number of traps that can be fished per vessel, 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 beyond this level, the number of allowable fishing days declines. The number of days and traps fished, as recorded by the vessel monitoring system, is converted to standard fishing days. A comprehensive environmental risk 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 provides a state-wide database of recreational boat fishers that can be utilised for survey purposes.

Demersal fish, particularly the iconic 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 statutory 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, goldband snapper and ruby 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 as reported in statutory logbooks and time spent in each management area derived from VMS pollings) for five indicator species and the total catch in each of the trawl-managed areas. In addition, ages are determined from otolith sections for selected indicator species in each trawl-managed

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area 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 biological 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 synthesised into an integrated age-structured model.

In 2010, a fishery independent research survey was conducted which involved an ecological assessment of the demersal fish assemblages and habitat characteristics across trap, trawl and targeted fisheries closed (Area 3) management areas. The results of that survey are currently being collated.

An intense six month independent observer program designed to monitor bycatch and interactions with endangered, threatened and protected species was completed in December 2012 in order to meet a specific set of conditions from SEWPaC within the current WTO for the Fishery. The outcomes of the observer program will be reported in a Fisheries Research Report in 2013.

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 ca. 5 years using an age-based stock assessment model where applicable to assess the status of two indicator species, red emperor and goldband snapper, based on age-composition data collected in previous years. The next assessment (nominally due in 2014) will incorporate age composition data collected during 2012 from two surveys conducted on board industry vessels. Age composition data were collected from both fixed and random sites within the fished areas of Zone B of Area 2 of the NDSF. 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. The level of catch from Zone A will be monitored closely in the future as this area of the fishery has been receiving more effort in recent years.

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 significantly lower than for Zone B.

Retained Species

Commercial landings (season 2012):

Pilbara Fish Trawl	1,312 tonnes
Pilbara Fish Trap	416 tonnes
Pilbara Line	77 tonnes
Kimberley (NDSF)	1,107 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 2012 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 stable.

Pilbara

The total catch of demersal scalefish taken by the trawl fishery has declined from an annual average catch of close to 2,500 t during the period 1995 – 2004 to an average of 1,182 t per annum since 2008 (North Coast Tables 1 and 2). These total annual catches have been below the target catch range (2,000 to 2,800 t) for six consecutive years, with 1,312 t landed in 2012 (North Coast Table 2). These lower annual catches are considered to be a response to the effort reductions imposed on the trawl fishery since 2008.

The catches of the major target species landed by the trawl fishery were generally higher in 2012 than the previous year, i.e. crimson snapper 182 t (130 t in 2011), bluespotted emperor 151 t (152 t in 2011), rosy threadfin bream 102 t (79 t in 2011), brownstripe snapper 90 t (63 t in 2011), goldband snapper 75 t (56 t in 2011), red emperor 62 t (54 t in 2011), saddletail snapper 52 t (43 t in 2011), spangled emperor 15 t (18 t in 2011) and Rankin cod 16 t (12 t in 2011). The total retained byproduct was 17 t (18 t in 2011) and included bugs, cuttlefish, and squid (North Coast Table 2).

The total annual catch taken by the Pilbara trap fishery has remained relatively consistent since 2004 averaging 451 t per year and remaining within the target catch range of 400-500 t (North Coast Tables 1 and 2). The total catch of 416 t in 2012 was slightly lower than the 2011 catch (North Coast Table 2). The major species taken by the trap fishery in 2012 were Rankin cod 64 t (60 t in 2011), red emperor 60 t (62 t in 2011), bluespotted emperor 59 t (71 t in 2011), goldband snapper 56 t (74 t in 2010), and crimson snapper 39 t (49 t in 2011).

The total annual catch of scalefish taken by the line fishery is historically much lower than that taken annually by the trawl and trap fisheries (North Coast Tables 1 and 2). In 2012, the total annual catch for the line fishery was 77 t, which was lower than that taken in 2011 but within the target catch range of 50-115 t (North Coast Table 2). In recent years (since ~2006), the line fishery catches have been dominated by ruby snapper and goldband snapper, typically accounting for more than 40% of the total annual catch. In 2012, the ruby snapper catch was 26 t (30 t in 2011) and the goldband snapper catch was 9 t (20 t in 2011) (North Coast Table 1). 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 need to be considered in any future assessment or development of a harvest strategy.

Kimberley

After the initial development period from 1990 to 1992, the catch of the NDSF reached the first peak in catch (> 900 t) in 1996 before declining to levels of about 500 t in 2003 (North Coast Figure 3). The total catch began to increase again in 2003, and the past five years have the highest recorded catches (> 1,000 t) since the inception of the fishery. The total catch in 2012 of 1,107 t is the second highest catch recorded during this period, with the Zone B catch (934 t) the highest ever recorded from this sector of the fishery. Catches in Zone A of the fishery remained relatively high (172 t), although they have continued to decline slowly since the peak catch in 2010 of 201 t (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 2012 is similar to that reported in 2011, with goldband snapper dominating the landed catch. The landed catch of goldband snapper in 2012 was similar to that reported in 2011 (487 t). Catch levels of goldband snapper have remained high since the peak goldband snapper catch of 523 t that was reported in 2010. The last three years represent the highest reported landings of this species, continuing an overall trend of increasing catches since 2005. The total catch of red emperor in 2012 was 134 t. Although the catch of red emperor in 2012 was slightly higher than the landed catch reported in 2011 (128 t), recent catches of red emperor have shown an overall declining trend since 2005. The cods/groupers catch in 2012 (170 t) was higher than that reported in 2011 (155 t), and represents the highest level of catch reported for this species complex. Rankin cod dominates the composition of the cod/grouper catch complex. The catch of Rankin cod increased from 41 t in 2011 to 52 t in 2012 (North Coast Table 7).

The catch rate of red emperor in Zone B in 2012 increased slightly, although the catch rate is low when compared to catch rates for this species reported from 2005-08 (North Coast Figure 4). The catch rates for goldband snapper in Zone B decreased slightly, but remained within the higher range reported since 2008. These high levels of catch rate (2008–2011) have followed the sharp increase in catch rates for goldband snapper from 2006 (North Coast Figure 5). The catch rate for the cod/grouper complex in Zone B in 2012 increased significantly, and is the highest recorded for this species complex. This continues a period of generally increasing catch rates for this species complex since 2005, with particularly high levels of catch rate since 2010 (North Coast Figure 6).

The 2012 catch of red emperor, goldband snapper and cods/groupers were within acceptable levels as defined in the Export exemption for this fishery (see 'Fishery Governance' section), with no species or species complex exceeding the threshold level (20% increase in average catch of the previous 4 years).

Recreational catch estimate (season 2012):

Pilbara	~3%
Kimberley	~3%

North Coast Bioregion

An integrated survey of boat-based recreational fishing in WA was conducted during 2011/12 (Ryan *et al.* 2013¹). Estimates from this survey are not directly comparable to the survey conducted in 1999/2000 (Williamson *et al.* 2006²).

1 Ryan K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. and Gaughan, D.J. 2013. An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia 162 pp.

2 Williamson, P.C., Sumner, N.R. and Malseed, B.E. 2006. A 12-month survey of recreational fishing in the Pilbara region of Western Australia during 1999-2000, Fisheries

A total of 153 finfish species were taken in the North Coast Bioregion (both Pilbara and Kimberley; Ryan *et al.* 2013). The most common were: stripey snapper (14%), grass emperor (12%), spangled emperor (9%), barcheek coral trout (4%), and barramundi, blackspot tuskfish, blackspotted rockcod, blue tuskfish, golden trevally and Spanish mackerel (3% each). These 10 species accounted for 57% of the total catch (by numbers). There is little overlap with the main species landed by recreational fishers and those landed by the commercial fisheries covered in this report.

An estimated annual harvest of 76.9 t was reported for the top 10 demersal species in the North Coast Bioregion (Ryan *et al.* 2013). In terms of estimated harvest, the dominant demersal species were grass emperor (16.1 t), spangled emperor (14.8 t), barcheek coral trout (11.2 t) and red emperor (9.3 t). Even though the catch estimate of the top 10 demersal species is an underestimate of the total recreational catch, the total demersal recreational catch can be estimated to be at least ~3% of the combined (commercial and recreational) demersal scalefish catch in the North Coast Bioregion in 2012. In addition, the red emperor recreational catch can be estimated to be ~4% of the combined (commercial and recreational) red emperor catch in the North Coast Bioregion in 2012.

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 2011 is estimated to be ~1.2% (~20 t) of the commercial catch. However, due to the increasing population in the Pilbara from mining developments, catches are likely to increase in the future.

The reported charter vessel catch of demersal scalefish in the waters of the Pilbara demersal fisheries in 2012 was estimated to be 24.3 t (red emperor – 3.3 t; Rankin cod – 7.6 t; spangled emperor – 2.3 t). The Pilbara charter vessel catch is estimated to be ca. 1.4% of the Pilbara commercial catch of demersal fish.

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 waters of the Kimberley demersal fishery in 2012 was estimated to be 11.8 t (grass emperor – 3.5 t; golden snapper – 3.0 t; goldspotted/blackspotted rockcod – 1.6 t). The Kimberley charter vessel catch is estimated to be ca. 1.1% of the Kimberley commercial catch of demersal fish.

Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is concentrated in the Broome sector of Area 1, which is closed to commercial fishing on demersal species. The magnitude of recreational fishing

catch in offshore areas 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 of these species taken from nearshore and inshore demersal waters of the NDSF.

Fishing effort/access level

Pilbara

Fishing effort utilisation by the trawl and trap sectors of the commercial fishery are monitored using VMS. Fishing effort for the trawl fishery is also recorded as the net bottom time (hours) in statutory logbooks. Information on fishing effort (days) for the trap and line fisheries are recorded in monthly catch and effort returns (North Coast Table 3).

The trawl fleet had the equivalent of three full-time vessels in the 2011/12 season. The percentage of allocated hours used by the trawl fleet during the 2011/12 season were 83% in Area 1, 110% in Area 2 (noting that vessels can exceed their entitlement within an area by 48hr as long as overall entitlement is not exceeded), 82% in Area 4 and 64% in Area 5. 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 2012, trap fishers were allocated 5,456 trap days (capacity is set in trap days with a value per unit of 1 unit = 1 trap day), with 98% of the units used as calculated from the VMS.

In 2012, line fishers reported operating for 328 days, compared with 376 days in 2011.

Kimberley

The nine fish trap vessels that fished in the NDSF in 2012 reported using between 20 and 36 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 2012. Effort across all zones of the fishery in 2012 was 1,059 days (North Coast Table 8).

The total effort allocated in Zone B in 2012 was 986 standard fishing days (i.e. using 20 traps per day) (North Coast Table 8). The number of standard fishing days (SFDs) recorded in Zone B using VMS data was 896 SFD's (90%). That is, 10% of effort allocated to Zone B in 2012 was not used. A total of 616 standard fishing days was allocated to Zone A in 2012. The number of SFDs recorded using VMS data was 162 (163 SFDs in 2011), indicating that ~74% remained unutilised in Zone A at the end of the season. The effort expended in Zone C in 2012 was negligible.

Thus, latent effort exists in all Zones of this fishery.

Stock Assessment

Assessment complete:

Pilbara Yes

Kimberley Yes

Assessment level and method:

Pilbara

Level 2 - Catch and catch rates (Annual)

Level 3 - Fishing mortality (Periodic - 2008)

Level 5 - Integrated model (Periodic - 2007)

Kimberley

Level 2 - Catch and Catch rates (Annual)

Level 5 - Integrated Model (Periodic -2009)

Breeding stock levels:

Pilbara

Trawl Fishery Adequate

Trap Fishery Adequate

Line Fishery Adequate

Kimberley Adequate

Pilbara

There are three 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. The different tiers of assessment (see How to Use This Volume for more details) are applied to the various indicator species of this suite. Catch and 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 biological reference points (BRP) based on ratios with natural mortality¹ 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 years) 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 each year from ca. 2004 to 2008 (North Coast Figure 2). From 2009-2011, the catch rates of the shorter lived indicator species (bluespotted emperor and brownstripe snapper) and total catch increased each year. The trends in catch rates of these shorter lived species from 2011

1 The BRPs for long-lived (> 20 years) species include (1) the Target level, where $F \leq 2/3$ 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.

to 2012 varied with rates increasing or similar between years in Areas 1, 2 and 5 for brownstripe snapper and areas 4 and 5 for bluespotted emperor, but decreasing in the other trawl managed areas. Catch rates for the total retained catch in 2012 remained stable relative to recent years in Areas 2, 4 and 5, but decreased in Area 1. The trends in catch rates for longer lived indicator species (red emperor, Rankin cod and goldband snapper) were inconsistent between species, with increasing or stable catch rate trends for Rankin cod in all trawl areas but decreasing trends for red emperor particularly in Areas 2, 4 and 5 (North Coast Figure 2).

Fishing Mortality

The high rate of fishing mortality of red emperor (> BRP 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 age-based stock assessment models for the two indicator species, red emperor and Rankin cod, were last run in 2009 based on age data up to 2007. The outcomes of these model runs indicated that; 1) red emperor spawning biomass was greater than 40% of virgin biomass overall, with declining trends forecast for Areas 1 and 4 and stable forecast trends for Areas 2 and 5 for future years; and 2) Rankin cod spawning biomass was greater than 40% of virgin biomass overall, with a declining trend forecast for future years across most management areas. However, 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 and a moderate risk of recruitment overfishing. These assessments were last run prior to effort reductions in the trawl fishery and the fishing mortality estimates from age structures of indicator species collected in 2007, 2008 and 2011. These age-based stock assessment models are scheduled to be updated following the completion of fishing mortality estimates derived from age structures of these indicator species collected in 2011.

Current Assessment

Following concerns for the sustainability of the Pilbara demersal scalefish resource based on; 1) declining trends in catch rates of all indicator species and the total catch from ca. 2004-2008, and; 2) fishing mortality estimates that exceeded limit reference levels for red emperor in Areas 1 and 2 in 2007, voluntary effort reductions were undertaken by the trawl industry in 2008 in Area 1 and implemented legislatively in 2009, in Areas 1, 2 (16% combined) and 4 (4%). This has resulted in the lowest historic levels of effort for the trawl fishery since the individual transferable effort system was introduced in 1998. It has been four years since these effort reductions were introduced and early signs of stock rebuilding are evident from increasing catch rates of the shorter lived indicator species (bluespotted emperor and brownstripe snapper). These species are expected to display positive responses earlier than the longer lived indicator species (red emperor and Rankin cod) considering they are selected by the trap and trawl fisheries at a younger age (i.e. 2-3 vs. 5-6 years) and they have inherently higher population productivity. The longer lived indicator species (red emperor and Rankin cod) have displayed marginal increases in catch

rates in some management areas and stable catch rates in others since the implementation of effort reductions (2009). If they are also recovering, it is expected that increases in catch rates will be evident from 2013/14 onwards due to the lag between recruitment and vulnerability to the trawl fishery (5-6 years of age). Otoliths of the indicator species, red emperor, Rankin cod, bluespotted emperor, brownstripe snapper and ruby snapper were collected in 2010/11 from each management area of the trawl, trap and line fisheries. The age structures derived from these otolith collections will be used to evaluate changes in fishing mortality since previous estimates 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, i.e. red emperor and Rankin cod. 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 2009 by synthesising the available data in an age-structured model.

Kimberley

Assessment of the indicator species in the NDSF is also undertaken using a multi-tiered 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 2009. Age composition data for the next assessment was collected during 2012. The next assessment of the fishery is due in 2014.

Catch Rates

The catch rate (or catch per unit of effort, CPUE) presented in this status report is a nominal catch rate statistic calculated as the annual mean of the landed catches divided by corresponding units of fishing effort expended within Zone B of the fishery, which is the traditional core area fishing activity. Effort is adjusted for gear type used (based on standard fishing days). Nominal CPUE from data recorded on monthly catch and effort returns (1998-2008) were calculated as the sum of landed catches divided by total standard fishing days reported by each vessel in each month. Nominal CPUE from data recorded on daily trip returns (from 2010 onwards) were calculated as the landed catch divided by the total standard fishing days reported for each trip. For the 2009 reporting year, since some vessels had not yet switched to reporting their catch and effort on daily trip returns, the annual mean CPUE was calculated as the mean of monthly and trip CPUEs weighted by effort. A study is currently underway to use statistical catch rate standardisation methods in order to produce a more informative index of abundance for these stocks by correcting for factors such as spatial, seasonal and fishing power effects on CPUE.

Nominal catch rates for Zone B only are presented in North Coast Figures 4-6, as this area represents the historical core

fishing area of the NDSF prior to zoning in 2006. During 2012, Zone B catch rates for the indicator species were 125 kg/std day for red emperor, 507 kg/std day for goldband snapper and 198 kg/std day for cods/groupers. Catch rates for red emperor were slightly above those reported in 2011 (119 kg/std day), while the catch rate for cods/groupers increased significantly from 150 kg/std day in 2011. The catch rate for goldband snapper declined from 544 kg/std day reported in 2011.

While the 2012 catch of cods/groupers from all zones exceeded the average of the previous four years, it did not exceed the ESD trigger point of a 20% increase in catch above the average of the past four years. The 2012 catches of red emperor and goldband snapper were both 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 increases 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. A study is currently underway to use statistical catch rate standardisation methods in order to produce a more informative index of abundance for these stocks by correcting for factors such as spatial, seasonal and fishing power effects on CPUE. Results will be made available with the next stock assessment advice.

Age Structured Model

The spawning biomass of the key target species in the NDSF was last estimated by an age-structured stock assessment model using age data collected prior to 2007, which indicated the spawning biomass was above the international target 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, who concluded that the model was appropriate for use but would benefit from modifications, including the better determination of levels of model uncertainty. The model is currently being updated with continuous ongoing improvements being undertaken ahead of the next assessment.

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 either stable or declining gradually 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 at acceptable levels. Zone A of the fishery continues to receive increasing levels

of effort and catch. There is currently only a low to moderate risk to the sustainability of the fishery resources in this zone. Zone C of the fishery received a negligible level of effort in 2012. Therefore, there is currently a very low risk to the sustainability of the fishery resources in this zone.

NDSF: The annual 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 2012, the catches of goldband were equivalent to 2011. The 2012 level of catch of cods/groupers was above 2011 and the average of the previous four years, but this did not exceed the trigger point. The 2012 red emperor catch was above that taken in 2011, but below the average of the preceding four years. Combined with the spawning biomass for both red emperor and goldband snapper having been assessed as greater than 40% of virgin biomass in 2009, all species/groups are considered to currently have adequate breeding stock levels.

Non-Retained Species

Bycatch species impact:

Pilbara	Low - Moderate
Kimberley	Low

Pilbara

Species of teleosts caught as bycatch by the trawl fishery are typically small bodied and/or short lived. Such species are considered less vulnerable compared to longer-lived teleost species based on their population production potential. Thus, the indicator species used in the weight-of-evidence stock assessments for the Pilbara demersal scalefish resources are considered to provide an adequate indication for similar or less vulnerable retained and bycatch species. In 2010, an ecological assessment of fish assemblages and habitat characteristics in trap, trawl and a 12 year targeted fishery closed area was undertaken. The results of this study are being collated.

An intense six month observer program was completed in the last half of 2012 that investigated catch rates and subsurface expulsion rates in trawl nets. This program used dual-lens above water and subsurface within-net, secure camera systems to achieve a high level of observer coverage on all trawl vessels operating in the Pilbara fishery (n = 3). The observer coverage rates of 85.2% of trawl catches above water (n = 1,916 trawls observed), and 71.7% of day trawls (n = 774 trawls observed) and 53.9% day trawl hours (n = 1,013 h observed) below water, was unprecedented. About two thirds of all chondrichthyans were expelled from escape hatches during trawling, with the majority expelled relatively quickly (< 10 min). This resulted in more than half of the trawl catches containing no chondrichthyan bycatch (51.4%).

The fish trap and line fisheries have minimal bycatch (see Kimberley below).

Kimberley

As a result of the catching capacity of the type of gear used 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 pose a significant risk to the sustainability of this species.

Protected species interaction:

Pilbara **Low - Moderate**

Kimberley **Negligible**

Pilbara

The Pilbara Fish Trawl Fishery (PFTF) has a long history of developing and adopting mitigation measures that have resulted in very low capture rates of endangered, threatened and protected (ETP) megafauna, i.e. dolphins, turtles, sea snakes and sawfish. However, there has been uncertainty over the potential for unaccounted mortality of ETP megafauna from subsurface expulsion through escape hatches in the trawl nets (particularly air breathing species). To examine this issue, all trawl operations in the fishery ($n = 3$) were fitted with dual-lens above water and subsurface within-net, secure camera systems. This resulted in a high level of observer coverage from June to December 2012 that far exceeded that stipulated in the Bycatch Action Plan (22%) and levels achieved from previous studies from the PFTF. Capture rates of ETP megafauna were very low, despite very high levels of attendance and depredation in and around trawl nets by bottlenose dolphins ($> 75\%$ of trawls). All observed catches of ETP species were reported in statutory logbooks and these catch rates were consistent with previous data since exclusion grids were mandated in March 2006. Therefore, there was no evidence to suggest that captures of ETP species were being unreported by commercial fishers. The subsurface expulsion of megafauna in poor condition was extremely rare (only one dolphin was observed from over 1,000 trawl hours of within-net observations) and thus reporting rates in statutory logbooks are likely to be close to census. Extensive subsurface observations determined that current mitigation strategies are highly effective for sea snakes and turtles, and that further mitigation strategies in the forward sections of trawl nets would likely be more effective for dolphins and sawfish. The very low rates of mortalities of these ETP megafauna by the PFTF were considered to pose a negligible risk to their sustainability based on their wide distributions, high mobility and life history strategies. The outcomes of this observer program are to be reported in a Fisheries Research Report in 2013.

The reporting of interactions with protected species has improved for the Kimberley and Pilbara trap fisheries. These fisheries regularly capture sea snakes. In 2011 the Pilbara and Kimberley trap fisheries reported 151 and 231 sea snakes respectively, all of which were returned alive.

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. Despite dolphins foraging in and around trawl nets during $> 75\%$ of trawls (FRR Report) their capture is very rare (~ 0.005 trawl $^{-1}$ in 2011, reported by in statutory logbooks).

Based on estimates from independent observers, exclusion devices that were made compulsory in fish trawl nets in March 2006 reducing the incidental catch of dolphins by 64% and turtles by 97%. Subsequently, dolphin mortalities reported in statutory logbooks have reduced to less than 25 per year since 2006 (North Coast Table 5) and this rate has been independently verified.

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, can be present in high numbers at discrete locations within the fishery. Potato cod rarely enter traps due to their large size and girth limiting their capacity to pass through the entrance funnel into the traps.

Ecosystem Effects

Food chain effects:

Pilbara **Low**

Kimberley **Negligible**

Pilbara

The Pilbara Fish Trawl Interim Managed Fishery operates with standard stern trawling gear (single net with extension sweeps) within an area previously trawled by foreign vessels. Previous 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 and only in restricted parts of the continental shelf. At the present levels of catch and effort by the fish trawl, fish trap, and line fisheries, the broader effect on the trophic levels and community structure of the North West Shelf is considered to be at an acceptable level. 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) over the past 30 years.

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. 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) over the past 30 years.

Habitat effects:

Pilbara **Moderate**

Kimberley **Low**

Pilbara

Direct impacts to the habitat are limited to those of the Pilbara Fish Trawl Interim Managed Fishery, which is restricted to less than 5% of the North West Shelf (North Coast Figure 1). Area 3 and the waters inside the 50 m isobath 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) are detached per year. It is not known whether the detachment rate exceeds the rate of re-growth. Considering effort for the trawl fishery is at historically low levels and the effective area trawled within the managed areas has been greatly reduced, it is likely that the trawl fishery imposes a moderate risk to the small amount of habitat in the Areas open to trawling (5% of NWS) but a negligible risk to the total habitat in the North West Shelf.

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 is significantly less than this.

Social Effects**Pilbara**

It is estimated that 14 fishers on 3 vessels were directly employed during 2011 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. Overall, 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

Nine vessels fished in the 2012 fishing season, with approximately three crew per vessel, at least 27 people were directly employed in the NDSF. Approximately half the fish from this fishery are supplied to Perth metropolitan markets, while the other half is supplied to east coast metropolitan markets.

Economic Effects**Estimated annual value (to fishers) for 2011-12:**

Pilbara **Level 3 - \$5 - 10 million**

Kimberley **Level 3 - \$5 - 10 million**

The value of each of the North Coast Demersal fisheries is individually reported using the 6 categories defined in Fletcher *et al.* (2010) used to assess the relative economic (based on gross value product, GVP) and social amenity values associated with each regional level ecological asset. These values are based on GVP figures derived from the 2010-2011 financial year.

Pilbara

The fish trawl demersal scalefish catch is dominated by lower-valued species such as bluespotted emperor and threadfin bream, and its value is estimated to be Level 2 – \$1-5 million. For social amenity some of the species may be caught recreationally and/or there is some specific interest in the asset by the broader community. The fish trap and line catches are dominated by valuable species such as red emperor and goldband snapper, and the demersal scalefish catch from these sectors was estimated to have an economic value of \$1-5 million and the social amenity is also Level 2. For the line fishery the economic value is Level 1 < \$1 million and social amenity is minimal because there is no recreational fishing for these offshore species and no specific broader community interests.

Kimberley

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor resulting in an economic value of \$5-10 million. The social amenity value is that this is an important asset locally.

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 **Acceptable**

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 five seasons. Considering that; 1) catch rates of indicator species are increasing or stable since effort reductions; 2) effort within the trawl fishery is currently at historically low levels; and 3) results from a higher level fishing mortality-based stock assessment and ecosystem based ecological assessment will be available in 2013 and 2014; current levels (2012) of

effort and catch in the Pilbara fish trawl fishery are considered to impose a moderate risk for stock sustainability for the Pilbara Demersal Scalefish resource.

In the Fish Trap Fishery, the total catch was within the target catch range in 2012. The line catch was also within the acceptable catch range in 2012.

Kimberley

For the 2012 calendar year, the total allowable effort was set at 986 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 2012 catches were above the reported range. However, given the recent increases in fishing effort in Zone A, 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) taken by the fishery should not increase by more than 20% above the average for the previous four years. Of the key target species/groups, only the 2012 catch of the cods/groupers complex was above the average of the previous four years, but did not exceed the ESD performance measure. Both the goldband snapper and 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 following assessment of the next representative age sample.

New management initiatives (2012/13)

Pilbara

The Pilbara Fish Trawl Interim Managed Fishery Management Plan cessation date was recently extended to 30 June 2016. The extension was provided to allow for the results of the observer program to be analysed and published (as a Fisheries Research Report in 2013) and to assess the long-term future of the Pilbara Fish Trawl Interim Managed Fishery, including consideration of moving the Fishery to “managed” Fishery status.

Kimberley

In 2013 the industry agreed zoning and effort allocation arrangements of Area 2 of the NDSF will be incorporated into the management plan. The Department continues to address the findings of the Prescott Review ahead of the next Level 5 assessment.

All commercial fisheries in the North Coast Bioregion will undergo MSC pre-assessment in late 2013.

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, there is little information as to the impacts and therefore the risks from seismic operations on demersal scalefish.

Kimberley

The impacts of environmental variation on the fishery are not considered to be large as target species are long-lived and inter-annual variability is likely to be ‘smoothed’. 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.

NORTH COAST TABLE 1

Commercial catches (tonnes) and the percentages of each major species taken by trawl, trap and line in the Pilbara in 2012 (catches rounded to the nearest tonne).

Species		Trawl catch		Trap catch		Line catch		Total catch tonnes
		tonnes	%	tonnes	%	tonnes	%	
Bluespotted emperor	<i>Lethrinus punctulatus</i>	151	72%	59	28%	-	-	210
Crimson snapper	<i>Lutjanus erythropterus</i>	182	81%	39	17%	4	2%	225
Rosy threadfin bream	<i>Nemipterus furcosus</i>	102	99%	1	< 1%	-	-	103
Brownstripe emperor	<i>Lutjanus vitta</i>	90	83%	19	17%	-	-	109
Goldband snapper	<i>Pristipomoides multidens</i>	75	53%	56	40%	9	6%	139
Red emperor	<i>Lutjanus sebae</i>	62	51%	60	49%	1	1%	122
Saddletail snapper	<i>Lutjanus malabaricus</i>	52	73%	15	22%	3	5%	71
Spangled emperor	<i>Lethrinus nebulosus</i>	15	35%	17	42%	9	23%	42
Frypan snapper	<i>Argyrops spinifer</i>	31	93%	2	6%	< 1	1%	33
Rankin cod	<i>Epinephelus multinotatus</i>	16	20%	64	78%	2	2%	82
Ruby snapper	<i>Etelis carbunculus</i>	-	-	-	-	26	100%	26
Other demersal scalefish		537	83%	85	13%	23	4%	645
All demersal scalefish		1,312	73%	416	23%	77	4%	1,806

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 for the past decade.

Year	Demersal Scalefish			Total	Byproduct*
	Line	Trap	Trawl		Trawl
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
2011	112	459	1,085	1,656	18
2012	77	416	1,312	1,806	17

* Byproduct in 2011 consists mainly of bugs, cuttlefish, and squid.

NORTH COAST TABLE 3

Summary of the fishing effort in the Pilbara Demersal Scalefish Fisheries for the past decade. 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)
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
2011	376	420	545	7,338
2012	328	441	707	10,269

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	$F > F_{\text{limit}}$	$F > F_{\text{limit}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	$F_{\text{limit}} > F > F_{\text{threshold}}$
Rankin cod	2006	$F = F_{\text{target}}$	$F < F_{\text{target}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	$F = F_{\text{threshold}}$	$F < F_{\text{target}}$
Goldband snapper	2008	$F_{\text{threshold}} > F > F_{\text{target}}$	$F < F_{\text{target}}$	$F < F_{\text{target}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	ns
Bluespotted emperor	2008	$F_{\text{threshold}} > F > F_{\text{target}}$	ns	ns	ns	ns

NORTH COAST TABLE 5

Reported bycatch of protected species by skippers in the Pilbara trawl fishery in 2012.

	Number released Alive	Number deceased*	Total Reported
Bottlenose dolphins	5	24	29
Pipefish	8	16	24
Green sawfish	17	10	37
Narrow sawfish	31	10	41
Seahorses	2	10	12
Sea-snakes	116	15	131
Turtles	0	0	0

*Where the condition was not reported, the animal was considered deceased.

NORTH COAST TABLE 6

Recent total annual catches of major target and byproduct species or species groups across all zones in the NDSF.

Species	NDSF annual catch (tonnes)							
	2005	2006	2007	2008	2009	2010	2011	2012
Goldband snapper (<i>Pristipomoides</i> spp.)	429	331	405	457	485	524	487	487
Red emperor (<i>Lutjanus sebae</i>)	192	164	179	173	156	142	128	134
Saddletail snapper (<i>Lutjanus malabaricus</i>)	92	78	99	104	108	126	87	100
Spangled emperor (<i>Lethrinus nebulosus</i>)	21	27	15	17	23	30	20	25
Cod/grouper (Epinephelidae)	110	127	126	149	142	153	155	170
Other species	78	62	107	102	132	144	161	191
Total demersal scalefish catch	922	789	933	1002	1046	1117	1037	1107

NORTH COAST TABLE 7

Catches of major target and byproduct species or species groups by zone in the NDSF in 2011 and 2012.

Species	NDSF annual catch (tonnes)			
	2011		2012	
	Zone A & C	Zone B	Zone A & C	Zone B
Goldband snapper (<i>Pristipomoides</i> spp.)	13.1	473.7	17.2	470.2
Red emperor (<i>Lutjanus sebae</i>)	38.8	88.8	32.8	100.9
Saddletail snapper (<i>Lutjanus malabaricus</i>)	12.5	74.8	11.6	88.8
Spangled emperor (<i>Lethrinus nebulosus</i>)	1.9	17.8	1.3	24.0
Rankin cod (<i>Epinephelus multinotatus</i>)	17.8	23.4	18.3	33.9
Other Cods/groupers (Epinephelidae)	25.2	88.9	23.1	94.6
Other species	78.7	81.9	70.3	120.3
Total demersal scalefish catch	188	849	175	933

NORTH COAST TABLE 8

Total catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF since 2001.

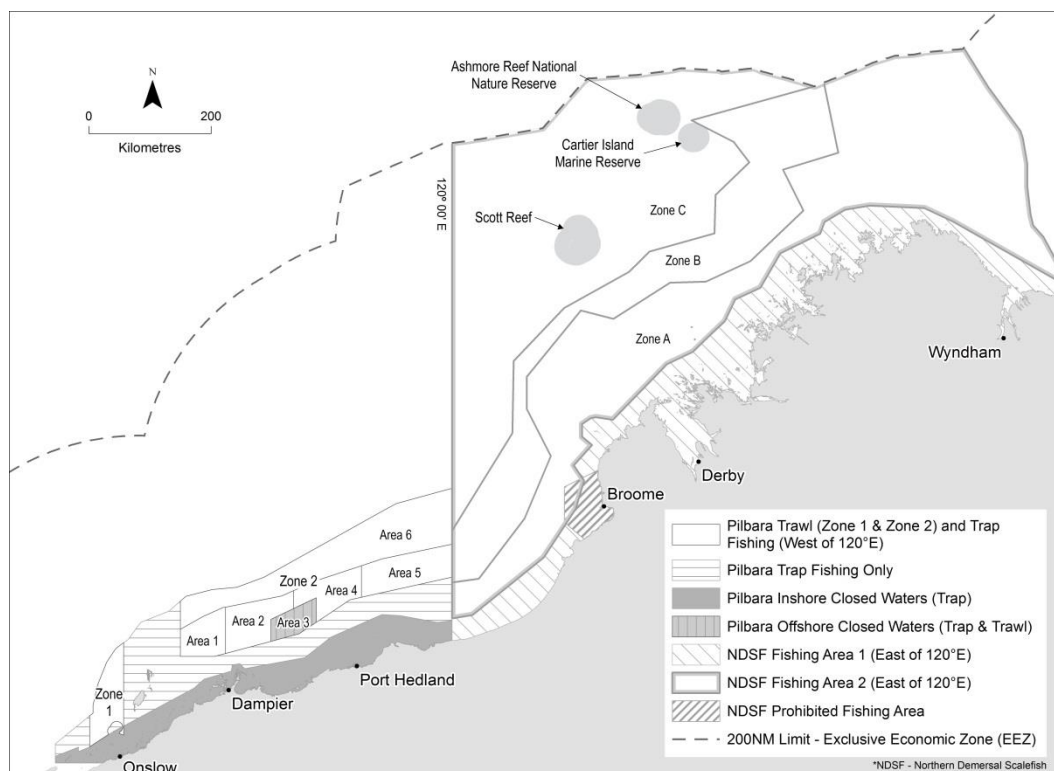
Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	0	0	690	1,300	690
2005	1,760	0	0	922	1,318	922
2006	1,144	0	0	801	1,193	801
2007	1,144*	0	0	933	1,235#	933
2008	1,144*	7	0	1,003	1,150#	1,010
2009	1,144*	0	0	1,046	1,090#	1,046
2010	1038*	0	0	1,116	1,178#	1,116
2011	986*	0	0	1,037	1,042#	1,037
2012	986*	0	0	1,107	1,059#	1,107

(* = TAE is for B Zone only; # = total effort is from all zones; 2012 Estimated Catch: Zone A = 172 t, Zone B = 933 t; 2012 Estimated Effort: Zone A = 162 SFDs, Zone B = 896 SFDs)

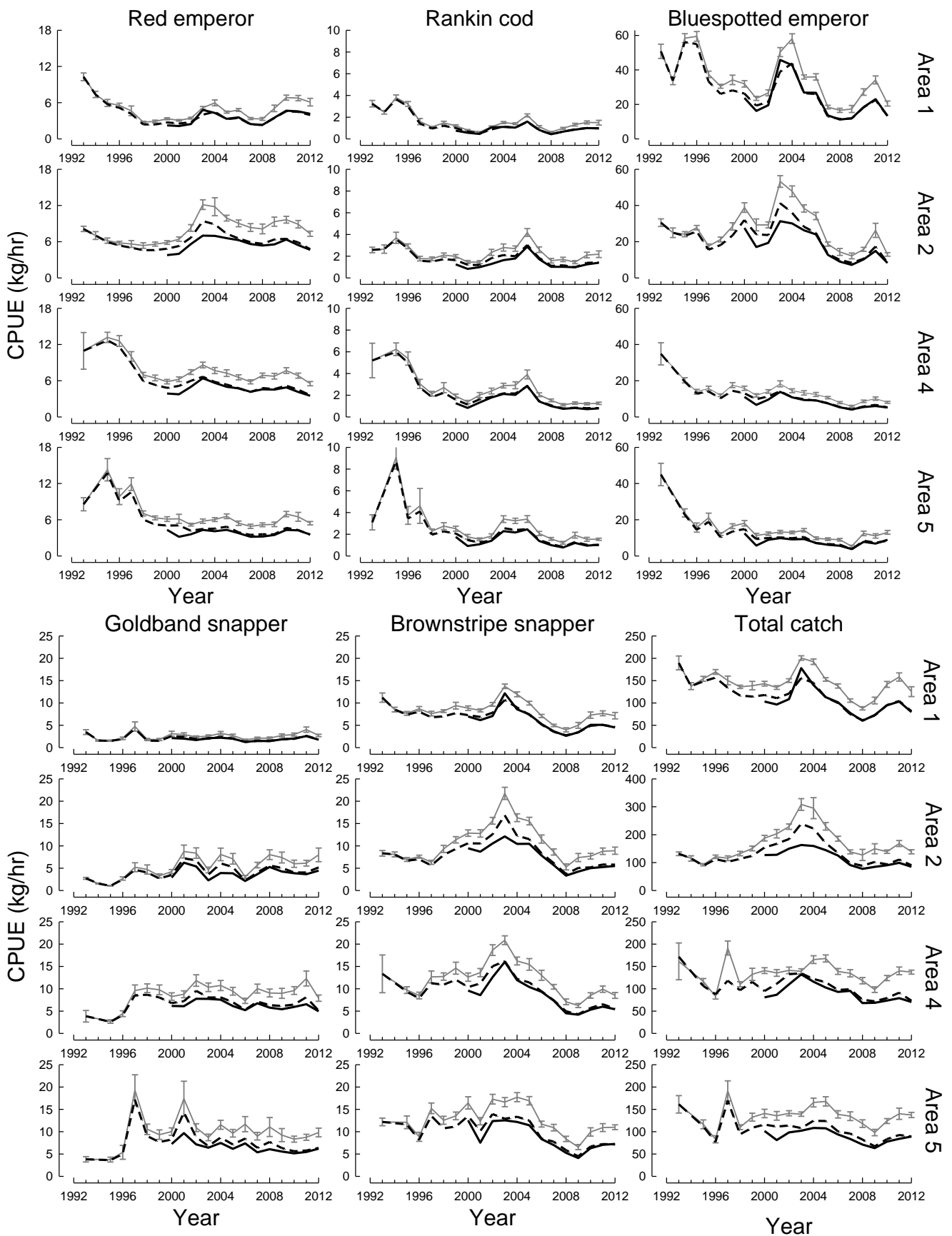
NORTH COAST TABLE 9

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 2012.

Species	Pilbara catch		Kimberley (NDSF) catch		Total catch
	tonnes	%	tonnes	%	tonnes
Red emperor	122	48%	133.7	52%	255.7
Saddletail snapper	71	41%	100.3	59%	171.3
Crimson snapper	225	82%	49.6	18%	274.6
Brownstripe snapper	109	96%	4.9	4%	113.9
Goldband snapper	139	22%	487.4	78%	626.4
Spangled emperor	42	62%	25.3	38%	67.3
Bluespotted emperor	210	80%	54.0	20%	264
Rankin cod	82	61%	52.2	39%	134.2
Frypan snapper	33	97%	< 1	3%	34
Rosy threadfin bream	103	99%	< 1	1%	104
Other demersal scalefish	645	76%	199	24%	844
Total all demersal scalefish	1,806	62%	1,107	38%	2,913

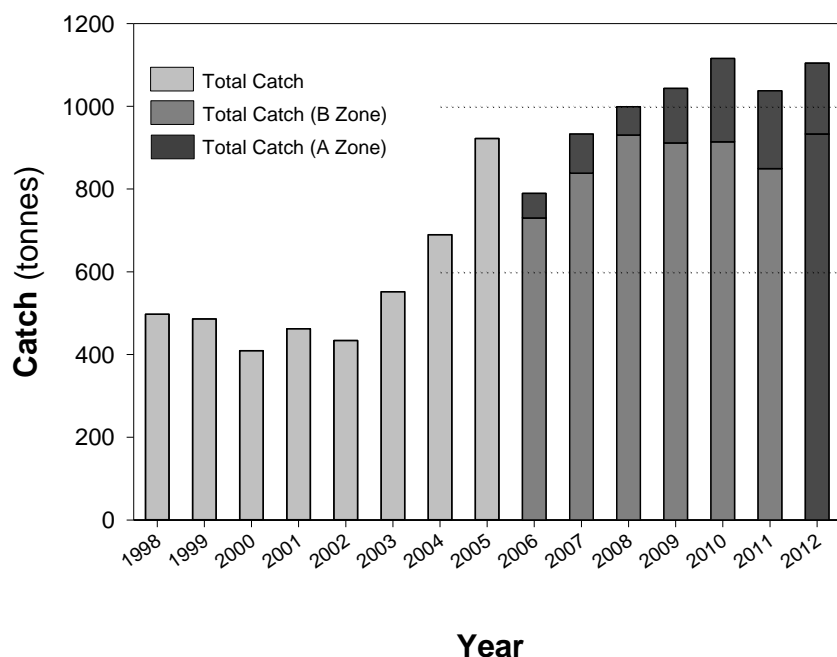
**NORTH COAST FIGURE 1**

Demersal scalefish fisheries of the North Coast Bioregion of Western Australia. In the Pilbara subregion: 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. In the Kimberley subregion: Zones A, B and C lie in Area 2 of the NDSF.

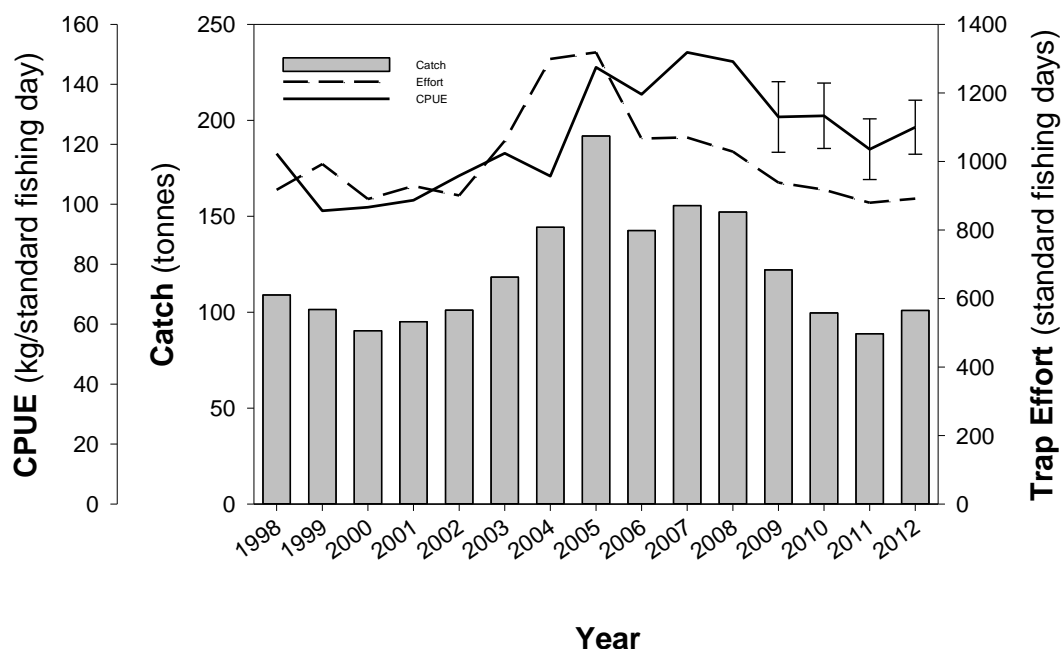


NORTH COAST FIGURE 2

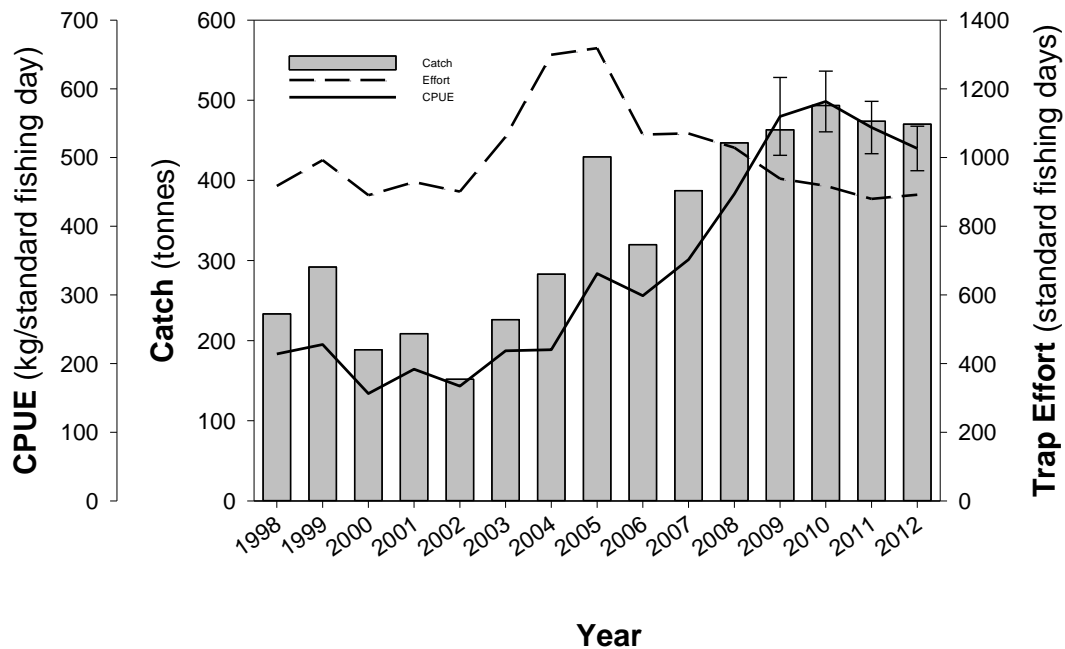
Annual mean Catch Per Unit Effort (CPUE, kg/hour) for five indicator species and the total catch in Areas 1, 2, 4 and 5 of the Pilbara Trawl Fishery from 1993–2012. The solid grey line is nominal catch rate (± 1 se) with trawl time as the effort measure, the dashed black line is catch rate incorporating 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 3**

Catch levels of demersal finfish in the NDSF by line and trap from 1998–2012. Note that prior to 2006 the NDSF was not differentiated in zones. Since 2006 catches are reported separately by zones within Area 2 of the fishery. The dashed lines represent the acceptable catch range of 600-1000 tonnes for the fishery.

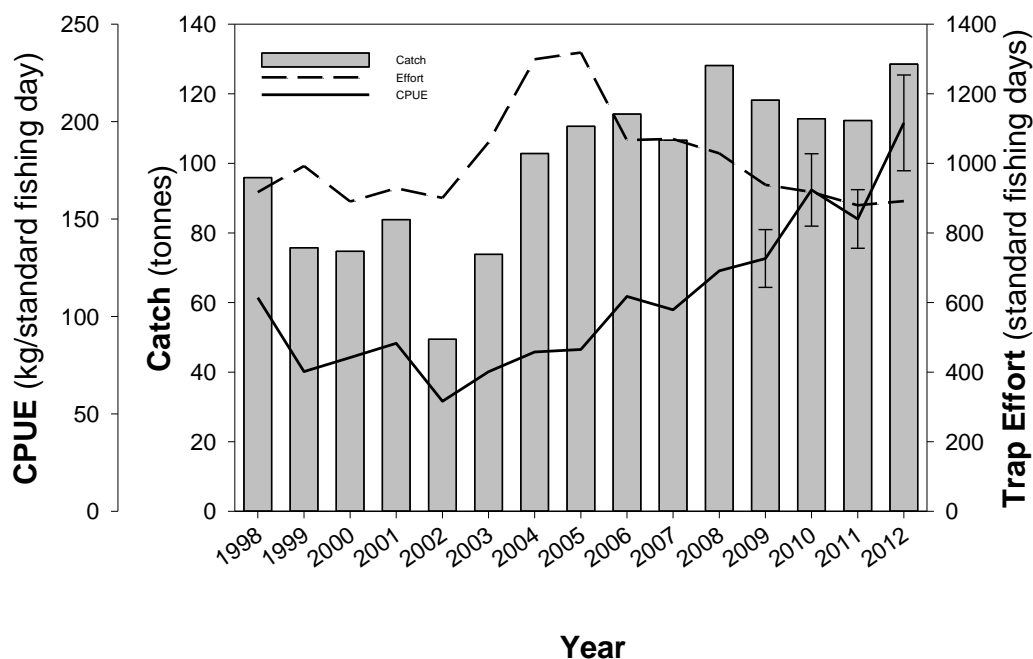
**NORTH COAST FIGURE 4**

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2012 (2006-2012 for Zone B only, catches represent total landings in B Zone, whereas effort and catch rate (CPUE) are determined from commercial vessel activity only). The catch rate (CPUE) presented here is a nominal catch rate that is calculated as the mean of monthly fleet catches divided by effort adjusted for gear type within Zone B of the fishery only, except for data from daily trip returns, where catch rates are calculated as the mean of all catch rates attained during separate fishing trips. Standard error bars illustrate variability in CPUE from the two sources of catch returns in 2009, and variability in trip CPUE data from daily log books (2010-12).



NORTH COAST FIGURE 5

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998–2012 (2006–2012 for Zone B only, catches represent total landings in B Zone, whereas effort and catch rate (CPUE) are determined from commercial vessel activity only). The catch rate (CPUE) presented here is a nominal catch rate that is calculated as the mean of monthly fleet catches divided by effort adjusted for gear type within Zone B of the fishery only, except for data from daily trip returns, where catch rates are calculated as the mean of all catch rates attained during separate fishing trips. Standard error bars illustrate variability in CPUE from the two sources of catch returns in 2009, and variability in trip CPUE data from daily log books (2010–12).



NORTH COAST FIGURE 6

Catch, effort and catch per unit of effort of the cod/grouper complex in the NDSF by trap, 1998–2012 (2006–2012 for Zone B only, catches represent total landings in B Zone, whereas effort and catch rate (CPUE) are determined from commercial vessel activity only). The catch rate (CPUE) presented here is a nominal catch rate that is calculated as the mean of monthly fleet catches divided by effort adjusted for gear type within Zone B of the fishery only, except for data from daily trip returns, where catch rates are calculated as the mean of all catch rates attained during separate fishing trips. Standard error bars illustrate variability in CPUE from the two sources of catch returns in 2009, and variability in trip CPUE data from daily log books (2010–12).

Mackerel Managed Fishery Report: Statistics Only

B. Molony, E. Lai and S. Walters

Fishery Description

Commercial

The Mackerel Fishery uses near-surface trolling gear from 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 trolling, 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 (121° E to WA/NT border); Area 2 - Pilbara (114° E to 121° E); Area 3 - Gascoyne (27° S to 114° E) and West Coast (Cape Leeuwin to 27° S) (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

The Fishery became fully managed on 1 January 2012, formalising the interim management arrangements. The Mackerel Managed Fishery (MMF) operates under an Individual Transferable Quota (ITQ) system which includes the setting of 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 licensing period (1 January to 31 December) is limited to the quantity of mackerel determined by the Director General. The TACC for each Area of the Fishery for 2012 was:

	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 licences 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.

Licence holders may only fish for mackerel by trolling or handline. There are currently 49 licences in the Fishery with 15, 15 and 19 licences in Areas 1, 2 and 3 (respectively), with the combined quota allocations being consolidated onto 14 boats operating within the fishery.

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. 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 2012)

Spanish mackerel	318.1 tonnes
Grey mackerel	11.9 tonnes
Other mackerel	0.4 tonnes

Commercial

The majority of the catch is taken in the Kimberley 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 2012 season estimated at 318.1 t which is similar to the levels that have been taken in this fishery (averaging about 300 t) since quotas were introduced in 2006 (Spanish Mackerel Figure 2).

A total of 12.3 tonnes of other species of mackerel were landed in the 2012 season, including 11.9 t of grey mackerel. The catch of grey mackerel in 2012 was of a similar magnitude to grey mackerel catches by the fishery since 2006 but well below the TAC and the historical high catches of 'other mackerel' recorded in the late 1980s and 1990s.

All commercial estimates reported do not include fish caught and released or lost to sharks.

Recreational

Estimates of recreational catches of Spanish mackerel were generated from data collected in the integrated survey of boat-based recreational fishing in WA conducted during 2011/12. Estimates are available at the level of individual Bioregions (Spanish Mackerel Table 1). A total of 68.1 t of Spanish mackerel were landed by recreational boat-based fishers in 2011/12, with most (26.2 t) landed in the North Coast Bioregion. An additional 61.2 t were captured and subsequently released. Recreational anglers also reported much lower catches of other mackerel, including blue mackerel (*Scomber australasicus*), grey mackerel

(*Scomberomorus semifasciatus*), school mackerel (*Scomberomorus queenslandicus*), shark mackerel (*Grammatorcynus bicarinatus*), spotted mackerel (*Scomberomorus munroi*) and wahoo (*Acanthocybium solandri*). Recreational anglers also reported small amounts of unidentified mackerel.

Reported annual catches of Spanish mackerel by recreational charter boats are relatively minor.

Fishery Governance

Target commercial catch range :

246 – 410 tonnes

The total catch in 2012 of 318.1 t was within the acceptable catch range for the Fishery. The reported catch from the Kimberley Area of 180.3 t was within the Area's acceptable catch range (110 – 205 t), and within the range reported since 2005. Catches in the Pilbara Area have been relatively stable since 2006, with the 2012 catch of 88.0 t (acceptable catch range 80 – 126 t) the highest catch since 2005. Catches from the Gascoyne/West Coast Area in 2012 were 49.8 t, below the acceptable range of 56 – 79 t but similar to the range of catches from this Area since 2004.

Current Fishing (or Effort) Level: **Acceptable**

Fishing effort throughout the Fishery has been relatively stable since 2006 following reductions due to management changes. The increasing trend in catch rates for the two main (Northern and Pilbara) fishery areas, with Area 1 (Kimberley)

now at near record levels, indicates a relatively high abundance of Spanish mackerel in this management Area (Spanish Mackerel Figure 3). Catch rates in the Pilbara Area were also high in 2012 and were stable for the Gascoyne /West Coast Area.

As the minimum legal size for Spanish mackerel is 900 mm total length which is similar to the size at maturity for this species, the spawning stock is essentially the same as the exploited stock. Therefore the status of the Spanish mackerel spawning stock is measured using the catch rates for each areas of the Fishery. With area based catch rates either increasing or stable this suggests that the overall spawning stock is increasing.

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 (2013)

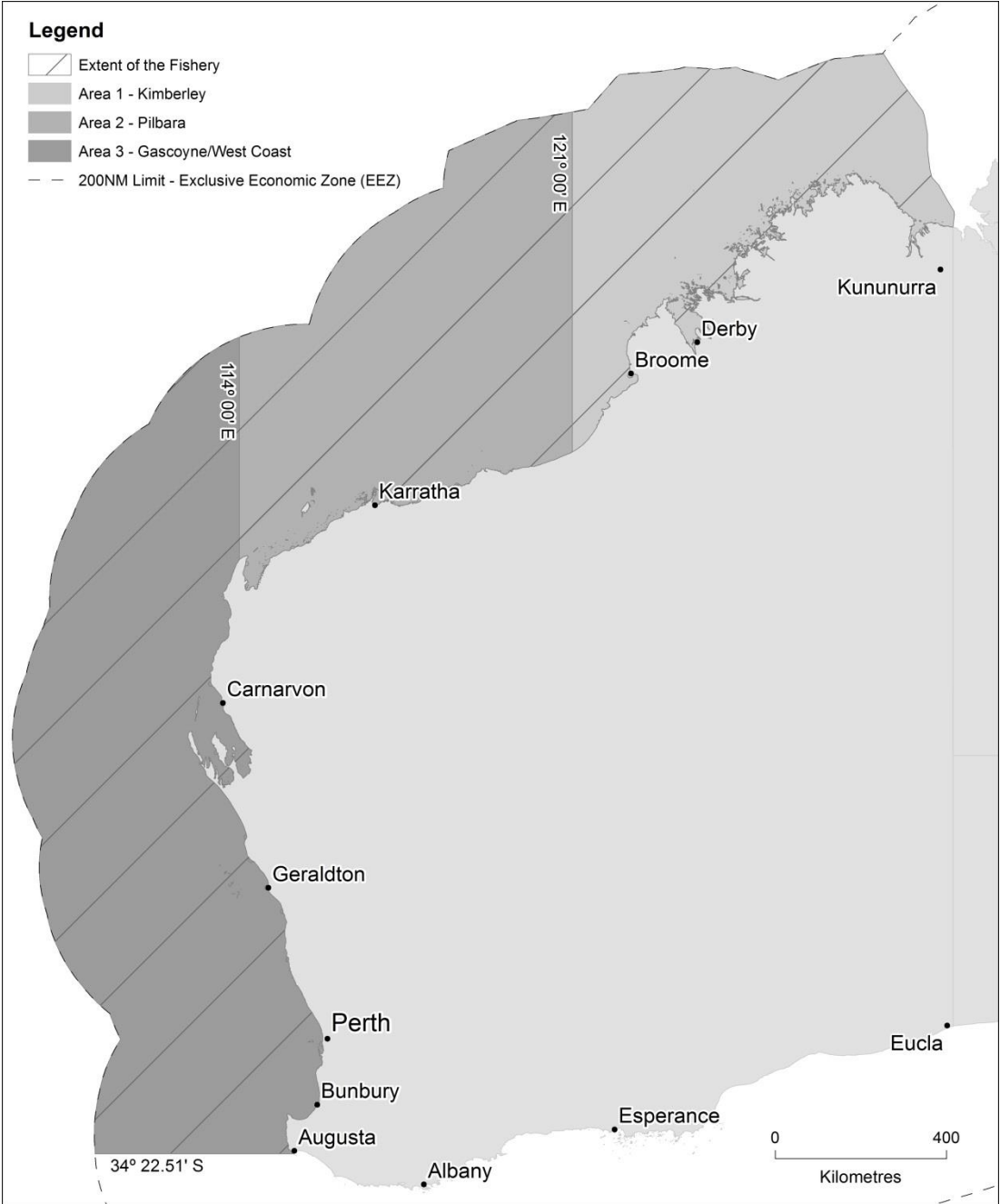
A review of the acceptable catch ranges and TACCs for the Fishery will be undertaken during 2013 with any changes being introduced in 2014. It is anticipated that a formal harvest strategy will be developed for the fishery in the future to assist in monitoring the fisheries performance and reviewing TACCs.

An operator's guide is also being developed for licence holders and skippers to enhance their understanding of the management arrangements for the Fishery.

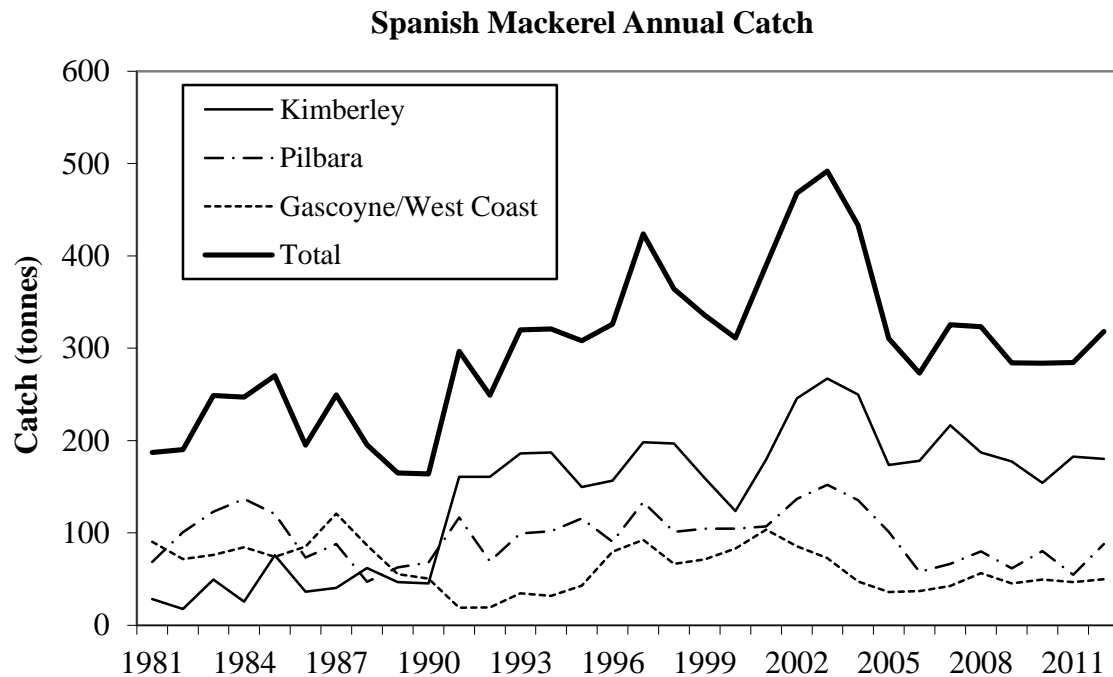
SPANISH MACKEREL TABLE 1

Recreational boat-based catch estimates (in tonnes, t) of Spanish mackerel in Western Australia 2011/12. Estimates are based on an average weight of a Spanish mackerel of 6.9 kg. No Spanish mackerel were reported from the South Coast Bioregion during 2011/12.

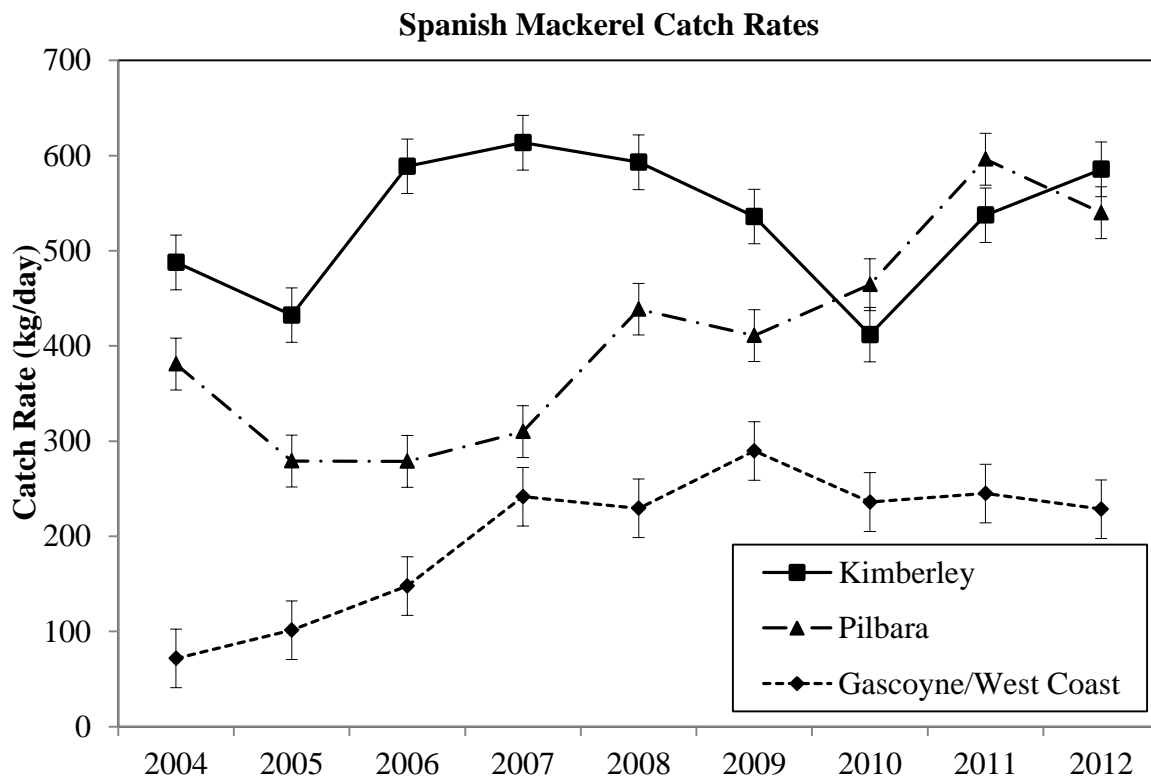
Bioregion	Retained catch (std. error)	Released catch (std. error)	Total catch (std. error)
North Coast	26.2 t (3.66 t)	30.8 t (6.58 t)	57.0 t (8.59 t)
Gascoyne Coast	21.3 t (2.80 t)	24.0 t (4.81 t)	45.2 t (6.61 t)
West Coast	20.7 t (3.02 t)	6.3 t (1.46 t)	27.0 t (3.81 t)
Statewide (total)	68.1 t (9.47 t)	61.2 t (12.84 t)	129.3 t (19.01 t)



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, 1979–2012. Note: quota management was introduced in 2006.

**SPANISH MACKEREL FIGURE 3**

Annualised catch rates of Spanish mackerel in Western Australia derived from daily logbooks, 2004–2012.

Northern Shark Fisheries Status Report: Statistics Only

B Molony, R. McAuley and F. Rowland

Fishery Description

Commercial

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 two fisheries have been considered as a single fishery for reporting purposes given confidentiality concerns resulting from the small number of operators in the Fishery. However, there has been no reported fishing activity in the northern shark fisheries since 2008/09. Since fishing commenced in 1994, the northern shark fisheries have targeted various species, including sandbar (*Carcharhinus plumbeus*), blacktip (*Carcharhinus* spp., at least two species), tiger (*Galeocerdo cuvier*), hammerhead (Family: Sphyrnidae) and lemon sharks (*Negaprion acutidens*). The primary fishing method employed in these fisheries was demersal longlining with a relatively small amount of pelagic gillnetting in the JANSF.

Recreational

Recreational fishers target similar species mainly using line fishing methods.

Boundaries

Commercial

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).

Recreational

The recreational fishery operates throughout the North Coast Bioregion from the WA/NT border to 114°06'E.

Management arrangements

The commercial take of shark in northern Western Australian waters east of 123°45' E longitude is jointly managed by the Commonwealth Government and Western Australia under an arrangement agreed through the Offshore Constitutional Settlement. 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 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. This resulted in zoning of the WANCSF into three separate areas with different levels of access, including an indefinite closure to protect the breeding stock of sandbar sharks that support the southern fishery (see Temperate Demersal Gillnet and Demersal Longline Fishery Status Report).

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 be legally exported. For more detailed information on the Fishery see previous State of the Fisheries and Aquatic Resources Northern Shark Fisheries Status Reports.

The Department of Fisheries is currently reviewing future options for managing the WANCSF and is working with the Commonwealth Government to determine management arrangements for the JANSF.

Landings and Effort (Season 2011/12)

Commercial landings (season 2011/12)

Northern Shark Fisheries: 0 tonnes

Other Commercial Fisheries: 1 tonne

The Northern shark fishery has not operated since 2008/09. The level of shark catch by other commercial fisheries in this Bioregion is negligible.

Recreational catch estimate:

283 (+/- 128) Individual sharks retained (2011/12)

Relatively few sharks were retained by the recreational fishery in the North Coast Bioregion, as estimated by the integrated survey of boat-based recreational fishing in WA during 2011/12. Approximately 93% of all sharks were released.

Commercial Fishing effort/access level

There was no reported fishing effort in the northern shark fisheries in 2011/12.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Sandbar shark: Level 3 - Catch
(relative to previous direct survey)

Blacktip sharks: Level 1 - Catch

Breeding stock levels:

Sandbar shark: Recovering

Blacktip sharks: (Adequate, based

on assessment of the NT component only)

For details of sandbar shark assessment, see Temperate Demersal Gillnet and Longline Fisheries Status Report.

Fishery Governance

Target catch range:

Sandbar sharks: 0 - 20 tonnes

Current fishing (or effort) level:

Effort: Acceptable (2011/12)

Sandbar shark catch: Acceptable (2011/12)

There has been no reported fishing effort in the northern shark fisheries since 2008/09 including in 2011/12.

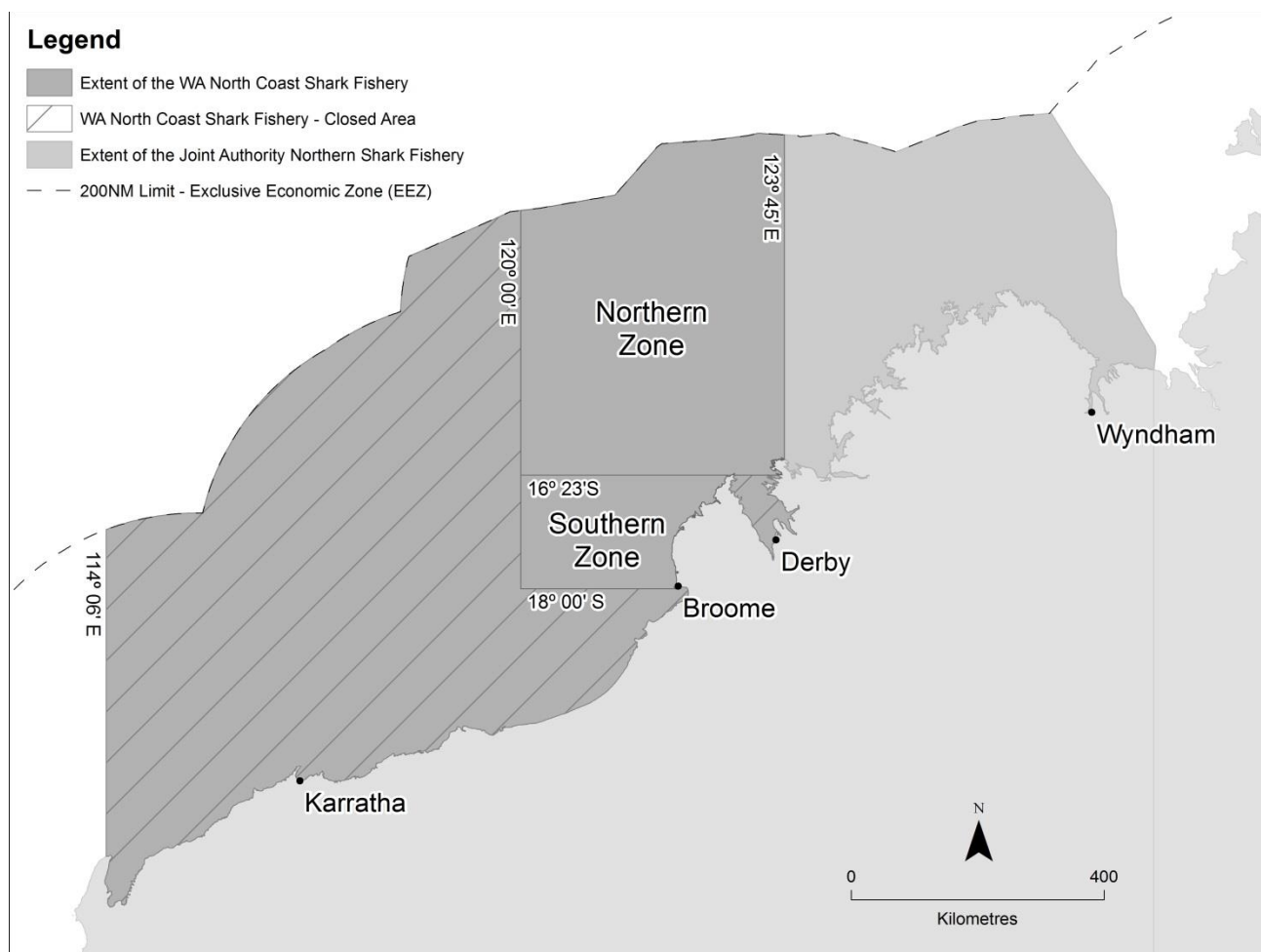
New management initiatives (2011/12)

Future management arrangements for the JANSF and the WANCSF are the subject of continuing discussion between the State and Commonwealth Governments. A recent NT assessment (2012) of blacktip sharks (multiple species) suggested that the stock status was acceptable. However, the applicability of these results for the Western Australian blacktip stocks is not clear due to uncertainties around historic and recent catch levels, poor species identification

and significant declines in catch rates observed for some species in the late 1990s and mid 2000s. The relevance of the NT assessment will be resolved in 2014.

External Factors

The primary external factor affecting the northern shark fisheries is the withdrawal (JANSF) and expiry (WANCSF) of export approvals under the Commonwealth Government's EPBC Act. Development of demonstrably ecologically sustainable management arrangements required for 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 Temperate Demersal Gillnet and Longline Fisheries Status Report).



NORTHERN SHARK FIGURE 1

Management boundaries of the WA northern shark fisheries.

Pearl Oyster Managed Fishery Status Report

A. Hart and D. Murphy, and S. Walters

Main Features

Status

Stock level	Adequate
Fishing level	Acceptable

Current Landings

Commercial Pearl Oyster Catch	
Shell numbers (All Zones)	685,888 shells

Fishery Description

The Western Australian pearl oyster fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. It is a quota-based, dive fishery, operating in shallow coastal waters along the North-West Shelf.

The harvest method is drift diving, in which six to eight divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legal-sized oysters by hand as they are seen. The species targeted is the Indo-Pacific, silver-lipped pearl oyster (*Pinctada maxima*).

Governing legislation/fishing authority

Pearling Act 1990

Pearling (General) Regulations 1991

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

Consultation process

The Department undertakes consultation directly with licensees on operational issues. Formal licensee holder engagement is convened by the West Australian Fishing Industry Council (WAFIC) under a Service Level Agreement with the Department.

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. This zone has not been fished since 2008.

Pearl Oyster Zone 2: East of Cape Thoun (118°20' E) and south of latitude 18°14' S. The 9 licensees in this zone also have full access to Zone 3. This zone is the mainstay of the fishery

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' between zones 1 and 2, which may be accessed by licensees from both Zones, although 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.

The pearl oyster fishery is managed primarily through output controls in the form of a total allowable catch (TAC) divided up into individually transferable quotas (ITQs). There are 572 wild-stock ITQ units allocated across three management zones (Zone 1 – 115; Zone 2 – 425; Zone 3 – 32). Hatchery production is also controlled by ITQs; currently there are 350 hatchery ITQ units allocated amongst 14 pearling licensees, however this restriction is currently under review.

The value of a hatchery quota unit is 1,000 shell. The value of wild-stock quota units varies, depending on the status of wild stocks in each management area. Between 2008 and 2011 it was set at historically high levels (3,500 shell in 2011) in Zone 2&3 due to increased stock abundance. The wild stock quota unit for Zone 2/3 for the 2012 season was reduced to 1,400 shell, as a result of stock levels returning from record high 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 new minimum legal size of 100 mm shell length which is under trial for seasons 2012-2013.

Historically the legal size limit has been 120 mm shell length, and maximum legal sizes and area-specific TACs have been set where appropriate (e.g. in Exmouth Gulf in Zone 1). The catch of pearl oysters is divided up into two size classes; "culture" shell, between 100 and 175 mm, and "MOP" shell, which are greater than 170 mm.

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

Research summary

Current stock assessment research is focused on 5 main areas: (1) catch and effort statistics, (2) monitoring an index of settlement for predicting future years catch levels, (3) stock and habitat surveys using length frequency data and diver observations, (4) development of decision rules for determining the TAC; and (5) investigating 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, improved health and safety for pearl divers and pearl oyster health. The main aims of the pearl oyster health study are to investigate aspects of oyster oodema disease (OOD) in *Pinctada maxima*, to assist in mitigating the impacts and understand pathways to disease and disease response in pearl oysters.

Retained Species

Commercial landings (season 2012):

685,888 shell

In 2012, catch was only taken in Zone 2/3 and the number of wild-caught pearl oyster shell was 685,888 comprised of 556,567 culture shells and 129,321 MOP shells (Pearl Figure 2). The TAC for culture shells was 639,800, thus 87% of the TAC was caught. In comparison, 765,000 culture shells were caught in 2011. The reduced catch in 2012 was due to a lower quota as a result of the abundance returning to more normal levels. The take of 129,000 shells for MOP, which are large oysters (>175 mm shell length), represents a 300% increase over the 30,949 MOP caught in 2011 (Pearl Figure 2).

There has been no fishing in Zone 1 since 2008.

Fishing effort/access level

Total effort was 17,396 dive hours (Pearl Figure 2), an increase of 20% from the 2011 effort of 14,361 hours and the highest effort level since the early 1990s. Of this total effort, 15,589 hours was focused on culture shell fishing, and the remaining 1,807 hours was applied to MOP fishing.

Stock Assessment

Assessment complete: Yes

Assessment level and method Level 3

Catch rate predictions, standardised CPUE

Breeding stock levels: Adequate

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2012 fishing season based on catch and effort statistics, settlement analysis (53,000 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (13,000 shells measured), shell discard rates by size and location, population dive 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 2013 was undertaken and provided to the Stock Assessment Working Group (SAWG). The SAWG is a Department-Industry group that provides integrated advice to the Director General on the sustainable harvest of the pearl oyster resource. The results for each zone, and issues relevant to stock sustainability were:

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 2012, CPUE was 36 shells per dive hour, a decline of 35% from 2011 (55 shells per dive hour; Pearl Figure 3). The decline over the past two years indicates that stock levels are returning to normal levels after record high levels in 2008 - 2011.

Catch rate prediction: Recruitment to the fishery is predicted by the piggyback spat abundance index at 4 to 6 years prior to the current fishing year and is used in conjunction with effort range to set the quota for forthcoming years. A very high 0+ spat abundance detected in the Zone 2 fishery in 2005 was confirmed in the 1+ spat 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 (Pearl Figure 3), but CPUE has now returned to normal levels as a result of spat settlements returning to normal levels.

Using the catch prediction system, the culture catch quota for 2013 was reduced to a unit value of 1,200 shells (TAC = 548,400) which is a 14% reduction in the 2012 TAC of 639,800 shell. Fishers were also given an MOP quota of 163 shell per unit to further explore the potential of the MOP fishery, resulting in a total quota of 1,363 shells per unit.

Zone 1: The Zone 1 fishery has not been fished for three years.

Breeding stock: Under average growth and mortality and recent levels of TAC, 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. Despite the fishery trialling a minimum size of 100 mm for 3 years, the basis for quota setting remains the abundance within the 120-165 mm size class.

Animals that survived this 'gauntlet' were effectively protected from the age of 6 to 7 years onward, and could have lived for another 15 to 20 years. With very low natural mortalities, this results in a large broodstock being built-up over time. The fishery is trialling the capture of a conservative level of MOP shell which should not make a significant impact on the breeding stock. In Zone 1, breeding stock should also be increasing due to the low effort since 2002, including no fishing in 2004, 2009 - 2012.

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 2012. 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 36 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 has demonstrated that pearl farming has negligible impacts on habitat and environment.

Social Effects

Direct

Pearl oyster fishing vessels operate from the Lacepede Islands north of Broome to Exmouth Gulf in the south. The number of vessels in the fishing fleet has been slowly reducing from 16 in 1997 (overall), mostly due to increased fleet efficiency and increased reliance on hatchery-produced

shells. In 2009, with the negative impact of the Global Financial Crisis (GFC) on the industry, only two vessels fished. The number of vessels fishing in 2012 was five.

Most vessels presently operate 10 – 14 crew for the fishing of pearl oysters between March and June each year. These vessels also support shell operations and 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 Total Industry value for 2012

Level 5 - > \$20 million (\$79 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 byproducts in 2012 was considered to be approximately \$79 million, which is slightly lower than 2011, in which it was around \$93 million.

Fishery Governance

Target effort range: **14,071 - 20,551 hours**

The target effort range relates to the time required to achieve the TAC (culture shell only) in the pearl oyster fishery of 694,800 oysters in 2012 (639,800 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 15,589 dive hours of effort, which was within the target range. Zone 1 of the pearl oyster fishery was not fished in 2012.

Current effort level: **Acceptable**

Overall fishery effort level is acceptable.

New management initiatives (2013)

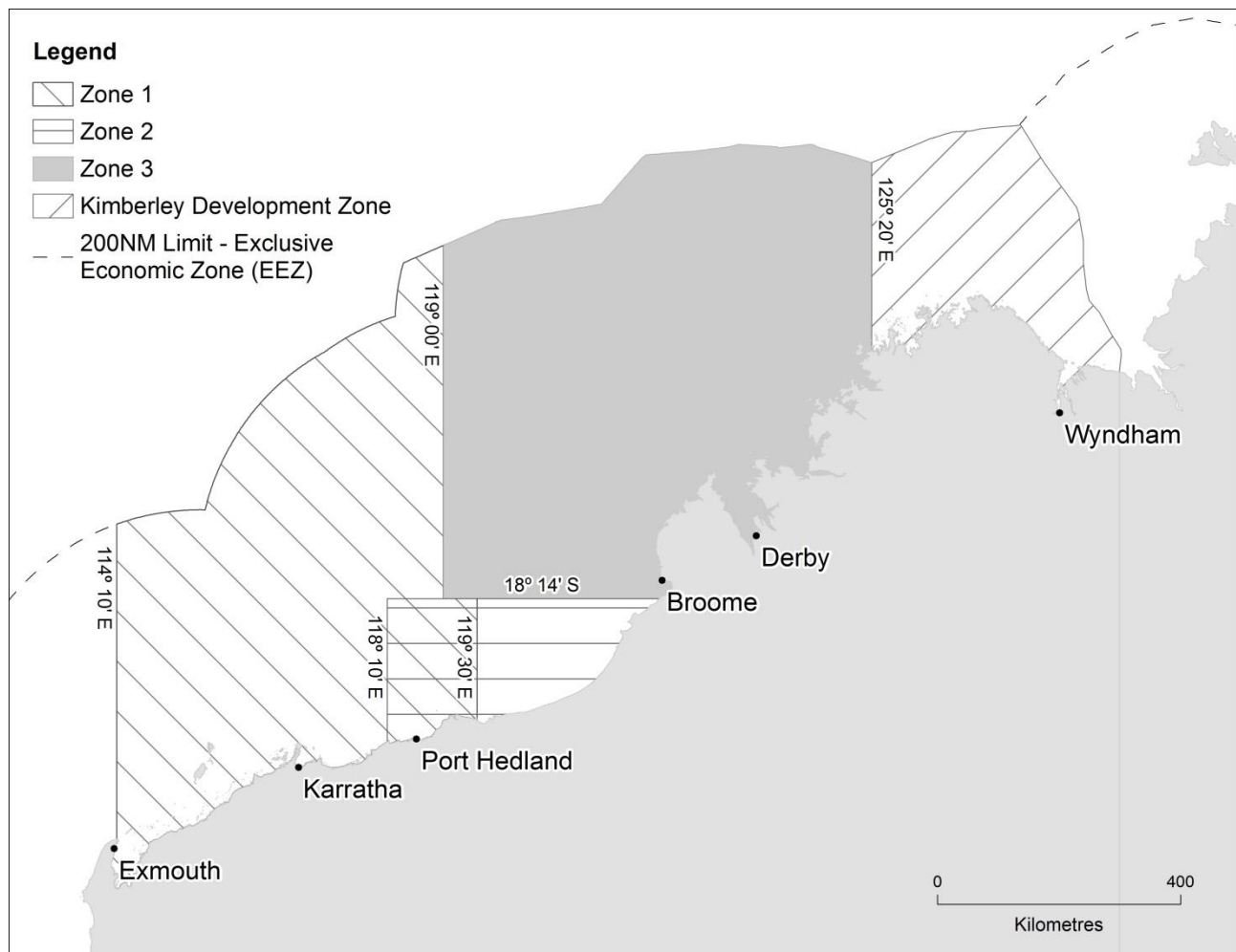
DoF has approved a two-year trial (2012/2013) for industry to take smaller shell legally, 100-120 mm, and to harvest MOP. The request to take smaller shell was put forward by industry to evaluate the economics for their business model. DoF advised that there were no sustainability issues, under a fixed TAC.

A new State Act of Parliament to ensure the sustainability and management of all WA's aquatic biological resources is planned for introduction into Parliament in 2013. The new Act will replace both the Fish Resources Management 1994 and the Pearling Act 1990. The Department is facilitating a review of the current legislative framework ahead of the introduction of the new Act to adopt a more streamlined governance structure for the pearl oyster fishery and activities associated with pearl culture.

driver of the high abundance in 2008-2011. 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. Future signs for 2013 suggest a market recovery but natural declines in oyster abundance due to lower settlement. 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.

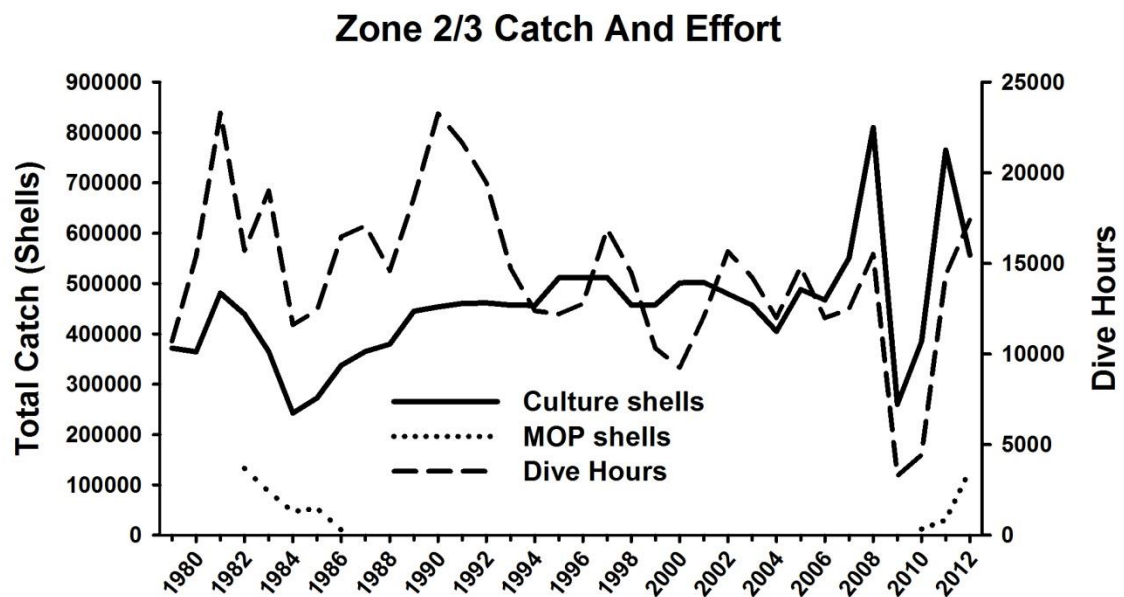
External Factors

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



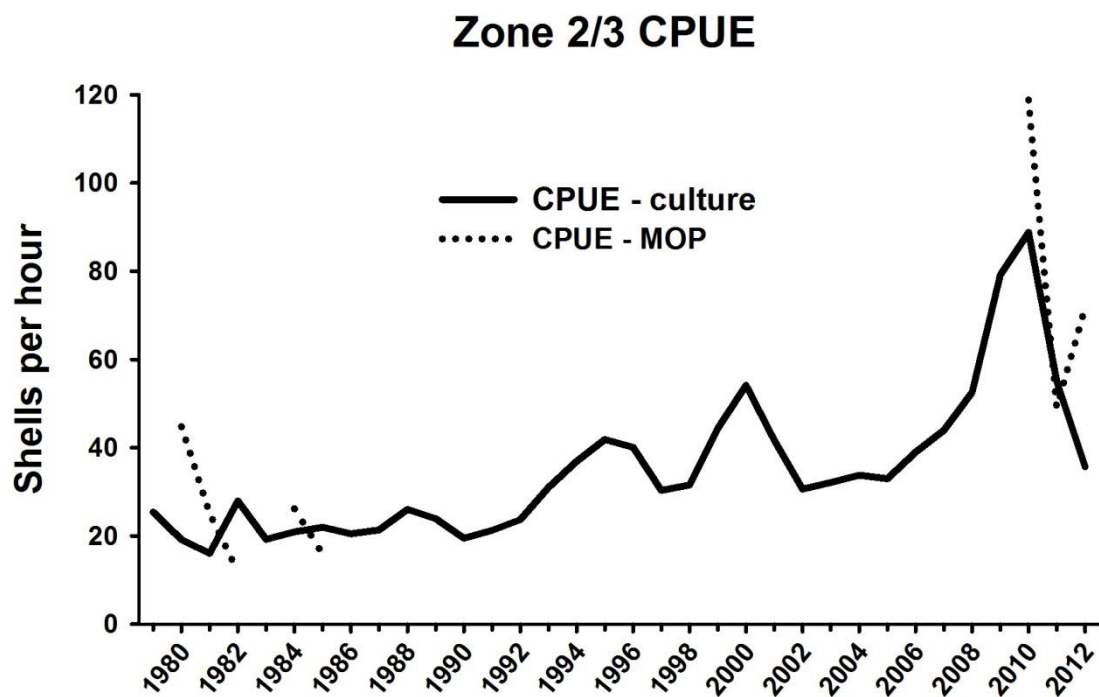
PEARL FIGURE 1

Distribution of pearl oyster stocks and fishing zones in Western Australia.



PEARL FIGURE 2

Pearl shell catch and effort – Broome area (Zone 2/3)



PEARL FIGURE 3

Pearl shell catch per unit effort (CPUE) in the Zone 2/3 fishery.

Beche-de-mer Fishery Status Report

A. Hart, D. Murphy and K. Green

Main Features

Status

Stock level	Acceptable
Fishing level	Acceptable

Current Landings

<i>Holothuria scabra</i> – Sandfish	13 t
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Fishery Description

Beche-de-mer, also known as ‘sea cucumbers’ or trepang, are in the Phylum Echinodermata, Class Holothuroidea. They are soft-bodied, elongated animals that usually live with their ventral surface in contact with the benthic substrate or buried in the substrate.

The Western Australian *beche-de-mer* fishery is primarily based in the northern half of the State, from Exmouth Gulf to the Northern Territory border, however fishers do have access to all Western Australian waters. It is a hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading. While six species have been taken, prior to 2007 it was primarily a single species fishery, with 99% of the catch being sandfish (*Holothuria scabra*). An additional species (deepwater redfish - *Actinopyga echinites*) was also targeted during 2007-2010.

Governing legislation/fishing authority

Fisheries Notice no. 366

Exemption under 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

Industry Annual General Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), under a Service Level Agreement with the Department. Annual Broome Consultative Forum.

Boundaries

The *beche-de-mer* fishery is permitted to operate throughout Western Australian waters with the exception of a number of specific closures around the Dampier Archipelago, Cape Keraudren, Cape Preston and Cape Lambert, the Rowley Shoals and the Abrolhos Islands.

Management arrangements

The developing fishery for *beche-de-mer* is managed through input controls including limited entry, maximum number of divers, species-dependent minimum legal size limits, and gear restrictions. Access to the fishery is limited to the 6

Fishing Boat Licence holders listed in the Instrument of Exemption enabling the take of *beche-de-mer*.

Beche-de-mer may only be harvested by hand or diving by licensed commercial fishers operating under the authority of a Fishing Boat Licence that is listed on the Instrument of Exemption.

The maximum number of divers (per endorsed fishing boat licence) allowed to dive for *beche-de-mer* at any one time is four, with a maximum number of six crew allowed on the vessel.

There are six species of *beche-de-mer* harvested in Western Australia. At present, the minimum target lengths for these commercial *beche-de-mer* species are based on the Northern Territory's minimum sizes, which have been set based on size at sexual maturity.

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

Research summary

Current research is focused on reporting of annual catch and effort statistics. A daily catch and effort logbook designed for the fishery 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 2012):

13 tonnes (live weight)

Landings

In 2012 the total *beche-de-mer* catch was 13 t live weight (*Beche-de-mer* Table 1), a decrease of 77% over last year's catch of 56 t and the lowest catch in 18 years, due to nil catch from the newly developing redfish fishery, and reduced effort focused on the traditional sandfish fishery.

On a species-specific level, the 13 t catch was made up of (100%) *Holothuria scabra* (*Beche-de-mer* Figure 1), being 63 % lower than the 2010 catch of 35 t. This is the second year in the last 6 years that *Actinopyga echinites* has not been

NORTH COAST BIOREGION

caught and represents an effort reduction on this new target species. Industry has advised they are adopting a rotational fishing strategy with *A. echinites*, with 2011 and 2012 being a rest period.

Fishing effort/access level

Only 1 of 6 licensed vessels fished for *beche-de-mer* in 2012, 1 vessel less than 2007 to 2011.

Total effort for sandfish was 413 hours fished – about 73% lower than in 2011 and approximately 61% below the average of the last 7 years for sandfish fishing only (*Beche-de-mer* Table 1). The effort comprising of 47 hours wading and 366 hours diving.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Level 2 - Catch rate

Breeding stock levels: Adequate

The overall catch rate for sandfish (diving only in 2012) was 31 kg/hour, this is 15% below last year's catch rate of 37 kg/hour and close to the average of the last 10 years, being 36 kg/hour (*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 – 0.55) for the same species suggests that a cautious interpretation of the model outputs is required. The model is updated with new data every year.

The 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 2012, the catch (13 t) was not met but catch rate (31 kg/hr) was 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 2012, there was no fishing for this species so the performance measures could not be evaluated.

Non-Retained Species

Bycatch species impact: Negligible

No bycatch species are known to be taken in this fishery. Given the selective method of fishing used (diving or wading, collection by hand only), the minimal level of interaction with other species is likely to be maintained.

Protected species interaction: Negligible

There are currently no known interactions with protected

species in this fishery and given the methods of collection this is likely to remain the case.

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 2012, one vessel with a total of four crew worked 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 2012:

Level 1 - < \$1 million

The estimated annual value for 2012 was \$42,290 based on an average product price of \$10.00/kg for sandfish (gutted and boiled) or \$3.33/kg live weight. This is a farm gate value and supports a substantial processing and value-adding sector.

Fishery Governance

Sandfish catch range: 20 – 100 tonnes

Redfish catch range: 40 – 150 tonnes

Current fishing level of 13 tonnes for Sandfish are not within the target ranges due to reduced effort in the fishery and no fishing in the newly developed Deepwater Redfish fishery.

New management initiatives (2012/13)

A review of the developing Beche-de-mer fishery is planned for 2013/14.

The species-specific information on catch and effort from the daily logbook, implemented in 2007, has facilitated the development of species-specific performance indicators and these will be refined as more information arises.

park planning has to date restricted this fishery from general use zones of MPAs. However consideration of removal of this restriction is currently underway as all other fisheries have access to general use zones. If successful, this action will likely see some expansion into previously unfished areas. Currently, lack of experienced fishers and suitable vessels is restricting catch to low levels. This situation is expected to change within the next two years.

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

BECHE-DE-MER TABLE 1

Catch and effort of *Beche-de-mer* in Western Australia for the last decade.

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)
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
2011	56	1539	56	1539	0	0	0
2012	13	413	13	413	0	0	0

BECHE-DE-MER TABLE 2

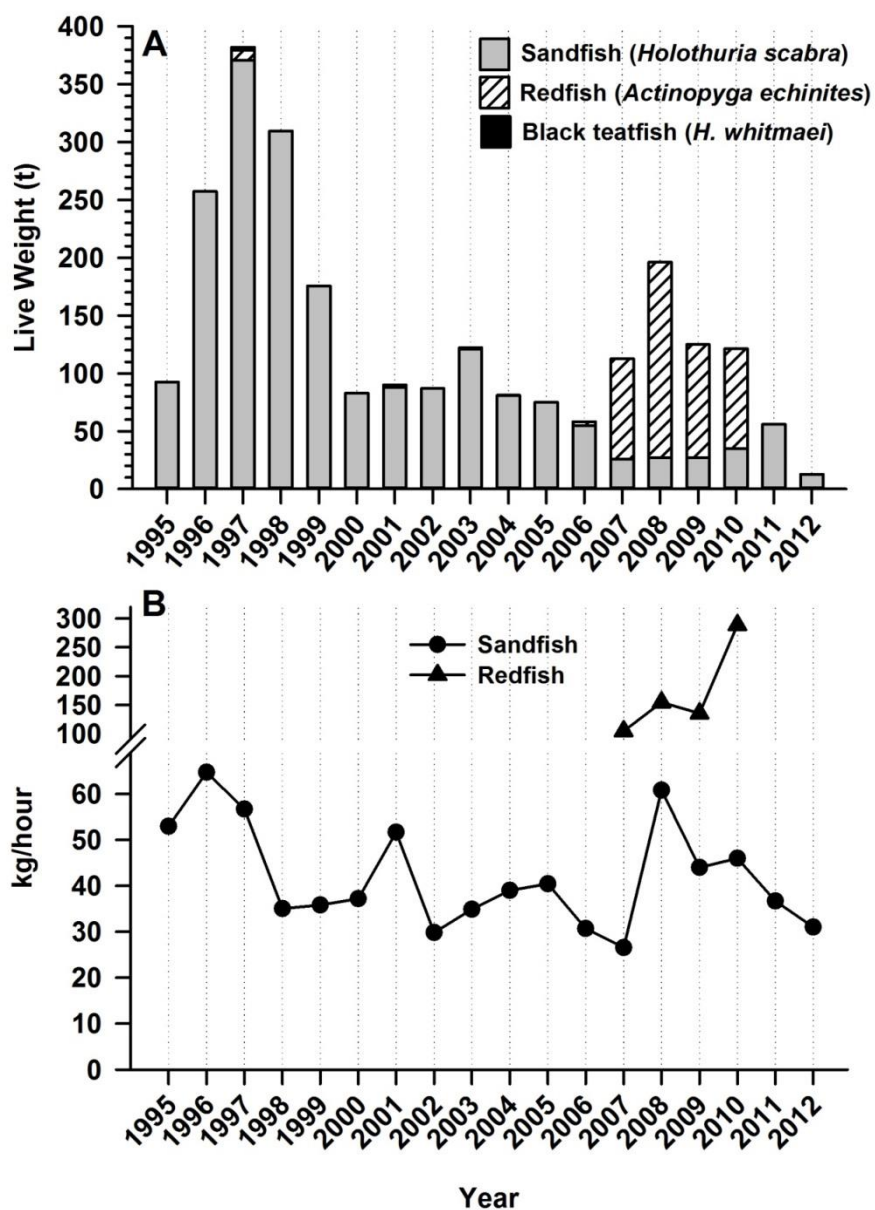
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

Area	MSY (t)	Current average catch (2005-2012) (t)	Parameter estimates*		
			r	K (t)	q
Entire Fishery	143	40	0.84	966	0.21
Kimberley region (Grid 1425 and 1426)	70	34	0.95	423	0.55

* 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.

North Coast Crab Fishery Status Report

D. Johnston, D. Harris, C. Marsh and P. Carter

Main Features

Status		Current Landings	
Stock level		Blue swimmer crab	
Blue swimmer crab	Acceptable	Commercial	12 t
Mud crab	Unknown	Recreational	3.4 t
Fishing Level		Mud crab	
Blue swimmer crab	Acceptable	Commercial	1.3 t
Mud crab	Acceptable	Recreational	9387 retained animals

Fishery Description

Blue Swimmer Crab

The blue swimmer crab (*Portunus armatus*) 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 stocks are concentrated in the coastal embayments and estuaries between Geographe Bay in the south west and Nickol Bay 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 Pilbara Developing Crab Fishery are only permitted to use 'hourglass' traps. The Onslow and Nickol Bay prawn trawl fisheries also retain crabs as a by-product.

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 of the *Fish Resources Management Act 1994* (FRMA). The exemptions were issued to allow for the sustainable exploration of the commercial viability of fishing crab stocks along the Pilbara coastline.

Mud Crab

Four species of mud crab (*Scylla* spp.) have been identified in the Indo-West Pacific region, of which the green mud crab (*Scylla serrata*) and brown mud crab (*Scylla olivacea*) occur in Western Australia (Keenan *et al.*, 1998)¹. The maximum size reported for green mud crabs is between 250 – 280 mm carapace width (CW) (Lloris, 2001)², whereas the maximum size of brown mud crabs is between 135 – 139 mm CW (Tongdee, 2001)³. A species identification waterproof card

outlining minimum legal size limits and defining characteristics between green and brown mud crabs was produced by the Department of Fisheries in 2011 and is widely available to members of the public.

The green mud crab is predominantly found in estuarine habitats in north-western Australia from the Northern Territory border to Shark Bay, but have also been found as far south as the Wilson Inlet at Denmark in years of strong southern coastal Leeuwin Current flow (Gopurenko *et al.*, 2003)⁴. The brown mud crab has a more restricted distribution limited to northern embayments, with most catches from King Sound 200 km northwest of Broome. Brown mud crabs are more tolerant of low salinity than green mud crabs, but less tolerant of lower temperatures. They are also considered to exhibit a strong preference for the intertidal zone, while green mud crabs make regular use of both intertidal and subtidal habitats up to 20 m depth offshore (Hill, 1994⁵, Robertson, 1996⁶).

The Kimberly Developing Mud Crab fishery targets the green (giant) mud crab and the brown (orange) mud crab via the use of crab traps, between Broome and Cambridge Gulf near the WA and Northern Territory border, with fishing effort concentrated around Cambridge Gulf, Admiralty Gulf, York Sound and King Sound (see North Coast Crab Figure 1 and 2). From 1994 to 2005 commercial fishing for mud crabs was authorised through permissive conditions on Fishing Boat Licences. From 2006 to present, access to the Kimberly Developing Mud Crab Fishery has been granted via

1 Keenan, C.P., Davie, P.J.F., and Mann, D.L. (1998). A revision of the genus *Scylla* de Hann, 1833 (Crustacea: Decapoda: Brachyura: Portunidae). *Raffles Bulletin of Zoology*. 46(1): 217-245.

2 Lloris, D. (2001). FAO/SIDS species identification sheet: *Scylla serrata*

3 Tongdee, N. (2001). Size distribution, sex ratio and size at maturity of mud crab (*Scylla* spp.) in Rangong Province, Thailand. *Asian Fisheries Science* 14: 113-120.

4 Gopurenko, D., Hughes, J.M., and Bellchambers, L.M. (2003) Colonisation of the south-west Australian coastline by mud crabs: evidence for a recent range expansion or human-induced translocation? *Marine and Freshwater Research*. 54. 833-840.

5 Hill, B.J. (1994) Offshore spawning by the portunid crab *Scylla serrata* (Crustacea: Decapoda). *Marine Biology*. 120:3. 379-384.

6 Robertson, W.D. (2011) Abundance, population structure and size at maturity of *Scylla serrata* (Forsk.) (Decapoda: Portunidae) in Eastern Cape estuaries, South Africa. *South African Journal of Zoology*. 31:4. 177-185.

Exemptions, which were formerly issued under Section 7(3)(c) of the Fish Resources Management Act 1994, for 'the exploration or development of fisheries or the development of fishing technology'.

The design of mud crab trap permitted to be used is not prescribed in the management arrangements at present, in order to allow some flexibility for exemption holders to determine the most appropriate gear for the high tidal conditions. However, prior to use the design of mud crab trap must be approved by the Department of Fisheries. At present in the Fishery there are two styles of mud crab trap used, a rectangular trap or a round trap. The rectangular design generally follows the dimensions of not more than 1000 mm length, 600 mm width and 300 mm height with a rigid mesh of 50x70 mm with 2 openings for crabs to enter the trap. The round trap design is generally 500 mm high; 1000 mm diameter with flexible nylon mesh of around 50 mm mesh size (knot to knot) with 4 openings for crabs to enter the trap.

Access to the Kimberly Developing Mud Crab Fishery is made up of two broad groups: Aboriginal Community Commercial Mud Crab Exemption holders and Commercial Exemption holders. There are currently 3 commercial operators and 2 Aboriginal corporations holding exemptions to fish for mud crabs in WA. The fishers generally operate from March to November, with May to September being the most productive months to avoid summer and associated seasonal cyclone weather events. Commercial operators generally fish on a part-time basis with most operating other endorsements including Kimberley Gillnet and Barramundi Managed Fishery Licences and fishing boat charters. Operators tend to fish remote waters for long periods of time in large mother ships, using small dinghies known as doreys to enter mangrove estuaries with crab traps generally checked each daylight high tide.

Governing legislation/fishing authority

Commercial

Blue Swimmer Crab

Fish Traps Prohibition Notice 1994

Exemptions under Section 7 of the *Fish Resources Management Act 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

Mud Crab

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

Notice 539 – Crab Fishing Restrictions (Roebuck Bay) Notice 1991

Notice 194 – Mud Crabs (Scylla sp)

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Consultation process

Commercial

Industry Annual Management Meetings are convened by the West Australian Fishing Industry Council (WAFIC), under a Service Level Agreement with the Department. Annual Broome Consultative Forum (Mud crabs)

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

Boundaries

Blue Swimmer Crab

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 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.

Mud Crab

Three commercial operators are permitted to fish from King Sound to the Northern Territory border, with closed areas around communities and fishing camps. One Aboriginal Corporation is permitted to fish in King Sound, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier Peninsular, north of Broome.

Notices issued under the *Fish Resources Management Act 1994* prohibit all commercial fishing for mud crabs in Roebuck Bay and an area of King Sound near Derby.

Management Arrangements

Blue Swimmer Crab

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. The commercial minimum size of 135 mm carapace width which applies in the Pilbara Developing Crab fishery should ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

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. A maximum of 400 pots are permitted in the fishery.

Management controls for the 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) monitors the activities of all trawlers in these fleets.

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 north Coast bioregion, along with a bag limit of 20 crabs per person with a boat limit of 40 crabs. Restrictions also govern gear types that can be used to take blue swimmer crabs.

Mud Crab

Since 2006, access to the Kimberly Developing Mud Crab Fishery has been granted via Instruments of Exemption, issued under Section 7 of the *Fish Resources Management Act 1994*. The mud crab fishery is managed under an input control system, primarily through the regulation of vessel and trap numbers (maximum of 1,070 traps), gear restrictions and spatial closures. Three commercial operators are permitted to fish 300 traps from King Sound to the Northern Territory border, one Aboriginal Corporation is permitted to fish in King Sound using 150 traps, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier Peninsular, north of Broome using 20 traps. Prior to the exemption not being renewed in 2011, a third aboriginal corporation fished in Carnot Bay and Camp Inlet using 20 traps.

From 1 May 2013, mud crab exemption holders have been permitted to retain by catch of other *Portunid* crabs for a two year trial period ending 30 April 2015. This is likely to result in small numbers of blue swimmer crabs being retained. A minimum size limit of 135 mm for blue swimmer crabs has been imposed, consistent with the size limit used in the Pilbara Developing Crab Fishery. No limits have been placed on the number of blue swimmer crabs retained.

Breeding stocks are protected by maintaining minimum size limits (150 mm CW for green mud crab and 120 mm CW for brown mud crabs) set well above the size at sexual maturity (90-110mm CW for green and 86-89mm CW for brown). These size limits apply to both the recreational and commercial take of the species.

Recreational fishers for mud crabs are restricted to a daily bag limit of 5 mud crabs, with a boat limit of 10 mud crabs.

Research Summary

Blue Swimmer Crab

Data for the assessment of blue swimmer crab stocks in the North Coast bioregion is obtained from trap fishers' compulsory monthly catch and effort returns and daily research log books, and trawl fishers' daily logbooks.

Baseline 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.

Mud Crab

Data for the assessment of mud crab stocks in the North

Coast bioregion is obtained from trap fishers' compulsory catch and effort returns and daily logbooks. Relevant research information is sourced from 2 recent FRDC funded projects involving NT Fisheries investigating escape gap sizes of traps (Grubert & Lee., 2012)¹ and environmental correlations with mud crab catches in the Northern Territory (Meynecke *et al.*, 2010)². A third FRDC project has also been recently completed on equipping the mud crab industry with innovative skills through extension of best practice handling (Poole *et al.*, 2012)³.

Retained Species

Commercial landings (season 2011/12):

Blue swimmer crabs **12 tonnes**

Mud crabs **1.3 tonnes**

Blue Swimmer Crabs

The combined commercial catch of blue swimmer crabs from trap based crab fishers and prawn trawlers operating along the Pilbara coast during 2011/12 was 12 t, a 40% decrease on the 2010/11 catch of 20 t (North Coast Crab Figure 3). All of the recorded catch was taken by the trap fishery, with trawlers retaining no crabs during 2011/12. This catch accounted for 3% of the state commercial blue swimmer crab catch of 352 t for 2011/12 (West Coast Blue Swimmer Crab Figure 1).

Mud Crab

The total trap catch of mud crabs for the Kimberly Developing Mud Crab Fishery during 2012 was 1269 kg which represented 99.8% of the total catch of mud crab in Western Australia (North Coast Crab Figure 4). Logbooks submitted during 2012 reported that 99% or 1256 kg were brown mud crab and 1% or 13 kg were green mud crab. This catch level is significantly higher than the 218 kg reported in 2011 due to an increase in effort, with three commercial operators fishing and no Aboriginal Corporations fishing in the 2012 period. However, catch in 2012 was lower than the 5 year (2007 – 2011) mean of 3348 kg and may be attributed to the combination of cyclonic and flooding weather events and difficulty in retaining crew and securing local markets in 2012.

Recreational catch:

Blue Swimmer Crab

North Coast bioregion (boat-based catch 11-12)

3.4 tonnes

An integrated survey of boat-based recreational fish in WA was conducted from 1 March 2011 to 29 February 2012

1 Grubert, M.A. and Lee, H.-S. (2012). Improving gear selectivity in Australian mud crab fisheries, Northern Territory Department of Resources, Fishery Report.

2 Meynecke, J.-O., Lee, S.-Y., Grubert, M., Brown, I., Montgomery, S., Gribble, Johnston, D. and Gillson, D (2010) Evaluating the Environmental Drivers of Mud Crab (*Scylla serrata*) Catches in Australia. Final Report 2002/012. FRDC and Griffith University.

3 Poole, S., Mayze, J., Calogeras, C. (2012) Equipping the mud crab industry with innovative skills through extension of best practice handling. FRDC Project 2010-302. 183 pp.

(Ryan *et al.*, 2013)¹. The boat-based estimate for the North Coast bioregion was 3.4 t, compared with total landings of 15 t by the commercial sector over the same period.

A survey of recreational crabbing was conducted along the Pilbara coast between December 1999 and November 2000. The survey estimated the recreational catch of blue swimmer crabs for the region over the 12-month period to be 22 t, with most of the catch (19 t) taken from Nickol Bay (Williamson *et al.*, 2006)². 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.

Mud Crab

An integrated survey of boat-based recreational fish in WA was conducted from 1 March 2011 to 29 February 2012 and reported that 9387 green and brown mud crabs were retained during this period. Unfortunately a conversion to weight is not possible as species and sex was not recorded during the surveys. Mud crab species vary significantly in weight with anecdotal evidence suggesting brown mud crabs average around 300 grams, whereas green mud crabs can vary between 500 grams and 1.5 kg. There are also marked differences in weight between males and females.

Fishing effort/access level

Blue Swimmer Crab

Crab trap fishers along the Pilbara coast reported 13,880 traplifts during 2011/12, a 40% decrease on the 23,310 traplifts reported for 2010/11.

Mud Crab

Mud crab fishers along the Kimberley coast reported 2490 traplifts during 2012, a 908% increase on the 274 traplifts reported for 2011 (North Coast Crab Figure 4). However, this 2012 level of effort is significantly lower than the 5 year average of 4254 traplifts (2007-2011).

Stock Assessment

Assessment complete:

Blue Swimmer Crab **Pilbara - Yes**

Mud Crab **No**

Assessment level and method:

Blue Swimmer Crab **Level 2 - Catch rate**

Breeding stock levels:

Blue Swimmer Crab **Pilbara - Adequate**

Mud Crab **Unknown**

1 Ryan K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. and Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia 162 pp.

2 Williamson, P.C., Sumner, N.R. and Malseed, B.E. (2006). A 12-month survey of recreational fishing in the Pilbara region of Western Australia during 1999-2000, Fisheries Research Report No. 153, Department of Fisheries, Western Australia, 61 pp.

Blue Swimmer Crab

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.

The minimum legal size at first capture (127 mm carapace width for recreational fishers; 135 mm carapace width for commercial fishers based on industry agreement) for crab fisheries in the North Coast bioregion is set well above the size at first maturity 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 along the Pilbara coast are also supported by the influence of the warmer waters that occur at these latitudes which extends the spawning period over the whole year, whereas spawning is restricted to the late spring and early summer months on the lower West Coast.

Catch rates from the Pilbara trap fishery provides an index of abundance that can be used to assess fishery performance from year-to-year. Blue swimmer crab trap catch rates in the Pilbara Developing Crab Fishery increased steadily during the first three years of exploratory fishing for blue swimmer crabs along the Pilbara coast. This reflected more efficient fishing of 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. Favourable environmental conditions led to a significant increase in catch rates (~1.6-1.8 kg/traplift) from 2004/05 to 2006/07, before returning to longer-term mean catch rates (~0.7-1.0 kg/traplift).

The Pilbara Developing Crab Fishery recorded a mean catch rate for 2011/12 of 0.9 kg/trap lift – a slight increase on the catch rate of 0.8 kg/traplift reported during the previous year.

Mud Crab

Between 1994 and 2005, trap catch and effort for mud crabs in the Kimberly remained low, ranging between 68 kg and 2869 kg and between 40 traplifts and 5250 traplifts. Catch rate varied significantly during these years between 0.2 and 2.0 kg/traplift. When exemptions were formally established for commercial fishers and Aboriginal corporations in 2006, the catch and effort peaked at 9293 kg from 18720 traplifts. The majority of catch and effort was attributed to the extensive exploratory efforts of a single fisher with catch per unit effort for the fishery around 0.5 kg/traplift. Although catch and effort declined in 2007, catch rate increased significantly to 1.1 kg/traplift potentially due to greater knowledge of the fishery. Catch and effort remained fairly stable in 2008 and 2009 (~ 5000 kg from ~ 8000 traplifts) but has since declined significantly due to a lack of fishing by the majority of fishers, with one exemption not renewed in 2011. Catch rate over the past 5 years (2008 – 2012) has remained relatively steady between 0.5 and 0.8 kg/traplift, with a catch rate of 0.5 kg/traplift reported in 2012. Historically, the majority of commercial crabbing has occurred in the areas of Cambridge Gulf, Admiralty Gulf, York Sound and King Sound, with fishing reported from Cambridge Gulf and Admiralty Gulf in 2012.

The minimum legal size at first capture is 150 mm carapace width (CW) for green mud crab (*Scylla serrata*) and 120mm CW for brown mud crab (*Scylla olivacea*). This is set well above the size at first maturity of 90-110mm CW for green and 86-89mm CW for brown mud crab fisheries in the North Coast bioregion.

Non-Retained Species

Bycatch species impact

Negligible

Blue Swimmer Crab

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.

Mud Crab

Mud crab traps are purpose built to effectively target larger (legal sized) mud crabs. The overall trap design and large mesh size allows sub legal mud crabs and non-targeted bycatch species opportunity to escape the trap, preventing them from being retained. The gear needs to be pulled regularly, and undersized and berried crabs must be returned to the water.

Protected species interaction

Negligible

Blue Swimmer Crab

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.

Mud Crab

As mud crab traps are purpose built to target mud crab species and are set for relatively short periods of time, the possibility of causing harm to threatened and protected species is minimal.

Ecosystem Effects

Food chain effects

Low

Blue Swimmer Crab

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.

Mud Crab

As the retained commercial catch of mud crabs is low, the commercial fishery represents a small proportion of the

available biomass. Therefore secondary chain effects would not be likely to be significant within the surrounding ecosystem of the fishery.

Habitat effects

Negligible

Blue Swimmer Crab

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.

Mud Crab

Trap fishing in the shallow waters of associated mangrove tidal creeks and near shore embayments result in limited habitat disturbance. The large mesh size prevents capture of benthic organisms and only minor dragging of traps on the sea floor occurring in trap retrieval. The sheltered shallow mangrove environment is protected from wind and waves where the majority of traps are deployed, resulting in minimal habitat damage.

Social Effects

Blue Swimmer Crab

During 2011/12, two people were employed as skippers and crew on vessels fishing for blue swimmer crabs along the Pilbara coast. Additional employment for several workers has been created in Point Samson through the development of post-harvest processing of the crab catch.

Mud Crab

Historically the mud crab fishery has had a high community value and a low commercial value. Commercial fishers travel vast distances due to the remoteness of their operations and stay in the vicinity for several weeks before returning to unload catch. In this scenario crabs are frozen and generally sold to local markets although live product may also be sold at premium prices.

During the 2012 season, this fishery employed 3 commercial operators. The increased number and effort from commercial fishers in 2012 proportionally resulted in an increased catch and effort from 2011 when only 1 commercial and 1 aboriginal corporation fished. However the combination of unusual weather including seasonal flooding and cyclone activity coupled with difficulty with retaining crew, attracting investment and meeting local market requirements of product resulted in this lower than normal fishing level for the 2 Aboriginal Corporations in 2012.

Economic Effects

Estimated annual value (to fishers)

Level 1 - < \$1 million

Blue Swimmer Crab

Average beach prices for trap caught blue swimmer crabs in the North coast fisheries for the year were around \$5-6/kg. The frozen crabs landed by trawlers generally attract a slightly lower beach price than those landed from traps.

The crab catch from the Pilbara region was sold through local and interstate markets.

Mud Crab

Mud crab landings from the Kimberly mud crab fishery during 2012 were worth approximately \$33,000, an 82% increase on the \$6,000 generated in 2011. As the Kimberly region is the only commercial mud crab fishery in Western Australia this essentially represents the total value of the commercial mud crab fishery in Western Australia. The average beach price for green (uncooked) mud crabs in the Kimberly for 2012 was around \$26/kg (however note this value is based on a small proportion of total catch from an individual processor). Aboriginal corporations may also trade and barter product adding value to the local communities that cannot be estimated.

Fishery Governance

Target catch (or effort) range:

Blue Swimmer Crab Pilbara	N/A
Mud Crab	N/A

Current fishing (or effort) level:

Blue Swimmer Crab Pilbara	N/A
Mud Crab	N/A

Blue Swimmer Crab

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 had not fished under his exemption since the 2007/08 fishing season. This exemption was subsequently rescinded in 2009, and the number of traps in the Pilbara trap fishery has reduced from 600 down to 400.

Mud Crab

The mud crab fishery is currently being fished at low/precautionary levels due to the low number of fishers operating in the fishery and relatively low effort across a large area of the Kimberly. Although some fishing occurs in localised areas of the coastline it is believed that stock levels are not being significantly affected at this time.

New management initiatives

Blue Swimmer Crab (2011/12)

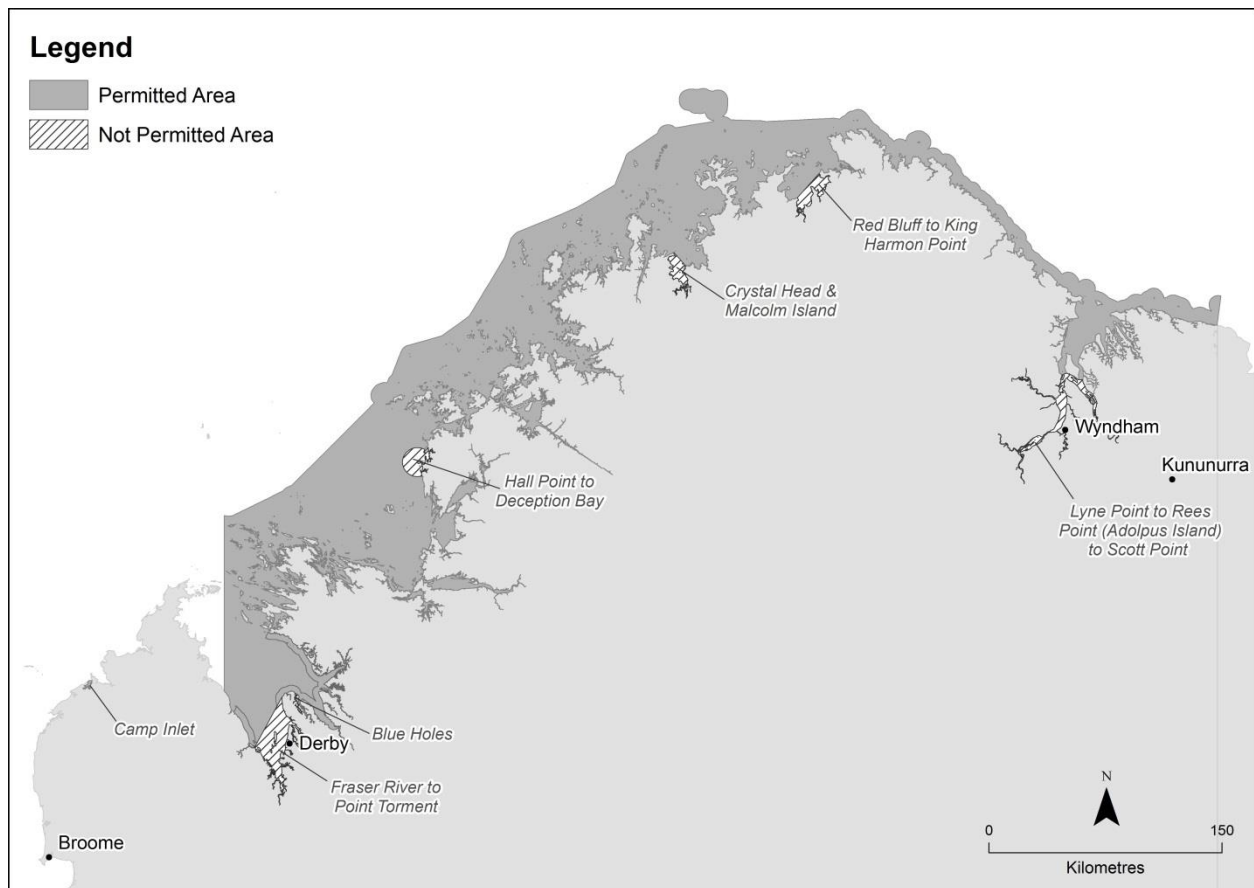
The Department proposes to bring the Pilbara Crab DNF under formal management arrangements in the near future.

Mud Crab (2012)

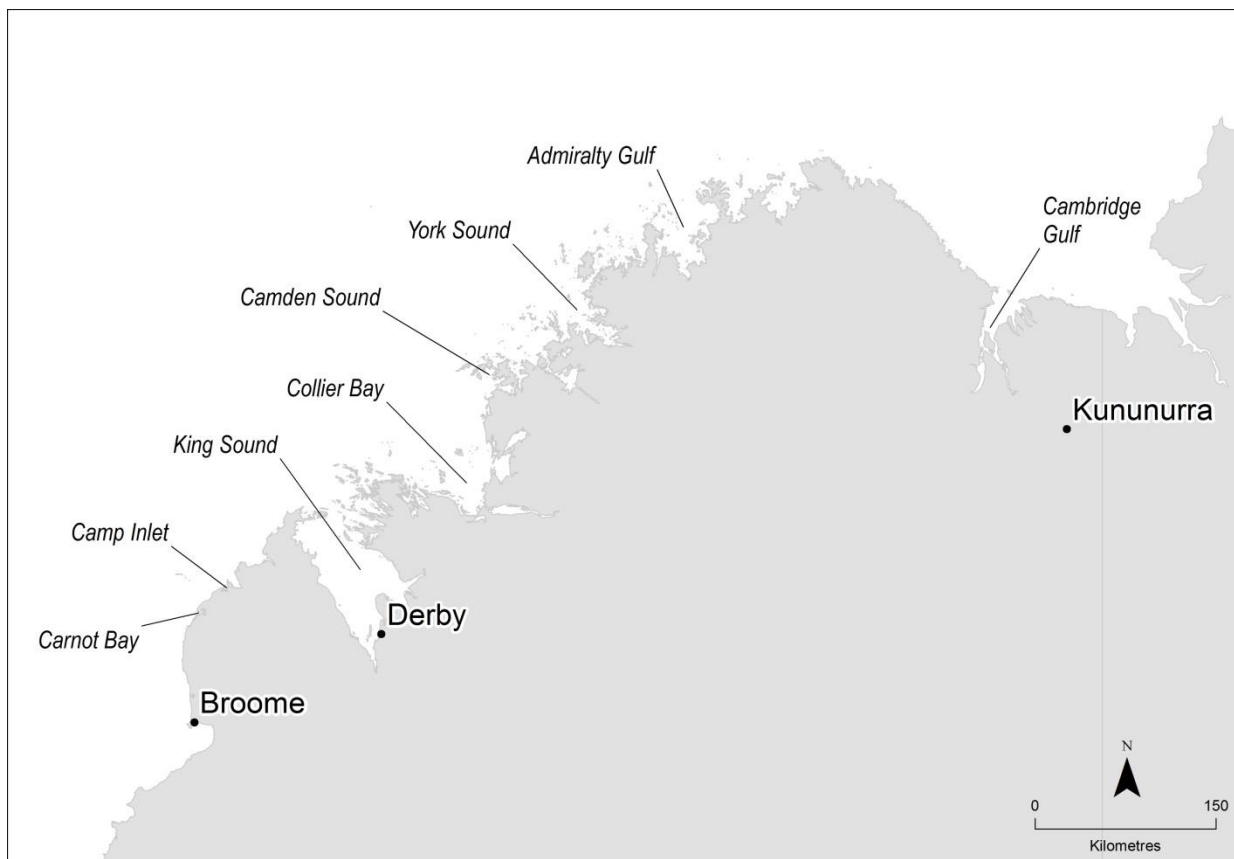
The Department proposes to bring the Mud Crab Fishery under formal management arrangements in the near future.

External Factors

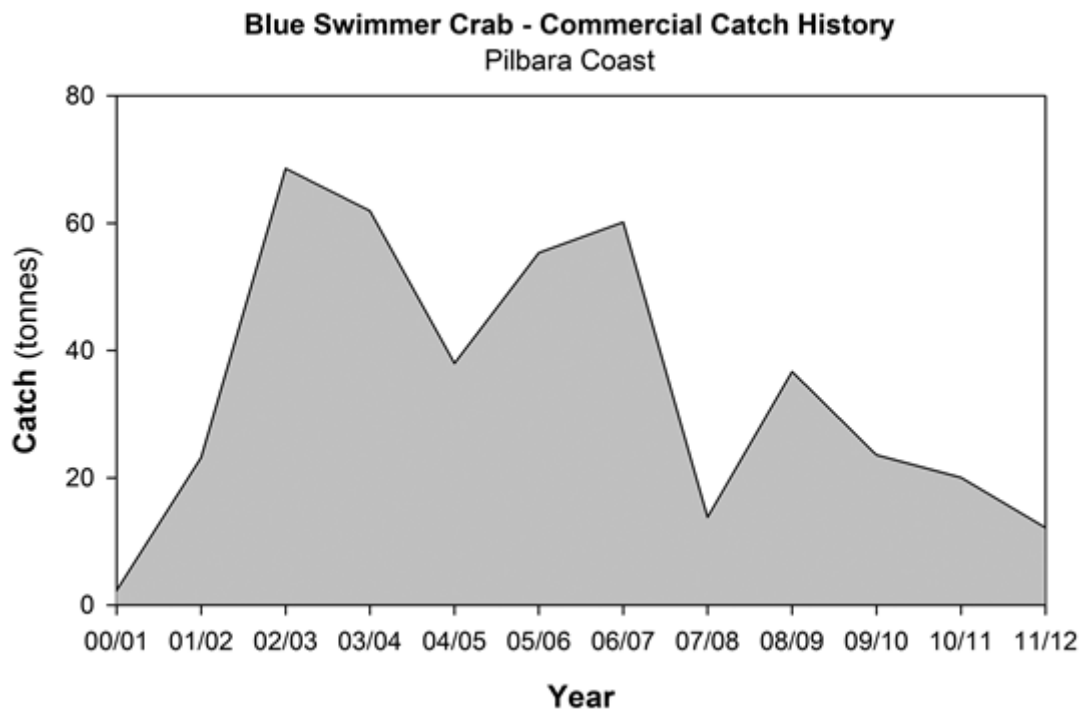
Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of these variations are not fully understood, it is considered most likely due to environmental influences on spawning success and larval survival through to recruitment. The relationship between environmental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

**NORTH COAST CRAB FIGURE 1**

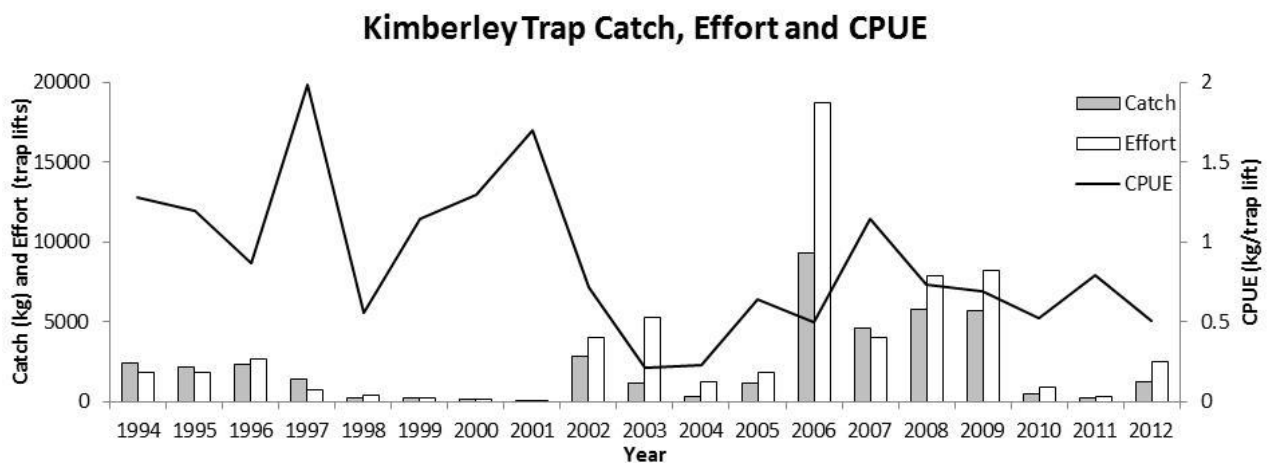
Areas fished for mud crab along the Kimberley coast of Western Australia.

**NORTH COAST CRAB FIGURE 2**

Key areas fished by exemption holders operating in the Kimberly Developing Mud Crab Fishery in Western Australia.

**NORTH COAST CRAB FIGURE 3**

Commercial catch history for the blue swimmer crab (*Portunus armatus*) along the Pilbara coast since 2000/01. Data represents the total crab catch for trap and trawl sectors, consequently it is difficult to incorporate effort and CPUE in this figure. Trap effort and CPUE is summarised in the text.

**NORTH COAST CRAB FIGURE 4**

Annual catch, effort and catch rate (CPUE) for the Kimberly Region since 1994 when permissive conditions of fishing boat licenses were issued. The Kimberly Developing Mud Crab fishery commenced by exemption in 2006.

AQUACULTURE

Regional Research and Development Overview

Aquaculture in the North Coast Bioregion is dominated by the production of South Sea pearls from the silver lip pearl oyster *Pinctada maxima*. This industry sector utilises both wild-caught and hatchery-reared oysters to produce 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, signed in June 2006, 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 Environmental Protection Authority (EPA) to increase output to 2,000 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 approval.

A demonstration project culturing marine microalgae for the production of bio-fuels, omega-3 lipid and protein biomass

has started near Karratha. The company is planning for significant increases in scale and production capability in the future.

To assist in addressing the regulatory and approvals issues concerning aquaculture development in WA, the Department of Fisheries has received Government funding of \$1.85 million over 2½ years to establish two aquaculture zones in the Kimberley and Mid-West regions. Through this project, the Department of Fisheries will secure strategic environmental approvals for the zones from the EPA, thereby streamlining the approvals processes for commercial projects within zoned areas and providing an “investment ready” platform for prospective investors. Located in the vicinity of Cone Bay, the Kimberley zone is expected to be established by the end of 2013.

The Department of Fisheries manages the operations of the Broome Tropical Aquaculture Park, which provides the basic resources and facilities for supporting aquaculture development and training.

An indigenous project at One Arm Point operates a marine hatchery that focuses on a variety of ornamental and edible marine species.

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. An additional two officer Recreational Mobile Patrols operates in the area throughout the year. 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 develops programs and coordinates delivery of education activities to school-aged children and awareness raising activities with the broader community. In-school and school holiday programs are the main method of reaching students in both the Pilbara and the Kimberley, while attendance at shows and local events target the broader community. An increased emphasis has been

NORTH COAST BIOREGION

placed on developing materials that focus on local issues and their dissemination through regional brochure stockists and local publications.

Activities during 2011/12

During 2011/12, the North Coast Bioregion's FMOs delivered a total of 6,314 officer hours of active compliance patrol time (North Coast Compliance Table 1). – an increase of 1,394 hours from the previous year (North Coast Compliance Figure 1) due to the impact of two additional Marine Park FMO's. FMOs also achieved 15,040 personal compliance contacts with the fishers and non-fishers across the recreational and commercial sectors.

There was improved engagement with short and long term visitors to the Pilbara and the Kimberley through a dedicated education program targeting caravan parks.

In the commercial sector FMOs undertook prosecution action as a result of compliance operations in 2011/12. This resulted in 11 infringement warnings, 28 infringement notices being issued and 41 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 174 infringement warnings were issued, 207 infringement notices and 22 matters resulted in prosecution action.

Initiatives in 2012/13

The Department will begin dedicated compliance and education patrols of the Camden Sound and 80 Mile Beach Marine Parks.

At sea compliance patrols of the 80 Mile Beach Marine Park will be carried out utilising the Departments first amphibious vessel, purposely built to be launched and retrieved in the large tides encountered in the Kimberley.

A new position as Marine Park Education and Interpretive Officer will be created for the Camden Sound Marine Park.

The Department's office in Kununurra will be increased to two FMO's. This will greatly enhance the ability of the Department to conduct education and compliance activities in the East Kimberley.

The Northern Region Mobile Patrol, comprising of two FMO's will continue to focus entirely on recreational fisheries compliance and education throughout the Northern Region.

A Fremantle based Statewide Mobile Patrol Unit will be based in the Pilbara District for July and August and will focus on recreational fishers operating in the area.

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.

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 2011/12 financial year

PATROL HOURS DELIVERED TO THE BIOREGION	6,314 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	241
Infringement warnings	11
Infringement notices	28
Prosecutions	41
Fishwatch reports***	1
VMS (Vessel Days)****	7,852
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	14,799
Infringement warnings	174
Infringement notices	207
Prosecutions	22
Fishwatch reports	21
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	459
Fishwatch reports	47

* 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 Houtman are included in West Coast Compliance Table 1.

*** Fishwatch reports are allocated to the District Offices relevant to the Bioregion. It is not possible to distinguish between calls relating to Inland Bioregions.

**** 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.

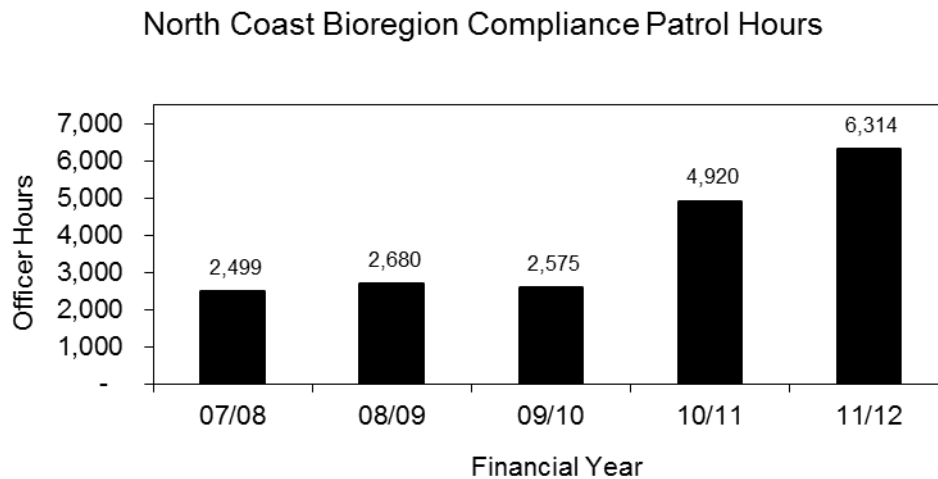
NORTH COAST COMPLIANCE TABLE 2

This table gives summary statistics for pearling compliance in all bioregions in the 2011/12 fishing season.

Total compliance hours*	460.5 Officer Hours
Field contacts by Pearling Officers	16
Letters of Warning issued**	0
Prosecutions	27

* Includes all time spent on compliance-related tasks by District Staff, e.g. investigations, prosecutions, etc. but does not include 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 2011/12 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 (1,350 in 2011/12).

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 Houtman* 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 winter minimum temperatures (away from terrestrial effects along the beaches) to about 16 to 17°C. Summer water temperatures in 2012/13 were at a record high, which may affect the recruitment of some species.

Fish stocks in this region are predominantly temperate, with many species' distributions extending right across southern Australia. Tropical species are occasionally found, which are thought to be brought into the area as larvae as they 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 western 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 off 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. Most recent development activity in the invertebrate sector has focused on land-based 'raceway' culture of abalone, using pumped sea water. In addition, an offshore abalone farm near Augusta is achieving encouraging early results for abalone grown out using purpose-built concrete structures located on the sea bed (See Aquaculture Regional Research and Development Overview section in this chapter).

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.

SOUTH COAST BIOREGION

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. The Department is developing a research and monitoring plan for the Walpole-Nornalup Marine Park, which forms one component of the Department's research and monitoring strategy within the broader bioregion. Collectively, this monitoring information is used to assess the effectiveness of management strategies applied to ensure sustainable management of the State's fish resources at the bioregional level. Additional access restrictions in the bioregion include 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 Commonwealth Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has also undertaken a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay. The federal minister for the environment has announced the final reserve network proposed for the South-West which spans the West Coast and South Coast bioregions.

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.

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.

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.

Currently there are no marine pest monitoring programs being undertaken by the Marine Biosecurity Research and Monitoring Group in the South Coast Bioregion. However, ongoing research includes an assessment of the likelihood of a marine pest being introduced into ports via commercial vessels and quantification of the risk associated with recreational vessels for the introduction and translocation of marine pests into this bioregion. Further detail may be found in the Appendix section entitled "Activities of the Marine Biosecurity Research Unit during 2012-13".

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	An assessment by Hall and Wise (2011) ¹ 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. A study (reported in detail elsewhere In this report) has recently confirmed that this is related to stock issues generated by reductions in recruitment
	Demersal	HIGH	Given the concerns that there could be an increase in targeting of demersal fishing on the south coast, an NRM funded project has begun to examine the stock status of this suite.
	Pelagic	LOW	While the spawning biomass of sardines has returned to appropriate levels, their capture levels and that of other pelagic fish has not returned to pre-virus levels due to market problems and changed fish behaviour.
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

¹ 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.

SOUTH COAST BIOREGION

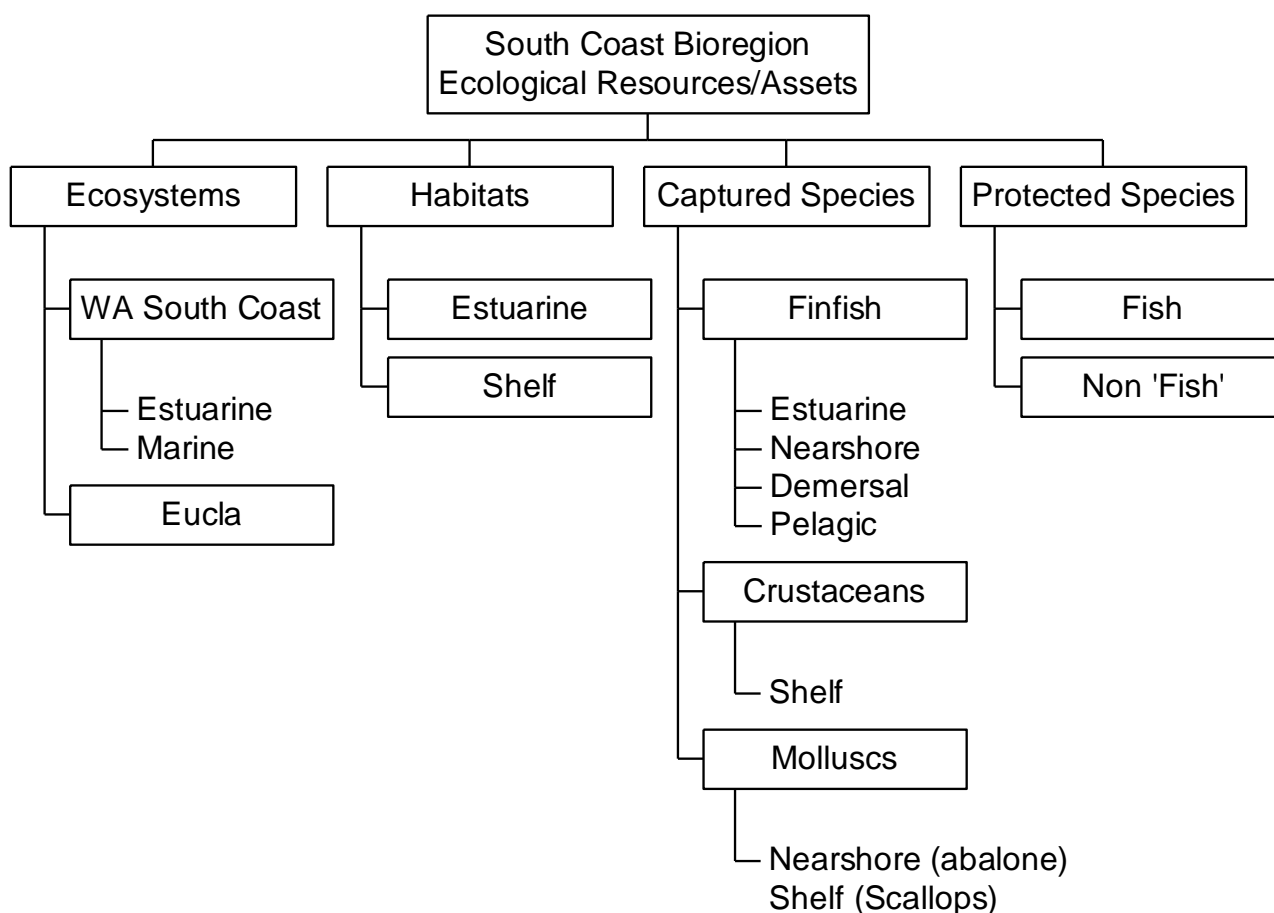
Protected fish species	Species	Risk	Status and Current Activities
	Mammals	MODERATE	The potential for the capture of sealions and seals by all fishing operations in this region, but especially gill nets has been the subject of a number of recent studies.
Protected 'Fish' Species	Fish	NEGLIGIBLE	There 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 identification of the pest algae <i>Codium fragile fragile</i> in Albany highlights the issues that now face many ports in Australia
Climate	LOW	This area is unlikely to be impacted by climate change in the near future.



SOUTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

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

FISHERIES

South Coast Crustacean Fisheries Report: Statistics Only

J. How and M. Stadler

Fishery Description

The 'south coast crustacean fisheries' comprise four 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 Southern Rock Lobster Pot Regulation Fishery operating in the Albany and Great Australian Bight sectors, and the South Coast deep-sea crab fishery (South Coast Crustacean Figure 1).

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 (South Coast Crustacean Figure 2). Western rock lobsters are a significant component of the catch in the Windy Harbour/Augusta Rock Lobster Managed 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 (managed by Fishing Boat Licence 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 licensees in the ERLF.

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.

The season for fishing for rock lobsters throughout all south coast crustacean fisheries mirrors the previous West Coast Rock Lobster Managed Fishery season (prior to the 2010/11 season i.e. 15 November to 30 June). Fishing for deep-sea crabs can currently occur all year, but during the rock lobster season operators fishing under the authority of a Southern Rock Lobster Pot Regulation Licence must only use the number of pots endorsed on their authorisation. There is currently no limit on the number of deep sea crab pots that can be used by holders of Fishing Boat Licence Condition 105. This is being addressed as part of the new management plan for the south coast crustacean fishery. Catch statistics for the fisheries are based on the period from 1 November to 31 October inclusive.

In 2011/12 there were two Windy Harbour/Augusta Rock

Lobster Managed Fishery Licences; eight licences in the ERMF (six vessels reported catch); 28 licences in the Southern Rock Lobster Pot Regulation Fishery (nine vessels reported catch) and 23 holders of Fishing Boat Licence Condition 105 (seven vessels reported catch).

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 authorising them to take rock lobster.

Landings and Effort

Commercial

Southern rock lobster	51 tonnes
Deep-sea crab	22 tonnes
Western rock lobster	not reported
due to confidentiality policy (too few operators)	

The 2011/12 season total catch of southern rock lobsters was 51.2 t, a decrease of 2% from the 2010/11 season. A catch of 26.2 t of southern rock lobsters was taken in the ERLF in 2011/12 – a decrease of 7% on the catch taken in the 2010/11 season (28.2 t). This is a slight downturn in the catch of southern rock lobster in the ERLF which had shown an increasing trend over recent seasons from low catches in 2008/09 (South Coast Crustacean Figure 2).

The combined catch for the Southern Rock Lobster Pot Regulation Fishery (Great Australian Bight (GAB) and Albany zones) in 2011/12 was 24.6 t, a 5% increase in catch compared to 2010/11. The catch in the Albany zone was 5.6 t, an increase of 16% compared to the 2010/11 season, while catch in the GAB zone remained very similar to last season with a 2% increase to 18.7 t (South Coast Crustacean Figure 2a). These catches have remained relatively stable since mid-2000, though there have been some fluctuations between the relative contribution from each region (South Coast Crustacean Figure 2a).

As a secondary target of the rock lobster fisheries, a total of 21.7 t of deep sea crabs was caught. The Albany zone is where the majority of crab catch is taken (South Coast Crustacean Figure 2b and 3) and included 6.9 t of giant crabs (an increase of 1.7 t from the 2010/11 season), 5.5 t of champagne crabs (an increase of 0.3 t from the 2010/11 season) and 1.6 t of crystal crabs (a decrease of 4.4 t from the 2010/11 season). Discussions with operators indicated that the dramatic decline in the crystal crab catch and increase in the catch of giant crabs in the 2010/11 season was a result of

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warm water currents along the continental shelf of the south coast, which they believe forced crystal crabs deeper and with the strong currents, made retrieval of the gear more difficult. This forced the crystal crabs deeper to a depth, combined with the strong currents, which was not economical to fish. This resulted in fishers targeting giant crabs. In the ERLF, 1.5 t of giant crabs were landed (an increase of 0.8 t from the 2010/11 season).

There was an overall nominal effort increase of 45% in the fishery (South Coast Crustacean Figure 4). The fishing effort in the ERLF increased by 29% in 2011/12 to 45,456 potlifts compared to the 35,339 potlifts in 2010/11. Effort increased by 62% in the Albany zone, however, it is not possible to split the effort of targeting lobsters from that of targeting deep-sea crabs.

Recreational

Southern rock lobsters

<5 tonnes

Estimates from mail surveys sent to a randomly selected sample of rock lobster licence holders (approx 10%) suggests that the recreational catch of southern rock lobsters on the south coast is less than 5 t per year.

The number 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. The small quantities taken on the south coast, does not significantly affect the overall sustainability of the stock, and therefore a more detailed survey is not a priority.

Fishery Governance

Target commercial catch range:

Southern rock lobsters

50 – 80 tonnes

In 2011/12, the south coast catch of 51.2 t was within the target catch range. However, this target catch range is

currently being reviewed as a part of the overall review of the management for this fishery.

Current Fishing (or Effort) Level

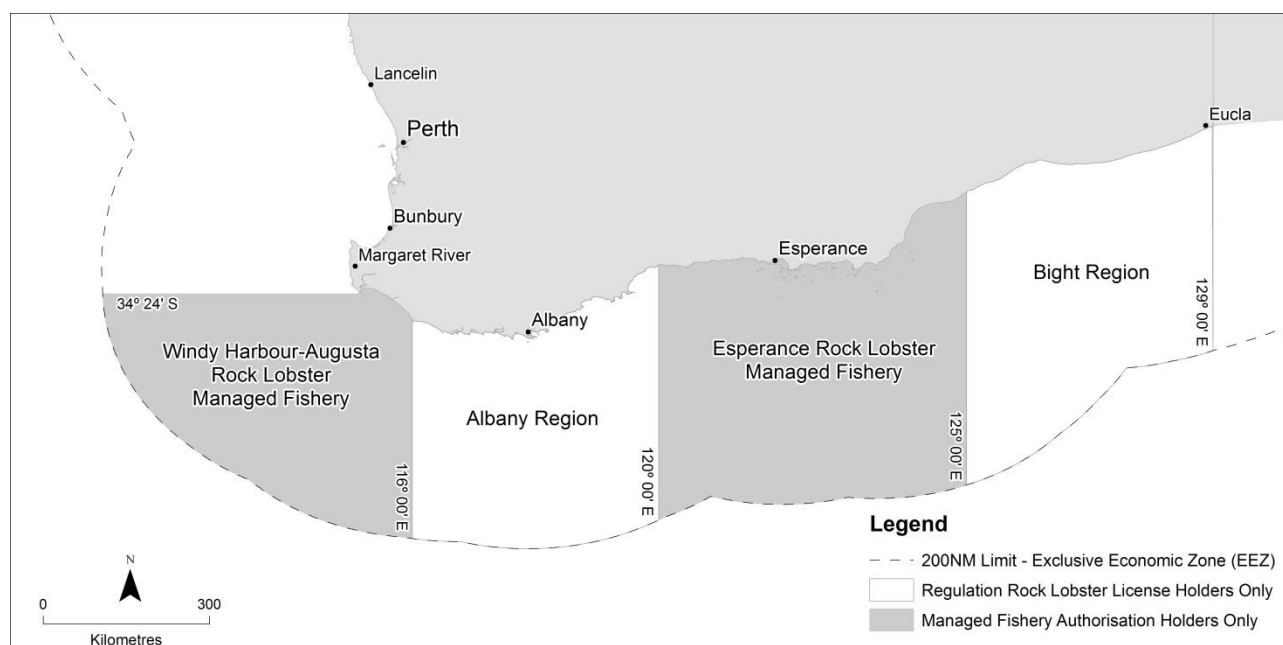
Acceptable

Effort in the fishery has increased over the last three seasons to 224,049 potlifts in 2011/12 (South Coast Crustacean Figure 4). This is lower than previous effort levels in the fishery which peaked in 1993/94 and was again high in mid-2000s.

New management initiatives (2012/13)

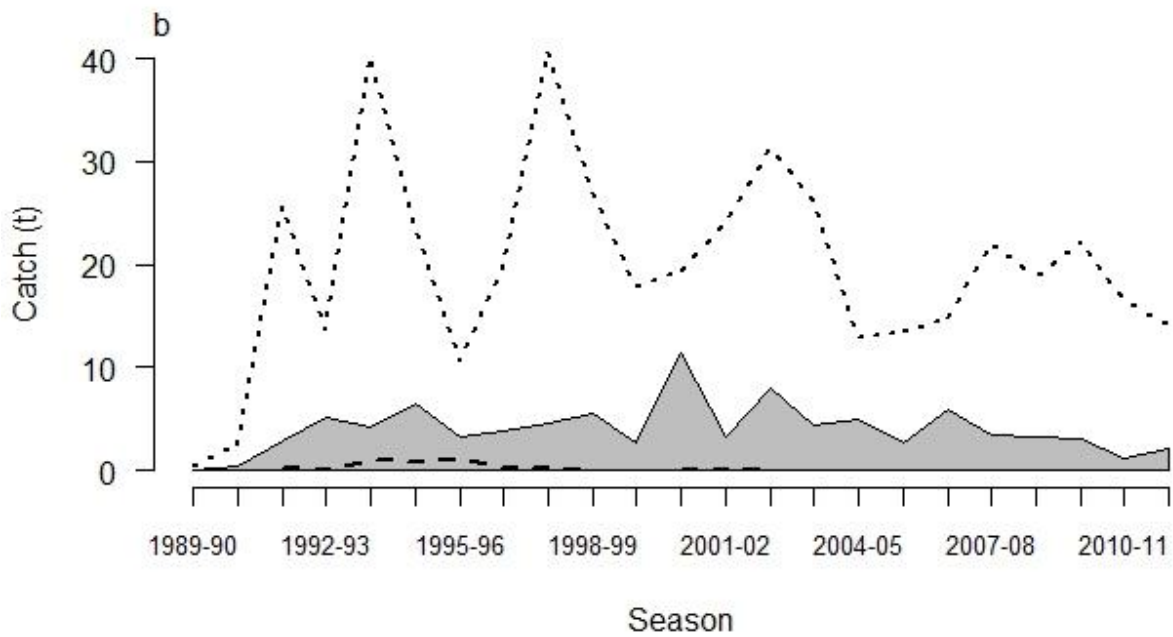
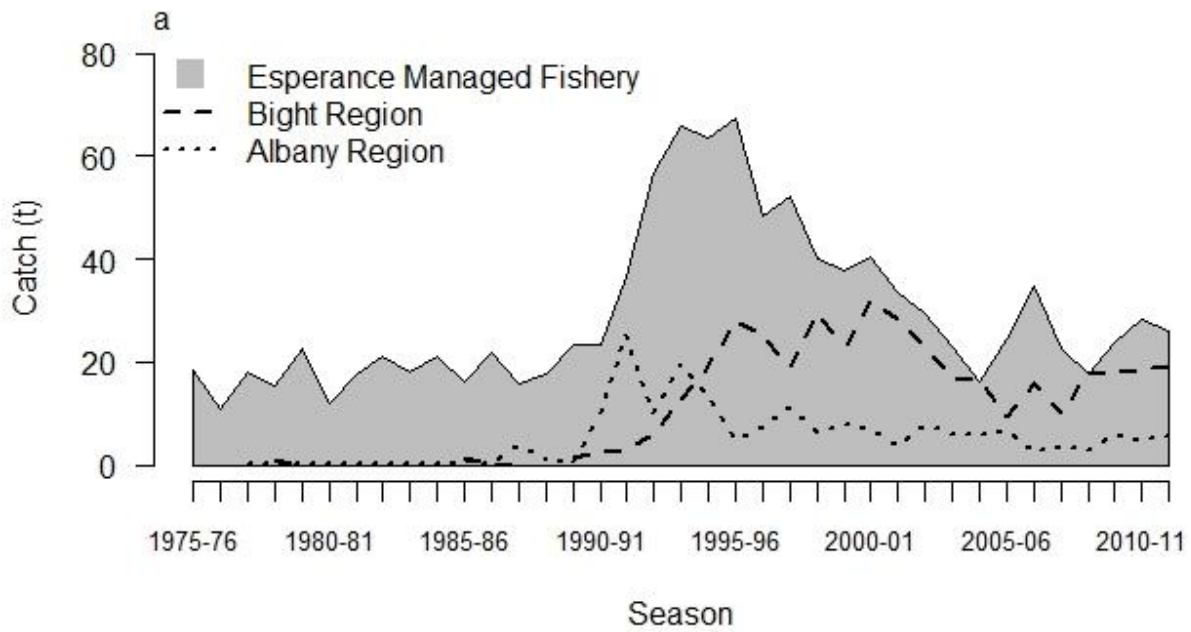
In January 2009 the Department released Fisheries Management Paper 232 entitled, 'The South Coast Crustacean Fishery: A Discussion Paper'. This public discussion paper provided a review of the management arrangements and history of the four south coast crustacean fisheries, as well as making a number of recommendations on future management arrangements. Two key recommendations included that one management plan should cover all four crustacean fisheries and that an independent panel make recommendations on access and allocation of entitlement in the new fishery.

In 2013 an independent access and allocation panel provided a recommended method of determining the criteria for access to each of the four proposed zones in the new fishery and the level of entitlement to be allocated to those who gain access. These recommendations are under consideration and if approved by the Minister for Fisheries, will form the basis for entry to one new 'South Coast Crustacean Fishery Management Plan' covering all four fisheries. The new Management Plan arrangements would then be developed following the procedures described under the *Fish Resources Management Act 1994*. This process will be reported in next seasons update.



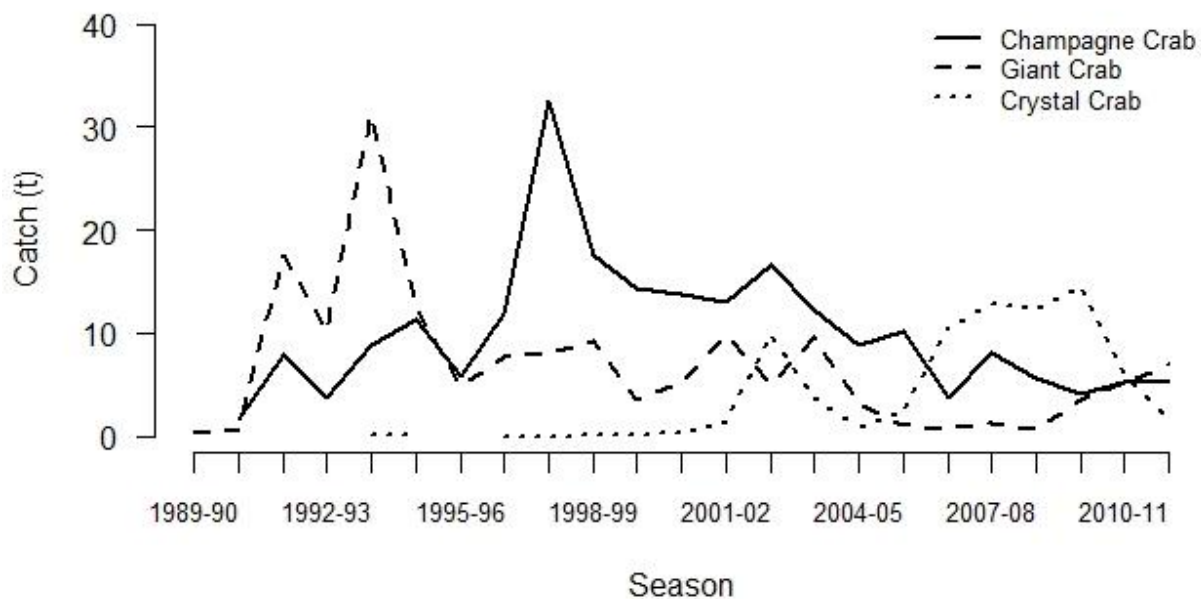
SOUTH COAST CRUSTACEAN FIGURE 1

Management boundaries in the South Coast crustacean fisheries.



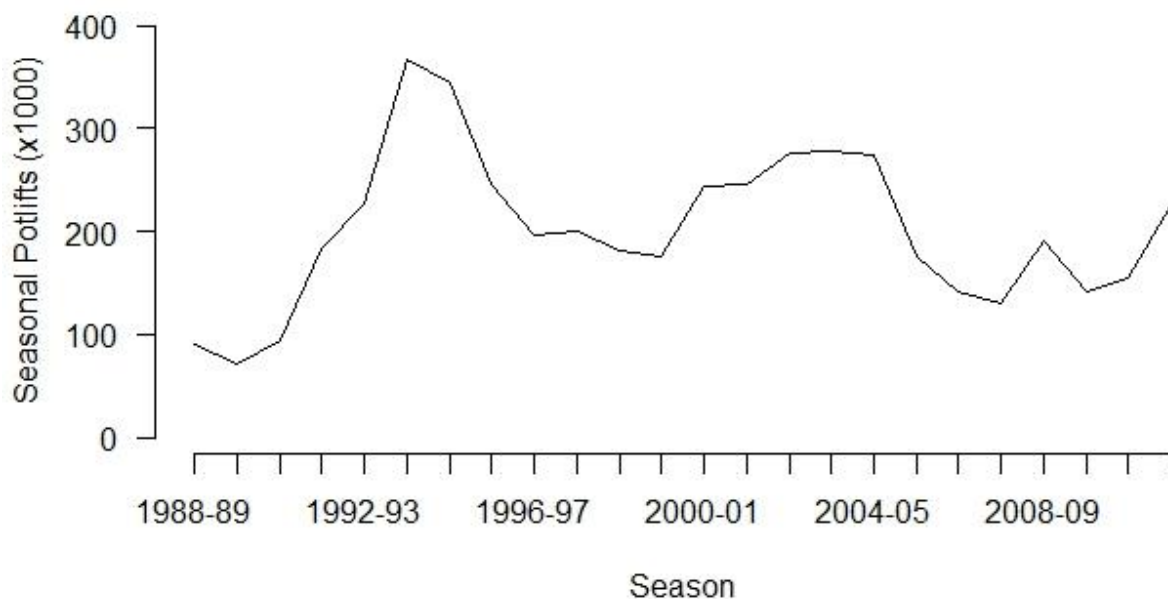
SOUTH COAST CRUSTACEAN FIGURE 2

Seasonal catches of a) southern rock lobster and b) deep sea crab by management area.



SOUTH COAST CRUSTACEAN FIGURE 3

Seasonal catches of deep sea crab species since 1989/90 in the Albany region.



SOUTH COAST CRUSTACEAN FIGURE 4

Annual level of seasonal effort for all regions in the fishery.

Greenlip/Brownlip Abalone Fishery Status Report

A. Hart, F. Fabris and J. O'Malley

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial	
		Total	202 t
Fishing level	Acceptable	Greenlip	168 t
		Brownlip	34 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 laevis*), 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

Commercial

Abalone Management Plan 1992

Abalone Managed Fishery Licence

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.

Recreational Abalone Fishing Licence

Consultation process

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

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 2012 was 209 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 155 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

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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 (SCPUE) index was developed that takes 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 2012/13, 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 2012): 202 tonnes

In 2012 the greenlip/brownlip catch was 202 tonnes whole weight (Greenlip Brownlip Abalone Table 1), which was the same as the 2011 catch. The Area 1 (Nullarbor fishery) exploratory quota remained at 1.2 t but was not fished in 2012.

The greenlip catch of 167.6 t whole weight from a total quota of 173.3 t, was very similar to the 2010 catch of 165.9 t. The brownlip catch of 34 t whole weight for the 2012 season was 6% lower than the 2011 catch of 36 t, and represents 94% of the quota of 36.1 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 2012.

Fishing effort/access level

Commercial

Total fishing effort on the main stocks in 2011 was 1,438 days. This was 17% higher than 2011 (1,224 days).

Recreational

For the 2012 season, 15,561 licences were issued allowing abalone fishing. This is similar to the numbers of abalone specific licences that have been obtained since the umbrella recreational licenses, which allowed for the catch of multiple species including abalone, were phased out in 2010 (Greenlip/Brownlip Abalone Figure 2).

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 level and method: Level 3

Standardised catch rates / Fishing mortality

Breeding stock levels: Adequate

A stock assessment of the greenlip/brownlip abalone fishery was undertaken for the 2012 fishing season, based on commercial catch and effort statistics, length-frequency and shell morphometry sampling, biological growth studies, and some fishery-independent surveys.

Standardised catch per unit effort (SCPUE): As a result of a recent review¹, the SCPUE for the greenlip fishery is now used as the principal indicator of the abundance of legal-sized abalone and the basis for the decision-rule

1 Hart, A., Fabris, F., Caputi, N. (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. 32 pp.

framework. Raw CPUE data (kg whole wt per diver per day) is also presented for comparative purposes.

In 2012, the SCPUE for the combined greenlip stocks was 35 kg whole weight per hour (Greenlip Brownlip Abalone Table 1). This was an increase from the 2011 value of 34 kg per hour (Greenlip Brownlip Abalone Table 1).

Fishing mortality (F): This analysis determines the proportion of the available abalone stock that is being harvested. Fishing mortality of greenlip abalone declined between 2011 and 2012 for the Augusta region and the South Coast of Area 3 (Greenlip Brownlip Abalone Figure 3a). Average F , based on a 3-yr running mean (2010-2012) was 0.39 (Augusta), 0.44 (Area 3 South Coast) and 0.48 (Area 2).

Fishing mortality of brownlip abalone in Area 3 was stable between 2011 and 2012, but no data were available from Area 2 for 2012 to ascertain the trend (Greenlip Brownlip Abalone Figure 3b). Average F , based on the most recent 3-yr running mean was 0.31 (Area 3) and 0.27 (Area 2).

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 2012, the average sizes of greenlip and brownlip caught were 187 g and 239 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 a lower average meat weight (declined from 286 g in 2006 to 239 g in 2012). TACC was therefore reduced to 39.9 t in 2012 (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 2012, the average sizes of greenlip and brownlip caught were 187 g and 239 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 (1,438 days) was above the set range that indicates sufficient biomass of breeding stock for the fishery overall (907 – 1,339 days – see 'Fishery Governance' section). This was due to operational developments in the fishery including the use of 2 divers per day on some vessels and new divers with lower catching efficiency.

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 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 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. As abalone are drift algae feeders, their removal is considered to result in little change in algal growth cover and therefore the ecosystems within the areas fished.

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.

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 15,561 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 fishers) for 2012:

Level 3 - \$5 - 10 million (\$8.0 million)

The estimated average price received by commercial fishers was \$107/kg meat weight (\$40/kg whole weight) for greenlip

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and \$91/kg meat weight (\$36/kg whole weight) for brownlip abalone, resulting in a fishery valued at \$8.0 million, compared to \$8.3 million in 2011.

Greenlip prices in 2012 were lower than 2011 (\$112/kg), and are still low compared to 10 years ago due to high value of the Australian dollar, although this pattern may now be changing.

Fishery Governance

Target effort range: 907 – 1,339 days

Current effort level: Acceptable

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 (209 t in 2012) 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 2011 was 1,438 days (main stocks), which is above the governance range. The range was exceeded due to operational changes in the fishery such as

the use of 2 divers per day on some vessels and new divers with lower catching efficiency which are all incorporated within the calculation of the standardised catch rates (see above).

New management initiatives (2011/12)

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 and industry size limits have been varied substantially above the legal minimum sizes. The value of the abalone fishery is still at historical low levels however this may change with recent increases in the relative value of the Australian dollar.

In addition, environmental effects, such as weather conditions, and the effect of technology changes, continue to have significant effects on diver efficiency.

GREENLIP/BROWNLIP ABALONE TABLE 1

Greenlip and brownlip abalone catch and effort¹ by quota period.

Quota period ²	Greenlip TAC kg whole weight	Greenlip caught kg whole weight (all stocks)	Brownlip TAC kg whole weight	Brownlip caught kg whole weight ⁴	Combined catch kg whole weight	Diver days (main stocks only) ³	Greenlip Raw CPUE kg whole (meat) ⁴ wt per diver 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)	35
1993	197,450	173,397	–	31,153	204,550	1,238	140 (53)	35
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)	31
1996	189,750	171,337	–	21,932	193,269	904	177 (66)	38
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)	35
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

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
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)	30
2006	171,755	168,752	39,750	37,265	206,017	1,161	133 (50)	30
2007	171,755	166,647	39,750	38,660	205,307	1,139	137 (51)	33
2008	163,220	157,224	41,900	39,515	196,739	1,144	135 (51)	33
2009	171,221	160,156	41,900	39,050	199,206	1,205	130 (49)	33
2010	171,221	165,558	41,900	39,006	204,564	1,196	138 (52)	37
2011	173,355	165,927	39,950	36,274	202,201	1,224	136 (51)	34
2012	173,355	167,562	36,150	34,187	201,749	1,438	117 (44)	35

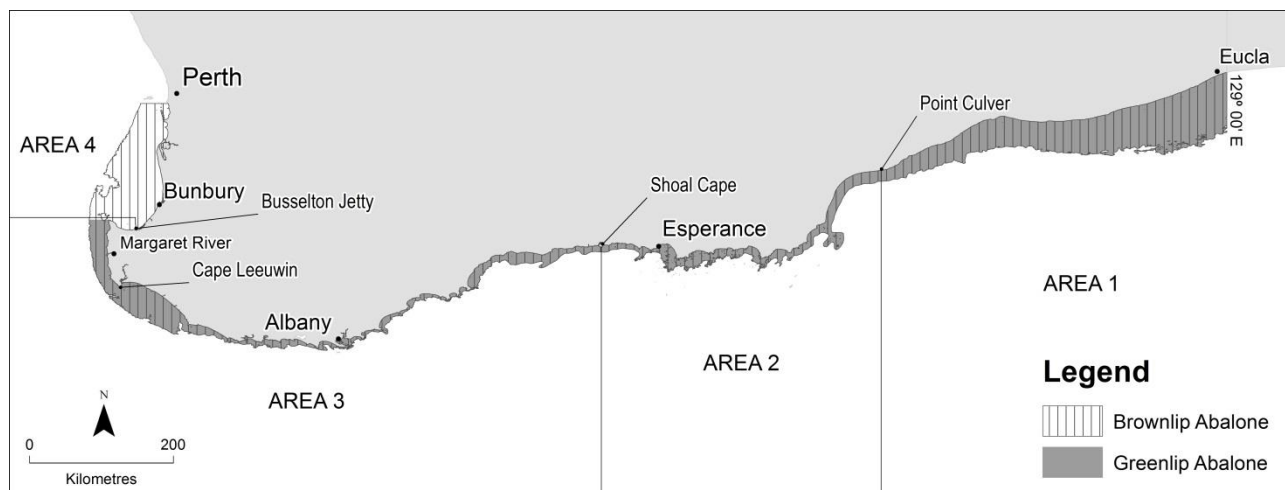
1. Data source: quota returns.
2. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.
3. Effort (diver days): main stocks are separated from stunted stocks, which are subject to controlled fishing regimes and not directly 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.

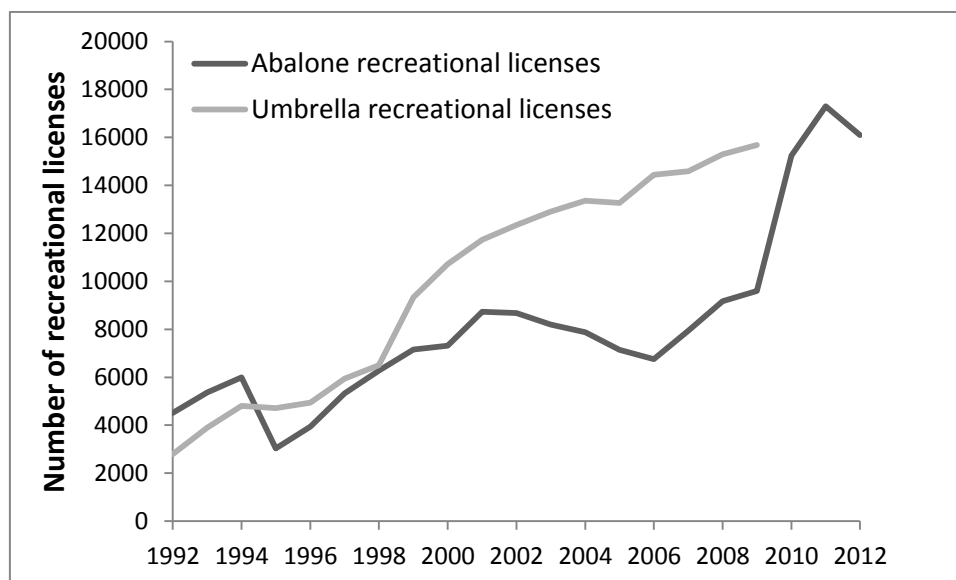
Location	Year	Effort	Greenlip		Brownlip	
			Catch Rate	Catch (tonnes)	Catch Rate	Catch (tonnes)
West Coast	2004	10,100 (6,500 – 13,600)	0.6	4 (2–6)	0.4	3 (1–5)
	2006	8,000 (4,700 – 11,300)	0.3	2 (0–3)	0.4	3 (0–5)
	2007	6,300 (3,800 – 8,800)	0.7	3 (0–6)	0.1	<1 (0–1)
South Coast ¹	2004	2,700 (1,700 – 3,700)	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).



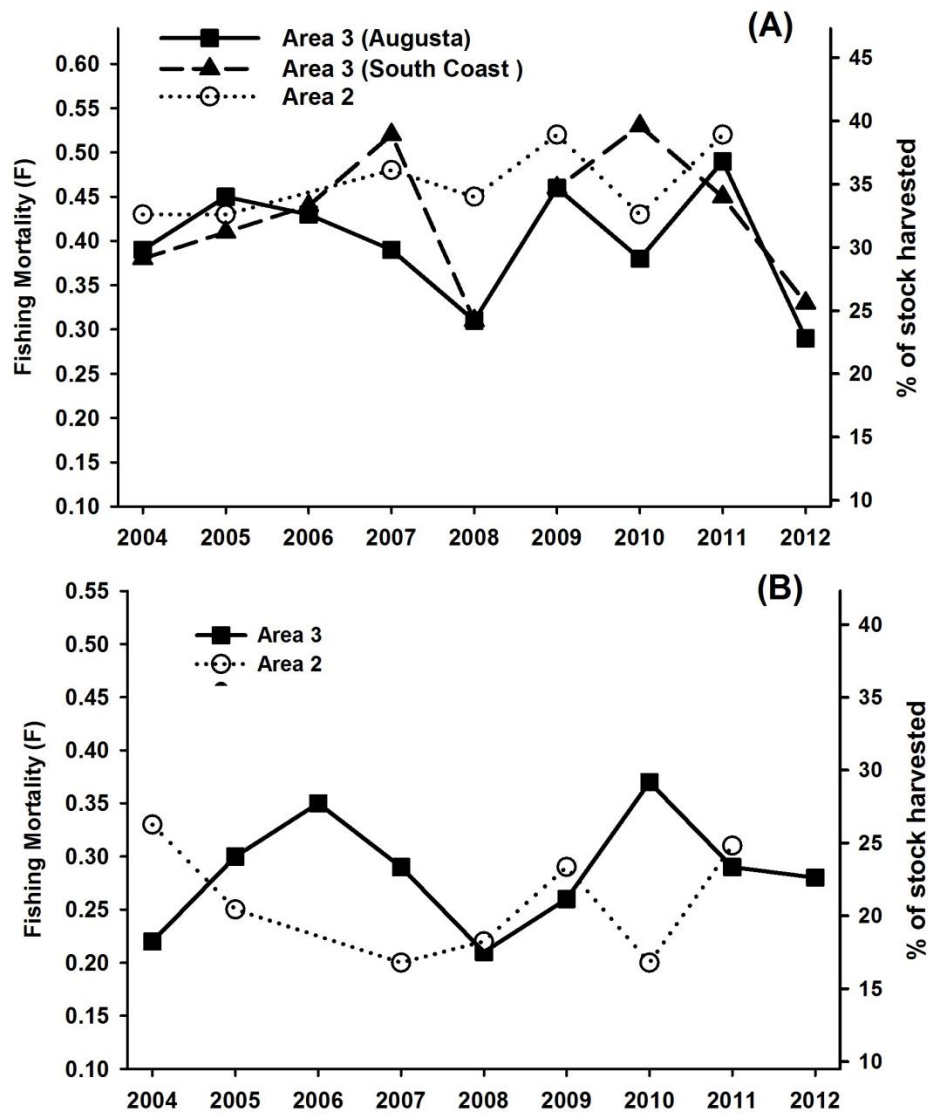
GREENLIP/BROWNLIP ABALONE FIGURE 1

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). Note umbrella licences were discontinued in 2010.



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, $K = 0.30$; Brownlip: $L_{\infty}=198$ mm, $K = 0.32$. Natural mortality (M) is assumed to be 0.25.

South Coast Nearshore and Estuarine Finfish Resources Status Report

K. Smith, A. Howard and M. Stadler

Main Features

Status		Current Landings (2012)	
Stock levels:		Commercial total	383 t (finfish only)
Australian herring	Inadequate	South Coast Salmon Fishery	75 t (salmon only)
Western Australian salmon	Adequate	South Coast herring trap net fishery	109 t (herring only)
Black bream (Stokes Inlet)	Adequate	South Coast Estuarine Fishery	187 t (finfish only)
Black bream (Beaufort Inlet)	Adequate	Other commercial	12 t (finfish only)
Black bream (Wilson Inlet)	Adequate		
Black bream (Oyster Harbour)	Adequate	Recreational total	(not available for current year)
Black bream (Walpole-Nornalup Inlet)	Not assessed	Most recent survey 2000/01	368 t (key species only)
Cobbler (Wilson Inlet)	Adequate	Recreational estuarine	
Cobbler (Oyster Harbour)	Adequate	Most recent survey 2002/03	50 t (key species only)
		Recreational boat-based	
Fishing Level:		Most recent survey 2011/12	37 t (key species only)
Australian herring	Unacceptable		
Other stocks	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 western 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.

Western Australian salmon and Australian herring both form large schools, particularly during their autumn pre-spawning seasons, that migrate along the coast in nearshore waters between South Australia and Kalbarri (WA). The main commercial fisheries for these species target pre-spawning schools as they migrate along south-western beaches in autumn. In WA, salmon is targeted exclusively by two commercial fisheries – the South Coast Salmon Managed Fishery (located in the South Coast Bioregion) and the South-West Coast Salmon Managed Fishery (located in the West Coast Bioregion). In these fisheries, salmon are captured by teams of fishers who set beach seine nets from the shore using either row boats or small jet-powered boats. Most of the commercial catch of Australian herring in WA is taken on beaches in the South Coast Bioregion using herring trap nets (also known as ‘G’ trap nets) which are set from the shore. The remainder of commercial herring catches are taken by various small nearshore and estuarine fisheries in the South Coast and West Coast Bioregions using beach seine nets, gill nets and haul nets.

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 (SCEMF). 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 (*Cnidogobius 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), western 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

Fisheries Notice No. 478 of 1991 (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 for salmon fisheries)

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Recreational Net Fishing Licence

Recreational Fishing From Boat Licence

Consultation processes

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual Management Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

Boundaries

Commercial - Nearshore

In the South Coast Bioregion, Australian herring can be taken commercially by holders of an unrestricted Fishing Boat Licence (FBL). The use of trap nets is restricted to holders of FBLs 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 (Black Point) to the WA/SA border.

Commercial - Estuarine

The South Coast Estuarine Managed Fishery encompasses 'the waters of all estuaries on the south coast of Western Australia between Cape Beaufort and 129° east longitude, including Princess Royal Harbour and Oyster Harbour, and all the rivers, streams and all the tributaries that flow into those estuaries.' The areas that are open to commercial fishing are (from west-to-east) Broke Inlet, Irwin Inlet, Wilson Inlet, Princess Royal Harbour, Oyster Harbour, 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 certain estuaries and nearshore waters of the South Coast Bioregion are open to recreational netting. Recreational net fishers must hold a licence. Recreational set nets are prohibited in all ocean waters of the South Coast at all times. Recreational net fishing regulations are complex – 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.

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 FBL condition (Condition 42). Holders of FBLs 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 western 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 FBL, 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. Size and possession limits apply to these species. A Recreational Fishing from Boat Licence 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 has selected indicator species for monitoring and assessing the status of the finfish resources in the South Coast Bioregion (DoF 2011¹). Western Australian salmon, black bream and cobbler are indicators for this Bioregion's nearshore and estuarine finfish suites. Australian herring and sea mullet are also significant components of fishery landings in this Bioregion (see *West Coast Nearshore and Estuarine Finfish Resources Status Report* for the status of these stocks).

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.

Research summary

The status of the fish resources in nearshore and estuarine waters of the South Coast Bioregion is assessed by monitoring the status of indicator species. Level 2 assessments of indicators are based on trends in commercial catch and effort obtained from compulsory monthly fisher returns, trends in recreational catch and effort obtained from voluntary fisher logbooks (the 'Research Angler Program') and recreational fishing surveys, and trends in juvenile recruitment obtained from fishery-independent surveys. Level 3 assessments of indicators include all of the above information plus information about rates of fishing mortality (F) estimated from the age composition of fishery landings. Fish frames collected from recreational and commercial fishers are used to determine age structure. When available, archived biological samples are used to estimate historical F levels.

All indicators are currently assessed at Level 2. Regular monitoring of the age structure of fishery landings has recently been implemented for cobbler (Wilson Inlet only) and western Australian salmon. In future, this information will be used to develop Level 3 assessments for these stocks.

An integrated survey of boat-based recreational fishing was conducted in WA during 2011/12 (Ryan *et al.* 2013¹). During this survey, nearshore and estuarine species, including King George whiting, black bream and Australian herring and school whiting, were the most common species caught in the South Coast Bioregion. This survey provided estimates for boat-based recreational fishers. Catches from shore-based fishers, who take a significant proportion of nearshore and estuarine species, were not estimated.

Retained Species

Total commercial finfish landings (2012):

196 tonnes in nearshore waters

187 tonnes in estuarine waters

Commercial landings by fishery (2012):

South Coast Salmon 75 tonnes (salmon only)

Herring trap net 109 tonnes (herring only)

South Coast Estuarine 187 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 generally not included in this report, although catches by all methods and all fisheries are included in the total catches reported for key species and are taken into account in stock assessments.

In 2012, the total commercial catch of finfish by estuarine and beach-based fisheries in the South Coast Bioregion was

383 t and included at least 38 species. The majority of the catch consisted of Australian herring (35% by weight) caught primarily by the trap net fishery, western Australian salmon (20%) caught by the South Coast Salmon Managed Fishery, cobbler (14%) and black bream (11%) caught by the South Coast Estuarine Managed Fishery.

In 2012, the nearshore finfish catch was comprised predominantly of Australian herring (59% by weight) and western Australian salmon (36%). The estuarine finfish catch was comprised mainly of cobbler (29%), black bream (24%), sea mullet (16%) and Australian herring (9%).

Since 2000, 95% of landings by the South Coast Estuarine Managed Fishery have been finfish. The non-fish component is dominated by blue swimmer crabs (*Portunus armatus*), which ranged from 1 t in 2006 to 39 t in 2001. In 2012, 14 t of blue swimmer crab was reported by this fishery. The majority of estuarine finfish landings in 2012 were taken by gill nets (92%), with smaller amounts taken by haul nets and fish traps.

Key finfish species - nearshore

Australian herring: see West Coast Nearshore and Estuarine Finfish Resources report.

Western Australian salmon: This species comprises a single stock in southern Australian waters. It is targeted commercially in Western Australia and South Australia (SA). Since 2000, 68% of total commercial landings of western Australian salmon in WA have been taken in the South Coast Bioregion, with the remaining 32% taken in the West Coast Bioregion.

Annual commercial landings of western Australian salmon in WA have been highly variable since the commercial fishery commenced in 1944. Peaks in total annual landings occurred in 1968 (4,223 t), 1984 (3,543 t) and 1995 (4,046 t) (South Coast Nearshore and Estuarine Figure 1). Total landings have been declining since 1995, with the decline becoming more pronounced after 2005. In 2012, the total WA catch was 122 t, which was the lowest since the commencement of commercial fishing in the 1940s. The decline since 1995 reflects the trend in the South Coast Bioregion, where the annual catch steadily declined from a peak of 2,728 t in 1995 to 75 t in 2012.

Commercial fishery landings of western Australian salmon in SA have also declined. From 1983/84 to 2002/3, total SA landings were relatively stable at around 400-600 t per year. In 2003/4, landings declined sharply, and from 2003/4 to 2011/12 landings were mostly <200 t per year². The decline in SA landings may partly reflect a decline in the supply of recruits to SA from the spawning area in WA. In WA, the historically low catch levels in recent years are believed to be due to a combination of factors – lack of targeting in response to low market demand, reduced availability of fish in some years due to low recruitment and environmental factors affecting catchability.

In the West Coast Bioregion, landings of salmon have ranged

¹ Ryan, K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. & Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia. 162 pp.

² Fowler, A.J., McGarvey, R., Steer, M.A. & Feenstra, J.E. (2012). South Australian Marine Scalefish Fishery. Stock Status Report 2011/12. Report to PIRSA Fisheries and Aquaculture South Australian Research and Development Institute (Aquatic Sciences), Adelaide. F2007/000565-7. SARDI Research Report Series No. 681. 44 pp.

from 0 to 1364 t per year since the commencement of the fishery. In 2012, 47 t of western Australian salmon was reported (South Coast Nearshore and Estuarine Figure 1).

Key finfish species - estuarine

Cobbler: Since 2000, 95% of commercial landings of cobbler in WA have been caught in estuaries of the South Coast Bioregion, with the remaining 5% taken in estuaries of the West Coast Bioregion. Over this period, 79% of cobbler landings in the South Coast Bioregion were in Wilson Inlet, 9% in Irwin Inlet, 8% in Oyster Harbour and 3% in Princess Royal Harbour. Total annual landings in the South Coast Bioregion ranged from 40 t (in 2004) to 95 t (in 2003).

In 2012, 53 t of cobbler was caught in the South Coast Estuarine Managed Fishery. The majority (82%) of this catch was taken in Wilson Inlet. 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. 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.

Black bream: In 2012, 97% of commercial landings of black bream in WA were caught in the South Coast Bioregion, with the remaining 3% from the West Coast Bioregion. In the South Coast Bioregion, landings were mainly taken in Beaufort Inlet (55% of landings), Stokes Inlet (16%), Oyster Harbour (14%) and Wilson Inlet (6%). Minor black bream landings were reported in 11 other estuaries.

In 2012, a total of 43 t of black bream was landed in South Coast estuaries. Since 2000, total South Coast landings of black bream have ranged from 30 t (in 2000) to 65 t (in 2010). The 2010 catch was the highest recorded in the South Coast Bioregion since 1993 (when the catch was 70 t), mainly due to high landings within Stokes Inlet.

Historically, Stokes Inlet has contributed the greatest proportion of black bream landings of any single South Coast estuary. From 1980 to 2012, annual landings in Stokes Inlet exhibited a stable (non-directional) trend and averaged 12 t per year (range 1-37 t).

Since 2005, Beaufort Inlet has surpassed Stokes Inlet as the main producer of black bream along the south coast. Minimal landings of black bream were taken in Beaufort Inlet prior to 1993. From the late 1990s to 2005, landings gradually increased and have remained relatively high in subsequent years. Since 2005, annual landings have ranged from 10 to 26 t. Annual landings of black bream in Wilson Inlet and Oyster Harbour also followed an increasing trend after the late 1990s. Wilson Inlet landings peaked at 18 t in 2005 and Oyster Harbour landings peaked at 12 t in 2008. The catches in these estuaries then declined gradually, reaching 3 t and 6 t, respectively, in 2012. These catch trends appear to be the result of strong recruitment by black bream in Beaufort Inlet, Wilson Inlet and Oyster Harbour in the mid-1990s.

Recreational catch estimate (2012): NA
Nearshore + estuarine catch (most recent estimate 2000/01): 368 tonnes (key species only)

Estuarine catch only (most recent estimate

2002/03): 50 tonnes (key species only)

Boat-based nearshore + estuarine catch (most recent estimate 2011/12):

37 tonnes (key species only)

Recreational catch levels of finfish in nearshore and estuarine waters of the South Coast Bioregion were not estimated in 2012. 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 current catch are probably similar to those caught in these surveys, the catch and effort levels by recreational fishers may have changed substantially. Therefore, the current total catch level cannot be estimated.

In 2000/01, the most abundant species retained in nearshore waters in the South Coast Bioregion were Australian herring (52% by number), skipjack trevally (*Pseudocaranx georgianus*) (11%), King George whiting (*Sillaginodes punctata*) (10%), whiting (various species, excluding King George) (9%) and western 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 skipjack trevally (4%). In 2000/01, shore-based fishers caught 73% of retained fish in nearshore waters and 28% in estuaries.

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, 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 8 species was estimated to be approximately 29% (by weight) of the combined recreational and commercial catch of these species during the survey period. A total of 48 species were reported in the recreational catch from south coast estuaries. However, the total recreational catch (by weight) of all species could not be estimated in 2002/03 due to uncertainties associated with small samples of less abundant species and limited data on the average size of fish in the catch.

With the inclusion of less abundant species and catches taken in estuaries closed to commercial fishing, the recreational catch share of recreationally-targeted finfish species in South Coast Bioregion estuaries was estimated to be 30-40% in 2002/03. If the landings of non-recreational species (cobbler, sea mullet and yellow-eye mullet) are also included, the recreational catch share of total finfish landings was estimated to be approximately 20%.

In 2002/03, the highest recreational fishing catch and effort of any south coast estuary was reported from the Walpole/Nornalup Inlet, which is closed to commercial fishing. The main species taken in this estuary was black

breem, with an estimated recreational catch of 15 t during the survey period.

A state-wide survey of boat-based recreational fishing was undertaken in 2011/12 (South Coast Nearshore and Estuarine Table 4). During this survey, total of 112 finfish species were taken by boat-based fishers in the South Coast Bioregion with nearshore and estuarine species dominating the catch. The most common were King George whiting (26% of the South Coast catch by number), black bream (18%), Australian herring (9%), southern school whiting (*Sillago bassensis*) (5%), silver trevally (5%) and bight redfish (*Centroberyx gerrardi*) (4%). An estimated 12 t of King George whiting and 7 t of black bream was retained by boat-based fishers in the South Coast Bioregion in 2011/12.

Total landings of nearshore and estuarine fish could not be estimated from the 2011/12 survey data because shore-based fishers, who are believed to take the majority of the recreational nearshore and estuarine finfish catch, were not included in the survey. The Department of Fisheries recently conducted a pilot study of shore-based fishers in an attempt to determine the best method to quantify recreational fishing catch and effort from this sector (Smallwood *et al.* 2011¹).

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 and since there has been no survey for over five years it is not appropriate to estimate the current catch share.

Fishing effort/access level

Commercial

Since 1990, the number of licences in nearshore and estuarine commercial fisheries has been substantially reduced via a 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 usually calculated as the number of days fished by each method. Fishing effort is sometimes reported as the number of units of access (vessels, licensees, teams, etc). This measure is sometimes the only type of effort data available throughout the history of the fishery and provides a general indication of effort changes over time. The commercial method of fishing for western Australian salmon and Australian herring (i.e. beach-based netting) includes a considerable amount of time spent observing or searching for fish ('spotting'). Hence effort in these fisheries is difficult to accurately quantify. The number of licensed teams that operate during each fishing season provides an approximate measure of effort in these fisheries.

South Coast Estuarine Fishery: Total effort in this fishery was reduced by a VFAS, which reduced the number of licensees 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 since 2004. In 2012, the fishery reported a total of 3,597 fishing days and an average of 17.4 boats fished per month.

In 2012, 39% of effort (method days) occurred in Wilson Inlet, 23% in Oyster Harbour, 18% in Princess Royal Harbour, 7% in Irwin Inlet, 7% in Beaufort Inlet, 3% in Broke Inlet and 2% in Stokes Inlet. The remaining effort (1%) occurred in Hamersley River, Culham Inlet, Oldfield River and Jerdacuttup Lakes. Two estuaries (Gordon Inlet and Waychinicup Inlet) were not fished during 2012.

Herring trap net 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 2012, only 5 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: Since 1999, there have been 18 licensed teams in this fishery. Some teams are inactive each year. Effort (number of active teams) has followed a declining trend since 2002. In 2012, western Australian salmon landings were reported by 8 of the 18 licensed teams.

Recreational

Current estimates of total recreational effort expended on targeting nearshore or estuarine finfish in 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 (Henry and Lyle 2003)². 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 line fishing events (nearshore and estuarine combined) 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 (Smallwood and Sumner 2007)³. 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

1 Smallwood, C.B., Pollock, K.H., Wise, B.S., Hall, N.G. & Gaughan, D.J. (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.

2 Henry, G.W. and Lyle, J.M. (2003). The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

3 Smallwood, C.B. & Sumner, N.R. (2007). A 12-month survey of recreational estuarine fishing in the South Coast Bioregion of Western Australia during 2002/03. Fisheries Research Report No. 159. Department of Fisheries, Western Australia. 56pp.

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%).

An integrated survey of boat-based recreational fishing in WA was conducted in 2011/12 (Ryan *et al.* 2013). In this survey, 49% of total annual boat-based fishing effort (boat days) in the South Coast Bioregion was estimated to have occurred in nearshore habitats (i.e. bottom depth <20m) and 22% in estuaries.

Stock Assessment

Assessments complete: **Not all**

Assessment level and method:
Level 3 - Fishing mortality

Breeding stock levels:

Australian herring¹ **Inadequate**

Assessment level and method:
Level 2 - Catch rates

Breeding stock levels:

West Australian salmon **Adequate**

Cobbler (Wilson Inlet) **Adequate**

Cobbler (Oyster Harbour) **Adequate**

Black bream (Stokes Inlet) **Adequate**

Black bream (Beaufort Inlet) **Adequate**

Black bream (Wilson Inlet) **Adequate**

Black bream (Oyster Harbour) **Adequate**

Black bream (Walpole-Nornalup Inlet)
Not assessed

Indicator species - nearshore

Western Australian salmon: Western Australian salmon form a single breeding stock across southern Australia. Adults undertake a westward migration along the southern coast of Australia to the lower West Coast Bioregion, where they spawn during autumn. The Leeuwin Current disperses eggs and larvae to coastal nurseries distributed from the West Coast Bioregion to Victoria. After spawning, adults migrate back to the South Coast Bioregion (but not to South Australia or Victoria). Traditionally, commercial fishers in WA have targeted western Australian salmon during the autumn (mainly March/April) pre-spawning migration, with approximately 95% of South Coast landings and 100% of West Coast landings taken during the January-June period each year.

Total landings of western Australian salmon in WA have been declining since 1995, with the decline becoming more

pronounced after 2005. This trend has been primarily driven by declining landings in the South Coast Bioregion, where the majority of the annual catch is traditionally taken. The South Coast Bioregion commercial catch and catch rate have been declining since 1995 (South Coast Nearshore and Estuarine Figures 1 and 2). In 2012, the catch (75 t) reached the lowest level since the commencement of the South Coast fishery in the 1940s. The catch rate (4 t per licenced team) was also the lowest on record. The historically low catch levels in recent years are believed to be due to a combination of factors – lack of targeting in response to the lack of markets and low wholesale prices paid for this species, reduced availability of fish in some years due to low recruitment and environmental factors affecting catchability.

In 2012, a relatively low catch (47 t) and catch rate (6 t per team) was also reported in the West Coast Bioregion. Very low (0-100 t) catches have occurred periodically (approximately every 11 years) throughout the history of this fishery and so the 2012 level was not exceptional. However, very low catches have occurred in the past 3 consecutive years (2010-2012), which is atypical. Low catches have previously been restricted to a single year.

Landings of salmon in the West Coast Bioregion are strongly influenced by the Leeuwin Current and water temperature. Low or nil catches typically occur during years of strong Leeuwin Current (resulting in warmer water along the West Coast). The low catch in 2011 was likely due to a 'heatwave' event during the spawning period, when a strong Leeuwin Current and unusually high water temperatures discouraged the northward migration of western Australian salmon (Pearce *et al.* 2011²). This behavioural response, resulting in low catches, was also observed in 2000 when a strong Leeuwin Current resulted in above average water temperatures on the West Coast. Relatively warm ocean conditions along the lower west coast in 2012 may have again affected catchability. The 'heatwave' in 2011 is also believed to have affected the catchability of salmon and limited the catch in the South Coast Bioregion in 2011.

Annual recruitment by juvenile (age 0 years) western Australian salmon has been variable since recruitment surveys commenced in 1994 but the long-term trend has been stable. Relatively high recruitment in 2008 and 2009 was followed by relatively low recruitment in 2010, 2011 and 2012 (South Coast Nearshore and Estuarine Figure 3). The lowest recorded recruitment coincided with the 'heatwave' event in 2011. Levels of annual recruitment provide an indication of future breeding stock level and are likely to influence catch rates 3-4 years later when each year class recruits to the fishery.

Indicator species - estuarine

Cobbler: Commercial targeting of cobbler in WA is restricted to estuaries. Each estuary hosts a discrete 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

¹ The stock assessment for Australian Herring is presented in the West Coast Nearshore and Estuarine Fisheries Report

² Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. & Gaughan, D. (2011). The "marine heat wave" off Western Australia during the summer of 2010/11. Fisheries Research Report No. 222. Department of Fisheries, Western Australia. 40 pp.

SOUTH COAST BIOREGION

Wilson Inlet and to a lesser extent 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 4). Catch rates suggest a slight increase in availability in these estuaries after 2000. The catch rate in Wilson Inlet remained relatively high in 2011/12. The catch rate in Oyster Harbour has been declining since 2007/8 and the catch rate in 2011/12 was the lowest recorded in this estuary since 1980/81 (3rd lowest on record). This suggests relatively low current abundance.

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 interpreting variations in catch and catch rates. Regular monitoring of the age structure of fishery landings was recently implemented in Wilson Inlet. In future, this information will be used to monitor levels of fishing mortality in this stock, which will be used in conjunction with trends in recruitment and catch rates to assess stock status.

Black bream: Black bream are restricted to estuaries. Each estuary hosts a discrete stock of black bream, which is genetically distinct to other estuarine populations. Most estuaries and coastal lagoons in south-western WA host a black bream population.

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 5). Since 2005, catch rates have remained relatively high in Beaufort Inlet, Oyster Harbour and Stokes Inlet. The catch rate has been declining since 2005 in Wilson Inlet, although recent levels are still high relative to historical levels.

Black bream landings vary in response to environmental factors in individual estuaries. The 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 cannot be assessed due to lack of recent data. Walpole-Nornalup Inlet is the most popular recreational fishery for black bream in the South Coast Bioregion. The estuary is closed to commercial fishing.

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.

Birds such as pelicans, cormorants and shearwaters sometimes interact with commercial fishing nets in estuaries and with recreational line-fishing gear but the risks to bird populations are considered to be low.

Ecosystem Effects

Food chain effects: **Low**

Excessive removal by commercial and recreational fisheries of certain species, such as Australian herring or western 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. Recreational fishing effort directed towards Australian herring is relatively high.

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 2012, there were approximately 22 commercial fishers involved in the South Coast Salmon Fishery and approximately 15 commercial fishers involved in the South Coast herring trap net fishery. In 2012, the South Coast Estuarine Managed 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 western 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 western 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 occurred in the South Coast Bioregion (Henry and Lyle 2003¹, Barharthah 2006²). Fish resources in estuaries and nearshore waters of the Bioregion are a focus for recreational fishers and have a high social value in the region.

Within the South Coast Bioregion, approximately 21% of the recreational fishing effort is estimated to occur in estuaries and rivers. A high proportion of people who fish in each South Coast estuary are non-residents, travelling from Perth, other WA regions or interstate. Consequently, fishing in South Coast estuaries has a great benefit to local tourism.

Australian herring is the most common finfish species retained by recreational fishers in the South Coast Bioregion (and in WA) and therefore has high social value. In 2000/01 Australian herring were estimated to comprise 15% of all finfish retained by South Coast recreational fishers.

Economic Effects

Estimated annual value (to fishers) for 2011/12:

South Coast Estuarine Fishery

(finfish landings only) Level 2: \$1 to 5 million

South Coast Salmon + Herring trap net fisheries

Level 1: <\$1 million

1 Henry, G.W. & Lyle, J.M. (2003). The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

2 Barharthah, T. (2006). Department of Fisheries community survey 2005. Fisheries Occasional Paper No. 33. Department of Fisheries, Perth.

Fishery Governance

Commercial

Current Fishing (or Effort) Level

South Coast Estuarine Fishery **Acceptable**

Herring trap net fishery **Under Review**

South Coast Salmon Fishery **Under Review**

Target commercial catch range:

South Coast Estuarine Fishery **200 – 500 tonnes**

South Coast herring **475 – 1,200 tonnes**

Salmon (South Coast + South West Fisheries)

1,200 – 2,800 tonnes

The 2012 South Coast Estuarine Managed Fishery total catch of finfish (187 t) was below the target range of 200–500 t. A high abundance of blue swimmer crabs in south coast estuaries is likely to have contributed to relatively low finfish landings in 2012. This fishery has reported a steady increase in landings of blue swimmer crabs, from 1 t in 2006 to 14 t in 2012. In some estuaries, fishers report that the presence of large numbers of undersized crabs in fishing nets has been inhibiting the capture of finfish. In some estuaries, fishing effort appears to have been redirected towards targeting crabs instead of finfish.

The 2012 South Coast herring catch of Australian herring (135 t³) was well below the target range. The catch has now been below the target range for 10 consecutive years. Recent research outcomes regarding stock status are being used as a basis for reviewing management arrangements to ensure ongoing sustainability for this iconic species.

The total catch of western Australian salmon (West Coast and South Coast landings combined) in 2012 (122 t⁴) was below the target range and was the lowest recorded since the commencement of these fisheries in the 1940s. The catch has now been below the target range for 6 consecutive years. Low catches are believed to be due to 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 recruitment variation. The recreational catch of Western Australian salmon is relatively low (unlike the closely related species Australian herring which has a high recreational catch). Hence, given the very limited commercial targeting of this species recently, the overall fishing pressure on western Australian salmon has been relatively low and is unlikely to have resulted in low stock availability. An age-based assessment of salmon to determine stock status using a catch–curve weight – of – evidence assessment could be considered in order to increase certainty in stock status.

3 Australian herring catch reported in Annual Report is lower than that reported here, due to the submission of additional 2012 catch and effort data by commercial fishers after publication of the Annual Report. The latest data are included here.

4 Australian salmon catch reported in Annual Report is lower than that reported here, due to the submission of additional 2012 catch and effort data by commercial fishers after publication of the Annual Report. The latest data are included here.

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 2012, 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 2012.

Recreational

Current Fishing (or Effort) Level: Not available

Target catch range: Not developed

New management initiatives (for the next year)

New state-wide recreational fishing rules (bag limits, size limits and total possession limits) were introduced in February 2013. This single set of state-wide rules replaced the various Bioregion-specific rules that previously applied to recreational fishers in WA.

An Exemption was implemented in late 2012 that allows South Coast Salmon Licence holders to fish for salmon by line from a Licensed Fishing Boat in the waters of the fishery. The Exemption is aimed at developing a more consistent market for small quantities of high quality, fresh salmon for human consumption and will be trialled over a three year period.

This fishery is scheduled to undergo MSC pre-assessment in late 2014.

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.* 2008¹). These impacts are expected to create both difficulties and opportunities for fisheries.

In 2011, a very strong Leeuwin Current resulted in unusually warm ocean temperatures in coastal waters of the southern West Coast Bioregion and the western South Coast Bioregion (Pearce *et al.* 2011). This 'heatwave' event resulted in atypical distributions of various species (e.g. tropical species occurring in temperate waters) and unusual fish behaviour.

The event altered the distribution and behaviour (eg. spawning activity, migration) of western Australian salmon and Australian herring, which reduced catch levels of these species in 2011 and may continue to affect them in subsequent years (due to effects on recruitment). Relatively warm coastal ocean temperatures also occurred in 2012 in the West Coast Bioregion and the western South Coast Bioregion.

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 western 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 western Australian salmon.

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 western Australian salmon in recent years have limited commercial catch and effort levels. By purchasing only a limited quantity of Australian herring and western Australian salmon each year, fish processors effectively restrict catch levels. Commercial fishers sometimes elect not to capture a school of fish, or release part of their catch, when a market is not available.

Variations in the abundance of target species in South Coast Bioregion estuaries are largely driven by environmental factors, independent of fishing. These factors 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'.

¹ Hobday, A.J., Poloczanska, E.S. & Matear, R.J. (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, 2008 to 2012.

Species	Scientific name	Catch (tonnes)				
		2008	2009	2010	2011	2012
Western Australian salmon	<i>Arripis truttaceus</i>	545.1	258.0	291.3	164.9	75.0
Cobbler	<i>Cnidogobius macrocephalus</i>	77.4	86.6	69.8	65.5	53.1
Black bream	<i>Acanthopagrus butcheri</i>	37.8	50.0	65.5	43.9	42.7
Australian herring	<i>Arripis georgianus</i>	236.3	151.3	182.7	110.6	135.0
Sea mullet	<i>Mugil cephalus</i>	21.8	26.3	32.3	29.8	30.4
Southern garfish	<i>Hyporhamphus melanochir</i>	16.8	7.6	13.7	11.1	5.4
King George whiting	<i>Sillaginodes punctata</i>	9.1	6.8	7.0	8.0	9.4
Leatherjackets	Monacanthidae	5.5	2.9	5.6	5.1	5.9
Flatheads	Platycephalidae	9.2	5.2	3.0	4.4	3.1
Tarwhine	<i>Rhabdosargus sarba</i>	5.3	2.7	2.8	6.7	3.9
Yelloweye mullet	<i>Aldrichetta forsteri</i>	4.6	3.4	2.6	3.9	4.5
Snook	<i>Sphyraena novaehollandiae</i>	2.9	2.4	1.3	1.7	1.6
Pink snapper	<i>Pagrus auratus</i>	3.6	1.9	0.9	1.3	2.1
Trevally	Carangidae	2.4	2.9	2.1	2.0	1.5
Flounders	Pleuronectidae	1.1	0.2	1.5	1.3	0.4
Trumpeters/Grunters	Teraponidae	0.3	1.7	0.3	1.6	0.3
Yellowtail scad	<i>Trachurus novaezelandiae</i>	0.3	0.2	0.6	0.8	2.2
Mulloway	<i>Agyrosomus japonicus</i>	0.5	0.3	0.4	0.7	1.0
Whiting species	<i>Sillago</i> spp.	1.2	0.3	0.4	0.6	1.4
Scaly mackerel	<i>Sardinella lemura</i>	0.5	0.9	0.4	0.3	0.3
Tailor	<i>Pomatomus saltatrix</i>	0.1	0.1	0.4	0.4	0.3
Other finfish	Teleostei	3.5	3.3	3.3	3.5	3.7
TOTAL		985.4	615.3	687.8	468.1	383.2

SOUTH COAST NEARSHORE AND ESTUARINE TABLE 2

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

Species	Scientific name	2000/01 Catch (tonnes)
Western Australian salmon	<i>Arripis truttaceus</i>	117
Trevally	<i>Pseudocaranx</i> spp.	93
Australian herring	<i>Arripis georgianus</i>	79
King George whiting	<i>Sillaginodes punctata</i>	40
Black bream	<i>Acanthopagrus butcheri</i>	28
Whiting	<i>Sillago</i> spp.	11
TOTAL		368

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 2007²).

Species	Scientific name	2002/03 Catch (tonnes)
Black bream	<i>Acanthopagrus butcheri</i>	23.3
King George whiting	<i>Sillaginodes punctata</i>	10.9
Trevally	<i>Pseudocaranx</i> spp.	6.1
Australian herring	<i>Arripis georgianus</i>	4.1
Southern blue-spotted flathead	<i>Platycephalus speculator</i>	2.6
Pink snapper	<i>Pagrus auratus</i>	2.6
Tarwhine	<i>Rhabdosargus sarba</i>	0.5
Southern sea garfish	<i>Hyporhamphus melanochir</i>	0.2
TOTAL		50.3

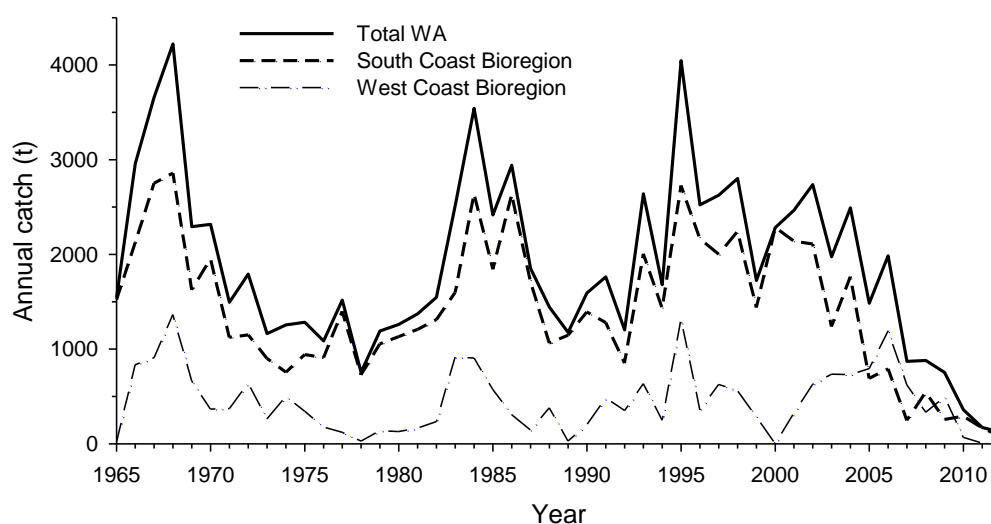
1 Henry, G.W. & Lyle, J.M. (2003). The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

2 Smallwood, C.B. & Sumner, N.R. (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.

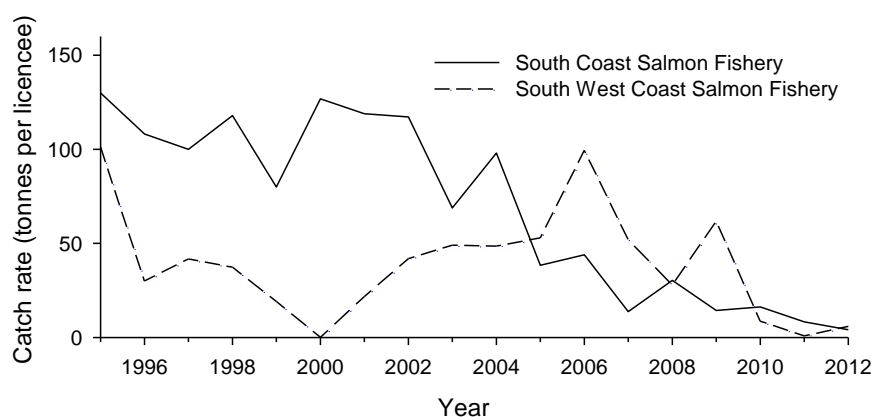
SOUTH COAST NEARSHORE AND ESTUARINE TABLE 4

Estimated annual catch of key nearshore and estuarine finfish species in the South Coast Bioregion by boat-based recreational fishers in 2011/12 (Ryan *et al.* 2013).

Species		Catch (tonnes)
King George whiting	<i>Sillaginodes punctata</i>	12
Black bream	<i>Acanthopagrus butcheri</i>	7
Western Australian salmon	<i>Arripis truttaceus</i>	7
Silver trevally	<i>Pseudocaranx dentex</i>	5
Australian herring	<i>Arripis georgianus</i>	4
Southern school whiting	<i>Sillago bassensis</i>	2
TOTAL		37

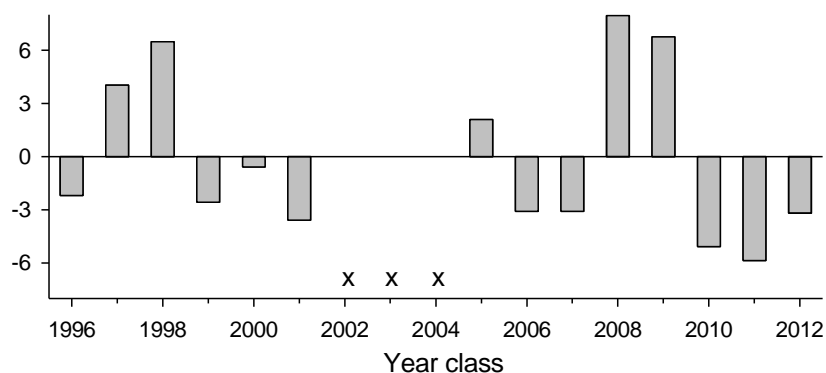
**SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 1**

Total annual commercial catches of western Australian salmon in the South Coast and West Coast Bioregions, 1965 – 2012.

**SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 2**

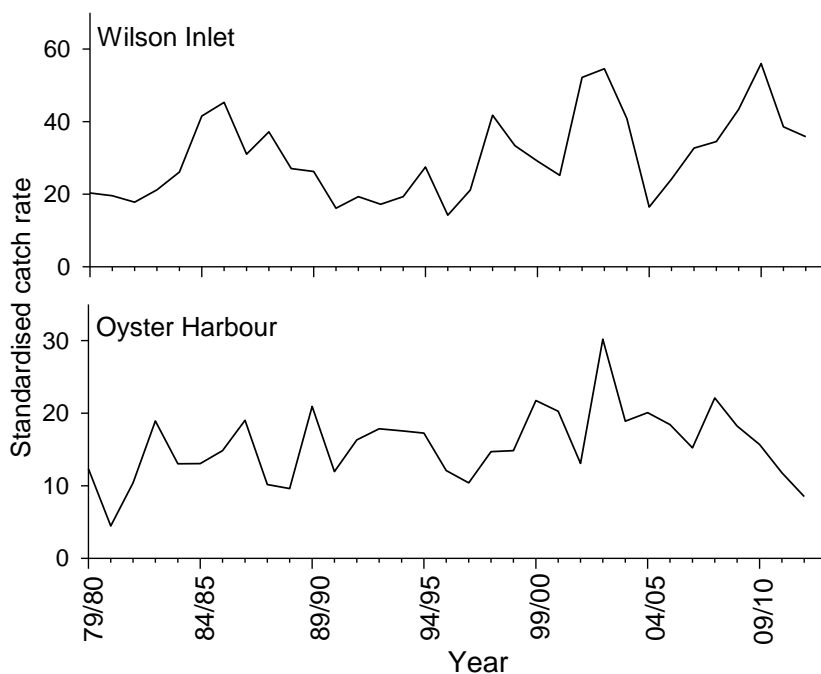
Total annual commercial catch rate (tonnes per licensee per year) of western Australian salmon in the South Coast Salmon Fishery (South Coast Bioregion) and the South West Coast Salmon Fishery (West Coast Bioregion), 1995 – 2012.

SOUTH COAST BIOREGION



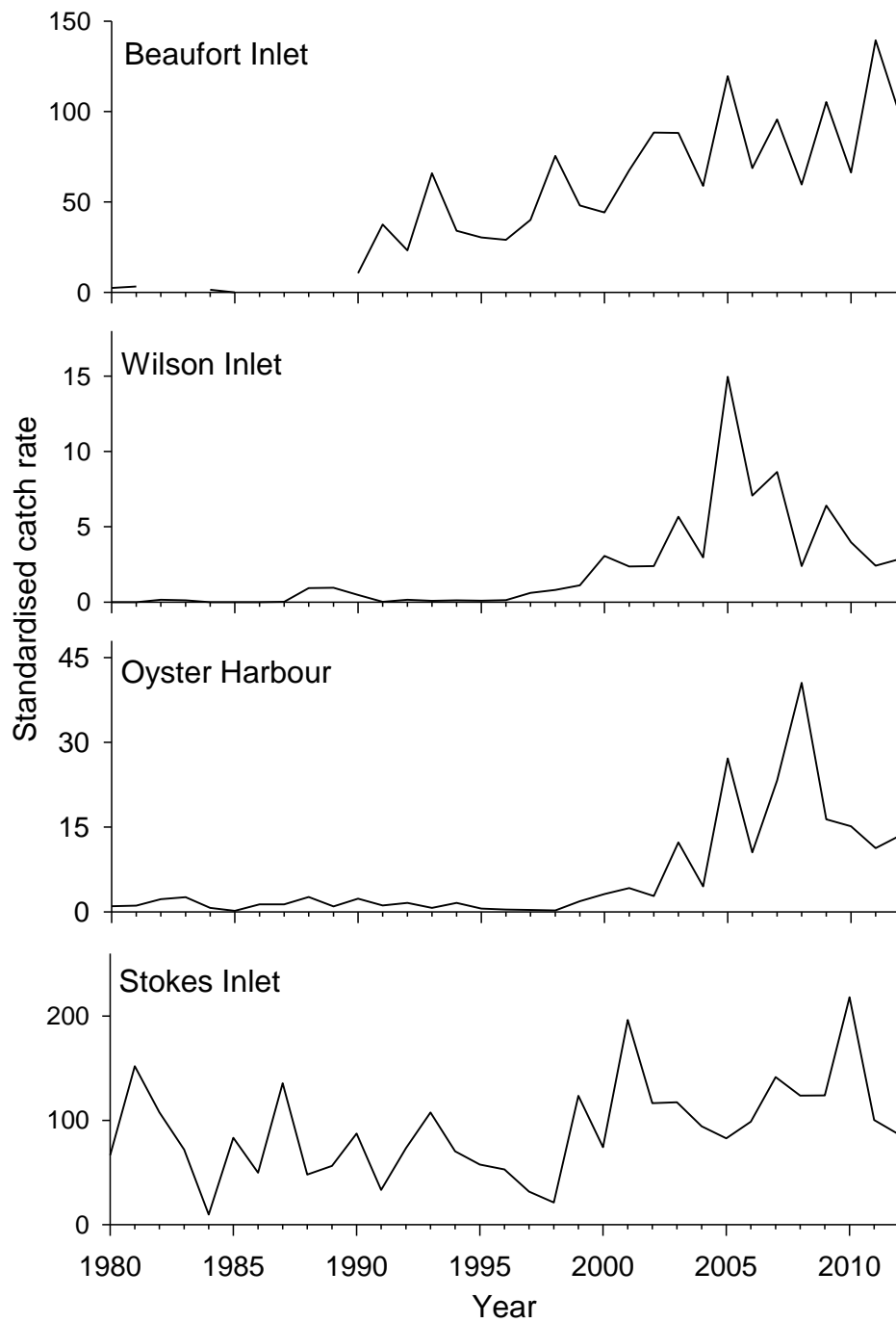
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 3

Annual fishery-independent relative recruitment index for western Australian salmon in the South Coast Bioregion, 1996 – 2012. Data represent annual deviations from the long-term average. e.g. bars above the line indicate better than average number of recruits. (x – no sampling conducted in that year).



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 4

Annual commercial catch rates of cobbler in Wilson Inlet and Oyster Harbour, 1979/80 – 2011/12.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 5

Annual commercial catch rates of black bream in Beaufort Inlet, Wilson Inlet, Oyster Harbour and Stokes Inlet, 1980 – 2012.

South Coast Purse Seine Fishery Report: Statistics Only

B. Molony, E. Lai, M. Stadler, M. Holtz and R. Jones

Fishery Description

The South Coast Purse Seine Managed Fishery (SCPSF) 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 South Coast Purse Seine Management Plan 1994 also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*), scaly mackerel (*Sardinella lemuru*), sandy sprat (*Hyperlophus vittatus*) blue sprat (*Spratelloides robustus*) and maray (*Etrumeus teres*).

Boundaries

The SCPSF consists of five Management Zones (South Coast Purse Seine Fishery Figure 1). Zone 1 extends from Peak Head to Vancouver Peninsula (the waters in and around King George Sound, Albany). Zone 2 extends from Point D'Entrecasteaux to Cape Knob. The Bremer Bay Zone (Zone 3) extends from Cape Knob to longitude 120°E. The large Esperance Zone (Zone 4) extends from 120°E 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. The Zones are broken down into finer spatial scale blocks for reporting of catch and effort in the mandatory Catch and Effort Disposal forms but for this report catches are reported for the major zones (Zones 1 and 2 combined; Zone 3 and Zone 4 separately) plus the total catches (South Coast Purse Seine Fishery Figure 2) based on mandatory catch and effort logbook submissions.

Management arrangements

This SCPSF is primarily managed through output controls in the form of individual transferable quota (ITQ) units. Four of the five zones in the fishery (i.e. zones 1 – 4) have been allocated a set amount of ITQ units whose values are determined by dividing the total allowable catch (TAC) 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 SCPSF runs from 1 July to 30 June of the following year. The Albany zone has an annual TAC of 2,683 tonnes, while both the Bremer Bay and Esperance zones each have an annual TAC of 1,500 tonnes. Zone 5 of the fishery is considered a development zone and can only be fished by a licence holder in the SCPSF 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

Bremer Bay and Esperance:	Cannot report
Albany	1641 tonnes

Effort in the SCPSF was within the range of recent years in 2011/12, with a total of 1,359 days of fishing (2009/10: 1,450 days; 2010/11: 1,290 days). Compared to 2010/11 fishing season, effort increased in the Albany Zones (Zones 1 and 2), decreased in the Esperance Zone (Zone 4), and was stable in the Bremer Bay Zone (Zone 3).

The 2011/12 pilchard catch in the South Coast Purse Seine fishery was the second highest since 1998. Commercial pilchard catches during the 2011/12 were 2,380 t similar to catches reported in recent years (2010/11: 2,322 t; 2009/10: 2,647 t) but still trending upward since the late 1990s (South Coast Purse Seine Figure 2). This suggests that the pilchard biomass is still recovering since the pilchard virus and kills of the late 1990s. Less than 8 t of other pelagic species were also landed, dominated by yellowtail scad.

Most of the commercial catches were reported from the Albany Zones (1,641 t). However, overall effort and catches remain below those recorded during the late 1980s and 1990s.

Fishery Governance

Target commercial effort range: **Not available**

For the 2011/12 season, the total pilchard catch (2,380 t) was still well below the total TAC for the entire fishery (5,683 t) (South Coast Purse Seine Fishery Table 1) with catches from each of the Management Zones remaining well below their respective TACs.

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 Management Zone is likely to be at adequate levels and the current level of fishing is acceptable. The catch levels in other jurisdictions further support the continued recovery in the biomass of pilchards across southern Australia.

New management initiatives (2012/13)

Since 2006 /07, the SCPSF protected species bycatch mitigation program has undertaken a range of measures to monitor and mitigate shearwater bycatch during the peak interaction period between 1 March to April 30. These bycatch mitigation measures are reviewed annually and continually being refined and improved.

There are no significant legislative management changes planned for this fishery.

This fishery is planned to undergo MSC pre-assessment in late 2014.

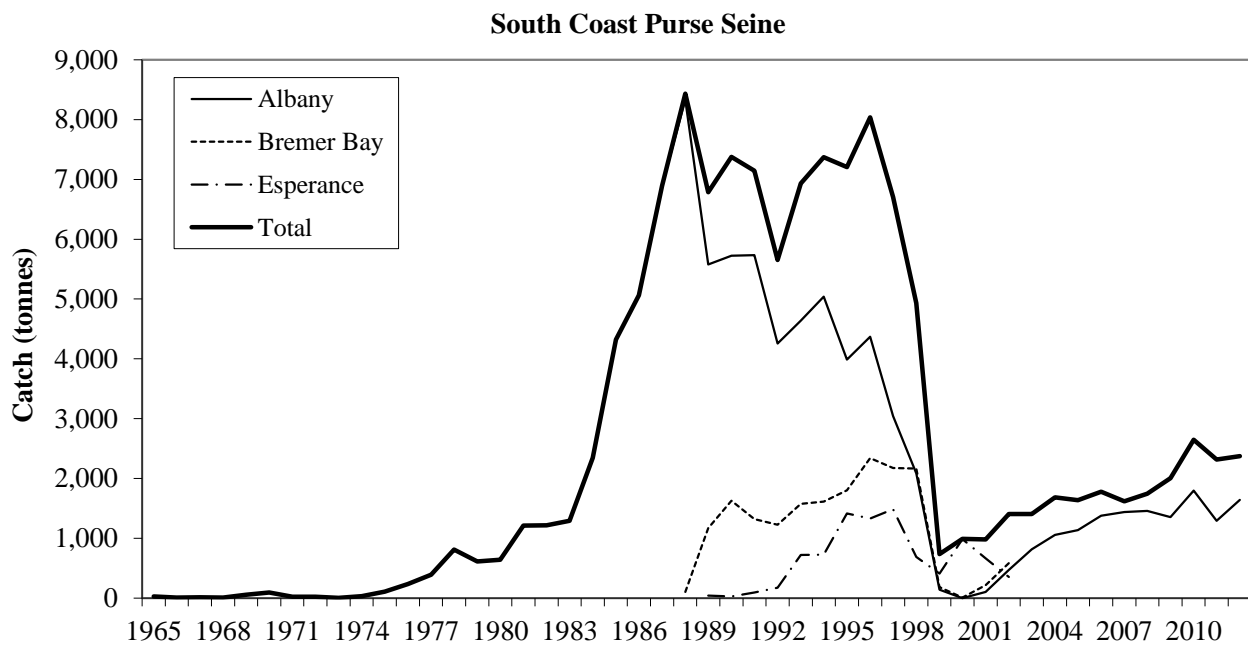
SOUTH COAST PURSE SEINE FISHERY TABLE 1

2011/12 pilchard catches and TACs in tonnes (t) for each of the major Management Zones. * Three or less vessels operated in each of these zones in 2011/12 and cannot be reported.

Management Zone	TAC (t)	2011/12 catch (t)	2011/12 catch as percent of TAC
Albany (Zones 1 and 2)	2,683	1,641	61.2%
Bremer Bay (Zone 3)	1,500	*	-
Esperance (Zone 4)	1,500	*	-
Total for Fishery	5,683	2,380	41.9 %

**SOUTH COAST PURSE SEINE FISHERY FIGURE 1**

Map of the extent of the South Coast Purse Seine Fishery.



SOUTH COAST PURSE SEINE FISHERY FIGURE 2

Annual catches of pilchards along the south coast, by major fishing zone, 1965 – 2011/12. Data post 2002 for the SCPSF operating in the Bremer Bay and Esperance Zones are not shown due to three or fewer vessels fishing in those years. However, the total catches for the SCPSF include catches reported from all Zones of the fishery.

Temperate Demersal Gillnet and Demersal Longline Fisheries Status Report

M. Braccini, R. McAuley & F. Rowland

Main Features

Status		Current Landings (2011/12)	
Stock level		Demersal Gillnet and Demersal Longline Fishery	
Gummy shark	Adequate	Total sharks and rays	909 t
Dusky shark	Recovering	Total scalefish	150 t
Sandbar shark	Recovering		
Whiskery shark	Adequate	Indicator species	
		Gummy shark	354 t
Fishing Level		Dusky shark	233 t
JASDGLDF Zone 1	Acceptable	Sandbar shark	34 t
JASDGLDF Zone 2	Acceptable	Whiskery shark	102 t
WCDGLDF	Acceptable		
		Catch of sharks and rays by other commercial fisheries	4 t
		Recreational catch (2011/12)	<5% of commercial catch

Fishery Description

The Temperate Demersal Gillnet and Demersal Longline Fishery (TDGDLF) is comprised of the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGLDF) and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGLDF). These fisheries operate in continental shelf waters along the south and lower west coasts respectively. The majority of operators employ demersal gillnets and power-hauled reels to target sharks, with scalefish also being a legitimate component of the catch. Demersal longline is also a permitted method of fishing, but is not widely used.

The main shark species targeted in the TDGDLF are gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and sandbar shark (*Carcharhinus plumbeus*). On the south coast, operators primarily target gummy and dusky sharks, while dusky and sandbar sharks are targeted on the west coast. Whiskery sharks are an important component of both fisheries catch. 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 these fisheries.

As their stocks span multiple bioregional boundaries, dusky, sandbar and whiskery sharks are assessed and monitored as indicators of the State-wide inshore demersal suite of shark species. Gummy sharks, however, have a more limited southern range and are an indicator species of the South Coast Bioregion inshore demersal shark species suite. The two fisheries are reported together here because extensive research has demonstrated that they share these key unit stocks.

Governing legislation/fishing authority

South Coast

Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992

Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery Licences

West Coast

West Coast Demersal Gillnet and Demersal Longline (Interim) Management Plan 1997

West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery Permits

Consultation processes

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

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 has been prohibited off the Metropolitan coast (between latitudes 31° S and 33° S) since November 2007.

Management arrangements

The Southern and West Coast fisheries are regulated through two complementary management plans. The JASDGLF (Joint Authority jurisdiction fishery) became managed under WA state law in 1988 and since then the fishery has been managed by the Western Australian Government on behalf of a Joint Authority comprising the Western Australian and Commonwealth Governments. The WCDGLF (a state jurisdiction fishery) is managed 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 WCDGLF, 264 hours in Zones 1 and 3 of the JASDGLF or 380 hours in Zone 2 of the JASDGLF. In addition to these effort controls all boats operating in the TDGLF are closely monitored by the Department's satellite-based Vessel Monitoring System.

A suite of shark management arrangements in target and non-target fisheries have been in effect since the 2006/07 season to ensure sustainable catches of target, byproduct and bycatch species, to assist in the recovery of historically over-exploited whiskery, dusky and sandbar shark stocks and to maintain acceptably low risks to endangered, threatened and protected (ETP) species. These include:

- the State-wide commercial protection of all sharks and rays;
- 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;
- a significant increase in penalties for illegally possessing sharks or rays; and
- a closure during the main whiskery shark pupping season, of inshore waters to 200m depth throughout all of the WCDGLF and the waters of the South Coast west of 118° E (in the JASDGLF) to assist in the recovery of the over-exploited whiskery shark stock.

In addition, to further assist in the protection of medium-high risk dusky 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) was closed to most commercial fishing activities, including those of the WCDGLF, in November 2007. 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 (VFAS) that bought back 36% of WCDGLF entitlements.

The TDGLF was first declared as an approved Wildlife Trade Operations (WTO) in February 2006. The fishery has been reassessed twice, and most recently re-accredited in May 2012, 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. The current WTO expires on 28 August 2015.

In addition to the renewal of the WTO the fishery was re-accredited for the purposes of Part 13 of the EPBC Act which provides protection for operators who may interact with threatened and protected species (TEPs) by accrediting the fisheries management plans as managing the fishery so as not to put populations of ETPs at undue risk. Addressing the potential interaction between fishers and Australian sea lions is a condition of this Part 13 accreditation.

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 TDGLF 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 three year FRDC-funded study of movements of the four indicator shark stocks commenced in 2011. Results from this study will be used to help in the reassessment of the status of these stocks enabling 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 and to improve assessments of key stocks and facilitate the more

detailed reporting requirements of the fisheries' export accreditation under the Commonwealths Environment Protection and Biodiversity Conservation (EPBC) Act, statutory daily/trip catch and effort logbooks were introduced in 2006/07. After rectifying some initial problems this exercise generally improved reporting standards and has provided the basis for development and implementation of new catch and effort data validation protocols.

Tactical research is also completed on bycatch issues with Threatened Endangered and Protected (ETP) species. 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 was undertaken in 2010-11. WA Government funded research into white shark (*Carcharodon carcharias*) movements around the south-west of Western Australia may also yield information on the ecology and population structure of this protected species.

Retained Species

Commercial landings (seasons 2001/12)¹:

All sharks (and rays):	909 tonnes
Indicator shark species:	723 tonnes
Gummy:	354 tonnes
Dusky²:	233 tonnes
Whiskery:	102 tonnes
Sandbar:	34 tonnes

Other finfish (i.e. non shark) catch: In addition to their primary catch of sharks, the JASDGLDF and WCDGLDF land a variety of scalefish species, which totalled 150 t in 2011/12 (Demersal Gillnet and Longline Figure 3). This catch included 50 t of demersal scalefish species taken in the West Coast Bioregion and 79 t of demersal scalefish taken in the South Coast Bioregion and a total of 21 t of non-demersal scalefish species (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 (e.g. 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 (4 t in 2011/12).

Recreational catch estimates: < 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.

An integrated survey of boat-based recreational fishing in WA during 2011/12 estimated the recreational capture of sharks at 25,908 individuals, from which only 4,514 were retained (Ryan *et al* 2013³). For the West Coast and South Coast Bioregions, a total of 15,086 individuals were captured and 3,056 retained, which equates to approximately 15 t. The most commonly retained species were hound sharks (43%), followed by whalers (28%), other sharks (14%), wobbegongs (9%) and hammerheads (5%). For the West Coast Bioregion, the most commonly retained species were also hound sharks (38%), followed by whalers (31%), other sharks (16%), wobbegongs (10%) and hammerheads (5%), and the total number of retained individuals was 2,664. This is consistent with the number of retained sharks estimated for this region in 2005/06.

Fishing effort/access level

There are 57 licences in the JASDGLDF (24 in Zone 1 and 33 in Zone 2) and 20 WCDGLDF permits, which can be used collectively in conjunction with a fishing boat licence. Only 5 Zone 1, 11 Zone 2 and 6 WCDGLDF vessels reported active fishing returns during 2001/12, 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, the historically small amount of longline fishing effort is incorporated within analyses by transforming 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 spend fishing (i.e. 'soak time'). With the transition from monthly to hourly effort entitlement units and the introduction of a daily catch and effort logbooks in 2006/07, actual soak times have been more accurately reported over the last six years. Thus, the hourly components of fishing effort reported in monthly and daily fishing returns are not directly comparable. To allow for historical

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.

3 Ryan, K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H., & Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia 162 pp.

comparison and assessment of effort and CPUE trends in the fisheries, the entire 37 year time series of effort data have been recalculated in comparable units of kilometre gillnet days (km gn.d⁻¹; Demersal Gillnet and Longline Figure 4). For these same reasons, fishing effort is also monitored against 2001/02 target levels in units of km gn.d⁻¹.

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 are considered likely to deliver sustainable catches of target, byproduct and bycatch species and acceptably low risks to ETP 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 JASDGLF, 20 hours day⁻¹ in Zone 2 and 24 hours day⁻¹ in the WCDGLF. Thus, specified fishing effort limits for each management zone of the fishery are:

JASDGLF Zones 1 and 3:	84,075 km gn.hr ⁻¹ (3,503 km gn.d ⁻¹)
JASDGLF Zone 2:	144,102 km gn.hr ⁻¹ (7,205 km gn.d ⁻¹)
WCDGLF ¹ :	67,692 km gn.hr ⁻¹ (2,832 km gn.d ⁻¹)

Expended effort in 2001/12 was 64,772 km gn.hr (3,589 km gn.d⁻¹) in Zone 1; 106,792 km gn.hr (5,790 km gn.d⁻¹) in Zone 2 and 11,238 km gn.hr (523 km gn.d⁻¹) in the WCDGLF (Demersal Gillnet and Longline Table 1). The effort decline in the WCDGLF is consistent with the gradual declining trend observed in recent years explained by the combination of fishing units reduction due to the VFAS, area closures and new effort management regimes. When measured in km gn.hr, 62% of the fisheries' effort capacity was utilised in 2001/12 (77% in Zone 1, 74% in Zone 2 and 17% in the WCDGLF). When measured in km gn.d⁻¹, 73% of the fisheries' effort capacity was utilised in 2001/12 (102% in Zone 1, 80% in Zone 2 and 18% in the WCDGLF). Zone 1 km gn.d⁻¹ effort is at its maximum and must be closely monitored.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Gummy shark	Level 2 - CPUE
(annual -relative to previous Level 5 assessment)	
Dusky shark	Level 2 - CPUE
(annual -relative to previous Level 4 assessment)	
Sandbar shark	Level 2 - CPUE

¹ The WCDGLF 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.

(annual -relative to previous Level 4 assessment)

Whiskery shark Level 5 - Age Structured Model

Breeding stock levels:

Gummy shark	Adequate
Dusky shark	Recovering
Sandbar shark	Recovering
Whiskery shark	Adequate

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 (e.g. 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 previously 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' annual 'effective' Catch Per Unit Effort (CPUE) data. 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 the 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, slightly above its minimum acceptable level of 40% of its virgin level. 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 estimates have been higher than at any time since records began, the unprecedented spike and subsequent decline in effective CPUE over the last five years is inconsistent with previous estimates 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 for this stock was conducted in 2005 and subsequent assessments 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 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.

There has been an increasing trend in the effective CPUE over the past seven years. While the effects of reduced gear competition in the WCDGDLF resulting from the reduction in fishing units due to the VFAS and a general reduction in fishing effort could have contributed to the increasing trend, the average effective CPUE for the past five years has been higher than any time since 1984/85. This suggests that recruitment has been increasing strongly since measures were introduced to protect adult sharks and constrain effort in the TDGDLF. Combined with the recent catches of juvenile sharks of this species having been reduced to approximately half of the quantity 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 from 2006¹, the current management arrangements are considered suitably precautionary to ensure that fishing mortality is now at a level such that recovery of this stock is occurring.

Whiskery shark: Previous age structured modelling of the whiskery shark stock (based on hourly CPUE data)

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.

concluded that total biomass was depleted to less than 40% of its virgin level by the early 1990s but the stock had shown preliminary signs of recovery to slightly above 40% of virgin biomass by the late 2000s. Using the new series of daily effective CPUE data from south of 28°S latitude to 129°E longitude off the south coast (Demersal Gillnet and Longline Figure 7) in the model supports 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. The best (median) estimates of total biomass have indicated only very modest increases and that biomass in 2009/10 was 52.1% of its virgin level (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 (around 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 reported 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 was 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 8), the full

SOUTH COAST BIOREGION

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 since 2008/09 have been at levels that should allow a gradual recovery of the breeding stock. With the breeding stock likely to be close to the minimum acceptable limit (40% of virgin biomass), 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.

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 less than 70% of the mid to late 1990s levels, bycatch in all management zones is expected to have been 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 due to its very high post-capture survival from gillnet fisheries (Braccini *et al* 2012¹).

Protected species interaction: **Negligible-Low**

Historical on-board observer programs have shown that protected species interactions were very low throughout the fishery. The Demersal Gillnet and Longline Table 2 details individual interactions between the fishery and all protected species since 2006/07.

Recently completed analyses of potential encounter rates of Australian sea lions with demersal gillnet gear and interpretation of those rates in the light of historical observer data have supported Department's Negligible-Low risk rating and suggested that sea lion captures in these fisheries are likely to be extremely low frequency events.

It should also 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 sea lions are present.

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, 2011)² 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 that would be contacted by this gear on an annual basis.

Social Effects

Direct: Fishing returns reported that between 50 and 66 crew were employed in the JASDGLF and over between 20 and 23 were employed in the WCDGDLF during 2011/12. 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 humans 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 value (to fishers) for 2011/12:

JASDGLF: **Level 2 - \$1 - 5 million**

WCDGDLF: **Level 2 - \$1 - 5 million**

* 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.

1 Braccini, J.M., Van Rijn, J.A. & L.H. Frick. High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? PLoS ONE, 7: e32547

2 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. 112 pp.

Fishery Governance

Target commercial catch range:

All key shark species 725–1,095 tonnes

Individual key shark species:

Gummy shark 350–450 tonnes

Dusky shark 200–300 tonnes

Sandbar shark < 120 tonnes

Whiskery shark 175–225 tonnes

Current Fishing Level

JASDGLF Zone 1 Acceptable

JASDGLF Zone 2 Acceptable

WCDGLF 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 exceeded the upper limit of their acceptable range between 2003/04 and 2009/10, 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. Although gummy shark catches were lower than their historical peak, current catches were similar to last year and at the lower limit of their target range. As gummy CPUE appears to have been maintained at a relatively high rate, this year's catch is 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 three years does not continue.

Dusky shark catches have been within their acceptable range since 2000/05, except for 2006/07 when they were 5 tonnes below the minimum limit. The dusky shark catch in 2011/12 was 233 t which is within the target range of 200–300t. However, the fishery has not utilised its full entitlement during 2011/12 and as such the Department will need to carefully monitor the catch levels to ensure they do not increase above sustainable levels. The acceptable catch range will require re-evaluation if catches increase in coming years.

Whiskery shark Total catches of whiskery shark have steadily declined since the mid-1990s although, until 2010/11 had been maintained slightly above or below the minimum acceptable level. The 127 t catch in 2010/11 and 102t catch in 2011/12 were 48 and 73 t, respectively, less than the minimum level and had been the fisheries' lowest annual catch since 1975/76. The low catches of recent years mostly reflect the outcomes of management measures to recover this stock, in particular, the introduction of the seasonal whiskery 'pupping' closure. As these measures are intended to increase catch rates in coming years the acceptable catch range may need to be reviewed as the magnitude and rate of stock

recovery can be determined.

Sandbar shark catches exceeded their maximum acceptable level until effort declined dramatically in the WCDGLF in 2008/09 when catches declined to more sustainable levels of 81 t in 2008/09, 107 t in 2009/10, 71 t in 2010/11, and 34 t in 2011/12. The historically low catch of sandbar sharks is likely to reflect the low level of fishing effort and other fleet dynamics in the WCDGLF. At these levels, recruitment to the breeding stock should improve in coming years and gradually allow the mature biomass to recover from more than a decade of excessive catches in the northern shark fisheries (see Northern Shark Fisheries Status Report).

New management initiatives (for 2012/13)

The review of the whiskery shark 'pupping' closure for the 2012/2013 fishing season resulted in a reduction of the closure to the peak pupping period of the entire month of September only. The area of the closure remained as in previous years. Given that the virgin biomass has likely exceeded B_{40} a reduction in the duration of the closure was considered appropriate. However, although cohorts born since 2006 will recruit to the fisheries around 2012/13, with the longterm sustainability of the species in mind, and the uncertainty surrounding the status of the whiskery shark stocks in the absence of a formal stock assessment (due for commencement in 2014/15) the Department will review the closure again for the 2013/14 fishing season. The FRDC-funded desktop study that began in August 2010 to estimate potential interaction rates of Australian sea lions with demersal gillnets in the TDGDLF was completed and accepted by FRDC in early 2012. The model developed as part of the project was used to conduct a (partial) reanalysis of existing independent observer data from the TDGDLF to assist in evaluating management options to ensure interactions with Australian sea lions are maintained with acceptable levels.

The WTO for the TDGDLF was renewed on 31 May 2012 and expires on 28 August 2015. In addition, the Part 13 accreditation of the management plans for the fisheries were re-accredited. This accreditation allows fishers to interact with endangered, threatened and protected species with fear of prosecution. The accreditation carries a condition associated with addressing interactions between the fishery and Australian sea lions. The Department is convening an Australian sea lion working group that will consist of Departmental staff from both management and research, as well as industry, the conservation sector and the Department of Environment and Conservation. It is intended that the above mentioned working group will identify management measures that address this Part 13 condition and mitigate interaction between the fishery and Australian sea lions.

The proposed South-west Commonwealth marine reserve network was proclaimed in November 2012. Following the change of Federal Government in 2013 the marine reserve network is to be reviewed. The potential for the reserves to impact on the TDGDLF will depend on the outcomes of that review. The State Ngari Capes Marine Park was also reserved in June 2012, however the zoning scheme has not yet been given effect. This marine park is likely to have some impact on Zone 1 TDGDLF operators.

External Factors

As the TDGDLF key target species span multiple regional boundaries there are a number of factors outside of the control of the fishery which can negatively impact the performance of key temperate shark stocks. In particular, the potential for ongoing catches of breeding stock of sandbar sharks across the northern shark fisheries (from Western Australia, Northern Territory and northern Queensland and Commonwealth managed fisheries) remains cause for concern. Other potential factors affecting key temperate shark

stocks include targeted fishing for gummy shark by Commonwealth managed vessels that occurs to the east of Zone 2 of the JASDGLF (although the fishery is tightly managed via quota controls) and incidental catches of dusky and gummy sharks in other State and Commonwealth Government-managed fisheries. While the risks associated with these outside influences are largely unqualified they must be taken into account in the stock assessment for individual species (and the TDGDLF 'suite') to ensure appropriate management strategies are implemented that address the long-term sustainability of the shark stocks.

DEMERSAL GILLNET AND LONGLINE TABLE 1

Summary of 2011/12 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		WCDGLF	Bioregion		Total
		Zone 1	Zone 2		South Coast	West Coast	
Sharks and rays							
Gummy	<i>Mustelus antarcticus</i>	34.4	318.8	0.5	326.6	27.1	353.7
Dusky whaler	<i>Carcharhinus obscurus</i>	122.5	95.0	15.1	120.8	111.8	232.7
Whiskery	<i>Furgaleus macki</i>	24.9	73.3	3.3	78.2	23.3	101.6
Sandbar	<i>Carcharhinus plumbeus</i>	9.9	5.5	18.5	10.3	23.5	33.8
Hammerheads	F. Sphyrnidae	21.6	36.8	1.6	39.2	20.8	60.0
Spinner (long nose grey)	<i>Carcharhinus brevipinna</i>	40.0	6.7	12.5	11.8	47.5	59.2
Wobbegongs	F. Orectolobidae	18.1	11.2	3.5	15.3	17.5	32.8
Rays	Batoidea	2.4	5.7	3.4	6.6	5.0	11.5
Common saw shark	<i>Pristiophorus cirratus</i>	0.9	7.1	<0.1	7.1	1.0	8.1
School	<i>Galeorhinus galeus</i>		1.2		1.2		1.2
Other elasmobranchs		7.9	4.4	2.4	5.5	9.2	14.7
Total elasmobranchs		282.6	565.7	60.9	622.6	286.7	909.2
Scalefish							
Queen Snapper	<i>Nemadactylus valenciennesi</i>	11.1	25.6	0.2	28.5	8.3	36.9
Blue Groper	<i>Achoerodus gouldii</i>	21.5	20.1	0.5	25.7	16.5	42.1
Dhufish	<i>Glaucosoma hebraicum</i>	8.7	1.2	2.4	2.3	9.9	12.2
Pink snapper	<i>Pagrus auratus</i>	6.7	8.4	5.7	9.8	11.1	20.9

Name	Species or taxon	JASDGLF		WCDGDLF	Bioregion		Total
		Zone 1	Zone 2		South Coast	West Coast	
Boarfishes	F. Pentacerotidae	1.5	5.7	<0.1	6.1	1.1	7.2
Samsonfish	<i>Seriola hippos</i>	4.1	1.4	1.8	3.0	4.4	7.4
Redfishes	<i>Centroberyx</i> spp.	0.3	6.1	<0.1	6.4	0.1	6.5
Mulloway	<i>Argyrosomus hololepidotus</i>	2.4	1.2	0.6	1.4	2.8	4.2
Sweetlips	F. Haemulidae			1.0		1.0	1.0
Baldchin groper	<i>Choerodon rubescens</i>		<0.1	1.4	<0.1	1.4	1.4
Other scalefish		6.1	2.5	1.7	3.0	7.3	10.2
Total scalefish		62.4	72.2	15.3	86.1	63.8	149.9
'Demersal scalefish suite' component		49.9	67.6	11.7	79.3	49.9	129.2
Fishing effort (km gn d)		3,589 (102) ¹	5,790 (80) ¹	523 (18) ²			9,902 (73) ²
Fishing effort (1000 km gn hr)		65 (77) ³	107 (74) ³	11 (17) ³			183 (62) ³

1 Percentage of respective 2001/02 levels

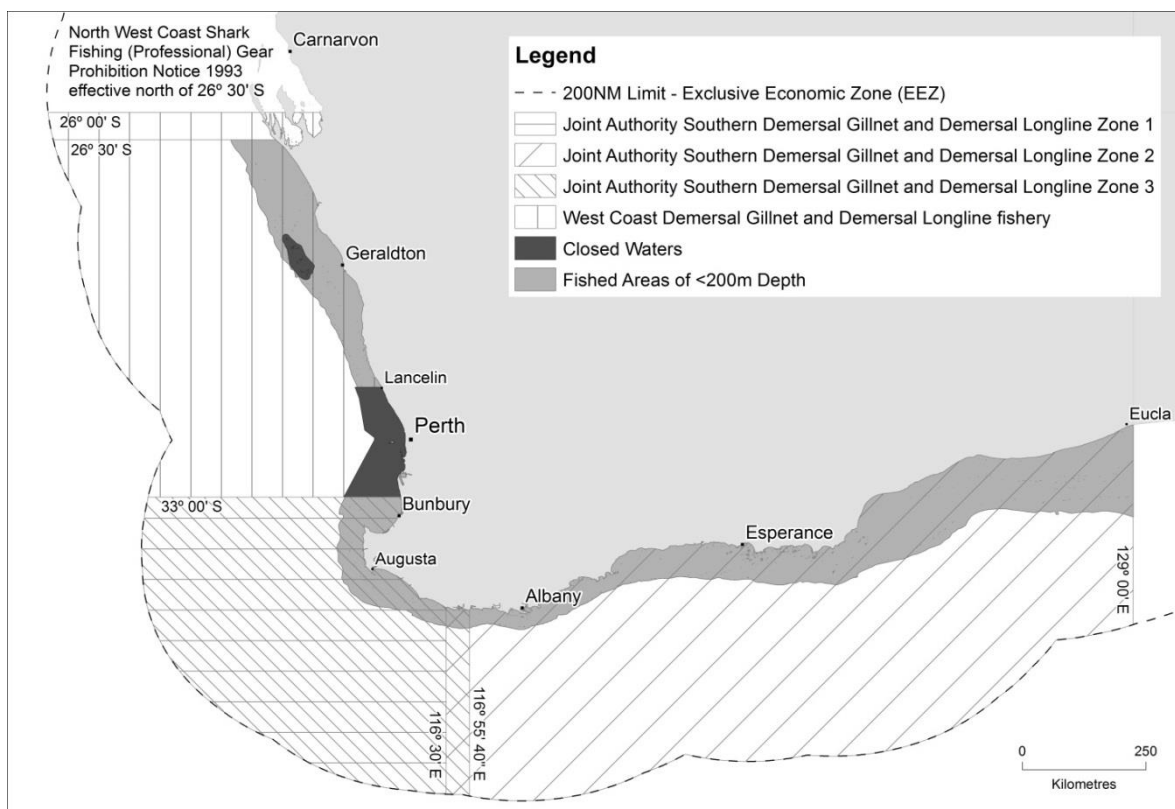
2 Percentage of VFAS adjusted 2001/02 levels

3 Values in parentheses are percentages of each management zone's maximum hourly effort capacity

DEMERSAL GILLNET AND LONGLINE TABLE 2

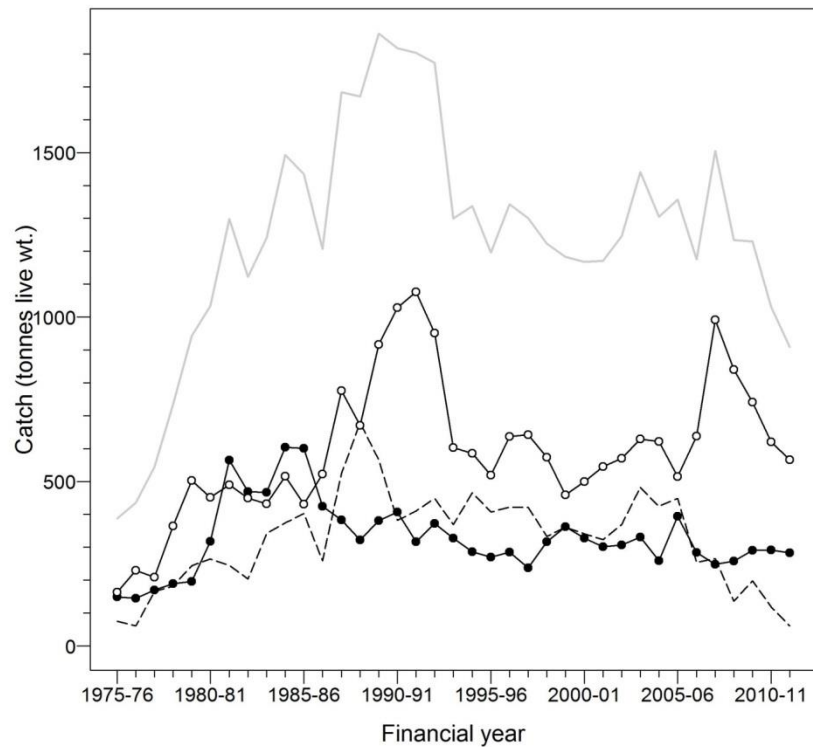
Recorded interactions with Threatened, Endangered, Protected (ETP) species.

ETP SPECIES	2006/07		2007/08		2008/09		2009/10		2010/11		2011/12	
Alive(A)/Dead(D)	A	D	A	D	A	D	A	D	A	D	A	D
Dolphins		6	1		1	2		2		3		
Manta Rays	2								2			
Muttonbird, General							7		4			
Sawfish, General			1						1			
Sea Birds	1	3		2	2	1						
Sea Lions						2						3
Seal, NZ Fur	1	1		2	1	5		7		1		3
Shark, Grey Nurse	61	18	38	16	63	18	59	27	53	19	69	18
Shearwater, Fleshfooted								2				
Snake, Sea				2								
Turtle, General	4	3	5		2	2	2	1	1		3	
Whales					1							
White Pointer	10	3	10	3	14	2	2	1	3	5	19	3

**DEMERSAL GILLNET AND LONGLINE FIGURE 1**

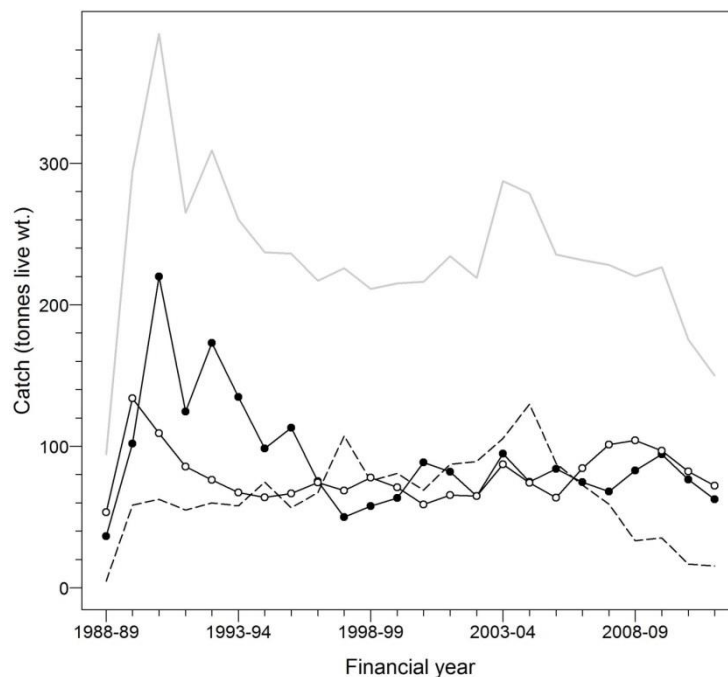
Management boundaries of the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Black shading

represents fished areas of less than 200m depth.



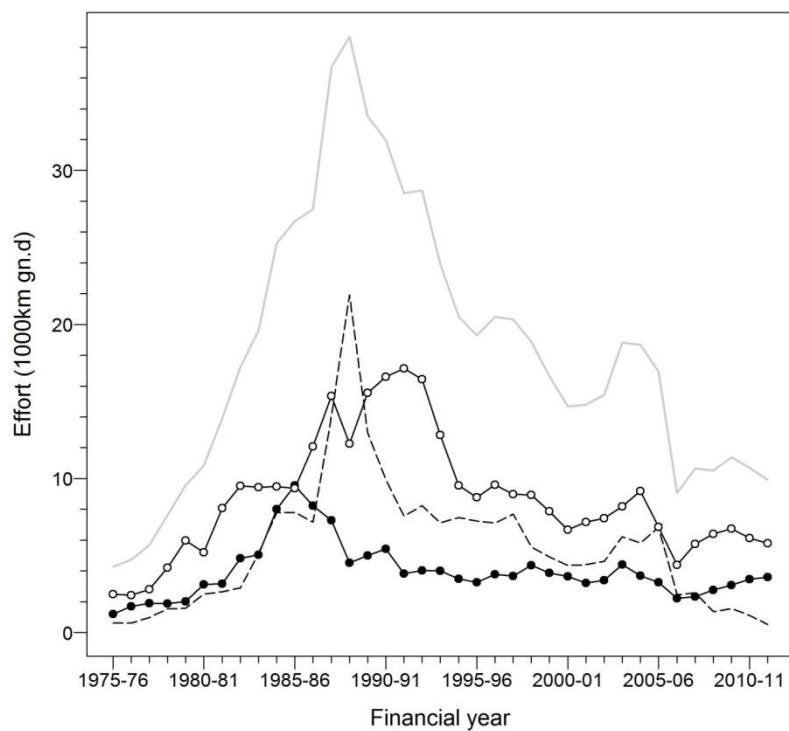
DEMERSAL GILLNET AND LONGLINE FIGURE 2

Total elasmobranch catches. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; dashed black line = WCDGLF; plain grey line = total from the three management zones.



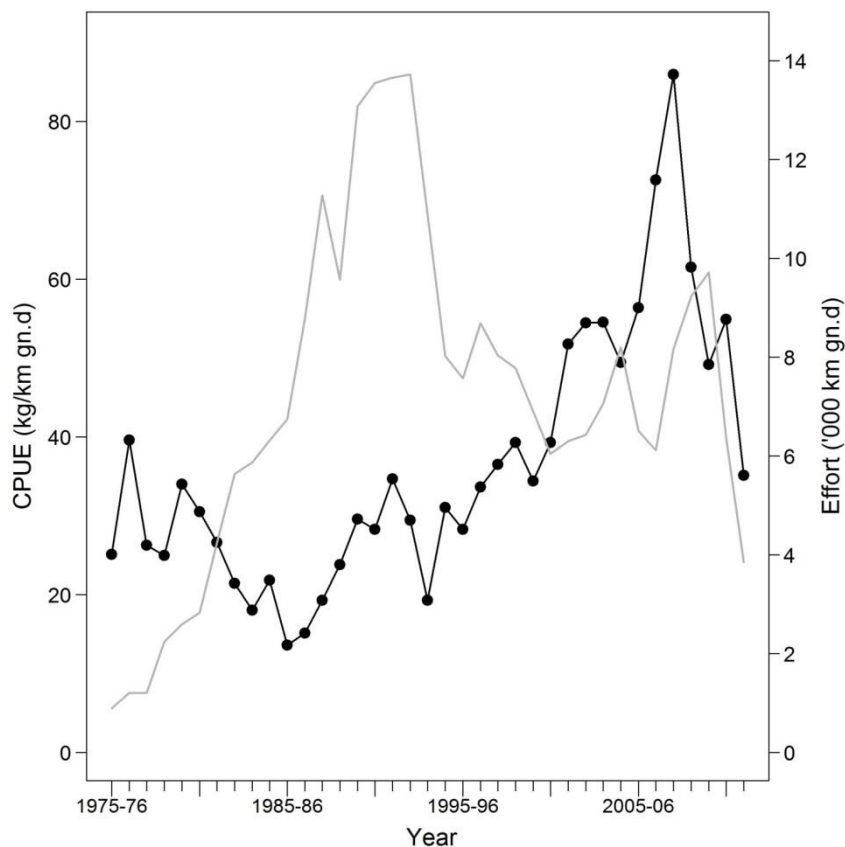
DEMERSAL GILLNET AND LONGLINE FIGURE 3

Total scalefish catch. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; dashed black line = WCDGLF; 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.



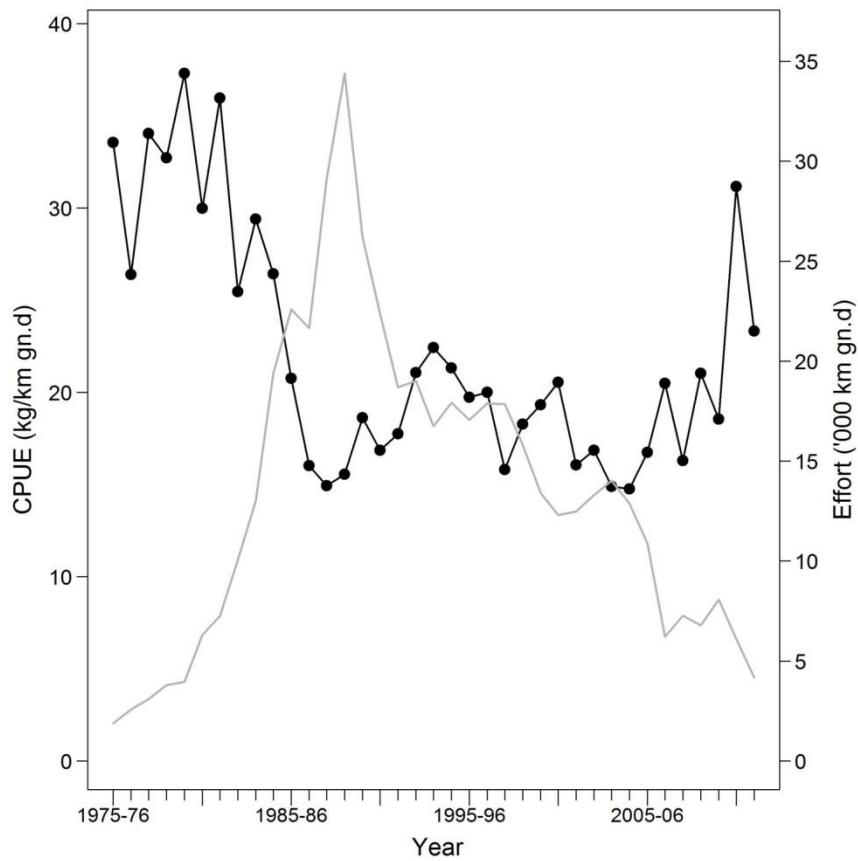
DEMERSAL GILLNET AND LONGLINE FIGURE 4

Standardised demersal gillnet and demersal longline effort. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; dashed black line = WCDGLF; plain grey line = total from the three management zones.



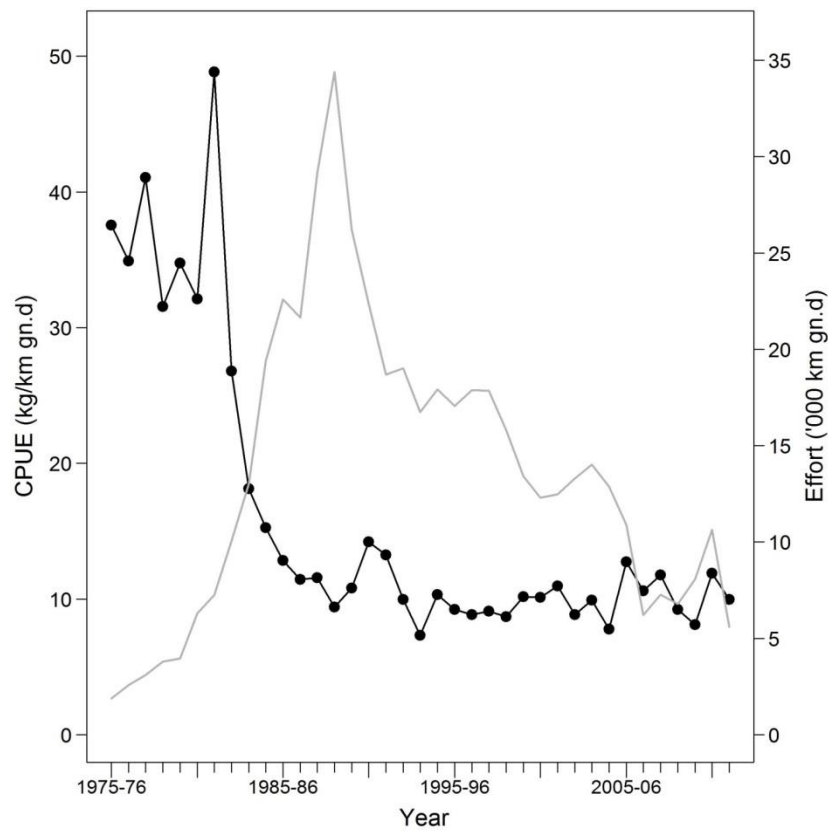
DEMERSAL GILLNET AND LONGLINE FIGURE 5

Gummy shark effective effort (grey line) and CPUE (black circles).



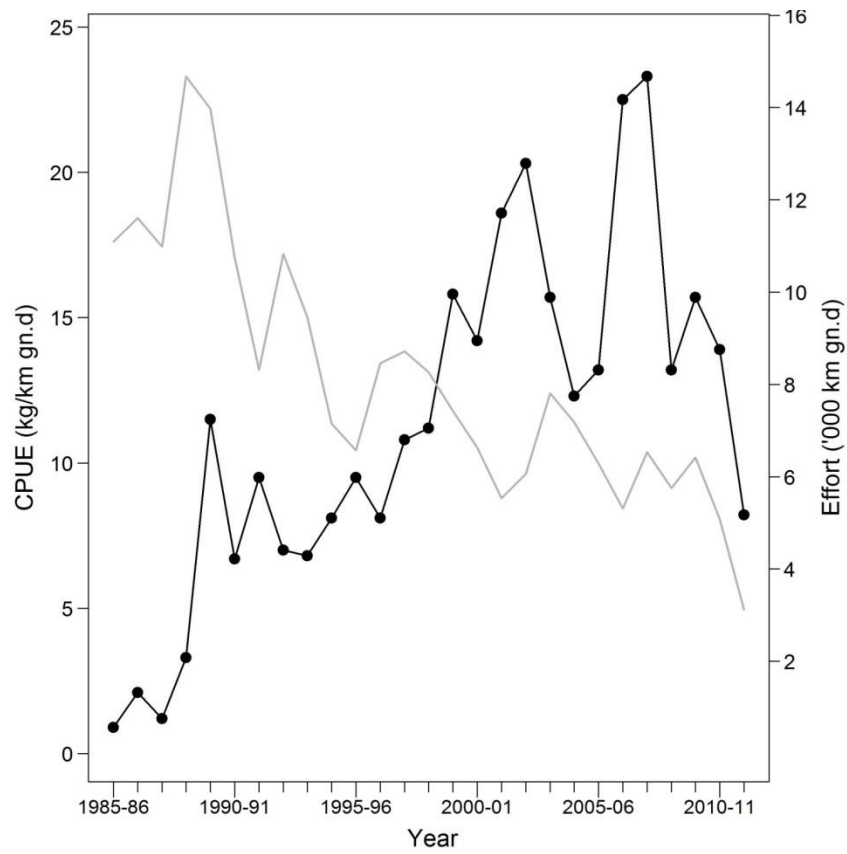
DEMERSAL GILLNET AND LONGLINE FIGURE 6

Dusky shark effective effort (grey line) and CPUE (black circles).



DEMERSAL GILLNET AND LONGLINE FIGURE 7

Whiskery shark effective effort (grey line) and CPUE (black circles),



DEMERSAL GILLNET AND LONGLINE FIGURE 8

Sandbar shark effective effort (grey line) and CPUE (black circles).

South Coast Demersal Scalefish Resource Report: Statistics Only

J. Norriss, E. Lai and M. Stadler

Fishery Description

Commercial

Operators in this fishery target demersal scalefish species such as pink snapper, Bight redfish, blue morwong (queen snapper) and hapuku stocks in waters of the South Coast Bioregion, primarily using droplines and handlines. The fishery is herein referred to as the south coast “wetline” fishery, although minor quantities of demersal scalefish taken in nearshore waters by haul nets and set nets whilst targeting nearshore species (e.g. herring, whiting, mullet) are included.

The take of scalefish by trap and trawl methods, salmon by line and beach netting, estuarine 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’s oceanic waters from near Black Point at 115° 30’ E to the WA/SA border at 129° E (South Coast Wetline Figure 1).

Governing Legislation

Commercial

Fish Resources Management Act 1994, Fish Resources Management Regulations 1995 and other subsidiary legislation.

The commercial ‘wet line’ fishery is currently ‘open access’ for the holder of an unrestricted 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 other subsidiary legislation.

Total Landings (Season 2012):

105.2 tonnes (demersal scalefish only)

Commercial

Estimates of catches are monitored through the mandatory Catch and Effort Statistics (CAES) logbook system. Bight redfish, blue groper, blue morwong and pink snapper have been identified as indicator species for the inshore demersal suite of finfish for the South Coast Bioregion. These indicator species are used to monitor the status of the resource and make up the large majority of the catches (~80 to 90%) of

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.

The catch of 105.2 t of demersal scalefish during 2012 is similar to the two previous years and remains within the range of catches since 2000 (77–139 t, South Coast Demersal Scalefish Resource 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’ E to either the South Coast Bioregion wetline fishery or the West Coast Demersal Scalefish Managed Fishery, respectively. In addition, 23.5 t of non-demersal scalefish were reported in 2012, predominantly Samson fish (13.1 t, pelagic suite) and skipjack trevally (2.0 t, nearshore suite).

Recreational

Preliminary data from a survey of boat based recreational fishing for the 12 months to 29 February 2012 indicates the catch (tonnes ± standard error) of some demersal indicator species: Bight redfish 11.8 (±1.7), blue morwong 12.0 (±1.8), pink snapper 9.4 (±2.3). Final estimates of the suite will be available in 2013 from the full survey report.

Fishery Governance

Target commercial catch range: Not available

A formal catch range has not been developed for this fishery. However, the 2012 catch of demersal species falls within the 77 - 139 t range of annual catches reported since 2000.

Current Fishing (or Effort) Level: Not available

This fishery is likely to undergo review following the completion in 2015 of a newly commenced Western Australian Natural Resource Management (WANRM) Office funded research project, described under New Management Initiatives (below). Development of an interim catch range will be considered during this review. An assessment of the 2005 and 2006 catches of hapuku from the South Coast Bioregion suggests they may be fully exploited, although there is uncertainty about the status of this resource (Wakefield *et al.* 2010¹). Opportunistic sampling of the catch-at-age of this species will occur in synchrony with the WANRM project.

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

New management initiatives (2012/2013)

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 fishing effort to the South Coast Bioregion. Increased resource sharing conflict between the recreational and commercial sectors and within the commercial sector has been reported.

A new WANRM-funded research project commenced in 2013 with the objective of providing age based stock assessments of inshore demersal indicator species for the South Coast Bioregion (snapper, Bight redfish, blue morwong and western blue groper), and to provide information on their stock structure. A research report will be finalised in 2015.

The nearshore species targeted by open access inshore (oceanic) netters are also vulnerable and the recent increase in this activity has led to reports of resource sharing and user group conflict.

The Department will continue to monitor the fishery and intends to develop more formal management arrangements for wetline fishing off the South Coast. These arrangements will aim to help address stakeholder concerns and provide an improved framework for the sustainable management of the

commercial line and net fisheries and recreational fishery into the future.

This fishery is planned to undergo MSC pre-assessment in late 2014.

External Factors

The Great Australia Bight Trawl Sector (GABTS) is part of a Commonwealth managed fishery operating across southern Australia. Off the Western Australia coast it operates in waters from Cape Leeuwin to the South Australian border, excluding State fishery shelf waters (depth less than 200 metres), except for east of 125° E (approximately 250 km east of Esperance) to the South Australian border where shelf waters are fished by the GABTS. Bight redfish are an important component of the GABTS catch, with 352 tonne caught in the 2011-12 fishing season. The proportion taken in waters off West Australia is unknown. Thus the South Coast Demersal Scalefish resource is also exploited by the GABTS and is affected by management arrangements in that fishery. The current WANRM-funded project is working in collaboration with the GABTS and stock assessments and other analyses will also include details of catches by this sector.

SOUTH COAST DEMERSAL SCALEFISH RESOURCE TABLE 1

Catches (t) of demersal indicator species, total demersal and total non demersal scalefish catches by the 'open access' commercial wetline fishery in the South Coast Bioregion, 2007–2012.

Species	2008	2009	2010	2011	2012
Bight Redfish*	47.2	33.5	31.2	35.9	44.7
Blue groper	1.1	1.2	0.6	1.3	0.5
Blue Morwong	5.2	8.0	4.9	5.0	4.4
Pink Snapper	37.9	44.9	40.7	29.6	27.9
Hapuku	13.1	18.5	13.6	16.6	14.4
Blue-eye trevalla	5.5	2.4	3.3	3.4	2.5
Eightbar grouper	0.6	0.7	0.5	1.5	3.4
Other demersal scalefish	15.6	12.5	13.2	8.9	7.5
Total demersal scalefish	126.3	121.8	108.0	102.1	105.2
Total non-demersal scalefish**	27.7	26.6	21.4	32.4	23.5
Total Scalefish	153.9	148.4	129.4	134.5	128.7

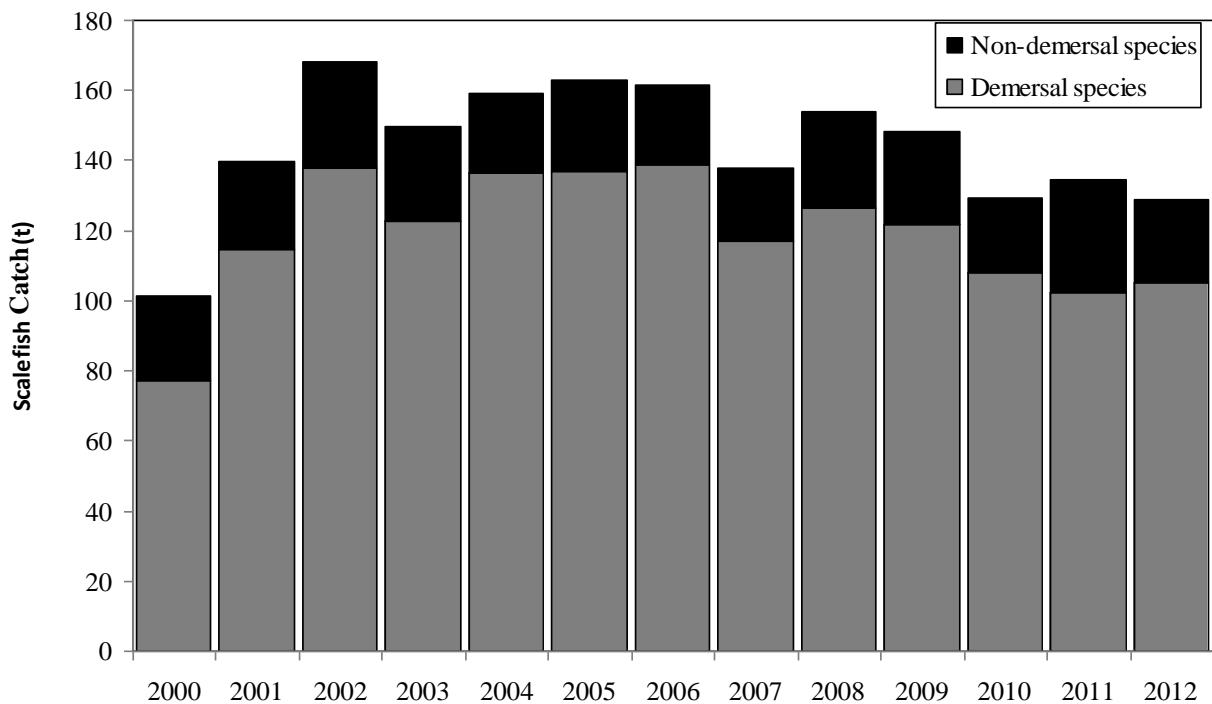
* Estimates of Bight redfish catches include fishes reported as 'Bight redfish', 'yelloweye redfish' and 'redfish', confirmed by recent catch sampling to be almost exclusively Bight redfish.

** Non demersal scalefish includes fishes from the pelagic suite (mainly Samson fish) and nearshore suite (mainly skipjack trevally).



SOUTH COAST DEMERSAL SCALEFISH RESOURCE FIGURE 1

Map of the extent of the "open access" wetline fishery in the South Coast Bioregion.



SOUTH COAST DEMERSAL SCALEFISH RESOURCE FIGURE 2

Catches (t) of demersal and non demersal scalefish in the "open access" wetline fishery, 2000—2012.

AQUACULTURE

Regional Research and Development Overview

Greenlip abalone (*Haliotis laevis*) is considered a key species for aquaculture development on the south coast of WA.

An abalone farm and associated hatchery near Bremer Bay have been upgraded and modified to cater for planned growth in production and to accommodate biosecurity requirements. The land-based farm and hatchery are being operated according to a Biosecurity Plan, developed with input from the Department of Fisheries. Independent audits are undertaken to ensure compliance with the Biosecurity Plan.

An offshore abalone farm near Augusta is achieving encouraging early results for abalone that are being grown out using purpose-built concrete structures located on the sea

bed. The operator is testing two new sites under an Exemption issued by the Department of Fisheries.

The abalone aquaculture industry sector currently operates under the policy entitled *Abalone Aquaculture in Western Australia*. To address the risk of a disease outbreak in wild and cultured abalone stocks, and because abalone aquaculture comprises an increasingly important part of Western Australia's growing aquaculture industry, the Department of Fisheries is reviewing its Abalone Aquaculture Policy. A key purpose of the revised Abalone Aquaculture Policy is to establish clear management guidelines and hence provide greater certainty to the sectors of the abalone industry.

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 and using a Recreational Mobile patrol vehicle. FMOs conducted compliance activities of both the recreational and commercial fisheries. The compliance strategies include both overt and covert operations. Inspections of fishing activities are done at land based locations, at-sea inspections, commercial processors, aquaculture and wholesale/retail outlets. The inspections are of vessels, catches, fishing gear, marine safety equipment and checking of licenses for both the commercial and recreational fisheries.

There are two part-time South Coast Marine Education Officers who deliver the Education program for the South Coast.

Activities during 2011/2012

Compliance

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 3800 hours of "field" compliance activity during 2011/2012.

South Coast Compliance Table 1 represents an increase from the previous year (South Coast Compliance Figure 1).

Commercial Fisheries

Officers made contact with a total of 250 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.

The remainder of the commercial fishery compliance effort was directed to the wide range of minor commercial fisheries operating in the bioregion. There was an increase in Catch

Inspections of the Estuarine fisheries and Commercial Licence Inspections.

A dedicated effort was applied to persons unlawfully interfering with commercial fishing gear. A covert strategy coupled with intelligence information identified the target places and times of probable offending resulting in a number of persons being apprehended and prosecuted. These operations were complimented by the assistance of some commercial fishers who provided equipment and fish to aid the investigation.

During the year, 10 infringement warnings and 8 infringement notices were issued with a further 6 cases resulted in prosecution action being taken against commercial fishers (or those offending against commercial gear)

Recreational Fisheries

Recreational compliance activities concentrated mainly on checking shore and boat based anglers, net fishers and shellfish collectors. Fisheries and Marine Officers contacted a total of 6947 recreational fishers. During 2011/2012, there were 95 infringement warnings and 46 infringement notices issued and 6 prosecution actions were taken 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, marron, marine finfish and estuarine netting. There continues to be a growing awareness of the open season and availability of abalone on the south coast.

Education

Community and school education programs in the Southern Bioregion were conducted by the Marine Education Officer's. Activities included the delivery of school incursions and excursions to 1564 primary and secondary students across the region in 70 structured sessions. A further

571 people were contacted through structured community education activities such as school holiday programs, presentations to interest groups and direct community engagement with recreational fishers.

Four regional events were also attended with 1625 contacts made. These included agricultural shows and science expos. Where possible, education initiatives were delivered in collaboration with other environmental education providers. Partnerships included the Department of Parks and Wildlife, South Coast Natural Resource Management, the WA Museum, the Fishers with Disabilities Association and the Oyster Harbour Catchment Group.

Initiatives in 2012/2013

Compliance

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.

Renewed focus on complaints and investigations with a view towards improving the keeping of records, gathering and managing evidence and delivering outcomes of those matters in a more timely fashion – with feedback (where appropriate) to the complainants.

Biosecurity is a strategic focus for the region with the complimentary efforts between compliance staff and the Biosecurity Unit.

Training and development of staff continues to be driven with FMOs attending several investigation and management courses.

Peak fishing periods including higher influx of holiday makers and fishers has become a focus of both high-profile presence of FMOs, and of community education activities. The Mobile Recreational Fishing vehicle is rostered to conduct patrols in the Bioregion and increase the high-

profile presence and roster start-times are designed to maximise contacts with recreational fishers.

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, and Department of Transport with a focus on joint operations to maximize the management presence in the marine park.

A dedicated and targeted approach on the unlawful taking of Abalone by recreation fishers for commercial purposes will target the known high risk areas. Intelligence information identifies this activity is taking place and the mostly likely locations and methods that are being used by some recreational fishers.

Education

The education program will aim to strengthen direct engagement with the community, including recreational and commercial fishers. This will be done through providing direct engagement opportunities for the community at boat ramps and caravan parks, as well as regional events and fishing competitions.

Education staff will continue the delivery of community activities such as school holiday programs and workshops, in partnership with other agencies where possible. The education program will continue to deliver school-based incursions and excursions focused on sustainability and key departmental initiatives, as well as provide resources to teachers which help to create positive marine stewardship within their class.

Education for the Walpole-Nornalup Inlets Marine Park will continue to be delivered in collaboration with the Department of Parks and Wildlife. The Marine Education Officers will also support all local community participation initiatives such as the South Coast Demersal Send Us Your Skeletons program, the Research Angler Program and Biosecurity Watch.

SOUTH COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the South Coast Bioregion during the 2011/12 financial year.

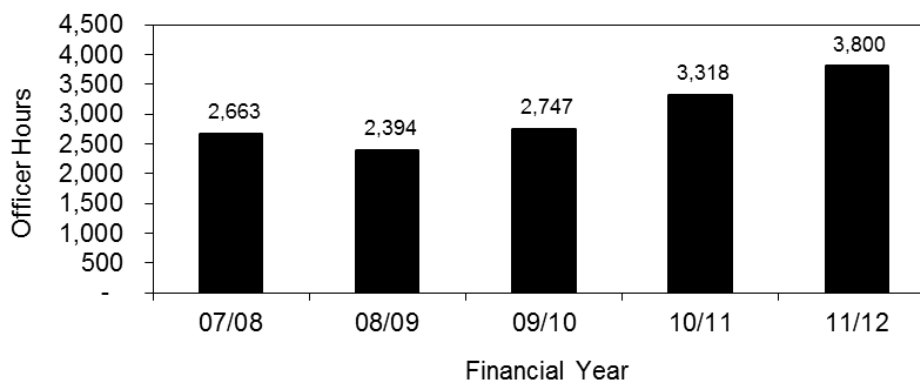
PATROL HOURS DELIVERED TO THE BIOREGION		3,800 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY		
Field Contacts by Fisheries & Marine Officers		250
Infringement warnings		10
Infringement notices		8
Prosecutions		6
Fishwatch reports**		7
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY		
Field Contacts by Fisheries & Marine Officers		6,947
Infringement warnings		95
Infringement notices		46
Prosecutions		6
Fishwatch reports		17
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*		
Field Contacts by Fisheries & Marine Officers		320
Fishwatch reports		14
VMS (Vessel Days)***		3,482

*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.

** Fishwatch reports are allocated to the District Offices relevant to the Bioregion. It is not possible to distinguish between calls relating to Inland Bioregions.

*** 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 Bioregion Compliance Patrol Hours

**SOUTH COAST COMPLIANCE FIGURE 1**

"On Patrol" Officer Hours showing the level of compliance patrol activity delivered to the South Coast Bioregion over the previous 5 years. The 2011/12 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, which encompasses 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 of 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 recently funded 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.

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.

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 Parks and Wildlife, 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.

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

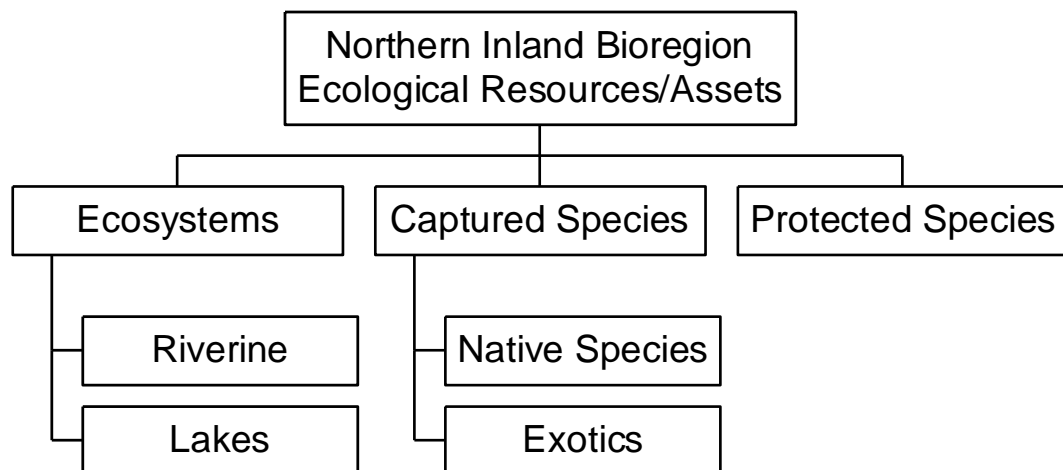
Ecosystem	Risk	Status and Current Activities
Ecosystems	LOW (non fishing)	Minimal threats and these would be due to non-fishing activities

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.


NORTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the ecological assets identified and separately assessed for the Northern Inland Bioregion

FISHERIES

Lake Argyle Silver Cobbler Fishery Report: Statistics Only

S.J. Newman, C. Skepper, G. Mitsopoulos, A. Thomson and P. Carter

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 (*Neoarius midgleyi*).

Recreational

A small 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 between the dam wall and 16° 37' south latitude.

Recreational

In addition to the waters of Lake Argyle, recreational anglers can fish in all creeks and tributaries that feed into the Ord River and Lake Argyle.

Management arrangements

The LASCF is a limited entry fishery, with six Fishing Boat Licences 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.

In June 2012 the *Lake Argyle Fishery Notice 1994* was revoked and replaced with a new notice (Prohibition on Commercial Fishing (Lake Argyle) Order 2012) containing the management arrangements for the Fishery. Under this Order the six Fishing Boat Licences listed are permitted to use no more than 1,500 metres of net at any one time, and 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 silver cobbler during the spawning season. Furthermore, 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 operators are not permitted to take barramundi (*Lates calcarifer*) at any time and all nets used by LASCF operators must be suitably marked with licence identification.

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.

A Bycatch Action Plan has also been developed for the LASCF which 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.

Landings and Effort

Commercial (season 2012): 118.5 tonnes

The fishery first developed in 1979 with increasing catches reported until 1989 (143 t). Catches have fluctuated between approximately 50 t and 230 t per year since 1990 (Lake Argyle Silver Cobbler Figure 2). Catches from 2009 to 2010 were less than 70 t, while the 2011 catch increased to over 100 t, with the 2012 catch over 118 t. The 2012 catch is within the acceptable catch range.

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'. During 2012, four vessels were active in the fishery, and generated an effort of 8,685 units (100 m net days), this level of effort is similar to that reported in 2000 and is much higher than that reported in recent years (Lake Argyle Silver Cobbler Table 1).

The level of catch in the fishery at present is a reflection of the variable level of effort expended. In recent years effort in the fishery has been variable due to inconsistent fisher participation rates. Participation in the fishery can be variable as a result of the availability of fishers (i.e. active in other fisheries/industries) and market demand.

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 2012 was less than 1 t of silver cobbler per annum. There are no data available on general angling catches. There are no minimum legal size limits for silver cobbler, however, fishers are restricted to a mixed species bag limit of 4 freshwater fish per day.

Fishery Governance

Commercial

Target commercial catch range: 90-155 tonnes

The current target catch range is a confidence interval for total catch from those observed during a stable time period for this fishery (1990 through to 1998). This interval was calculated using the estimate of variance that assumes seasonal catches are serially correlated and are explained by an autoregressive moving average model.

Current Fishing (or Effort) Level

The level of catch in the fishery in 2012 is within the acceptable catch range. The lower levels of catch in the fishery in 2009 and 2010 are likely to have allowed the breeding stock to increase in size if environmental conditions were favourable during those years.

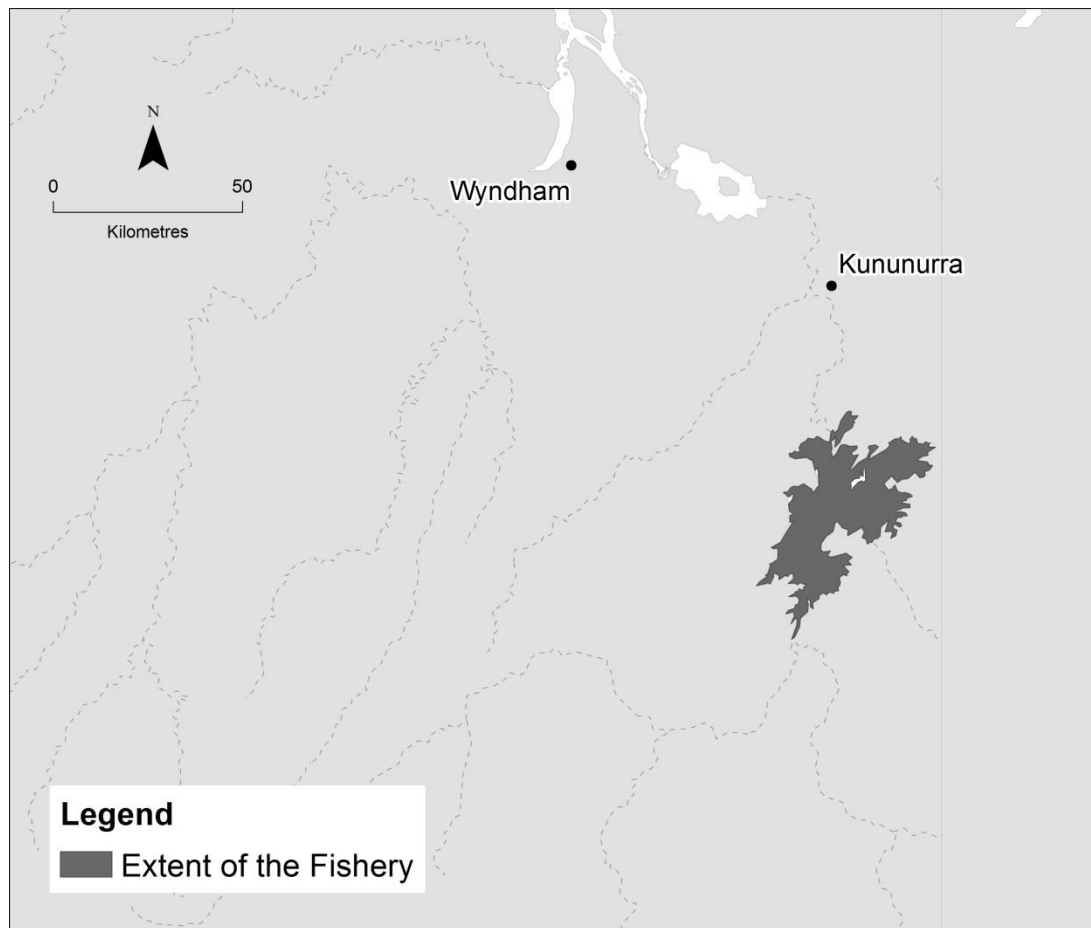
Acceptable**New management initiatives**

The new Order for this Fishery was gazetted in June 2012 which provided greater clarity around areas permitted to be fished. The next management review for the Fishery is scheduled for 2016/2017.

LAKE ARGYLE SILVER COBBLER TABLE 1

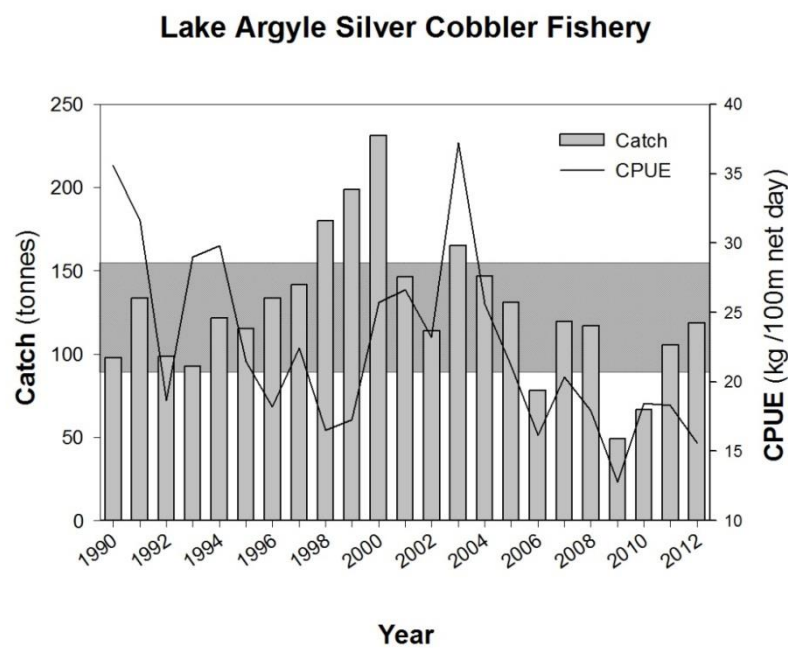
The annual effort (100 m net days) for silver cobbler in the Lake Argyle Silver Cobbler Fishery over the period from 1979 to 2012.

Year	Effort (100m net days)
1979	100.00
1981	166.40
1982	312.33
1983	348.95
1984	703.82
1985	4945.15
1986	2964.13
1987	3630.89
1988	4059.08
1989	2972.81
1990	2869.86
1991	5234.28
1992	5426.90
1993	3642.50
1994	4384.67
1995	5737.96
1996	7481.55
1997	6629.47
1998	11154.89
1999	11485.50
2000	9181.22
2001	5569.88
2002	4698.17
2003	5069.66
2004	6631.87
2005	6471.63
2006	5153.73
2007	5822.67
2008	6787.17
2009	4004.00
2010	3808.50
2011	7335.00
2012	8685.00



LAKE ARGYLE SILVER COBBLER FIGURE 1

Location of the Lake Argyle Silver Cobble Fishery in northwestern Australia illustrating the remoteness and extent of the fishery.



LAKE ARGYLE SILVER COBBLER FIGURE 2

The annual catch and catch per unit effort (CPUE, kg/100 m net day) for silver cobble in the Lake Argyle Silver Cobble Fishery over the period from 1990 to 2012. The upper and lower bounds of the target commercial catch range are shown by the shaded catch area between 90 and 155 tonnes.

AQUACULTURE

Regional Research and Development Overview

The process to identify a site to enable and support aquaculture around Lake Argyle as part of the implementation of the Ord Stage II final agreement continues to progress slowly. The issue of a lease has been delayed while the relevant group reviews its options.

A licence to produce barramundi has been issued, but is currently inactive; the licensee 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.

A Western Australian company is contemplating the development of a large-scale, land-based aquaculture project in coastal areas of the northern inland area of the State. The project, which proposes to focus on the production of marine prawns in a vertically integrated system, is in the early stage of development.

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 and Ord Rivers 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 2011/12

During 2011/12, Fisheries and Marine Officers (FMOs) recorded 2,459 hours of active compliance patrol time in the Northern Inland Bioregion – an increase compared to previous years due to the impact of the Recreational Mobile Patrol (Northern Inland Compliance Patrol Hours Figure 1).

Across the Northern Inland Bioregion, personal contact was made with 4,639 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 illegal fishing activities.

Compliance and education was also undertaken in the Lake Argyle area, where FMOs inspected commercial silver cobbler fishers to ensure that compliance with management, protected species interaction and environmental objectives were being met.

The Community Education Officer develops programs and coordinates delivery of education activities to school-aged children and awareness raising activities with the broader community. In-school and school holiday programs are the main method of reaching students in both the Pilbara and the Kimberley, while attendance at shows and local events target the broader community. An increased emphasis has been placed on developing materials that focus on local issues and their dissemination through regional brochure stockists and local publications.

Initiatives in 2012/13

Compliance service delivery will continue to target any areas of non-compliance and high levels of recreational fishing pressure. These locations are reviewed during annual risk-assessment processes.

The Department's office in Kununurra will be increased to two FMO's. This will greatly enhance the ability of the Department to conduct education and compliance activities in the East Kimberley.

The Departments Northern Region Mobile Patrol will focus on compliance and education of recreational fishers. A large portion of the 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.

The Departments Statewide Mobile Patrol will assist by delivering a compliance and education program through the Pilbara and Kimberley during the peak tourist season.

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.

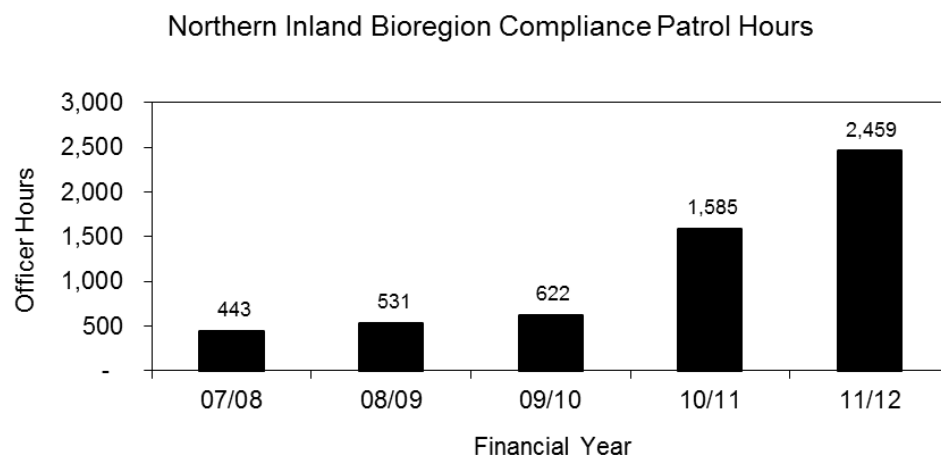
NORTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Northern Inland bioregion during the 2011/12 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,459 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY ¹	
Field contacts by Fisheries & Marine Officers	14
Infringement warnings	4
Infringement notices	2
Prosecutions	3
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	3,892
Infringement warnings	27
Infringement notices	44
Prosecutions	22
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY	
Field contacts by Fisheries & Marine Officers	733
Fishwatch reports ²	N/A

1 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.

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



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 2011/12 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 these 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 the estuarine black bream which are artificially stocked into some inland impoundments that have become saline.

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 are 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, the Department of Parks and Wildlife and other stakeholders, to facilitate information exchange and identify research projects and associated funding sources to mitigate environmental impacts and so better protect native fish species. This is being facilitated by the recent establishment of the Freshwater Ecosystem Working Group which aims to coordinate a whole-of-Government approach to the management of freshwater ecosystems in the State.

The Department undertakes a risk-based approach to managing the spread of feral fish in the bioregion. To support this, it has developed a community based reporting tool and education program to support its own routine surveillance activity. Information on aquatic pest distribution is used to prioritise management actions aimed at limiting the impact and preventing the spread of high risk pest fish within the State's freshwater ecosystems.

A key element of reducing the risk of feral fish is the approval process that the Department has 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.

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.

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 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 species. Maintaining populations of hairy marron in the upper reaches of the Margaret River is

vital for the conservation of this species and will require ongoing removal of smooth marron and hybrids 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. The Department has recently collaborated with the University of Western Australia to develop improved genetic tools to identify and characterise hairy marron to support further development of a controlled breeding program. This has resulted in production of genetically pure hairy marron and efforts are now underway to scale up production. Numbers of hairy marron in the Margaret River have declined significantly in recent years due to them being outcompeted by smooth marron and hybrids. As such the priority to ensure that this species does not become extinct is to establish a self-sustaining repository population that can be used to support any future Margaret River restocking program.

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 tenuimanus*). 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.

Research and monitoring is also underway to support feral fish surveillance and management. The Department adopts a risk-based approach to managing the threats posed by non-native fish which are widespread in metropolitan waterbodies. Such research includes the evaluation and implementation of control mechanisms (e.g. trapping methods, barrier controls, poisoning) as well as developing methods to identify the diversity of fish species present in water bodies based on the DNA that they shed into their environment.

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
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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.
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Captured fish species

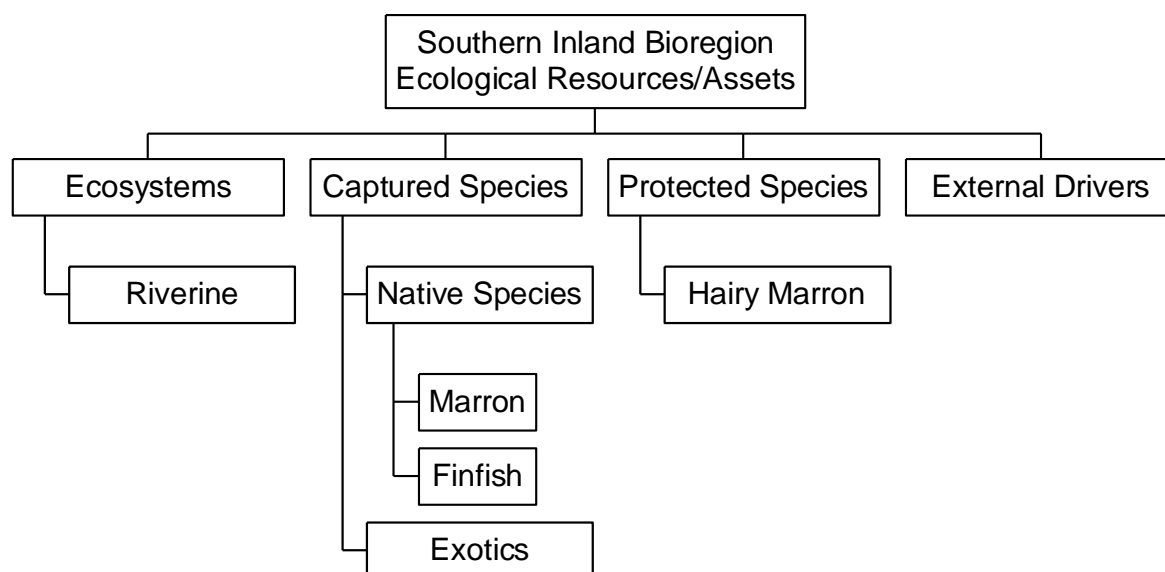
Fish species	Risk	Status and Current Activities
Finfish Native	HIGH (non-fishing)	The abundance and distribution of most native fish have been severely impacted due to reduced rainfall and land management practices. This has led to widespread fragmentation of native fish populations (i.e. regional extinctions, which without restocking will be permanent as there 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.

**SOUTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1**

Component tree showing the ecological assets identified and separately assessed for the Southern Inland Bioregion

FISHERIES

Licensed South-West Recreational Freshwater Angling Fishery Report: Statistics only

R. Duffy, N. Sumner and J. O'Malley

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.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

Fish Resources Management Regulations 1995

Freshwater Recreational Fishing Licence

Consultation process

Meetings between the Department of Fisheries, Recfishwest and Freshwater fishers.

Boundaries

The South-West freshwater angling license authorises anglers to fish for freshwater finfish species in all inland waters of Western Australia south of 29° 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. 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 July 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.

A combined daily bag limit of 4 applies to rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), together with a minimum legal size limit of 300 mm.

A daily bag limit of 30 applies to freshwater cobbler (*Tandanus bostocki*) when taken in the West Coast Bioregion. 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 predated 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 2011/12)

Not applicable

Recreational catch estimate (season 2011/12)

33,720 retained fish

Reporting of black bream has been dropped from this year's report due to difficulties in determining whether the catch originated from freshwater. An estimated total of 39,530 fish was landed in this fishery by recreational anglers in the 2011/12 season, including 27,765 retained fish and 11,765 captured and released fish. The estimated catch was composed of 10,000 rainbow trout, 1,700 brown trout, 27,000 redfin perch and 950 native freshwater cobbler (Freshwater Angling Figure 1).

The catch for the 2011/12 season varied for each species compared to the 2010/2011 season: redfin perch decreased by 40% from 44,600 fish; rainbow trout landings remained constant; brown trout increased 28% from 1,300; and landings of native catfish decreased 62% from 2,500 fish (Freshwater Angling Figure 1).

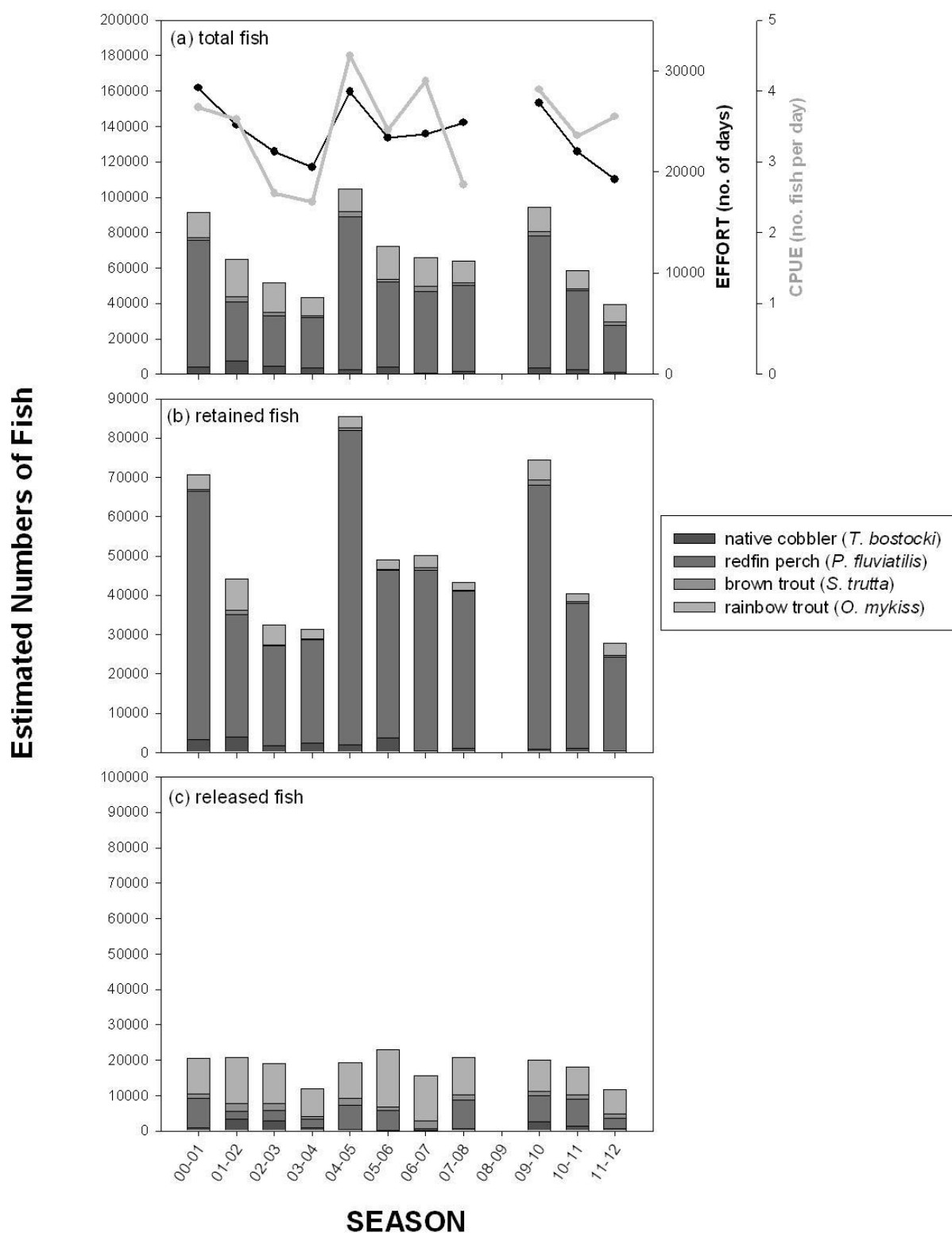
Estimates of fishing effort are based on telephone surveys of license holders. Total effort was estimated to be 19,253 days, slightly lower than in the previous reported season (22,000 days).

A catch rate of 3.64 fish of all species per day was estimated for the 2011/12 season similar to the previous season. This included 1.89 retained fish and 1.75 released fish per angler per fishing day.

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 often dominate the biomass where introduced. The cause of the reduction in redfin catches is unclear, but may be related to a reduction in suitable habitat due to reduced rainfall. Catch of cobbler showed an even greater decrease.

Fishery Governance

Target catch (or effort) range	Not applicable
Current fishing (or effort) level	Not applicable
New management initiatives (2011/12)	Nil

**FRESH WATER ANGLING FIGURE 1**

Estimates of the development of (a) total catch, effort and CPUE; (b) total numbers of fishes retained; and (c) total numbers of fishes released, by species in the South-West freshwater angling fishery since the 2000-01 season.

Licensed Recreational Marron Fishery Report

R. Duffy, N. Sumner and J. O'Malley

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial	nil
Fishing level	Acceptable	Recreational catch estimate	78,130 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

Marron Recreational Fishing Licence

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 south-west 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 2012 season, licensed fishers were permitted to fish for marron from 8th January to 5th February 2012. 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 for the 2012 season, the bag limit was reduced from 10 marron per day to 8 marron per day. The possession limit was decreased from 20 marron to 16 marron. The exception to these reductions were Harvey Dam, Waroona Dam and Hutt River which 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 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 2012)

78,130 marron

The total marron catch for the 2012 season was estimated at approximately $78,130 \pm 1,365$ standard error (SE) marron (See Fig. 1). This is similar to the previous seasons catch (2011: $74,400 \pm 7,100$ marron) despite the decrease in bag and possession limits due to limited rainfalls. Reduced rainfall can increase catches through reduced volumes of water concentrating marron and resulting in increased susceptibility to capture. This is reflected in an increase of the mean number of animals caught per day from 3.6 marron per fisher per day in 2011 to 4.6 marron per fisher per day in 2012. The catch per unit effort was higher in rivers (5.10 marron/day) than in dams (3.22 marron/day) (Figure 1b). The catch for 2012 is below the target catch range (see Fishery Governance below).

Total effort for the 2012 season was estimated from phone surveys at around 16,900 days, much lower than the previous season of 21,500 days. The number of participating fishers increased to 9,900 from the approximately 8800 participants in 2009, 2010 and 2011. The average number of fishing days per fisherman was 2.99 days in 2012, similar to 2009 (2.9 days) and 2010 (2.93 days) but less than the 3.6 days per fisherman in 2011.

There was no change in the proportion of total effort in dams from 25% last year. Of the remaining 75% of effort directed at rivers, it was widely spread among the rivers in the South-West. The Blackwood River (~18%) is the most popular site, followed by the Warren River (~13% effort). The Murray,

Preston, Collie, Deep and Donnelly rivers all received similar amount of effort of between 6 and 9%.

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 (i.e. those with seasons, bag limits, size limits and gear restrictions) 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. 2a).

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, the mean size in Moore river has been decreasing since a peak in 2009 and recorded the lowest mean size since initiation of the stock assessment survey in 2006 (Fig 3).

Marron abundance in Waroona Dam and Wellington dam was at the lowest levels yet measured during the fishery independent stock assessment. Both dams have exhibited a general decrease in CPUE since initiation of surveys. Donnelly, Blackwood, Murray and Moore rivers all showed a decrease in abundance to the lowest levels since the survey began in 2006. Of concern is that these declines coincide with a period of decreasing rainfall, about which, little can be done.

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. Present size restrictions seem to adequately protect the majority of the female breeding stocks. 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 (*Cherax quinquecarinatus*, *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 are already living in highly modified habitats, as such their removal does not significantly impact on natural freshwater ecosystem function.

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

The marron fishery is an iconic fishery and a major recreational activity in regional areas of the south-west of the State. The effect of rainfall on the availability of marron habitat is expected to increase awareness of changes in climate patterns in the South-West.

Economic Effects

The value of the 2012 season recreational marron catch could not be calculated as no data on the size of marron captured by recreational fishers was 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. 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 relatively stable marron abundance, a limited growth in the fishery is allowed while maintaining catches at a sustainable level. Variations 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 for 2011 was 21,500 fishing days with a 29 day season.

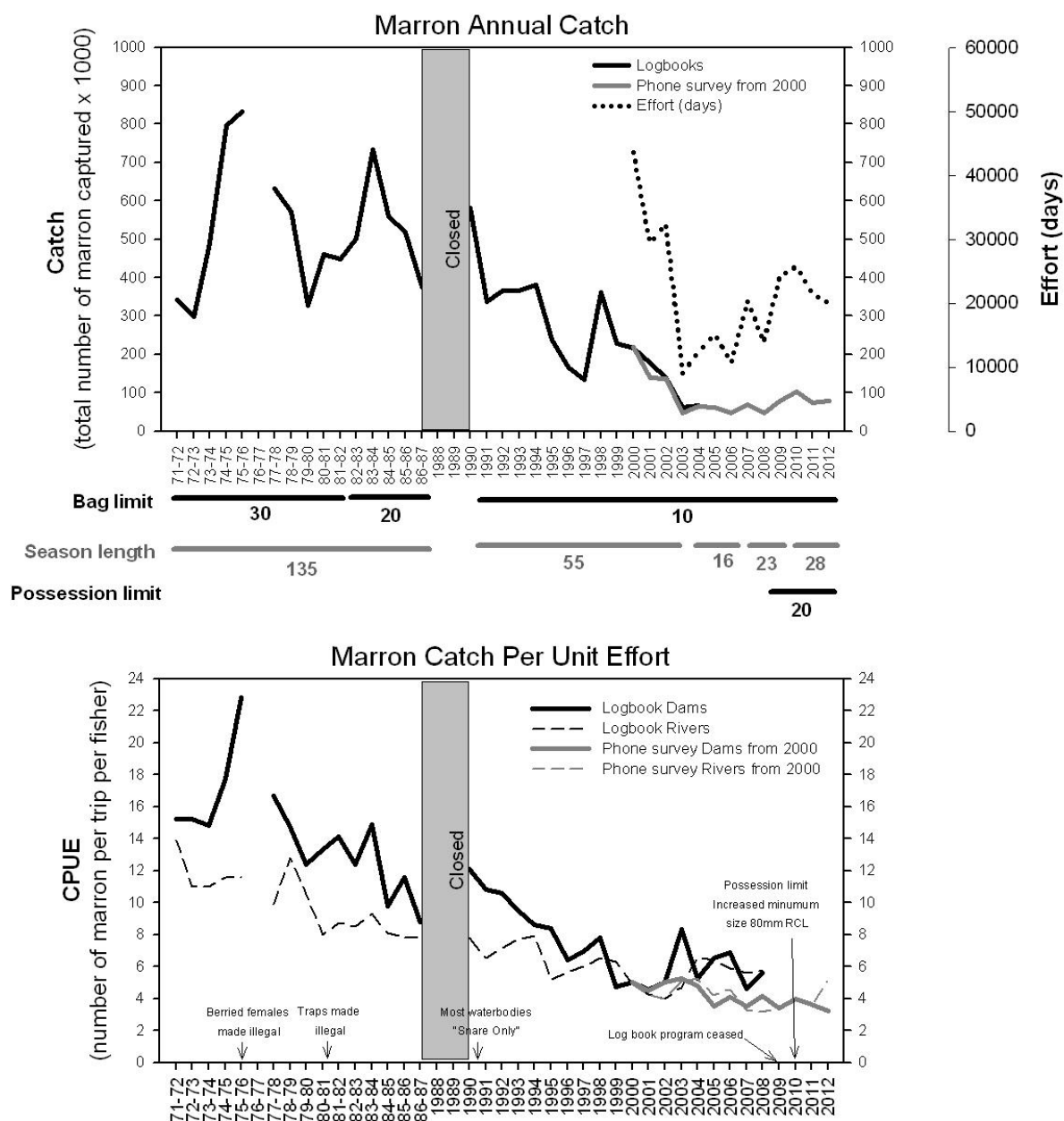
New management initiatives (2013/14)

For 2013 the marron season started on 08 January and ran 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. As a result of this monitoring and discussions with stakeholder groups, it was decided a precautionary approach would be taken and the 2012 daily bag limit would be reduced from 10 to 8 animals per licensed fisherman. The reduced limit will be maintained due to a reduced CPUE during the 2012 fishery independent surveys.

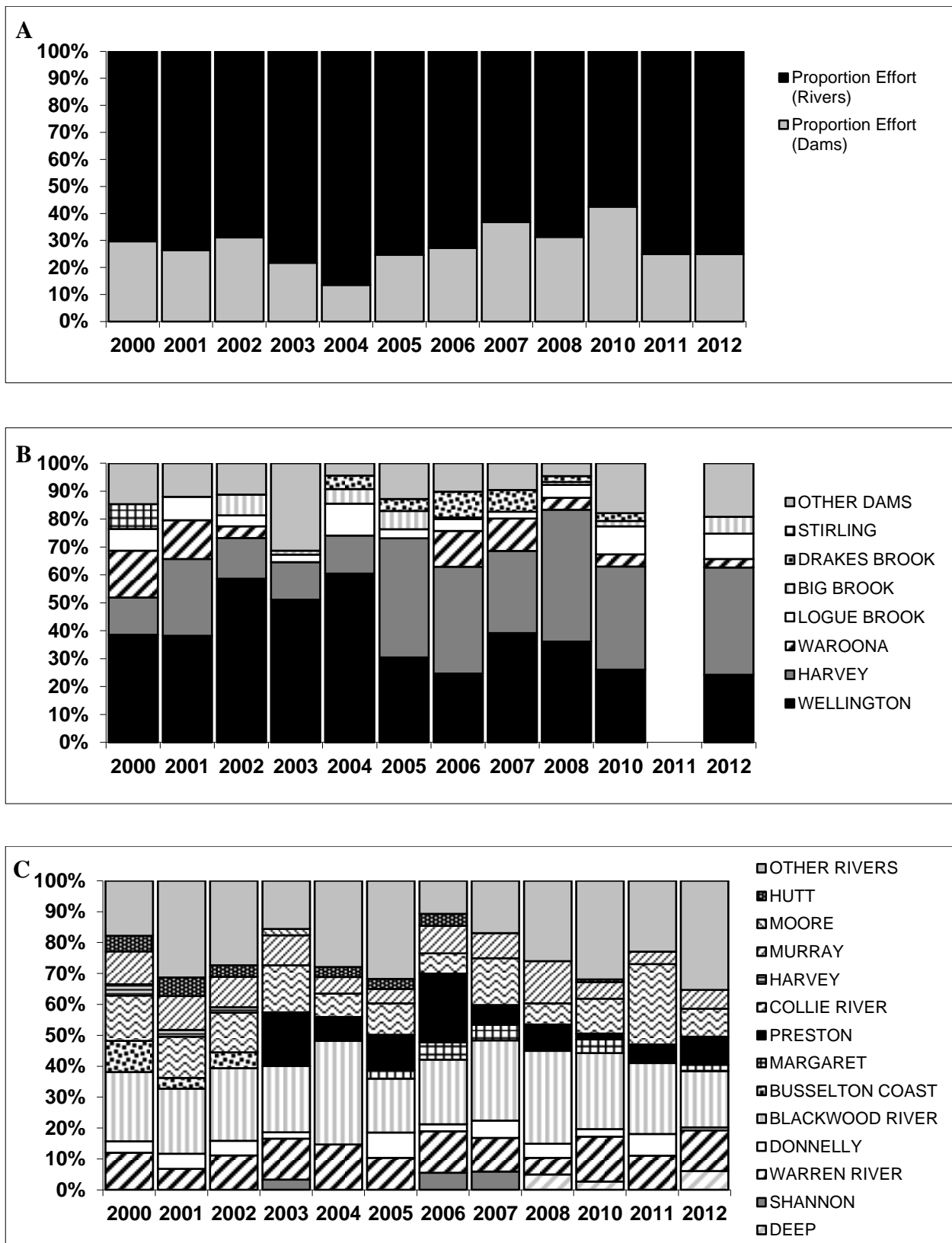
External Factors

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 water to the metropolitan water supply.

The Department of Fisheries has developed 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.

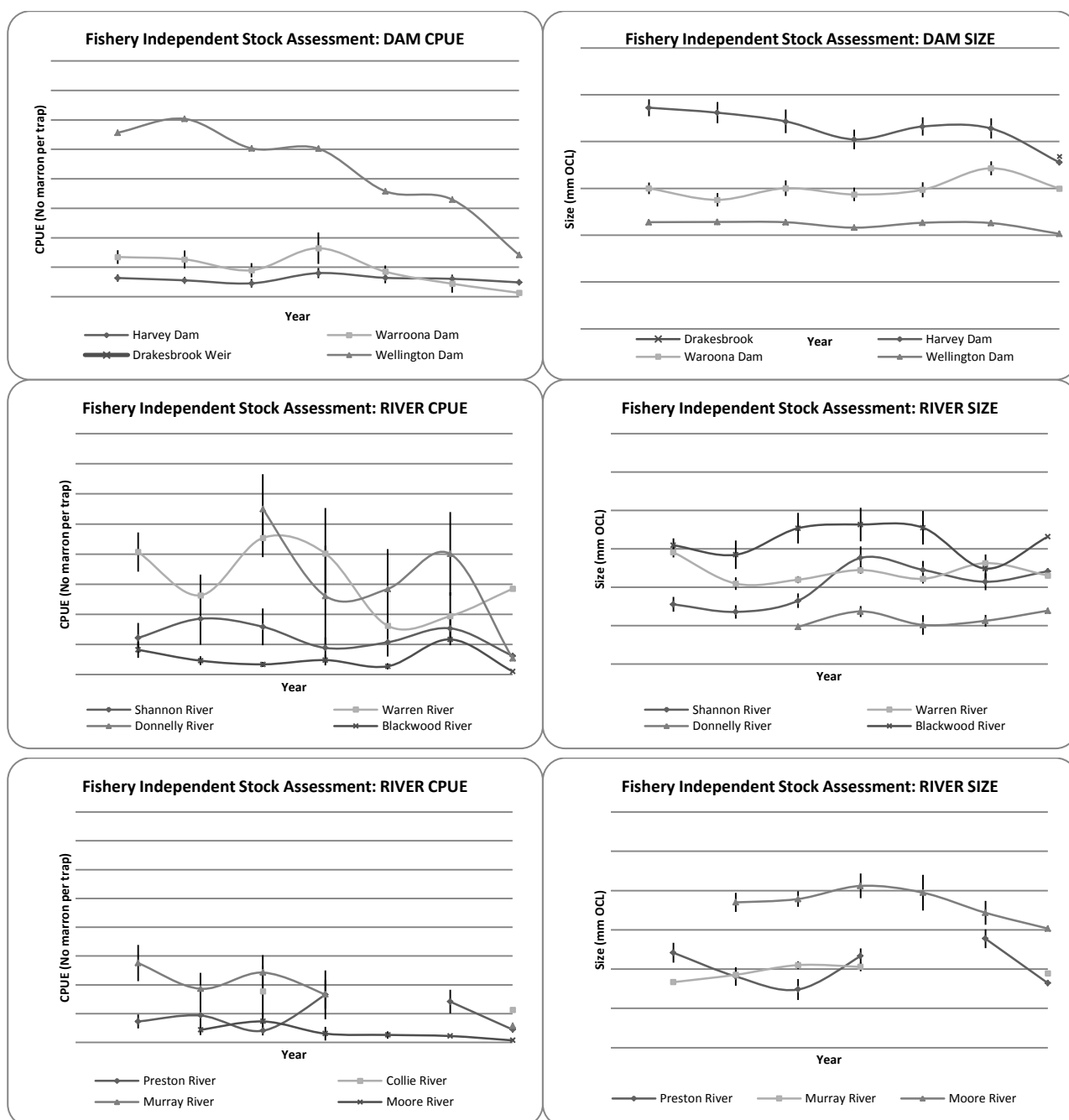
**RECREATIONAL MARRON FIGURE 1**

The estimated total catch (a) and catch per unit effort (b) of the recreational marron fishery between 1971 and 2011.



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 2011. An exact breakdown of fishing effort for dams was not possible due to changes to licensing.



RECREATIONAL MARRON FIGURE 3

The relative abundance (CPUE) and size (mm OCL) of marron in four dams and eight rivers as determined by the fishery-independent stock assessment. Note: Values may be missing for a year if the site was not able to be sampled.

AQUACULTURE

Regional Research and Development Overview

Previous research undertaken at the Pemberton Freshwater Research Centre focused on marron husbandry and selective breeding research. Current research is focusing on captive breeding programs for conserving endangered marron and native fish.

The Pemberton Freshwater Research Centre continues to be the only major supplier of trout fingerlings to the aquaculture industry and for recreational fisheries restocking. Future research in this area will focus on improving the efficacy of triploidy induction in the Pemberton trout line. The production of infertile triploid trout is considered an

important mechanism to prevent establishment and spread of stocked trout which also has potential benefits for aquaculture (eg increased growth rates). A new collaborative project with the University of British Columbia is underway which aims to understand the genetic basis for the high thermal tolerance of the selectively bred Pemberton trout line. This line is considered internationally significant and is potentially important in understanding thermal tolerance in trout. This has potential implications for future aquaculture and restocking programs worldwide, especially in areas affected by climate change.

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. The Marron season lasts for just 28 days annually (8 January to 5 February) and intelligence information shows there is a risk of illegal fishing during the closed season. This illegal fishing is usually higher during the period from September to December, after the winter rains and prior to the season opening.

During the open Marron season additional resourcing is provided to Compliance efforts in the Marron fishery. Strategic rostering practices ensure that available staff from neighbouring Districts contributes to operational needs in providing a high profile and professional presence. This presence is designed to provide education, licence inspections, size and bag limit inspections, and patrols of waterways to ensure no illegal gear is being used in the taking of Marron.

FMO'S frequently engage joint patrol/operation initiatives with police to investigate the theft of marron from private properties and licensed aquaculture sites.

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 DPaW officers have also been authorized as honorary FMO's and play an important role in the Marron compliance throughout the South West.

The other main fishery in the Southern Inland bioregion is the recreational trout fishery. The Compliance and Education focus in this fishery is to ensure compliance with bag limits, that fishers hold a current recreational freshwater fishing licence, and that line fishing does not occur during the closed season (1 July – 31 August).

Compliance patrols for the other recreational fisheries in these inland areas, as well as inspections of fish wholesale and retail premises form part of the compliance activities conducted by FMO'S in the Southern Inland bioregion.

Commercial fishing activity in rivers is 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 these fisheries focuses mainly on closed waters, setting times, net lengths and licensing.

Activities during 2011/12

During 2011/2012, FMO'S delivered 2232 compliance patrol hours to the Southern Inland bioregion (Southern Inland Compliance Table 1) – which is a marginal decrease from the 2283 compliance hours delivered in the previous year.

Officers conducted patrols throughout the bioregion in vehicles, dinghies and canoes, making 3515 field contacts with recreational fishers and 110 contacts with commercial operators. This is an increase of 28% for recreational contacts and 83% increase contact with commercial industry.

There were 117 infringement warnings and 60 infringement notices issued with a further 66 prosecutions for recreational offences.

The marron fishery continues to be the major focus for the compliance and education program in this bioregion. The compliance activities for the 2012 season included a pre-season operation which specifically targeted 'Out of Season' fishing activities. A number of people were found to be illegally fishing out of season and faced prosecution. The second phase of the operation included a high-profile presence during the Marron season which targeted both highly frequented and less frequented Marron fishing locations.

Aquaculture compliance activities (classified as 'commercial' In Table 1) are also a focus in the Southern Inland bioregion for FMO'S. Activities mainly involve inspection of aquaculture facilities, oversight of broodstock collection to ensure compliance with exemption conditions, and inspection

SOUTHERN INLAND BIOREGION

of proposed aquaculture sites to ensure that the harvesting does not affect the wild stocks in WA waters. FMO'S continue to work closely with police to investigate theft from farm dams.

Freshwater fishing attracted a higher focus towards the end of the Freshwater Ban period, there were few contacts made and no offences detected.

Initiatives for 2012/13

Compliance operations will again pay close attention to 'Out of Season' Marron fishing with both covert and overt patrols already planned.

A high-profile professional presence is again planned for the Marron season but in addition there are likely to be covert operations.

FMO'S are committed to maintaining Joint patrols and partnerships with external stakeholders. The joint patrols have been included in the operational plans for the coming

peak Marron fishing times.

Theft of Marron from dams on private property and aquaculture facilities remains a focus of joint agency collaboration in the sharing of intelligence information and resource sharing.

Freshwater fishing is purposely targeted towards the end of the Freshwater Fishing ban. Heavy rains and muddied waters are expected to see a decrease in activity but early results have seen some offending already.

Community Education activities will target recreational fishers prior to the start of the Marron fishery and the delivery of fisheries programs to school children and the public. The awareness of freshwater biodiversity and the threat posed by introduced species will also be promoted. The Community Education Team will maintain partnerships with natural resource management groups and the community to enable a holistic approach to catchment management and issues facing the sustainability of freshwater species.

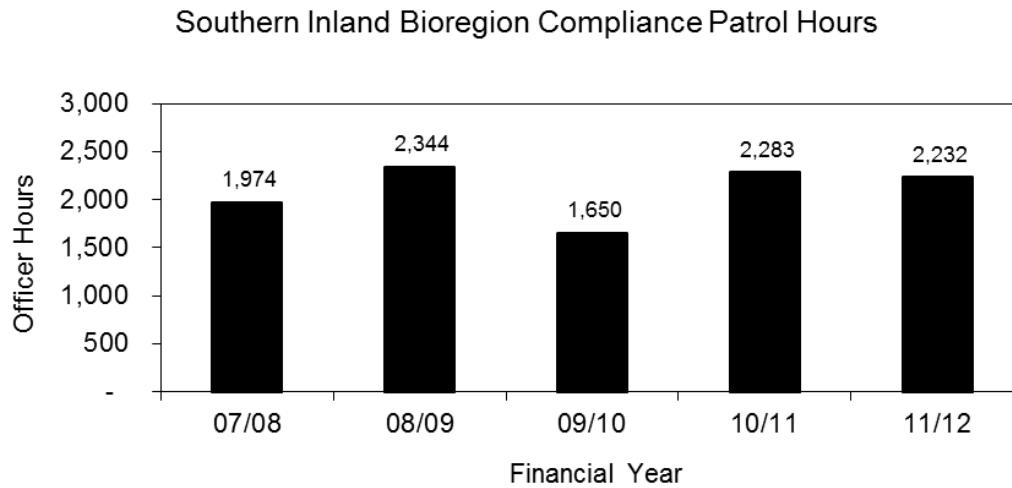
SOUTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Southern Inland bioregion during the 2011/12 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,232 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	110
Infringement warnings	11
Infringement notices	3
Prosecutions	28
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	3,515
Infringement warnings	117
Infringement notices	60
Prosecutions	66
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	1,541
Fishwatch reports**	N/A

* 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 reported for this Bioregion are reported in either West Coast or South Coast Bioregional summaries. It is not possible to distinguish between calls relating to Inland Bioregions.



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 2011/12 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.

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 in 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.

Summary of Monitoring and Assessment of Statewide Assets

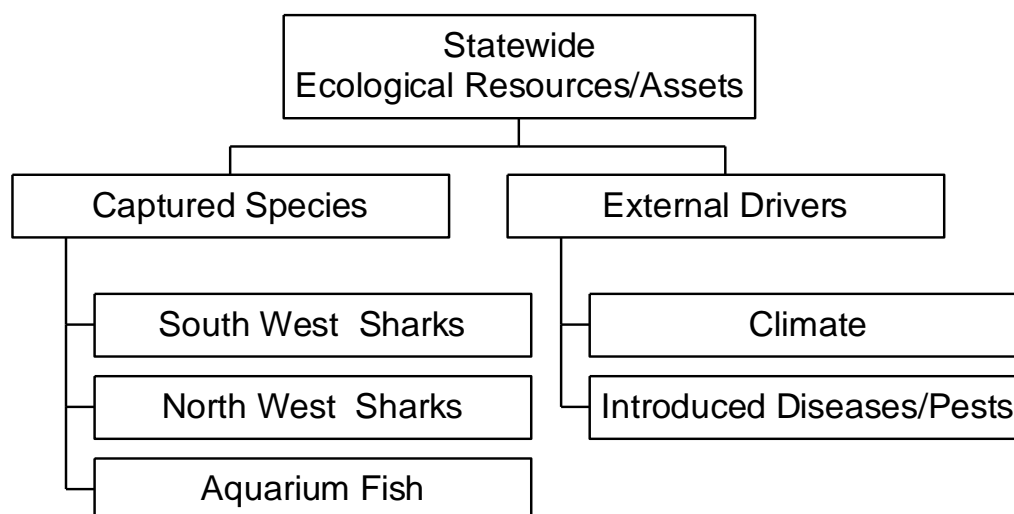
The Department is working closely with the Commonwealth Government and other jurisdictions to develop and implement the National System for the Prevention and Management of Marine Pest Incursions that will minimise the biosecurity risks associated with increased shipping in all parts of the State. Within WA, this is currently being achieved through the Fish Resources Management Act 1994 and the Biosecurity and Agriculture Management Act 2007. Work has also been undertaken to develop monitoring designs for introduced marine species for the high risk ports in WA. These designs have been approved by the Invasive Marine Pests Program within DAFF (Department of Agriculture, Fisheries and Forestry). This work contributes toward the management of introduced aquatic organism incursions and fish kill incident response programs already in place.

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch works collaboratively with the Department of Parks and Wildlife (DPaW) in monitoring the condition of the state's fish resources, particularly within Marine Parks across the State. Development of Collaborative Operational Plans between the Department and DPaW ensure efficient and cost effective delivery of research and monitoring activities where jurisdictions overlap. The Department has also drafted a statewide strategy for its research and monitoring activities within Marine Protected Areas, to detail the implementation of the Department's risk based prioritised research and monitoring program (under its EBFM framework) in conjunction with marine park management plans.

Fish species	Aquatic zone	Risk	Status and Current Activities
	Mid West – North	MODERATE	The stocks levels of some sharks in these regions are now considered to be recovering. The State based fisheries for this asset 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. Marine pest monitoring programs are being implemented at high risk port locations throughout the State.
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.

**STATEWIDE ECOSYSTEM MANAGEMENT FIGURE 1**

Component tree showing the Statewide ecological assets and external drivers identified and separately assessed.

FISHERIES

Marine Aquarium Fish Managed Fishery Report: Statistics Only

S.J. Newman, C. Bruce, C. Syers and K. Green

Fishery Description

Commercial

The Marine Aquarium Fish Managed Fishery (MAF) has the capacity to target more than 250 species of finfish 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 2011 the number of species landed ranged from 183 to 288; 228 fish species were recorded in 2012). By way of a Section 43 Order and Ministerial Exemption, fishermen also take coral, live rock, algae, seagrass and invertebrates. In 2012, a total of over 380 species or species groups were reported in the landed catch of the MAF. The reported catch included groups that were recorded to Order, Family, Genus or species. The MAF 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 protected fish such as leafy and weedy seadragons.

Boundaries

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 the Capes region, 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 2012, 9 licences operated in the fishery.

Licensees 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 across the State, a review will be initiated, and the results used to determine whether further management action is required.

Landings and Effort

Data for assessing the status of the MAF are derived from the catch and effort returns provided by industry. These data are compiled annually and used as the basis for this assessment.

A total of over 22,780 fish were landed in 2012. 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 2012 were higher than those reported in 2009 (18,575) and 2011 (19,776), but lower than those reported in 2010 (25,708).

The main fish species landed in 2012 were scribbled angelfish (*Chaetodontoplus duboulayi*) and green chromis (*Chromis cinerascens*) (Marine Aquarium Fish Table 2). Likewise, the main coral species landed in 2012 were the coral like anemones of the Corallimorpharia (Marine Aquarium Fish Table 3). The numbers of fish species and the weight of coral species landed vary from year to year depending on market demand.

The syngnathid catch was low and stable between 2009 and 2010 (i.e. 340 and 338 respectively). However, the syngnathid catches in 2012 (1,232) are similar to the catch levels reported in 2011 (1,138) and 2008 (1,218).

In 2012, 9 licences reported some level of activity (effort). Effort in the fishery has decreased from 981 fishing days (2007) to 475 fishing days in 2012, with 61 fishing days of this total effort being exclusively for land hermit crabs only. 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 includes effort of both MAF licensees and also those fishers that hold an exemption authorisation to collect land hermit crabs, *Coenobita variabilis*. In 2012, of the 5 land hermit crab exemption holders, 3 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 Western Australia) 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 Family Syngnathidae (seahorses and pipefish), which are listed under the Environment Protection and Biodiversity Conservation Act 1999, from state waters only (within 3nm). In 2012, the catch of syngnathids from all species and areas was 1,232 well below the target commercial catch range level of 2,000 individuals per year. The catch level of syngnathids has increased from 2009 and 2010 levels (340 and 338, respectively) to return to catch levels similar to those reported in 2011 (1,138) and in 2008 (1,218). 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 (2012/13)

In August 2011 an application for reassessment of the MAF as ecologically sustainable under the provisions of the EPBC Act 1999 was submitted to SEWPaC. This application was unsuccessful and the Wildlife Trade Operation (WTO) for the MAF expired on 24 October 2011, meaning any species taken in the fishery after this date were no longer able to be exported. The application for reassessment was unsuccessful due to the increased assessment and reporting requirements for the take of species listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The Department of Fisheries will be working with MAF licence holders and SEWPaC on requirements to gain a new WTO approval for the fishery in 2012-13.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Managed Fishery and associated endorsements in 2012.

Common Name	Quantity (numbers)	Weight (kg)	Litres (l)
Fish	22,780		
Syngnathidae (not included in Fish)	1,232		
Hermit crabs (land hermit crabs only - <i>Coenobita variabilis</i>) ¹	90,364		
Invertebrates (not including Hermit crabs or Corals)	30,364		
Algae			207.10
Hard coral		4,035.67	
Soft coral ²		5,989	
Living rock		19,576.50	
Sponges	2,481		

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 5,664.60 kg of coral like anemone groups such as corallimorphs and zoanthids in the Class Anthozoa. These are harvested under an invertebrate Ministerial Exemption and are not part of the annual coral TAC.

MARINE AQUARIUM FISH TABLE 2

Summary of the reported catch of the main fish species landed from the Marine Aquarium Managed Fishery from 2008 to 2012.

Species	Common Name	Year				
		2008	2009	2010	2011	2012
<i>Chaetodontoplus duboulayi</i>	Scribbled Angelfish	590	492	1333	2275	2527
<i>Chromis cinerascens</i>	Green Chromis	873	790	2998	1941	2203
<i>Istiblennius meleagris</i>	Spotted Blenny	1730	2846	1040	2081	1468
<i>Valenciennesa puellaris</i>	Orange-dashed Goby	100	26	440	1559	1250
<i>Chelmon marginalis</i>	Margined Coralfish	542	682	1266	1506	1048
<i>Anampses lennardi</i>	Blue and Yellow Wrasse	30	31	213	657	1046
<i>Chromis atripectoralis</i>	Black-axil Chromis	3065	50	1350	1550	1010
Gobiidae	Gobies	445	447	580	979	967
<i>Cirrhilabrus temminckii</i>	Peacock Wrasse	0	0	31	600	749
<i>Trachinops noarlungae</i>	Yellow-headed Hulafish	100	420	690	1525	580
Siganidae	Rabbitfishes	7	25	183	125	543
<i>Trachinops brauni</i>	Blue-lined Hulafish	150	300	992	2019	531
<i>Heterodontus portusjacksoni</i>	Port Jackson Shark	247	389	197	664	489
<i>Enoplosus armatus</i>	Old Wife	105	86	81	221	469
<i>Chromis klunzingeri</i>	Black-headed Puller	115	220	480	575	421

MARINE AQUARIUM FISH TABLE 3

Summary of the reported catch of the main coral species landed from the Marine Aquarium Managed Fishery from 2008 to 2012.

Species	Common Name	Year				
		2008	2009	2010	2011	2012
Corallimorpharia - undifferentiated	Coral-like anemones	1377.6	1899	2233	2932	3725
Zoanthidae - undifferentiated	Zoanthid anemones	238.5	2184	1606	799	527.5
<i>Palythoa</i>	<i>Palythoa</i> soft coral	1365.6	0	0	70	0
<i>Zoanthus</i>	<i>Zoanthus</i> colony polyps	811.5	744	669	558	513
<i>Duncanopsammia axifuga</i>	Duncan coral	439.2	548	877.4	407.3	456.4
<i>Trachyphyllia geoffroyi</i>	<i>Trachyphyllia</i> brain coral	396.9	503.5	640.4	470.9	266.3
<i>Euphyllia ancora</i>	Anchor coral	370.5	414.8	605.6	599.7	491.8
<i>Euphyllia glabrescens</i>	Torch coral	198.7	149.8	374.1	402	504.6
<i>Symphyllia wilsoni</i>	<i>Symphyllia</i> brain coral	125.7	556.2	283	82.9	2.4
<i>Acropora</i>	<i>Acropora</i> corals	336.6	333.3	193.5	285.6	186.2
<i>Echinophyllia</i>	Chalice coral	162.5	511	293	222.4	197.3
<i>Lobophyllia</i>	<i>Lobophyllia</i> brain coral	261.2	462.8	430.2	438.5	293.2
<i>Moseleya latistellata</i>	Giant star coral	110	188.6	294.1	79.3	11.4
<i>Plerogyra sinuosa</i>	Green bubble coral	10.8	0	22	380	30
<i>Catalaphyllia jardinei</i>	Elegance coral	78.3	63.2	154.05	239	265.2
<i>Sarcophyton</i>	Toadstool coral	300.9	166.2	174.1	203.4	118.8
<i>Favia</i>	Favia coral	296.1	481	267.1	243.8	140.6
<i>Rhodactis</i>	Mushroom corals	275.1	0	6	0	0

Specimen Shell Managed Fishery Status Report

A. Hart, C. Bruce, C. Syers and K. Green

Main Features

Status		Current Landings	
Stock level	Adequate	Specimen Shell Catch Total	
Fishing level	Acceptable	Shell numbers	16, 148 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.

Just under 200 (196) different Specimen Shell species were collected in 2012, using a variety of methods. The main methods are by hand by a small group of divers operating from small boats in shallow coastal waters or by wading along coastal beaches below the high water mark. A new Exemption method being employed by the fishery is using a remote controlled underwater vehicle at depths between 60 and 300 m. While the fishery covers the entire Western Australian coastline, there is some concentration of effort in areas adjacent to population centres such as Broome, Karratha, Exmouth, Shark Bay, metropolitan Perth, Mandurah, the Capes area 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

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

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 21 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 2012):

16,148 shells

Recreational catch estimate (season 2012):**Unknown****Commercial Landings**

In 2012, the total number of specimen shells collected was 16,148 distributed over a wide range of species. This is based on 100% of submitted catch returns. In the past 5 years, more than 494 separate species of molluscs have been collected, with an average of more than 200 species per year – the majority in low numbers.

There is some focus of effort on mollusc families most popular with shell collectors, such as cowries, cones, murexes and volutes. For example, *Cypraea venusta*, *C. marginata* and *C. friendii* (including identified sub-species) make up approximately 18% of those collected in 2008, 31% of those collected in 2009, 16% of those collected in both 2010 and 2011 and 14% in 2012. Cypraeidae or cowries are noted for their localised variations in both shape and colour, making them attractive to collectors.

Fishing effort/access level

Although there are 32 licences in the fishery, only about 9 of these are regularly active. Effort has been stable over the past 5 years, at an average of around 932 days fished. In 2012, 729 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 2012 season the catch rate was approximately 22 shells per day.

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 an overall average of approximately 51 % of the shells sighted were not harvested. The measure of the number of shells sighted is reported correctly in about 84% 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 30% in 2009 to 84% in 2012. 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 2012 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. However, with the introduction of the remote controlled underwater vehicles these depth restrictions are starting to be overcome.

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 2012, the catch level of approximately 16,148 shells and catch rate of 22 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:**Negligible**

The fishery reported no interactions with protected species during 2012. Reports of interactions with protected species are required to be recorded on monthly catch and effort returns.

Ecosystem Effects**Food chain effects:****Negligible****Habitat effects:****Negligible****Social Effects**

In 2012 there were 32 authorisation holders in this fishery

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with around 9 licences recording consistent activity, the number of people employed regularly in the fishery (licensees plus crew/ dive buddies) is likely to be around 17. There were also around 19 people (licensees plus crew/dive buddies) that operated occasionally in this fishery. With many of the licences there might be the additional employment of people to prepare the shells for collection, pack and distribute the shells and also, some licensees might have shop fronts, therefore, employing shop assistants. The number employed in this area is unknown.

Economic Effects

Estimated annual value (to fishers) for 2012:

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 (2011/12)

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 two licensees to trial the use of a remote operated underwater vehicle to collect shells in water depths of 60 to 300 metres.

APPENDICES

APPENDIX 1

Fisheries Research Division staff publications 2012/13

Scientific Papers

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APPENDIX 2

Table of catches from fishers' statutory monthly returns for 2011/12

This table contains the landed¹ and estimated live weight² of species recorded in the compulsory catch and fishing effort returns provided by commercial fishers each month. These data include the catch taken as byproduct 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 'Redfish' may be used for several species of the genus *Centroberyx*.

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.

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH				
<i>Carcharhinidae</i>				
	Blacktip Whaler	<i>Carcharhinus tilstoni</i> / <i>Carcharhinus limbatus</i> / <i>Carcharhinus spp.</i>	2	2
	Bronze Whaler	<i>Carcharhinus brachyurus</i>	36	56
	Dusky Whaler	<i>Carcharhinus obscurus</i>	112	177
	Sandbar Shark	<i>Carcharhinus plumbeus</i>	21	34
	Spinner Shark	<i>Carcharhinus brevipinna</i>	37	59
	Tiger Shark	<i>Galeocerdo cuvier</i>	2	4
<i>Lamnidae</i>				
	Shortfin Mako	<i>Isurus oxyrinchus</i>	1	2
<i>Orectolobidae</i>				
	Wobbegong Shark	<i>Orectolobidae</i>	21	33
<i>Pristiophoridae</i>				
	Common Sawshark	<i>Pristiophorus cirratus</i>	3	8
<i>Rajidae</i>				
	Skates	<i>Rajidae</i>	5	12
<i>Sphyrnidae</i>				
	Hammerhead Shark	<i>Sphyrnidae</i>	38	60

APPENDICES

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
<i>Squatinae</i>				
	Angel Shark	<i>Squatina spp.</i>	2	3
<i>Triakidae</i>				
	Gummy Shark	<i>Mustelus antarcticus</i>	222	354
	Pencil Shark	<i>Hypogaleus hyugaensis</i>	< 500 kg	1
	School Shark	<i>Galeorhinus galeus</i>	1	1
	Whiskery Shark	<i>Furgaleus macki</i>	68	102
	Shark, Other		4	5
	Shovelnose / Fiddler Rays	<i>Rhinobatidae / Rhynchobatidae</i>	< 500 kg	1
<i>Ariidae</i>				
	Catfishes	<i>Ariidae</i>	10	10
<i>Ariidae</i>				
	Silver Cobbler	<i>Neoarius midgleyi</i>	79	111
<i>Atherinidae</i>				
	Hardy Heads	<i>Atherinidae</i>	3	3
<i>Berycidae</i>				
	Bight Redfish	<i>Centroberyx gerrardi</i>	46	46
	Redfish	<i>Centroberyx spp.</i>	25	25
	Yelloweye Redfish	<i>Centroberyx australis</i>	9	9
<i>Clupeidae</i>				
	Australian Sardine (Pilchard)	<i>Sardinops sagax</i>	2410	2410
	Sandy Sprat (Whitebait)	<i>Hyperlophus vittatus</i>	83	83
<i>Hemiramphidae</i>				
	Southern Garfish	<i>Hyporhamphus melanochir</i>	24	24
<i>Platycephalidae</i>				
	Flatheads	<i>Platycephalidae</i>	6	6
<i>Plotosidae</i>				
	Cobbler	<i>Cnidoglanis macrocephalus</i>	46	65

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
<i>Latidae</i>				
	Barramundi	<i>Lates calcarifer</i>	20	31
<i>Polyprionidae</i>				
	Bass Groper	<i>Polyprion americanus</i>	1	1
	Hapuku	<i>Polyprion oxygeneios</i>	16	16
<i>Serranidae</i>				
	Breaksea Cod	<i>Epinephelides armatus</i>	6	6
<i>Epinephelidae</i>				
	Barcheek Coral Trout	<i>Plectropomus maculatus</i>	20	20
	Common Coral Trout	<i>Plectropomus leopardus</i>	3	3
	Birdwire Rockcod	<i>Epinephelus merra</i>	3	3
	Blackspotted Rockcod	<i>Epinephelus malabaricus</i>	27	27
	Chinaman Rockcod	<i>Epinephelus rivulatus</i>	1	1
	Coral Rockcod	<i>Cephalopholis miniata</i>	1	1
	Duskytail Grouper	<i>Epinephelus bleekeri</i>	4	4
	Eightbar Grouper	<i>Hyporthodus octofasciatus</i>	19	20
	Flowery Rockcod	<i>Epinephelus fuscoguttatus</i>	45	45
	Goldspotted Rockcod	<i>Epinephelus coioides</i>	42	42
	Rankin Cod	<i>Epinephelus multinotatus</i>	134	134
	Tomato Rockcod	<i>Cephalopholis sonnerati</i>	1	1
	Cods	<i>Epinephelus / Cephalopholis</i>	70	70
<i>Glaucosomatidae</i>				
	Northern Pearl Perch	<i>Glaucosoma buergeri</i>	27	27
	West Australian Dhufish	<i>Glaucosoma hebraicum</i>	85	87
<i>Priacanthidae</i>				
	Bigeyes	<i>Priacanthidae</i>	13	13
<i>Terapontidae</i>				
	Trumpeters	<i>Terapontidae</i>	3	3

APPENDICES

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
<i>Sillaginidae</i>				
	King George Whiting	<i>Sillaginodes punctatus</i>	15	15
	Yellowfin Whiting	<i>Sillago schomburgkii</i>	48	48
	Whittings	<i>Sillaginidae</i>	101	101
<i>Pomatomidae</i>				
	Tailor	<i>Pomatomus saltatrix</i>	28	28
<i>Rachycentridae</i>				
	Cobia	<i>Rachycentron canadum</i>	14	14
<i>Carangidae</i>				
	Amberjack	<i>Seriola dumerili</i>	9	9
	Black Pomfret	<i>Parastromateus niger</i>	1	1
	Golden Trevally	<i>Gnathanodon speciosus</i>	2	2
	Queenfish	<i>Scomberoides commersonnianus</i>	< 500 kg	1
	Samson Fish	<i>Seriola hippos</i>	45	47
	Silver Trevally	<i>Pseudocaranx spp.</i>	10	10
	Trevallies	<i>Carangidae</i>	151	151
	Turrum (Goldspot Trevally)	<i>Carangoides fulvoguttatus</i>	1	1
	Yellowtail Kingfish	<i>Seriola lalandi</i>	1	1
	Yellowtail Scad	<i>Trachurus novaezelandiae</i>	12	12
<i>Arripidae</i>				
	Australian Herring	<i>Arripis georgianus</i>	168	168
	Western Australian Salmon	<i>Arripis truttaceus</i>	200	207
<i>Lutjanidae</i>				
	Brownstripe Snapper	<i>Lutjanus vitta</i>	47	47
	Chinaman Fish	<i>Symphorus nematophorus</i>	11	11
	Crimson Snapper	<i>Lutjanus erythropterus</i>	266	266
	Darktail Snapper	<i>Lutjanus lemniscatus</i>	17	17
	Five Line Snapper	<i>Lutjanus quinquelineatus</i>	3	3

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
<i>Lutjanidae (continued)</i>				
	Flagfish / Spanish Flag	<i>Lutjanus vitta / quinquelineatus / carponotatus / lutjan</i>	51	51
	Goldband Snapper	<i>Pristipomoides multident</i>	727	727
	Mangrove Jack	<i>Lutjanus argentimaculatus</i>	13	13
	Moses Snapper	<i>Lutjanus russelli</i>	47	47
	Red Emperor	<i>Lutjanus sebae</i>	277	277
	Rosy Snapper	<i>Pristipomoides filamentosus</i>	5	5
	Ruby Snapper	<i>Etelis carbunculus</i>	45	46
	Saddletail Snapper	<i>Lutjanus malabaricus</i>	172	172
	Sharptooth Snapper	<i>Pristipomoides typus</i>	2	2
	Tropical Snappers	<i>Lutjanidae</i>	2	2
<i>Nemipteridae</i>				
	Monocle Bream	<i>Scolopsis spp.</i>	9	9
	Threadfin Breams	<i>Nemipteridae</i>	80	80
<i>Lobotidae</i>				
	Tripletail	<i>Lobotes surinamensis</i>	1	2
<i>Haemulidae</i>				
	Javelin Fish	<i>Pomadasys spp.</i>	24	24
	Painted Sweetlips	<i>Diagramma labiosum</i>	12	12
	Sand Snapper	<i>Haemulidae</i>	48	48
<i>Lethrinidae</i>				
	Bluespotted Emperor	<i>Lethrinus punctulatus</i>	258	258
	Drab Emperor	<i>Lethrinus ravus</i>	5	5
	Grass Emperor	<i>Lethrinus laticaudis</i>	6	6
	Longnose Emperor	<i>Lethrinus olivaceus</i>	15	15
	Mozambique Seabream	<i>Wattsia mossambica</i>	2	2
	Redspot Emperor	<i>Lethrinus lentjan</i>	28	28
	Redthroat Emperor	<i>Lethrinus miniatus</i>	62	62
	Robinson's Seabream	<i>Gymnocranius grandoculis</i>	36	36

APPENDICES

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
<i>Lethrinidae (continued)</i>				
	Spangled Emperor	<i>Lethrinus nebulosus</i>	85	85
	Yellowtail Emperor	<i>Lethrinus atkinsoni</i>	1	1
<i>Sparidae</i>				
	Black Bream	<i>Acanthopagrus butcheri</i>	45	45
	Frypan Bream	<i>Argyrops spinifer</i>	35	35
	Snapper (Pink Snapper)	<i>Pagrus auratus</i>	478	480
	Tarwhine	<i>Rhabdosargus sarba</i>	6	6
	Western Yellowfin Bream	<i>Acanthopagrus latus</i>	9	9
<i>Sciaenidae</i>				
	Black Jewfish	<i>Protonibea diacanthus</i>	2	2
	Mulloway	<i>Argyrosomus japonicus</i>	14	14
<i>Mullidae</i>				
	Red Mullet	<i>Mullidae</i>	23	23
<i>Clupeidae</i>				
	Scaly Mackerel	<i>Sardinella lemuru</i>	346	346
<i>Kyphosidae</i>				
	Sweep	<i>Scorpius aequipinnis</i>	2	2
<i>Pentacerotidae</i>				
	Boarfish	<i>Pentacerotidae</i>	7	7
<i>Oplegnathidae</i>				
	Knifejaw	<i>Oplegnathus woodwardi</i>	1	1
<i>Cheilodactylidae</i>				
	Blue Morwong	<i>Nemadactylus valenciennesi</i>	41	44
<i>Mugilidae</i>				
	Sea Mullet	<i>Mugil cephalus</i>	193	194
	Yellow-Eye Mullet	<i>Aldrichetta forsteri</i>	22	22

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
<i>Sphyraenidae</i>				
	Pikes	<i>Sphyraenidae</i>	5	5
	Snook	<i>Sphyraena novaehollandiae</i>	2	2
<i>Polynemidae</i>				
	King Threadfin	<i>Polydactulus macrochir</i>	41	44
	Threadfin	<i>Polynemidae</i>	5	5
<i>Labridae</i>				
	Baldchin Groper	<i>Choerodon rubescens</i>	20	20
	Blue Groper	<i>Achoerodus gouldii</i>	37	43
	Bluespotted Tuskfish	<i>Choerodon cauteroma</i>	4	4
	Pigfish	<i>Bodianus spp.</i>	1	1
	Tuskfishes	<i>Choerodon spp.</i>	3	3
	Wrasses	<i>Labrid spp.</i>	1	1
	Parrotfishes	<i>Scarid spp.</i>	4	4
<i>Acanthuridae / Zanclidae</i>				
	Surgeonfishes	<i>Acanthuridae / Zanclidae</i>	2	2
<i>Scombridae</i>				
	Bonito	<i>Sarda australis</i>	1	1
	Grey Mackerel	<i>Scomberomorus semifasciatus</i>	10	11
	Spanish Mackerel (Narrow-barred)	<i>Scomberomorus commerson</i>	193	277
	Yellowfin Tuna	<i>Thunnus albacares</i>	1	1
	Mackerel, Other		1	1
	Tuna, Other		1	1
<i>Centrolophidae</i>				
	Blue-Eye Trevalla	<i>Hyperoglyphe antarctica</i>	4	4
<i>Bothidae</i>				
	Flounder	<i>Bothidae</i>	2	2

APPENDICES

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
<i>Monacanthidae</i>				
	Leather Jacket	<i>Monacanthidae</i>	13	19
	Fish, Other		73	74
TOTAL FISH			8668	9191
CRABS				
	Crystal Crab	<i>Chaceon albus</i>	150	150
	Champagne Crab	<i>Hypothalassia acerba</i>	10	10
	Giant Crab	<i>Pseudocarcinus gigas</i>	12	12
	Blue Swimmer Crab	<i>Portunus armatus</i>	365	365
	Crab, Other		1	1
TOTAL CRABS			538	538
PRAWNS				
	Banana Prawn	<i>Penaeus merguensis</i>	378	378
	Black Tiger Prawn	<i>Penaeus monodon</i>	1	1
	Brown Tiger Prawn	<i>Penaeus esculentus</i>	1064	1064
	Coral Prawn	<i>Metapenaeopsis spp.</i>	174	174
	Endeavour Prawn	<i>Metapenaeus endeavouri</i>	128	128
	Western King Prawn	<i>Penaeus latisulcatus</i>	1278	1278
	Prawns, Other	<i>Penaeidae</i>	< 500 kg	< 500 kg
TOTAL PRAWNS			3023	3023
LOBSTERS				
	Southern Rock Lobster	<i>Jasus edwardsii</i>	53	53
	Western Rock Lobster	<i>Panulirus cygnus</i>	4839	4839
	Bugs/ Slipper lobster	<i>Scyllaridae</i>	6	6
TOTAL LOBSTERS			4898	4898

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
MOLLUSCS				
	Squid	<i>Sepioteuthis spp./Loligo spp.</i>	36	36
	Octopus	<i>Octopodidae</i>	129	166
	Cuttlefish	<i>Sepiidae</i>	34	34
	Saucer scallop	<i>Amusium balloti</i>	32	158
	Brownlip Abalone	<i>Haliotis conicopora</i>	16	39
	Greenlip Abalone	<i>Haliotis laevisgata</i>	67	178
	Roe's Abalone	<i>Haliotis roei</i>	67	67
	Molluscs, Other		2	2
TOTAL MOLLUSCS			383	680
OTHER INVERTEBRATES			14	43
GRAND TOTAL			17524	18373

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.
4. Common names are from the CAAB – Codes for Australian Biota database.

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 2011/12

Highlights for 2011/12

There were 488 licensed aquaculture producers

The farm gate value of aquaculture production in WA (excluding marine algae and pearl oysters) was just over \$16.18 million

The most valuable industry sector was barramundi (\$11.14 million), followed by marron (\$1.44 million), mussels (\$1.37 million) and yabbies (\$0.38 million)

The industry sector with the most participants was marron with 183 productive licences.

Introduction

The statistics contained in this document represent the reported production and estimated value of the aquaculture industry in Western Australia for the financial year 2011/12. Comparisons to the previous four years have also been presented. The following summaries were produced from information held within the Aquaculture Production Returns Database at the Department of Fisheries, Research Division, Hillarys.

Quarterly records received from industry are summarised by the Department of Fisheries and reported to Parliament by the Minister for Fisheries. They are also used in the yearly Department of Fisheries *Status Reports of the Fisheries and Aquatic Resources*, the annual report provided by Australian Bureau of Agricultural and Resource Economics (ABARE) and other publications.

Producers' returns constitute the official production and value figures for the aquaculture industry and these are dependent on the accuracy of licensees' returns. The data presented are based on the Aquaculture Production Returns Database, as of the 18th July 2013.

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 2011/12

A total of 488 aquaculture licence holders were required to submit quarterly returns for one or more quarters in the 2011/12 financial year. Of the 488 licences, 236 i.e. 48 per cent recorded production on their returns. Marron had the largest number of producers with 183 licences recording production (Aquaculture Production Table 1).

Estimated aquaculture production increased by 19 per cent from 1402 tonnes produced in 2010/11 to 1662 tonnes in 2011/12 (excludes algae, pearl oysters, and ornamental species) (Aquaculture Production Table 2).

The estimated value of Western Australian aquaculture (excluding algae and pearl oysters) increased by 22 per cent from \$13.3 million to \$16.2 million in 2011/12 (Aquaculture Production Table 3). Finfish aquaculture made up 73 per cent of the total value for 2011/12.

AQUACULTURE PRODUCTION TABLE 1.

Growout production for the Western Australian aquaculture industry in 2011/12

Common name	Productive licences	Quantity	Units*	Average price (\$)/unit	Value (\$)
Barramundi	6	1,127	tonnes	9.89	11,143,391
Marron	183	50	tonnes	28.62	1,443,877
Mussels	11	350	tonnes	3.91	1,367,470
Yabbies	9	19	tonnes	20.09	377,438
Silver perch	10	14	tonnes	18.02	254,883
Koi carp	7	21,366	No.	5.32	113,751
Rainbow trout	5	4	tonnes	14.52	61,012
Ornamental fish & crustaceans	11	24,908	No.	n/a	57,715
Goldfish	5	8,624	No.	2.99	25,759
Other species with <5 producers**	<5	97	tonnes	n/a	1,337,601
Algae	<5	**			**
Total (not including algae or pearls)					16,182,897

* 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 Six Production Years (2006/07-2011/12)**AQUACULTURE PRODUCTION TABLE 2.**

Estimated quantity of growout production of aquaculture species/categories in Western Australia over the past six financial years.

Common name	Units	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Barramundi	tonnes	43.2	365.9	455.2	433.0	862.5	1 127.0 ↑
Mussels	tonnes	621.9	481.2	433.5	506.5	364.9	349.8 ↓
Marron	tonnes	58.1	51.1	52.8	53.9	51.1	50.5 ↓
Yabbies	tonnes	87.9	60.8	44.1	46.7	19.7	18.8 ↓
Silver perch	tonnes	26.5	16.9	28.5	27.2	18.0	14.1 ↓
Rainbow trout	tonnes	11.7	13.3	11.7	7.5	11.0	4.2 ↓
Ornamental fish & crustaceans	No.	61 492	55 047	50 598	46 425	21 167	24 908 ↑
Koi carp	No.	30 124	35 620	34 270	44 787	39 944	21 366 ↓
Goldfish	No.	35 836	33 918	36 199	15 785	11 448	8 624 ↓
Other species with < 5 producers	tonnes	65.2	97.2	94.9	94.2	75.0	97.4

AQUACULTURE PRODUCTION TABLE 3.

Estimated farm gate value (\$) of growout aquaculture species/categories in Western Australia over the past six financial years.

Common name/ Category	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Barramundi	467,280	3,870,071	4,793,106	4,512,123	8,391,579	11,143,391 ↑
Marron	1,387,449	1,298,672	1,434,494	1,445,252	1,418,951	1,443,877 ↑
Mussels	1,811,298	1,531,849	1,618,594	1,870,531	1,357,009	1,367,470 ↑
Yabbies	1,381,248	1,059,532	810,608	760,595	389,920	377,438 ↓
Silver perch	317,275	245,157	405,506	435,624	310,977	254,883 ↓
Koi carp	137,195	160,597	168,279	184,708	173,928	113,751 ↓
Rainbow trout	105,391	135,007	140,422	101,681	133,257	61,012 ↓
Ornamental fish & crustaceans	294,308	237,408	276,986	230,856	108,023	57,715 ↓
Goldfish	65,536	80,732	73,992	52,139	32,771	25,759 ↓
Other	883,044	1,554,289	1,715,130	1,018,211	1,024,396	1,337,601
Total (not including algae & pearls)	6,850,022	10,173,312	11,437,116	10,611,720	13,304,811	16,182,897

APPENDIX 3

Research Division - Other Activities

Activities of the Pemberton Freshwater Research Centre 2012/13

C. Lawrence and T. Church

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 Forest Fresh Marron for processing and marketing the product from over 60 local marron growers.

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. In 2010/11 as part of the NRM funded hatchery infrastructure modifications a front office has been allocated for public enquiries, community education material and the recommencement of tours of the facility by the public. The community education material on the Department's activities in the region will be developed when resources permit. Once complete it will enable the PFRC hatchery to recommence public education tours.

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 2012/13 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 2012/13 the PFRC produced 677,000 fry. These consisted of 658,000 rainbow trout fry and 19,000 brown trout fry, representing a decrease in production of 11% and an increase of 46% respectively, compared with 2011/12. The majority of production (69%) consisting of 452,000 rainbow trout fry and 18,000 brown trout fry was stocked into public waterways to

support recreational fishing. A further 168,000 rainbow trout (25%) were sold to individuals and clubs for stocking private farm dams, to support recreational fishing and tourism operations and for licensed aquaculture production. There was a 16% decrease in sales from PFRC in 2012/13 to 168,000 down from 200,000 in 2011/12.

20,000 sterile triploid rainbow trout were produced at PFRC in 2012/13 which were supplied to licenced aquaculture producers and fishing associations. The remaining 38,000 trout produced (6%) were retained for future brood stock for PFRC, yearling stocking, and research.

In the winter-spring months of 2012 and May-June 2013 29,450 rainbow yearlings as well as 2,700 rainbow and 200 brown trout ex brood stock, were released to public waters for recreational fishing and control of stunted redfin perch populations.

The 330% increase in yearlings stocked in 2012/13 (29,450) compared with 2010/11 (8,700) is due to compliance with the Department of Fisheries revised translocation policy resulting in the yearling stocking being delayed until the later half of 2012. The translocation approval to stock the remaining yearlings held at PFRC was received in late June 2012 after which stocking commenced in July and proceeded as in previous years albeit delayed.

Trout research for recreational fishing and aquaculture

In late 2006 the Department commenced a review of trout production at PFRC to consider two key factors: brown trout embryo survival and rainbow trout brood stock selection strategies. In 2007 the Department commenced research to evaluate hatchery production techniques for producing sterile triploid trout and develop improved protocols using 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 investigated included poor sperm motility, water quality or climate change.

Investigations by the Department into brown trout sperm motility showed that some trout were not producing motile sperm. This resulted in modifications to hatchery protocols to include assessment of sperm quality prior to egg fertilisation. In 2009/10 sperm motility assessment using basic visual evaluation of sperm quality resulted in a 500% improvement

in brown trout 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 enabled research staff to efficiently analyse and quantify trout sperm fitness during the 2012 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 held discussions with both major client groups to establish and prioritise breeding objectives. This will ensure that in coming years, brood stock selection strategies at PFRC can be implemented to produce trout with traits that specifically meet the needs of key client groups.

The genetic line of rainbow trout at PFRC is unique. In 2008/09 staff completed a series of temperature tolerance experiments that demonstrated that the PFRC rainbow trout genetic line can withstand water temperatures of up to 28°C without any mortalities. This temperature tolerance is superior to most domesticated lines elsewhere and is significant in regards to adapting to global warming. Due to resource limitations between 2009-2012 the commencement of a trout selective breeding program to further increase temperature tolerance had to be delayed. In 2012 a Canadian based research team, with expertise in trout temperature physiology and genetics, developed a collaborative project with PFRC to undertake research into temperature tolerance of Pemberton trout.

Sterile triploid trout production

Triploids are valuable for both stocking and the environment as they cannot reproduce and continue to grow after reaching sexual maturity. The PFRC hatchery has produced triploids for over 20 years using temperature shock. However, temperature shocking is known to have considerable variability in triploidy rates.

Pressure shock provides less variability in ploidy rates than temperature shock. Over the past three years Department of Fisheries Researchers at PFRC have designed and built a system capable of delivering precise pressure shocking of embryos in a safe and reproducible manner. In the past two years researchers have developed and refined protocols for producing both triploids and tetraploids using hydrostatic pressure. In 2012 ploidy rates were validated by researchers from The University of Western Australia, with pressure shock (80%) providing better triploid rates than temperature shock (70%). Furthermore, researchers successfully produced tetraploid trout, albeit in low numbers. Department of Fisheries researchers are undertaking further work with colleagues from The University of Western Australia to develop and validate a more efficient technique of quantifying the percentage of triploids, diploids and tetraploids from embryo samples in 2013/14.

Native and endangered fish conservation and biodiversity research

In response to a declining prevalence of native fish in the Southwest, Department of Fisheries researchers have established brood stock populations of two endemic species pygmy perch (*Nannoperca 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 1) enable stocking of public and private water bodies in the Southwest, 2) develop and validate the most efficient production strategies for each species 3) transfer this technology to achieve captive breeding of two listed species (*Galaxias truttaceus* - Critically endangered and *Nannatherina balstoni* - Vulnerable to extinction).

Western minnow (*Galaxias occidentalis*)

In 2012 PFRC successfully achieved large scale spawning of the western minnow (*Galaxias occidentalis*) in hatchery ponds. Over 6,000 juveniles were produced from this pilot research project. The technology developed is now being applied to further increase mass production of western minnow for restocking and transferred to breeding the critically endangered trout minnow (*Galaxias truttaceus*).

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.

Pygmy perch (*Nannoperca vittata*)

In 2012 pygmy perch were spawned in tanks at PFRC following the protocols developed and refined at the Aquaculture and Native Fish Breeding Laboratory, in Shenton Park. This technology has now been scaled up to mass production in ponds on Thomson Flat and at Shenton Park to produce fish for restocking. Techniques developed for

breeding the pygmy perch are now being transferred to the related Balston's perch (*N. balstoni*), which is listed as vulnerable to extinction.

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, it appears that other native fish species consume more mosquito larvae. Therefore, while production and stocking of endemic species 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.

Listed native fish species

Broodstock populations of two endangered native fish species the trout minnow (*G. truttaceus*) listed as critically endangered, and Balston's pygmy perch (*N. Balstoni*) listed as vulnerable to extinction, are being established at PFRC and the Aquaculture and Native Fish Breeding Laboratory in Shenton Park. In addition to establishing a living gene bank before these species become extinct in the wild, the focus of this project is to close their lifecycles, develop large scale production techniques and restock waterbodies within their original distribution.

Native fish research priorities 2012/13

In 2012/13 Department of Fisheries will address the following native fish research priorities:

Techniques to increase production of pygmy perch & western minnows

A recent collaborative project with UWA showed that native fish are more abundant in waterbodies with complex habitat. One hypothesis, that has also improved marron breeding, is that this occurs due to the shelter provided to juveniles. This hypothesis will be examined by comparing native fish production among spawning ponds that either contain hides or without hides in 2012/13

The achievement of the first ever large scale pond production of western minnows (*G. occidentalis*) in earthen ponds at PFRC highlighted a production technology gap. The harvesting of several thousand small native fish from a pond is labour intensive, time consuming and exposes the fish to both stress and the risk of physical injury. Techniques to more efficiently remove native fish from ponds will be evaluated in 2013

Establishing key genetic lines for conservation and restocking

The Department of Fisheries NRM survey showed that genotypes of pygmy perch and western minnow among water bodies north of Collie are similar. However, those south of Collie are different from the northern populations and show increased variation among catchments. Consequently, in 2012/13 the breeding program for these two species will be split into two major populations, a northern genetic line at Shenton Park Aquaculture & Native Fish Breeding Laboratory for restocking the Swan Coastal Plain; and a southern genetic line at PFRC. This will require collection

and quarantine of northern genetic lines at the Shenton Park facility in 2012/13.

Endangered fish species

Broodstock populations of two endangered native fish species the trout minnow (*G. truttaceus*) listed as critically endangered, and Balston's pygmy perch (*N. Balstoni*) will be collected and established in 2012/13. They will be managed using the same suite of husbandry techniques that Department of Fisheries scientists have developed, and shown to be effective, for the production of the related western minnows (*G. occidentalis*) and pygmy perch (*Edelia vittata*).

Mosquito predation

While it is widely accepted that native fish consume more mosquito larvae than the introduced mosquito fish (*Gambusia*) this has yet to be scientifically verified. In 2013 Department of Fisheries researchers quantified the mosquito larvae consumption of key native fish and *Gambusia*. These results will also determine which species is the most suitable for stocking artificial water bodies in which mosquito control, rather than biodiversity, is the primary objective.

Native and endangered crayfish conservation and biodiversity research

The key focus of this program is to establish a living gene bank and breeding population of the critically endangered "hairy" Margaret River marron, before it becomes extinct in the wild. Department of Fisheries researchers working in collaboration with The University of Western Australia have developed a molecular technique to distinguish pure "hairy" marron from hybrids using real time PCR. This is being used to select broodstock marron for the captive breeding program at both PFRC (traditional pond techniques) and the Aquaculture and Native Fish Breeding Laboratory, in Shenton Park (intensive hatchery techniques).

In addition, a living gene bank representing marron populations from two other river systems are bred and reared in the captive breeding program at PFRC. These broodstock represent the genetic biodiversity of the ancestral Pemberton strain upon which the WA aquaculture industry has been developed, and the rare blue marron. Their progeny are used 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) where appropriate, restocking both catchments and farm dams in the region.

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 achieved production levels 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

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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 best performing mass and pedigree selected 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 in the near future.

Summary

In 2012/13 increased requirements to provide scientific support to i) policy development (translocation, biodiversity,

biosecurity, recreational angling) and ii) Water Corporation projects, as well as the conclusion of an 18-month rebuilding project at the Shenton Park based facility, required a reallocation of resources from research activities. Despite this key core activities for recreational and aquaculture stakeholders, including trout production and monitoring of recreational marron fishery were delivered. It is anticipated that freshwater research activities will return to normal in 2013/14.

Activities of the Fish Health Unit during 2012/13

The Fish Health Unit of the Department of Fisheries was formed in 1988 following an outbreak of disease in the state trout hatchery. The unit is based at South Perth within the Animal Health Laboratories of the Department of Agriculture and Food, bringing economies of scale through sharing of equipment. The unit is permanently staffed by one full-time principal scientist, one full time and one part-time fish pathologist, one research scientist, one laboratory manager, a part-time research officer and two part-time technical officers.

The unit is accredited to ISO 17025 and provides a diagnostic service to the seafood industries in Western Australia, undertakes disease surveillance for key fisheries, 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. In addition, protocols for high health hatchery status have been developed and adopted by key industries. Key activities and achievements of the unit during 2012/13 were as follows:

The fish health laboratory received a total of 165 diagnostic cases during 2012/13, which included a substantial number of *Seriola lalandi* (yellow tail kingfish) samples submitted from South Australia for pathology testing.

The provision of export health certificates for yabbies and marron has continued its downward trend since 2002, when 55 certificates were issued, to none for the last three years. 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 declined slightly from 14 to 8 in this reporting period.

Staff spent time assisting sea-cage culture farms in WA coastal waters. This is a growing area of activity in Western Australia.

There were 8 cases of notifiable diseases reported in 2012/13. Most notifications related to records of iridovirus in ornamental fish in quarantined imported fish. The notifiable bacterium *Edwardsiella ictaluri* was isolated from *Botia lohachanta* (Pakistani loach) with diagnosis being confirmed by the CSIRO Aquatic Animal Health Laboratory in

Geelong. The first recorded occurrence of *Pseudomonas anguilliseptica* was also reported during health investigations into a planned eradication of *Tandanus tandanus* which is not native to Western Australia.

A new project funded by the FRDC aimed at investigating the cause of disease in pearl oysters (*Pinctada maxima*) was recently established. The project represents a collaboration with Macquarie University and the Pearling industry and aims to exploit recent advances in molecular sequencing technology to identify the genetic signature of pathogens associated with Oyster Oedema Disease (OOD). This information can be used to investigate the role of such pathogens in contributing to disease and to potentially develop diagnostic tests to support its management.

A 3 year FRDC project 2011/005 to examine WA prawn samples for virus was started in early 2012. This project aims to identify emerging pathogens of potential significance to both wild fisheries and any potential developing prawn aquaculture industry.

In collaboration with staff from the Department of Water and the Water and Rivers Commission, 7 reports of 'fish kills' throughout the State were investigated. Most 'fish kills' were due either to poor water quality or toxic algal blooms. During the 2010/11 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. This initiative resulted in successfully obtaining samples from a fish kill, due to an algal bloom, in January 2012.

A range of national committees including: the national Subcommittee for Aquatic Animal Health; the Fisheries Research Development Corporation Subprogram on Aquatic Animal Health; 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 7 regional resource centres for aquatic animal health within the Network of Aquaculture Centres (NACA) in the Asia-Pacific.

A member of staff attended an intensive two week training program (AQUAVET) in fish pathology in the United States of America in May-June this year. The training and travel was funded by the FRDC's People Development Program: Aquatic Animal Health Training Scheme. The training program was organized and presented by Cornell University School of Veterinary Medicine and School of Veterinary Medicine at the University of Pennsylvania but held at Roger Williams University in Rhode Island. The training covered the comparative pathobiology of a wide range of aquatic animal species and included the examination of histology slides, case interpretation and practical dissections. The course not only provided world-class education and knowledge from many aquatic animal health specialists, but

facilitated the opportunity to network and meet aquatic animal colleagues from all over the world including Spain, Norway, all over the USA and New Zealand.

Members of the group also attended and presented at the FRDC Second Australasian Scientific Conference on Aquatic Animal Health in Cairns, Australia from 8th-12th July 2013. This conference represents an important opportunity to network with fish health professionals from across Australia and worldwide.

Activities of the Marine Biosecurity Research and Monitoring Group during 2012/13

Marine Unit

The Marine Biosecurity Research and Monitoring Group currently monitors high risk ports around the State and has developed research programs to increase our knowledge of the marine pest threat to our State waters.

Introduced Marine Pests

Introduced marine species are organisms that have moved, or been moved from their natural environment to another area. Many of these organisms remain inconspicuous and innocuous causing no known adverse effects. However, they can potentially threaten human health, economic values or the environment, in which case they are then referred to as marine pests. Introduced marine species are a global problem, and second only to habitat change and loss in reducing global biodiversity (Millennium Ecosystem Assessment, 2005).

The introduction of marine species into a new region can be deliberate or accidental. Deliberate introductions may result from aquaculture practices or releases from aquariums. Accidental introductions are primarily due to shipping and recreational craft moving from country to country, with the pests being transported in ballast water, on ship hulls, or within a vessel's internal seawater pipes. Introduced marine species also arrive naturally via marine debris and ocean currents.

The impacts of introduced marine pests are wide and varied. They can predate on native and farmed species, out-compete natives for space and food, alter nutrient cycles and lead to a loss of diversity in local species. In addition to environmental consequences, introduced marine pests have the potential to harm human health (e.g. cholera, paralytic shellfish poisoning), negatively affect commercial fish and seafood species, negatively affect amenity and recreational activities and reduce the fuel efficiency for all vessel types (hull fouling organisms). With increasing human population and associated travel, transport and trade, the risk of introducing new species is likely to grow (Convention on Biological Diversity, 2005).

Early detection of an introduced marine pest is vital if we are to have any chance of eradicating it before it becomes established. There has only been one introduced marine species that has been successfully eradicated to date in Australia, the black striped mussel which was found in Darwin Harbour in 1999. This program of eradication cost more than \$2M, but the mussel threatened the \$225M (value of production in 1998) pearling industry. If eradication is not an option then other management controls can be put in place, such as community education regarding boating habits and routines, quarantining areas and managing vessel movements between locations.

As an ocean bound nation Australia relies heavily on maritime transport, with over 95% of our imports and exports carried by sea. The large ocean going vessels that transport these goods represent one of the largest vectors of introduced species. For these reasons our ports and marinas become high risk areas for the introduction of a marine pest. The Commonwealth Government, together with the states and territory have developed a national system of policies and procedures to try and reduce the risk of marine pests arriving in Australian waters. Part of this system includes the monitoring of high risk ports, which are those ports that receive large numbers of vessels, high risk vessels (such as dredges) or are geographically close to areas with known invasive marine species.

The monitoring and research activities of the group are aimed at preventing or minimising further introductions of marine pests, and advocating control measures where they do exist.

Monitoring and Surveillance

The Marine Biosecurity Research and Monitoring Group is actively involved in developing and implementing monitoring programs for marine pests along our WA coast using a suite of tools. These programs adhere to the Australian Marine Pest Monitoring Guidelines and have been endorsed by the Commonwealth. These programs occur every two years and have been implemented in Fremantle, Port Hedland, Dampier, Geraldton and HMAS Stirling

(Garden Island, Defence Services Group) in late 2012/early 2013. The Marine Biosecurity Research and Monitoring Group has also developed targeted supplementary monitoring programs, to complement the above, which occur in the off years.

The Marine Biosecurity Research and Monitoring Group has also been approached by Garden Island, Defence Services Group to develop their marine pest incursion response plan for HMAS Stirling.

Early warning system

The Early Warning System uses settlement arrays to examine recruitment of marine organisms, thus potentially providing a mechanism for the early detection of marine pests. Settlement arrays are an established methodology currently being used by the Marine Biosecurity Research and Monitoring Group as a complementary method for marine pest monitoring in Dampier, Port Hedland and Fremantle Ports and at HMAS Stirling. These arrays are simple structures designed to act as extra surfaces for organisms to settle on, using 10cm x 10cm plates and mops as collectors. In addition to the deployment of the settlement arrays, twice a year shoreline searches are carried out and crab traps are deployed.

Surveillance in response to detection

Charybdis japonica

In 2012 three male specimens of the invasive Asian paddle crab *Charybdis japonica* were caught by members of the general public in the Swan River estuary and handed in to the Department of Fisheries Biosecurity team over a period of several months. This triggered extensive trap-based and diver surveillance of the target area in the lower reaches of the estuary. Over 8500 trapping hours and several days of diving surveillance failed to detect any more *C. japonica*. Follow up surveillance operations were conducted at 3 and 6 month intervals after the initial surveillance operation, bringing the total number of trap hours to more than 15,000. To date no further specimens of *C. japonica* have been detected by either the Department or the general public. One further survey is planned to complete this response in the second half of 2013, twelve months after the original detection.

Didemnum perlucidum

In 2011 the Department were alerted to the presence of *D. perlucidum* in our waters. This species is considered non-native to Western Australia and based on current knowledge has only been recorded once previously in Australia (on a vessel in NSW).

The initial detection of this species triggered further investigation by the Department's Marine Biosecurity Research and Monitoring Group who have since found the species to be present in many ports and marinas from Busselton to Broome. It has also been confirmed that this species is present as a component of hull fouling on several vessels traversing the coastline.

The widespread distribution and extensive growth of this species raises biosecurity concerns for the Department. *Didemnum perlucidum* is a heavy fouling species that may cover and smother other benthic assemblages. Based on information from the Northern Hemisphere, *D. perlucidum* displays typical invasive characteristics of a high growth rate, early maturity and extremely high fecundity. Further this species may spread asexually, both through lateral expansion

at the edges of the colony as well as through pieces breaking off.

Previously this pest species has been confined to artificial structures such as jetty pylons and vessels. Recent surveillance in 2013 by the Marine Biosecurity Research and Monitoring group has detected this species colonising the seagrass *Halophila ovalis* in the Swan River. This is the first record of this species colonising natural surfaces. The group are currently monitoring the effect this pest may be having on the seagrass and ongoing monitoring to further investigate impacts is planned. *Didemnum perlucidum* is a very difficult species to identify and differentiate from other native species which are known to exist in Australian waters. The Marine Biosecurity Research and Monitoring Group has developed identification capabilities for this species based on characterisation of its DNA. Analysis of populations detected in Western Australia indicates that this species is genetically identical to specimens originating from Brazil. Initial examination of *D. perlucidum* populations sampled along our coast suggests very low genetic variation which is consistent with a recent appearance of this species in Western Australian waters.

Research programs

Likelihood analysis

The Marine Biosecurity Research and Monitoring Group are finalising their analysis of vessels entering WA ports. This research examines the types and number of commercial vessels that visit our ports from domestic and international last port of calls, duration of the vessels stay, duration of the voyage, the bioregions the vessel traverses on its way to WA and environmental matching between the last port of call and the WA port(s) visited. This research will provide an up-to-date analysis of the likelihood of a potential marine pest introduction to individual ports based on the above data that will inform management and policy.

Recreational vessel study

WA has a very high ownership of recreational vessels (90,000 registered vessels: Department of Transport, 2012). However, very little is known about the risk associated with recreational vessels for the introduction and translocation of marine pests along our coast line. The Marine Biosecurity Research and Monitoring Group is commencing a study of recreational vessels from marinas all over the State. This has three main components - firstly a survey of vessel owners examining vessel use and maintenance practices. Secondly an examination of vessels for the presence of known IMPs and an assessment of the degree and type of fouling from different areas on a vessels hull and finally an examination of marinas to see how fouling present on structures correlates with that found on vessels. This information will be combined to allow for predictions in vessel mediated translocation of IMPs which will inform management strategies.

Vessel wrapping

Preventative measures such as maintenance of a clean vessel hull is widely acknowledged as more effective in curtailing invasions of marine pests than are eradication or control measures. The Marine Biosecurity Research and Monitoring Group completed a trial in collaboration with South Australian researchers to ascertain the efficacy of wrapping a recreational vessels hull in eliminating/killing biofouling.

Results were very promising for these small vessels. Further successful trials were completed on the efficacy of wrapping structures such as pylons to kill fouling which are currently being written up for publication.

Crab condos

Baited crab traps have been used in many decapod sampling regimes around the world and specifically target larger predatory/scavenger crustaceans. Crabs are lured inside the traps by an attractant, typically fish-bait and stay inside until the trap is recovered. This technology is effective at capturing larger and aggressive crab species: however, juvenile, small or non-carnivorous species are generally excluded from such devices. A device nick-named the 'crab condo' was developed by New Zealand researchers to try and target these 'excluded' species. The Marine Biosecurity Research and Monitoring Group completed research into the efficacy of these crab condos to sample these species and evaluate their efficacy in different habitats. A scientific journal article on this research was recently published in the international journal *Management of Biological Invasions*. We are proposing to introduce this sampling methodology into the Australian National System.

Indian Ocean Territories 2012/13

The Marine Biosecurity Research and Monitoring Group are currently conducting two projects in the Indian Ocean Territories.

Marine pest surveillance

The introduction and spread of marine pests poses a serious threat to native biodiversity and can have widespread effects on both our economy and health. The Marine Biosecurity Research and Monitoring Group developed a targeted marine pest monitoring program for Christmas Island in 2010. The aim was to detect the presence of introduced marine pests (IMPs) using a suite of tools. As part of the ongoing biennial project the Marine Biosecurity Research and Monitoring Group completed a large-scale marine pest monitoring program in Christmas Island port in late 2012. No marine pests were detected during the 2012 survey.

Marine pest research

The Marine Biosecurity Research and Monitoring Group are currently assessing the likelihood of a marine pest introduction into Christmas Island from commercial and recreational vessels. The aim of this document will be outline the perceived risk, identify and rank the most likely vectors and last port of call locations that pose a risk to this region. This is due to be finalised later in 2013.

Activities of the Freshwater Biosecurity Research Program 2012

A 2010 NRM funded survey of 114, of the over 4000, listed permanent lakes and swamps of the southwest coastal plain from Geraldton to Busselton, found that fish abundance in the majority of lakes surveyed was dominated by non-native species. The survey detected two new non-native fish species and a new location for a previously detected species. This survey identified the need for a more comprehensive survey program.

Prior to 2012 there were known to be 14 finfish and 2 crustacean pest species in Western Australia, these are listed in the table below. Most of these species successfully reproduce and are therefore considered feral, whilst some appear to, so far, be unsuccessful in this regard. Golden Perch and Silver Perch are the only two species that are yet to have known self-sustaining populations, this does not necessarily imply they are unable to successfully breed in WA.

All of the species listed in Freshwater Biosecurity Table 1 can have an adverse effect on the survival of West Australian native species, this may be via direct competition for food or habitat, by predation or by habitat modification.

Management Arrangements

The Department of Fisheries maintains a Translocation approval process for species considered to be of risk to the West Australian aquatic environment. The approvals process allows the Department to reject translocation applications where the risk is too high or to apply conditions to prevent or

limit the risk of release into the environment.

The greatest risk is the release of unwanted aquarium species and the deliberate release of angling species. The management of the release of fish species in this manner is difficult to prevent, however, the Department has increased community education in this area to reduce this risk. The Department has also increased its compliance activities to prevent new introductions and begun a process that would ban the entry into Western Australia of a large number of high risk ornamental fish species that are currently not kept by the ornamental fish keepers in the state.

Staff from the Research Division in addition to staff from all other Divisions across the Department have undertaken formal training in incident management so that there is readiness in case serious biosecurity incidents and emergencies that may occur in future. In tandem with the incident management training, the Department has refined its risk assessment processes and incident management protocols.

2012 Biosecurity Surveys

During 2012 the Freshwater Biosecurity Research Unit was formed to undertake comprehensive surveys, respond to pest species reports and undertake control measures of pest species where required. The survey work in 2012 was concentrated in the Perth area (Swan/Canning coastal plain), being an area identified as high risk due to; previous pest fish

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detections, the large urban population and the extensive lake and drainage systems connected to the Swan/Canning Rivers.

There are approximately 1200 permanent lakes listed for the Perth area, comprised of; natural lakes and swamps, man-made or highly modified lakes, water compensating basins as part of drainage management and permanent pools in ephemeral systems. Review of recent late summer aerial photos would indicate that only approximately half of these now retain water all year. Survey work of these lakes by the dedicated Freshwater Biosecurity Research Unit commenced during 2012 with priority being given to lakes around existing known pest fish species populations. Location visits, on occasion, found some lakes to be dry, too shallow or on private property where access was unable to be obtained. Where necessary for the detection of pest fish, creeks, rivers and drains connected to these lakes were also be sampled.

Sampling methodology

The majority of sampling in the Perth area in 2012 was undertaken using fyke nets, a trap net that has a leader net attached to the bank(s) that lead to a series of hoops and funnels that the fish swim into. These nets are generally unbaited. It is accepted that not all fish species are susceptible to capture by fyke nets, however, it is the most appropriate cost effective method for the large number of locations to be sampled. Many of the locations are also often unsuitable by other methods of sampling such as seine netting, electrofishing, gill nets and opera house traps due to habitat type, by-catch and staff safety. However, sampling on occasion, included the use of electrofishing, opera house traps or gill nets where these methods were appropriate. The fyke nets used by the Department were fitted with a float ring to provide access to the surface for any wildlife that were captured.

Research Activities

Departmental staff, prior to the formation of the Freshwater Biosecurity Research Unit, undertook surveys for Spangled Perch *Leiopotherapon unicolor* (detected during 2010 NRM survey), a Gascoyne/Pilbra species, in southern Perth starting in late 2011 and this data is included here. Department of Water staff also assisted with the Spangled Perch survey.

Control measures for the Eastern States Catfish *Tandanus tandanus* (detected during 2010 NRM survey) in Marmion Reserve, Myaree, were commenced with a population assessment and survey of surrounding lakes being undertaken.

In addition, during 2012, surveys of locations outside the Perth area were undertaken for collection of fish samples from the Collie River system for mercury contamination and surveys of some trout stocking locations for the presence of native fish and the feral Redfin Perch.

During 2012 a total of 146 samplings were conducted of which 9 samplings were repeat samplings at 7 locations. A few locations were sampled indirectly due to direct connections to sampled waterbodies and have been counted as the same waterbody. Data for any repeat sampling of a location has been combined for analysis.

Survey work detected the presence of a species, the convict cichlid (*Amatitlania nigrofasciata*), that had not previously

been found in Western Australia. Two individuals of convict cichlid, *Amatitlania nigrofasciata* (Figure 2), were captured in December, 2011, in a single lake within Forest Crescent Reserve (Lat -32.071, Lon 115.952). Lengths of the specimens were 45mm and 43mm SL. Determination of sex of specimens was not possible due to the small size and deterioration after preservation. Follow up sampling did not capture any more specimens, therefore it is possible that this species has not established a self-maintaining population despite an apparent serious risk.

Impact on non-target species

The use of fyke nets for fish sampling can unintentionally capture some wildlife, the most prevalent being oblong turtles. From a total of the 137 locations, turtles were captured at 81 locations. This included the use of 252 fykes capturing 838 turtles, all of which were returned live to the water. Therefore, this method of sampling has had no indirect impact on non-fish species.

Pest Reporting and Response

Pest species are able to be reported to the Department via Fishwatch, the Freshwater Fish Distribution website and direct contact with the Department. In 2012, 17 reports were received by the Freshwater Biosecurity Research Unit. The response to these reports were prioritised according to risk and previous known distribution. From these reports 6 were responded to with sampling and 2 involved the identification of samples that were able to be provided. The remaining reports were deemed to be of low risk or reports on species already known to be present.

Management Implications

It was clear from the 2012 survey work that the pattern observed during the 2010 NRM survey was repeated - few lakes contain indigenous fish (12%) and even fewer contain purely native fish (5%). Of the lakes that contained native species, most only contained between one and three of the eleven SW native species of freshwater finfish. A far greater percentage of lakes contained no native fish, however the reasons for the lack of native fish are unclear, but they may include: reduced water levels from reduced rainfall and/or increased groundwater extraction, poor water quality, acidification, toxic chemicals, eutrophication, salinization, sedimentation or predation/competitive exclusion by pest species. Immediate action may need to be taken to protect the remnant populations before they disappear completely.

Restocking

One method to protect remnant native freshwater fish populations would be via a breeding and stocking program of lakes that do not contain native fish species. This would require considerable quantities of fish, given the high number of lakes involved in the Perth area alone (up to 560). The breeding stock for the stocking program would need to be sourced from the remnant lake stocks to ensure fish with genetic traits suitable for survival in the highly modified lakes within the metro region.

No restocking has been undertaken during 2012.

FRESHWATER BIOSECURITY TABLE 1

Known Pest Fish in WA Prior to 2012

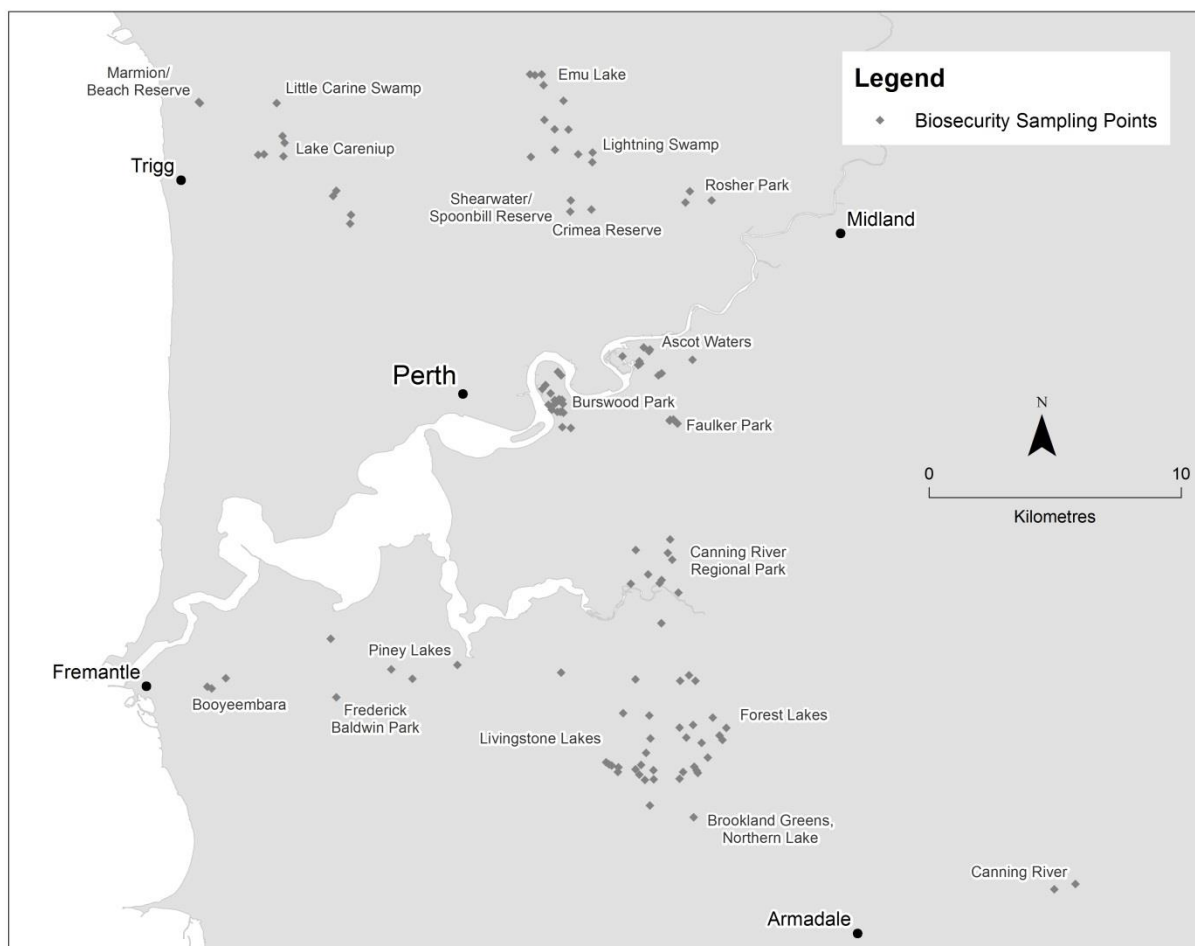
Common Name	Scientific Name	Origin
Finfish		
Carp (Koi)	<i>Cyprinus carpio</i>	Eurasia
ES Freshwater Catfish	<i>Tandanus tandanus</i>	Eastern Australia
Gambusia/Mosquito Fish	<i>Gambusia holbrooki</i>	Sth America
Golden Perch	<i>Macquaria ambigua</i>	Eastern Australia
Goldfish	<i>Carassius auratus</i>	Eurasia
Guppy	<i>Poecilia reticulata</i>	Sth America
Pearl Cichlid	<i>Geophagus brasiliensis</i>	Sth America
Redfin Perch	<i>Perca fluviatilis</i>	Europe
Rosy Barb	<i>Puntius conchonius</i>	SE Asia
Silver Perch	<i>Bidyanus bidyanus</i>	Eastern Australia
Spangled Perch	<i>Leiopotherapon unicolor</i>	Gascoyne
Speckled Mosquito Fish	<i>Phallocherus caudimaculatus</i>	Sth America
Swordtail	<i>Xiphophorus helleri</i>	Sth America
Tilapia	<i>Oreochromis mossambicus</i>	Africa
Crustaceans		
Redclaw Crayfish	<i>Cherax quadricarinatus</i>	Eastern Australia
Yabby	<i>Cherax destructor albidus</i>	Eastern Australia

FRESHWATER BIOSECURITY TABLE 2.

2012 Freshwater Biosecurity Sampling Results

	Total (Perth)	% (Perth)
Finfish		
Number of locations visited	153 (140)	
Number of locations by visit dry or too shallow	9 (9)	6 (6)
Number of locations sampled	137 (124)	95 (95)
Number of locations containing finfish	130 (119)	95 (96)
Number of locations containing no finfish	7 (5)	5 (4)
Number of locations containing Estuarine fish	43 (42)	31 (34)
Number of locations containing native freshwater finfish	17 (8)	12 (6)
Number of locations containing only native freshwater finfish	7 (3)	5 (2)
Number of locations containing feral freshwater fish	106 (99)	77 (80)
Number of locations containing only feral freshwater finfish	72 (71)	53 (57)
Number of new feral finfish species detected	1 (1)	<1
Number of new locations feral <i>Tandanus tandanus</i> detected in	0 (0)	-
Number of new locations feral <i>Leiopotherapon unicolor</i> detected in	8 (8)	6 (6)
Crustaceans		
Number of locations containing crustaceans	76 (66)	55 (53)
Number of locations containing no crustaceans	61 (60)	44 (48)
Number of locations containing native crustaceans	61 (51)	44 (41)
Number of locations containing only native crustaceans	38 (29)	28 (23)
Number of locations containing feral crustaceans	38 (37)	28 (30)
Number of locations containing only feral crustaceans	15 (14)	11 (24)

Note; also includes survey data (23 locations) undertaken in December 2011 for Spangled Perch (*L. unicolor*) response.



FRESHWATER BIOSECURITY FIGURE 1.

2012 Swan/Canning Coastal Plain Sampling Locations



FRESHWATER BIOSECURITY FIGURE 2.

Convict cichlids, *Amatitlania nigrofasciata* captured from a waterbody in the greater Perth region.

Finfish Ageing Laboratory

J. Norriss

The Finfish Ageing Laboratory (FAL) at the WA Fisheries and Marine Laboratory continues to produce age data for assessing stocks of key finfish species in Western Australian. Age demographics, recruitment patterns, growth rates, age at onset of sexual maturity and/or sex change, and longevity are all critical parameters for assessing fish stocks.

Estimating the age of a fish is a routine procedure accomplished by removing the otoliths (ear stones) and interpreting their alternating opaque and translucent zones deposited throughout the lifetime of the fish, similar to growth rings in a tree. Interpretation usually requires the otolith be sectioned and mounted on a microscope slide.

The priority species for the FAL are set by the Resource Assessment Framework (RAF) for Finfish Resources (Department of Fisheries WA, 2011)¹. It identifies the most important indicator species for a range of ecological niches across four marine Bioregions, ranked in terms of their risk to sustainability. The RAF is subject to periodic review.

In 2012 the FAL processed and aged 11,548 fish (see Table 1). The priority species were red emperor, rankin cod, brownstripe snapper and bluespot emperor from the North Coast Bioregion, spangled emperor from the Gascoyne

Bioregion, and West Australian dhufish, baldchin groper, Bight redfish and southern school whiting from the West Coast Bioregion.

The number of fish aged in 2012 was significantly lower than the ~16,000 fish aged in 2011. This was due to fewer fish from species that could be aged using whole rather than sectioned otoliths (e.g. 1,590 Australian herring were aged in 2011 compared with zero in 2012), and reduced staff.

The FAL continues to be involved in national developments in fish ageing protocols. It has joined the other fisheries agencies on the Australian Society for Fish Biology's committee for the National Framework for Routine Fish Ageing. A guide to methods used to age key finfish species from the West Coast and South Coast Bioregions is currently being developed, with a combined North Coast and Gascoyne Coast Bioregions guide to follow.

FINFISH AGEING LABORATORY TABLE 1.

The number of fish processed and aged by the Finfish Ageing Laboratory in 2012, by Bioregion, species, ecological suite and whether it is an indicator species for that suite.

North Coast Bioregion	Number processed	Ecological suite	Indicator species
Red Emperor <i>Lutjanus sebae</i>	1,757	Inshore demersal	Yes
Brownstripe Snapper <i>Lutjanus vitta</i>	642	Inshore demersal	Yes
Blue Spot Emperor <i>Lethrinus punctulatus</i>	683	Inshore demersal	Yes
Rankin cod <i>Epinephelus multinotatus</i>	2,204	Inshore demersal	Yes
Duskytail grouper <i>Epinephelus bleekeri</i>	56	Inshore demersal	No
Total	5,342		

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

Gascoyne Bioregion	Number processed	Ecological suite	Indicator species
Red Emperor <i>Lutjanus sebae</i>	291	Inshore demersal	Yes
Spangled Emperor <i>Lethrinus nebulosus</i>	387	Inshore demersal	Yes
Goldband Jobfish <i>Pristipomoides multidens</i>	271	Inshore demersal	Yes
Ruby snapper <i>Etelis carbunculus</i>	3	Offshore demersal	Yes
Eightbar Grouper <i>Hyporthodus octofasciatus</i>	4	Offshore demersal	Yes
Total	956		
West Coast Bioregion	Number processed	Ecological suite	Indicator species
Southern school whiting <i>Sillago bassensis</i>	640	Nearshore	Yes
King George Whiting <i>Sillago punctata</i>	150	Inshore demersal	No
West Australian Dhufish <i>Glaucosoma hebraicum</i>	2,172	Inshore demersal	Yes
(Pink) Snapper <i>Pagrus auratus</i>	100	Inshore demersal	Yes
Baldchin Groper <i>Choerodon rubescens</i>	990	Inshore demersal	Yes
Redthroat emperor <i>Lethrinus miniatus</i>	261	Inshore demersal	Yes
Bight Redfish <i>Centroberyx gerrardi</i>	494	Inshore demersal	Yes
Eightbar Grouper <i>Hyporthodus octofasciatus</i>	43	Offshore demersal	Yes
Bass Groper <i>Polyprion americanus</i>	38	Offshore demersal	Yes
Hapuku <i>Polyprion oxygenios</i>	128	Offshore demersal	Yes
Blue Eye Trevalla <i>Hyperoglyphe antarctica</i>	48	Offshore demersal	Yes
Total	5,064		

APPENDICES

South Coast Bioregion	Number processed	Ecological suite	Indicator species
Bass Groper <i>Polyprion americanus</i>	1	Offshore demersal	Yes
Eightbar Grouper <i>Hyporthodus octofasciatus</i>	1	Offshore demersal	Yes
Hapuku <i>Polyprion oxygenios</i>	40	Offshore demersal	Yes
Blue Eye Trevalla <i>Hyperoglyphe antarctica</i>	70	Offshore demersal	Yes
Total	112		
Statewide	Number processed	Ecological suite	Indicator species
Western wirrah <i>Acanthistius serratus</i>	1	Not assessed	No
Goldspot pigfish <i>Bodianus perditio</i>	3	Not assessed	No
Yelloweye red fish <i>Centroberyx australis</i>	8	Inshore demersal	No
Radiant rock cod <i>Epinephelus radiatus</i>	4	Not assessed	No
Flame snapper <i>Etelis coruscans</i>	1	Offshore demersal	No
Darwins roughy <i>Gephyroberyx darwinii</i>	1	Not assessed	No
Ocean perch <i>Helicolenus percoides</i>	1	Not assessed	No
Jackass Morwong <i>Nemadactylus macropterus</i>	1	Not assessed	No
Knifejaw <i>Oplegnathus woodwardi</i>	14	Inshore demersal	No
Whiteedge coronation trout <i>Variola albimarginata</i>	4	Not assessed	No
Yellowedge coronation trout <i>Variola louti</i>	9	Not assessed	No
Tomato rockcod <i>Cephalopholis sonnerati</i>	1	Not assessed	No
Red Bass <i>Lutjanus bohar</i>	6	Not assessed	No
Rosy snapper <i>Pristipomoides filamentosus</i>	16	Inshore demersal	No
Moon lightner <i>Tildon sexfasciatus</i>	1	Not assessed	No
Swallow tail <i>Centroberyx lineatus</i>	3	Inshore demersal	No
GRAND TOTAL	11,548		

Indian Ocean Territories Fishery Status Report

S.J. Newman, L. Bellechambers, C. Skepper, S. Evans and P. Carter

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* (Cth). Management responsibilities were transferred from the Australian Fisheries Management Authority to the Commonwealth Government, and the Western Australian Government's Department of Fisheries has now taken on management responsibilities for the marine Territorial waters of the Indian Ocean Territories on behalf of the Commonwealth Department of Regional Australia, Local Government, Arts and Sport (Department of Regional Australia). The location of the Indian Ocean Territories and their proximity to the Western Australian coast are illustrated in Indian Ocean Territories Figure 1.

Under a Service Delivery Agreement with the Department of Regional Australia, the WA Department Fisheries manages commercial, recreational and aquaculture activities at Cocos (Keeling) Islands and Christmas Island, in addition to providing fish health diagnostic services, biosecurity, fish pathology services 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.

The Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) primarily targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge jocularis*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*).

Recreational

Large amounts of recreational fishing are undertaken around the Cocos (Keeling) Islands and Christmas Island targeting both finfish and invertebrate species. The Cocos (Keeling) Islands consist of a diverse range of fishable habitats that include a sheltered lagoon, fringing reefs and offshore 'blue water' environments that support a range of demersal and pelagic fish species, as well as various crustaceans (e.g. crabs) and molluscs (e.g. gong gong), which are highly sought after by fishers for both individual and community

purposes. Christmas Island, on the other hand, 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.

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 around the Cocos (Keeling) Islands and Christmas Island (Indian Ocean Territories Figure 2 and 3).

Recreational

The territorial seas 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. Currently there are 3 licenses in the fishery. In 2012, 2 licences 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 operated in the fishery).

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

A risk assessment workshop was undertaken in 2011 to refine fisheries management and research priorities at the Indian Ocean Territories. Following this and previous workshops, finfish fisheries research has focused on undertaking visual census surveys of shallow reef fish assemblages, trialling baited remote underwater video systems and collecting biological material 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 in the wider Indo-Pacific. The Marine Ecology and Monitoring section has focussed invertebrate fisheries research on the Cocos (Keeling) Islands, assessing the abundance and biology of key recreational invertebrate species of gong gong (*Lambis lambis*) and giant clams (*Tridacna* spp.) whilst also conducting surveys to understand the abundance and distribution of bêche-de-mer (Holothurians). The Marine Ecology and Monitoring section has also established a reef-monitoring program at Cocos (Keeling) Islands to detect changes in reef health due to natural and anthropogenic impacts.

Retained Species

Commercial landings (season 2012)

Not reportable

Wahoo (*Acanthocybium solandri*) is the main target species of the CILF. Other pelagic species are also targeted during the trolling operations and primarily include yellowfin tuna (*Thunnus albacares*) and other tunas (except southern bluefin tuna (*Thunnus maccoyii*), and dogtooth tuna (*Gymnosarda unicolor*), which may not be taken), and to a lesser extent mahi mahi (*Coryphaena* spp.). 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 the exact catch data is not reportable due to confidentiality provisions. The total reported catch for this fishery has been less than 10 tonnes per annum over the last 5 years.

There is no commercial line fishery at the Cocos (Keeling) Islands.

The CKIMAFF targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge jocularis*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*). As there is only one license in the CKIMAFF the catch data is not reportable due to confidentiality provisions.

Recreational catch estimate (season 2012)

Not assessed

Recreational fishing vessels operate 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

Invertebrates:

Holothurians: 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 2012 indicate that the current abundance of gong gong is lower than 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 and Coral: 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, a stock abundance and distribution assessment of giant clams was undertaken in 2011/12. In addition, an on-going reef monitoring program has been established to monitor natural and anthropogenic impacts on the reef communities at Cocos (Keeling) Islands.

The implementation and ongoing monitoring of these initiatives will enable the Department of Fisheries to assess the health of the invertebrate stocks and 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 collected and collated to determine changes over time. A number of recent surveys have been undertaken at both localities (Hobbs, pers. comm., DoF). 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 (Hobbs, Choat pers. comm.), suggesting local depletion and/or overexploitation of the stock.

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.

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.

It is hoped that the introduction of recreational fishing rules at the Indian Ocean Territories will help to reduce the sustainability risks identified.

Aquarium Fish:

The CKIMAFF targets *Centropyge jocular* and to a lesser extent *Centropyge flavissima*. *Centropyge jocular* is endemic to the Cocos and Christmas Islands and inhabits fringing reefs from 15 to 70 m.

Little is known about the biology of *C. jocular* although Allen *et al.* (2007)² 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. However, catches can be lost to sharks.

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.

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.

2 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. 284 pp.

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 2012. 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 2012.

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 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 value (to fishers) for 2012:****Not assessed**

The value of the CILF is not known. The value of the CKIMAFF is also unknown, although *C. jocularis* commands a high price on the international market (reported in excess of AUS \$700.00 each).

Fishery Governance**Commercial****Target commercial catch range: Not available****Current Fishing (or Effort) Level: Not assessed**

The potential recreational 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 sustainable 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 (2013)

New island-specific fisheries management arrangements for the Indian Ocean Territories are currently being progressed to legislation.

The effective implementation of any future fisheries management legislation at the Indian Ocean Territories, will require ongoing community education and compliance enforcement programs.

External Factors

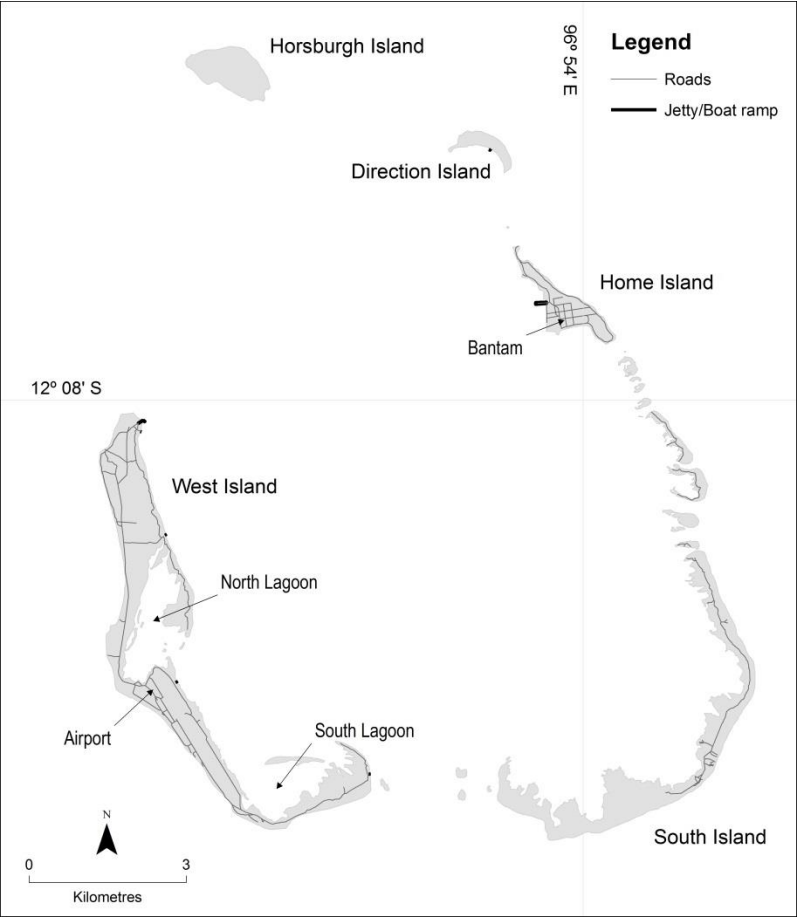
The demersal fish and invertebrate populations of Cocos (Keeling) Islands and Christmas Island are likely to consist of small, isolated populations that are expected to experience highly variable recruitment due to environmental fluctuations.

In February 2012, the MV Tycoon was grounded in Flying Fish cove on Christmas Island spilling phosphate and fuel oils into the Cove and surrounding areas. Assessments of the impacts of the MV Tycoon grounding on fish assemblages and reef habitats are awaiting completion.

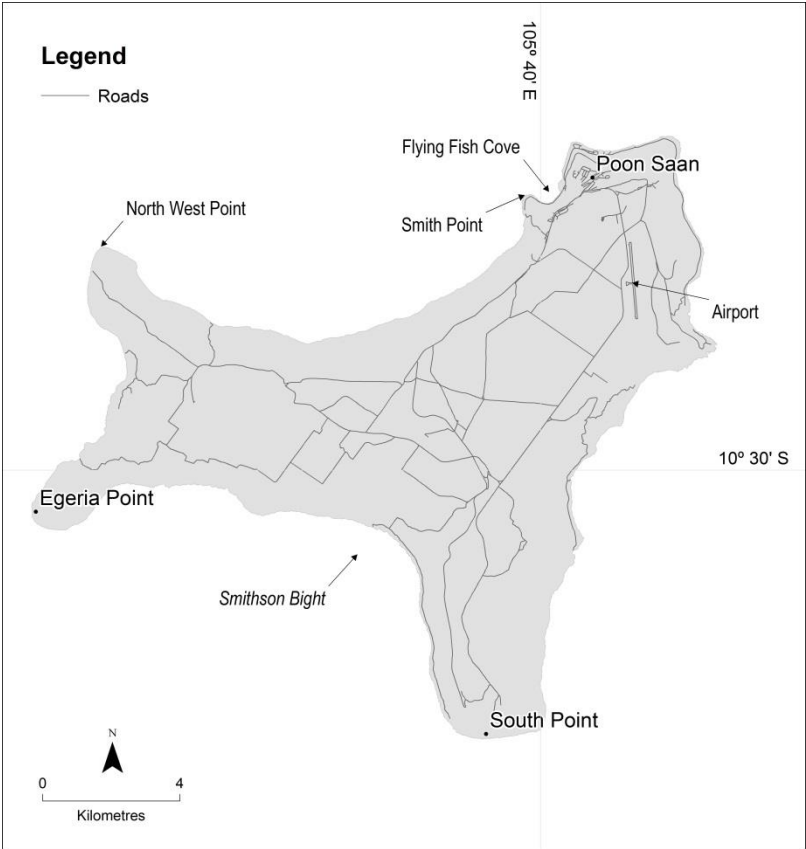


INDIAN OCEAN TERRITORIES FIGURE 1

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.

APPENDIX 4

Annual performance for commercial fisheries subject to export approval under the Commonwealth Government's Environment Protection and Biodiversity Conservation Act 1999

The following table provides a summary of the issues, performance measures and any conditions 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 2011/12 season or the calendar year 2012 for fisheries data but up to June 2013 for relevant research or management actions projects and actions.

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/Condition	Current performance in 2011/12 or 2012	Comment
<i>Fishery:</i> Abalone <i>Date of certification:</i> March 2008 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> September 2014	Greenlip/brownlip abalone Areas 2/3 (spawning stock)	Effort range 907–1,339 diver days; minimum meat weight 140 g greenlip, 160 g brownlip	Acceptable	
	Roe's abalone Area 1 (spawning stock)	Effort range 14–43 diver days; total catch 9.9 t	Acceptable	Exploratory quota. No fishing in 2011.
	Roe's abalone Area 2 (spawning stock)	Effort range 80–106 diver days; total catch 19.8 t	Acceptable	Total catch indicator only met in the Area 2 fishery. This is due to poor economic and weather conditions.
	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	Area 8 fishery closed to fishing due to environmentally induced mass mortality
	Roe's abalone Area 8 (spawning stock)	Effort range 140–200 diver days; total catch 12t	Acceptable	
<i>Fishery:</i> Abrolhos Islands and Mid West Trawl <i>Date of certification:</i> March 2013 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> March 2018	Scallops (spawning stock)	The residual stock index determines a predicted catch that sets the length of the next season and the fishing season ceases at a catch rate threshold level,	Inadequate	The survey catch prediction was below the target range therefore the fishery did not open in 2012 due to low stock levels

APPENDICES

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
<i>Fishery:</i> Beche-de-mer <i>Date of certification:</i> December 2004 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> August 2014	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	Only sandfish assessed. No fishing for Redfish occurred in 2012.
	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any one year	Acceptable	Very low level of effort this year.
<i>Fishery:</i> Broome Prawn <i>Date of certification:</i> August 2004, extended April 2010 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> August 2015	Coral prawns (spawning stock)	Total catch within acceptable range of 20–90 t (7-year catch range)	Acceptable	Low level of exploitation
	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	Catch rate below target level but above the limit due to adverse environmental conditions and now rebuilding.
<i>Fishery:</i> Exmouth Gulf Prawn <i>Date of certification:</i> February 2013 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> February 2018	King prawn (spawning stock)	Total catch within acceptable range of 350–500 t	Acceptable	Below range due but the catch prediction was low and landings were within the prediction range with a conservative harvesting strategy
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 120–300 t	Acceptable	Low effort as its distribution overlaps that of tiger prawns.
	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	
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–100 t	Acceptable	Low effort and value resulted in low retention rates
	Non –Retained species	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	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
<i>Fishery:</i> Gascoyne Demersal Scalefish Managed Fishery <i>Date of certification:</i> September 2009 <i>Approval type:</i> Export exemption <i>Expiry date:</i> 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).
<i>Fishery:</i> Kimberley Prawn <i>Date of certification:</i> November 2004, extended April 2010 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> August 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	Low landings due to low effort and targeting on high catch rates of banana prawns.
	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	Nil reported landings since 2004.
<i>Fishery:</i> Mackerel <i>Date of certification:</i> November 2009 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> November 2014	Spanish mackerel (spawning stock)	Total catch within acceptable range of 246–410 t: acceptable regional catch ranges: Kimberley 110–205 t: Pilbara 80–126 t: Gascoyne/West Coast 56–79 t	Acceptable	
<i>Fishery:</i> Marine Aquarium Managed Fishery <i>Date of certification:</i> October 2008 <i>Approval type:</i> Approved Wildlife Trade Operation Exemptions <i>Expiry date:</i> October 2011	Seahorses of hippocampus species	Total catch < 2000. Number taken - 1232	Acceptable	

APPENDICES

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
<i>Fishery:</i> Northern Demersal Scalefish <i>Date of certification:</i> June 2010 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> June 2015	Red emperor and goldband snapper (spawning stock)	Spawning biomass > 40% of virgin spawning biomass with lower limit of 30%; total annual catches should not increase > 20% above average catches of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years	Acceptable	
	Cods/groupers (spawning stock)	Total annual catch should not increase >20% above average catch of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years.	Acceptable	
<i>Fishery:</i> Onslow and Nickol Bay Prawn <i>Date of certification:</i> November 2004, extended April 2010 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> August 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	No fishing undertaken In 2012.
	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 and targeting on high catch rates of banana prawns and fleet transfer to other trawl fisheries.
	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 in Nickol Bay. No fishing in Onslow.
	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 details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
<i>Fishery:</i> Pearl Oyster <i>Date of certification:</i> September 2003, extended October 2008 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> October 2013	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 have returned to normal levels after 5 years of high catch rate due to high recruitment.
	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	
<i>Fishery:</i> Pilbara Trawl <i>Date of certification:</i> November 2004, extended to 29 November 2013 <i>Approval type:</i> :Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> June 2013, extended to November 2013	Bycatch of protected species - dolphins	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Dolphin mortalities reported in statutory logbooks have reduced to less than 25 per year since 2006
	Bycatch of protected species – turtles	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Mitigation devices implemented in nets in 2006 reduce the incidental captures of turtles by 97%
	Bycatch of protected species – syngnathids	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Number of pipefish caught and released alive should be < 500/yr; number of seahorses caught and released alive should be < 60/yr;

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Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
	Bycatch of protected species – sawfish	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Number of sawfish caught should be < 120/yr; number of sawfish released alive should be increased to 50% of captures by 2008
	General ecosystem – large epibenthos	The total area of the Pilbara demersal fish fishery (encompassing both trawl and trap fisheries) that is closed to trawling is 80%; the total area of the Pilbara demersal fish fishery between depths of 30 m and 120 m should remain at or below the current level of 60%	Acceptable	
<p><i>Fishery:</i> Salmon</p> <p><i>Date of certification:</i> November 2009</p> <p><i>Approval type:</i> Accredited Export Exempt Fishery</p> <p><i>Expiry date:</i> November 2014</p>	Western Australian salmon (spawning stock)	Expected catch range under the current management regime is 1,200–2,800 t	Acceptable	2012 catch below target range due to 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 recruitment variation. Stock level considered adequate.
<p>Fishery: Shark Bay Crab Interim Managed Fishery</p> <p><i>Date of certification:</i> November 2004</p> <p><i>Approval type:</i> Approved Wildlife Trade Operation Exemption</p> <p><i>Expiry date:</i> September 2016</p>	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Inadequate:	Voluntary commercial closure since April 2012. as a result of low abundance from June 2011 due to the marine heatwave event over the 2010/11 summer.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
<i>Fishery:</i> Shark Bay Prawn <i>Date of certification:</i> January 2013 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> February 2018	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	Acceptable	The spawning stock was well below target however recruitment in 2013 indicated no recruitment failure. The area assessed as the key spawning area is being reviewed.
	King prawn (spawning stock)	Total catch within historical acceptable range of 1,100–1,600 t, given no change in effort	Acceptable	Slightly below the historical range but within the new range set to account for reduced effort.
	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 nets so this performance measure is no longer valid. For the 2012 season, 6 turtles were recorded as caught in nets and all were recorded as being returned to the sea alive.
	Discarded fish (abundance)		Acceptable	Majority of bycatch species are found in relatively significant numbers outside of trawled areas
	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)		Acceptable	Reduction in amount of discards and ratio of discards to target catch from pre-catch reduction device levels and in water hopper system increasing survival of some bycatch species.

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Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
<i>Fishery:</i> Shark Bay Scallop <i>Date of certification:</i> January 2013 <i>Approval type:</i> Export exemption <i>Expiry date:</i> January 2018	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	Inadequate.	Catch prediction below target level due to poor environmental conditions and the fishery did not open.
	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	No fishing effort in 2012.
<i>Fishery:</i> South Coast Crustacean <i>Date of certification:</i> November 2011 <i>Approval type:</i> Wildlife Trade Order <i>Expiry date:</i> November 2014	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 2014
<i>Fishery:</i> Specimen Shell <i>Date of certification:</i> 25 May 2005 <i>Approval type:</i> Export exemption <i>Expiry date:</i> May 2015	Specimen shell species (spawning stock)	Preliminary acceptable catch range is from 10,000–25,000 shells; acceptable catch rate 10–40 shells per day	Not assessed	Both catch and catch rate within acceptable ranges
	Dusky and sandbar sharks	Review and report outcomes of actions taken to rebuild stocks,	Underway	Recovery of dusky sharks is clearly evident and sandbar sharks is now likely.
<i>Fishery:</i> Temperate Demersal Gillnet and Demersal Longline (Shark) Fisheries <i>Date of certification:</i> April 2009 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> 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) Completed (b) pending (a)	A recent FRDC-funded project examined the relative spatial risks of Australian sea lion interactions and a further FRDC-funded study estimated quantitative rates of sea lion encounters with demersal gillnets
<i>Fishery:</i> Western Rock Lobster <i>Date of certification:</i> May 2013 <i>Approval Type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> May 2015	Western rock lobster (spawning stock)	Spawning biomass at Abrolhos Islands and coastal regions to remain above respective levels during the early 1980s with 75% certainty	Acceptable	
	Octopus (spawning stock)	Catch rate not to drop outside of historic range by > 10%	Acceptable	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
	Sea lion (captures)	No increase in rate of capture	Acceptable	No sea lion captures were reported
	Leatherback turtle (entanglements)	No increase in rate of interactions	Acceptable	No entanglements were reported
	Whales and dolphins (entanglements)	No increase in rate of interactions	Un-acceptable	There were 13 confirmed whale entanglements in WRL gear during the 2012 humpback whale migration season. Several mitigation measures are being trialled to reduce whale entanglements.
<i>Fishery:</i> West Coast Deep Sea Crustacean Managed Fishery <i>Date of certification:</i> May 2013 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> May 2018	Champagne crab (spawning stock)	Unitisation of the fishery has permitted a maximum of 14t of Champagne crab (combined with Giant crab) to be taken in a season	Acceptable	
	Crystal Crab (spawning stock)	The fishery is quota based with catches limited to 140t of crystal crab per season	Acceptable	As the fishery has moved to catch quota, the performance measure needs to be updated.

APPENDIX 5

Fisheries Research Division staff adjunct positions and supervision of students

Staff Member	Position
David Abdo	Adjunct Lecturer, Faculty of Natural and Agricultural Sciences , University of Western Australia
Lynda Bellchambers	Adjunct Researcher, Faculty of Natural and Agricultural Sciences , University of Western Australia PhD co- supervision, University of Western Australia, supervises Luke Thomas - 'Coral recruitment on a high latitude remote reef system.'
Matias Braccini	PhD co-supervision, Universidad de Mar del Plata, Argentina, supervises Marcelo Perez – 'Patrones de desplazamiento del gatuzo (<i>Mustelus schmitti</i>) en el Ecosistema Costero Bonaerense a partir de la técnica de marcación con marcas convencionales. Implicancias para el manejo y explotación del recurso' (in Spanish). Honours co-supervision, University of Western Australia, supervises Matt Navarro - "Trends in abundance and management of vulnerable chondrichthyans to the effects of deep-sea fishing" Honours co-supervision, University of Western Australia, supervises Shelby Oliver- "Global patterns of chondrichthyan bycatch in commercial fisheries "
Dave Fairclough	Adjunct Senior Lecturer (Mar 2011 – Feb 2014), Centre for Fish and Fisheries Research, Murdoch University. Emeritus Professor, Murdoch University Scientific member of Northern Prawn Resource Assessment Group (NPRAG)
Norman Hall	Supervision, Elena Sulin - Comparisons of the size and age compositions and growth of King George whiting (<i>Sillaginodes punctata</i>) in different regions of south-western Australia. Research Masters by Training Degree, Murdoch University. (Thesis completed in 2012). Supervision, Emily Fisher - Tools for assessing data-limited fisheries and communicating stock status information. PhD, Murdoch University. (Thesis completed in 2012). Supervision, Calais Tink - Use of surveys and agent-based modelling to assess the management implications of the behaviours of specialised recreational boat fishers. PhD, Murdoch University Supervision, Alan Cottingham - Variations in the life-history characteristics of Black Bream <i>Acanthopagrus butcheri</i> in south-western Australia. PhD, Murdoch University Supervision, Eloïse Ashworth - Influence of environmental variables on the growth and reproductive biology of Black Bream, <i>Acanthopagrus butcheri</i> Supervision, Daniel Yeoh – Gillnet selectivity of Black Bream <i>Acanthopagrus butcheri</i> , Honours, Murdoch University
Alastair Harry	Adjunct Research Associate, School of Earth & Environmental Sciences, James Cook University

Staff Member	Position
Alex Hesp	Co-supervision Emily Fisher. Tools for assessing data-limited fisheries and communicating stock status information. PhD, Murdoch University. (Thesis completed in 2012).
	Co-supervision Elena Sulin. Comparisons of the size and age compositions and growth of King George whiting (<i>Sillaginodes punctata</i>) in different regions of south-western Australia. Research Masters by Training Degree, Murdoch University. (Thesis completed in 2012).
	Co-supervision Calais Tink. Use of surveys and agent-based modelling to assess the management implications of the behaviours of specialised recreational boat fishers. PhD, Murdoch University.
	Co-supervision Alan Cottingham. Variations in the life-history characteristics of Black Bream <i>Acanthopagrus butcheri</i> in south-western Australia. PhD, Murdoch University.
Craig Lawrence	Adjunct Associate Professor, The University of Western Australia
	PhD supervision Miriam Sullivan- Fishing for Answers: How can we improve welfare for aquarium fish? The University of Western Australia.
	PhD supervision Kelly Mills: Effects of oestrogens and wastewater treatment plant effluent on the Western Pygmy Perch. The University of Western Australia.
	Honours Supervision Ruyu Wang: Genetic Diversity of Western Minnow (<i>Galaxias occidentalis</i>) along the Swan and Canning river systems. The University of Western Australia.
Rod Lenanton	Adjunct Associate Professor, Faculty of Sustainability, Environmental and Life Sciences, School of Biological Sciences and Technology, Murdoch University.
Justin McDonald	Adjunct Lecturer, Faculty of Natural and Agricultural Sciences, University of Western Australia
	PhD co- supervision, University of Western Australia, supervises Tiffany Simpson - 'Factors influencing the establishment of invasive marine species'.
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
	Adjunct Associate Professor, School of Biological Sciences and Technology, Murdoch University 1/11/2012 – 1/11/2015
Stephen Newman	Adjunct Associate Professor – Marine Ecology Group, School of Plant Biology, University of Western Australia
Kim Smith	Masters co-supervision, Edith Cowan University, supervises Peter Malanczak – 'Influence of hydrological factors on distribution of spawning and recruitment by Perth herring in the upper Swan Estuary'
Corey Wakefield	Adjunct Senior Lecturer, Marine Ecology Group, University of Western Australia
	Honorary Research Fellow, Victoria University of Wellington, New Zealand
	Masters co-supervision, University of Western Australia, supervises Claire Wellington – 'Description and comparison of demersal fish ecology of the continental slope of Western Australia'.

Staff Member	Position
	Masters co-supervision, University of Western Australia and Curtin University of Technology, supervises Dion Boddington – ‘Comparison of the life history characteristics, habitat partitioning and stock status of three groupers off the north-western coast of Australia’.
	Masters co-supervision, Victorian University of Wellington New Zealand, supervises Natalie Stewart – ‘The population structure of <i>Polyprionidae</i> from Australia and New Zealand’.
	Honours co-supervision, Curtin University of Technology, supervises Chella Armstrong – ‘To what extent do the larger Hapuku (<i>Polyprion oxygeneios</i>) from the west coast of Western Australia reflect differences in growth or longevity to those from the south coast? Implications for management’.

GLOSSARY OF ACRONYMS

AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AIMWTMF	Abrolhos Islands and Mid West Trawl Managed Fishery
BPMF	Broome Prawn Managed Fishery
BRD	Bycatch Reduction Device
BRUVS	Baited Remote Underwater Video System
CAES	Catch and Effort Statistics
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
CSIRO	Commonwealth Scientific and Industrial Research Organisation
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
EBFM	Ecosystem Based Fisheries Management
ECU	Edith Cowan University
EPBC	(Commonwealth Government) Environment Protection and Biodiversity Conservation (Act 1999)

ERLF	Esperance Rock Lobster Managed Fishery
ESD	Ecologically Sustainable Development
ETP	Endangered, Threatened and Protected
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
FRR	Fisheries Research Report
GAB	Great Australian Bight
GDSF	Gascoyne Demersal Scalefish Managed Fishery
HMAS	Her Majesty's Australian Ship
IBSS	Independent Breeding Stock Survey
IFM	Integrated Fisheries Management
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IMP	Introduced Marine Pests
IMS	Introduced Marine Species
ISO	International Organisation for Standardisation
ITQ	Individually Transferable Quota
IUCN	International Union for the Conservation of Nature
IVR	Integrated Voice Response

APPENDICES

JANSF	Joint Authority Northern Shark Fishery
JASDGLF	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
MAF	Marine Aquarium Fish Managed Fishery
MBP	Marine Bioregional Plan
MFL	Managed Fishery Licence
MLL	Minimum Legal Length
MOP	Mother-of-Pearl
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NBPMF	Nickol Bay Prawn Managed Fishery
NDSF	Northern Demersal Scalefish Managed Fishery
NPF	Northern Prawn Fishery
NRM	Natural Resource Management
NTAC	Notional Target Total Allowable Catch
OCL	Orbital Carapace Length
OPMF	Onslow Prawn Managed Fishery
PFRF	Pemberton Freshwater Research Centre

RAP	Research Angler Program
RCL	Rostrum Carapace Length
RFBL	Recreational Fishing from Boat Licence
RFFSS	Recreational Freshwater Fisheries Stakeholder Subcommittee
RRAMF	Ranked Risk Assessment of Multiple Fisheries
SBBSMNF	Shark Bay Beach Seine and Mesh Net Managed Fishery
SBCIMF	Shark Bay Crab Interim Managed Fishery
SBSF	Shark Bay Snapper Managed Fishery
SCRIP	Strategic Criteria for Rural Investments in Productivity
SCTF	South Coast Trawl Fishery
SEWPaC	(Commonwealth Government) Department of Sustainability, Environment, Water, Population and Communities (formerly Department of Environment, Water, Heritage and the Arts)
SFD	Standard Fishing Day
SIEV	Suspected Illegal Entry Vessel
SLED	Sea Lion Exclusion Device
SMFG	Size Management Fish Ground
SSF	Specimen Shell Managed Fishery
SWCC	South West Catchment Council
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
UWA	University of Western Australia
TPSA	Tiger Prawn Spawning Area
VFAS	Voluntary Fisheries Adjustment Schemes
VMS	Vessel Monitoring System
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

WCB	West Coast Bioregion
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
WTO	Wildlife Trade Operation