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

Status reports of the fisheries and aquatic resources of Western Australia 2013/14

State of the fisheries

Fish for the future

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Edited by W.J. Fletcher and K. Santoro
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CONTENTS

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 status of fisheries and aquatic resources following the 2012-13 or 2013 season, the Departmental activities undertaken during 2013/14 plus 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 therefore 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 comprehensive, 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 continue to be at acceptable levels.

As outlined previously, 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, listed species, habitats or the broader ecosystem. The small number of fisheries which have previously been identified as posing some risk to these non-'capture species' have had direct management measures applied and they continue to meet their annual performance targets or have targeted research programs to reduce their interactions (e.g. whale entanglements) . 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 except where they are being affected by adverse environmental conditions. Approximately 97% of commercial fisheries are now targeting stocks where current management controls are either maintaining or achieving an acceptable breeding stock level from the effects of fishing. The detailed investigation of Australian herring off the South Coast and West Coast Bioregions presented in last year's report found that this stock had 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 are currently under development.

A further four fisheries in the Gascoyne and the West Coast Bioregion were also assessed as having inadequate breeding stocks but as a result of the negative impacts of environmental perturbations, not fishing. The poor recruitment and adult survival levels for Shark Bay crabs, Shark Bay scallops and scallops in the Abrolhos Island region which began to be observed during the marine heat wave event of 2011 have continued, with some recovery only being shown for Shark Bay crabs. The two scallop fisheries have now been completely closed for the past two seasons to protect residual stocks and only experimental fishing was undertaken for the 2012/13 season of Shark Bay crabs.

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 have been, or are in the process of undergoing 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 North Coast pre-assessment process has now also been completed and a combined assessment process is currently underway for the fisheries in the West and South Coast Bioregions. Importantly, some fisheries (e.g. Exmouth Gulf and Shark Bay trawl) are already progressing to full MSC assessment. Any 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.

HEATHER BRAYFORD
ACTING DIRECTOR GENERAL

November 2014

EDITOR'S INTRODUCTION

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2013/14* uses an Ecosystem Based Fisheries Management (EBFM) framework which is now the basis for management of Western Australia's aquatic resources (Fletcher, *et al*., 2010[1], 2012[2]). The format for this document is therefore consistent with the Department's full implementation of a risk-based approach to resource management. How this document fits within this process is outlined in Editor's Figure 1.

The introductory section for each Bioregion outlines the key ecological resources (assets) and summarises their current overall (cumulative) risk status. The assets that are examined in each bioregion include each of the IMCRA[3] meso-scale ecosystems plus the key habitats, captured species and listed 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 regional level assessments that are occurring as part of the Marine Stewardship Council (MSC) initiative, these sections are being progressively expanded. The North Coast has now joined the Gascoyne Coast as the bioregions that have adopted the new expanded format.

Within each Bioregion, the set of individual fishery reports are resource-based rather than activity (sector) based. The different fisheries accessing the same category of ecological assets are covered in a single report (e.g. West Coast Nearshore and Estuarine Finfish) which contains 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, provision of 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 located within WA plus those from 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 2013/14* 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 FRMA[4] to the

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

2 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 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.

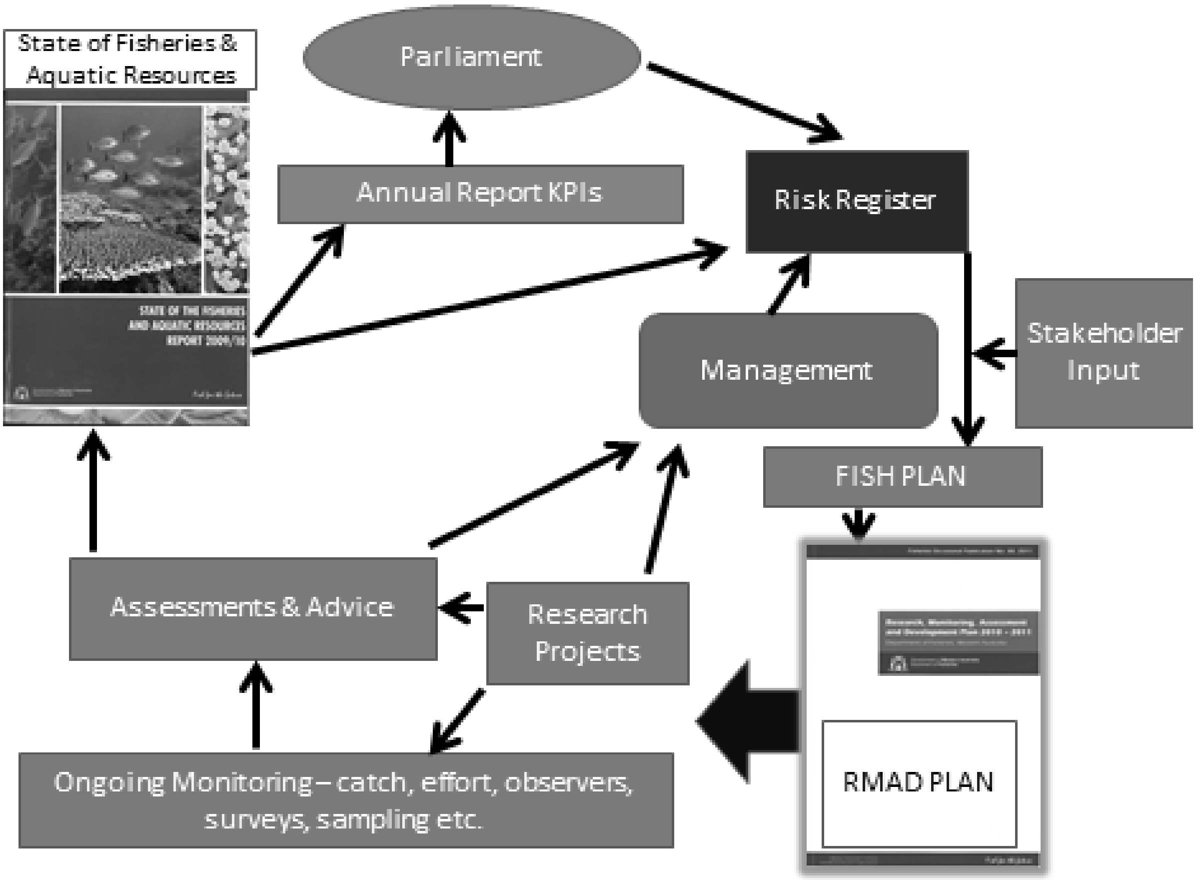
WesternAustralian Parliament and to the Commonwealth Government, on the performance of fisheries that are relevant under their EPBC Act. In addition, with the government initiative to have all WA commercial fisheries undergo pre-assessment for MSC certification this has resulted in some slight changes in the terminology that may be used within some sections of these reports in order to match that used in the MSC assessment criteria and also that presented in the Status of Key Australian Fish Stocks reports[1].

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

November 2014



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.

1 Flood et al. (2012) Status of Key Australian Fish Stocks. Fisheries Research & Development Corporation, Canberra, 420 pp.

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 the various terms and headings used in the text, the fishery status overview table (which also appears in the Department of Fisheries *Annual Report* 2013/14 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 the 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 but where possible also that used within the Status of Key Australian Fish Stocks reports[4].

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

With the adoption of the EBFM approach, a fully bioregional structure is used for these reports whereby 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 consistent with “*A guide to The Integrated Marine and Coastal Regionalisation of Australia*” - version 4.0 June 2006 (IMCRA v4.0)[5] except for the inclusion of the Gascoyne Coast as a separate Bioregion. This reflects 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. This section also outlines the current cumulative 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 listed 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) requires direct management to achieve acceptable performance. Full details of how the EBFM process is undertaken are presented in Fletcher *et al.* (2012) with a summary description outlined below.

Ecosystems: Within each Bioregion, one or more meso-scale 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.

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).

Listed species: This category, whichincludes Endangered, Threatened and Protected Species (ETPS) under State or Commonwealth Acts, was subdivided into listed ‘fish’ (e.g. White Sharks, Corals) and listed ‘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

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

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

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 Flood et al. (2012) Status of Key Australian Fish Stocks. Fisheries Research & Development Corporation, Canberra, 420 pp.

5http://www.environment.gov.au/coasts/mbp/publications/imcra/pubs/imcra4.pdf assessment processes, as detailed in Fletcher (2005)[1], Fletcher *et al.*(2011)[2] and Fletcher (2014)[3]. 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. The implications for the likely level of reporting and management responses that are required for each of the different risk categories are outlined below.

The accepted international definition of risk is "*the uncertainty associated with achieving objectives*" (ISO, 2009)[4], therefore any uncertainties from a lack of specific data are explicitly incorporated into the assessment enabling the calculation of risk to be completed with whatever data are available. All risk scoring considers both current level of management activities and controls already in place or planned.

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.

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 – regular monitoring	Increases to management activities needed
Significant	Unacceptable; major changes required to management in immediate future	Recovery strategy and detailed monitoring	Increases to management activities needed urgently

Recreational Fishing Estimates

To cost effectively monitor recreational fisheries in WA the Department of Fisheries has developed an integrated survey design to provide a robust approach for obtaining annual estimates of recreational catch by boat-based fishers at both the statewide and bioregional levels. These surveys utilise the Recreational Fishing from Boat Licence (RFBL) as the basis for sampling to provide estimates of catch and effort. The set of surveys provide sufficient information to validate the estimates by enabling comparisons across the various methods.

The integrated surveys include 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 statewide 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 and the second was undertaken from 1 May 2013 to 30 April 2014.

Estimates of recreational catch and effort at statewide and bioregional levels from the first survey were presented in Ryan *et al.* (2013)[5] provide the data for the catch and effort by the recreational sector throughout this report. When the updated estimates from the latest survey are available, these estimates will be examined against previous recreational surveys to determine if there have been any material changes

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 Fletcher, W.J. (2014). Review and refinement of an existing qualitative risk assessment method for application within an ecosystem-based management framework. ICES Journal of Marine Research. doi:10.1093/icesjms/fsu/142

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

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.

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 statewide survey of boat-based recreational fishing will be repeated every second year and the next (third) series of surveys will begin in mid-2015. Methods to cost effectively monitor shore based recreational fishing are currently under development.

Harvest Strategy

A Harvest Strategy Policy for the aquatic resources of WA is currently under development (DoF, in prep). A harvest strategy establishes clear and specifically articulated performance levels and the associated set of management actions designed to achieve each of the agreed objectives both for the resource and all relevant fishery sectors.

To ensure a holistic and integrated approach, the Harvest Strategy Policy for WA will not only cover target species abundance, it will incorporate social and economic considerations including sectoral allocations but also the management of unacceptable risks to other ecological resources.

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 on 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: The indicator(s) reflects that the stock status is (are) below the threshold or limit level(s) and a recovery plan has not yet been implemented or the management actions are not yet confirmed as operating effectively to reasonably assume that they are generating a sufficient rate of recovery. This outcome includes situations where excessive fishing pressure (catch), some external event, or a combination has led to the breeding stock biomass falling to levels where there is now a high risk of future recruitment levels being measurably reduced. This is equivalent to MSC's point of recruitment impairment.

Environmentally Limited: This indicates situations where the stock is at unacceptable levels due primarily to environmentally driven impacts (e.g. marine heat wave impacts), not from fishing activities.

Retained Species (Stock Assessment Methods)

To underpin the harvest strategy and determine stock status and fishery performance a stock assessment of the breeding stock level is completed for each major retained species.

Given the difficulites involved, the breeding stock is only directly measured for a few stocks, 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 using a 'weight of evidence' approach:

Assessment Level	Description
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, 2011[1]). 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.

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

Non-retained species

This refers to any species caught during a fishing operation none of which are retained by the fishing operation. This covers the potential impact on unwanted 'bycatch' species and any interaction with listed species, which includes Endangered, Threatened and Protected (ETP) 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 potential indirect impacts generated by removing fish from the ecosystem (food chain effects), 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.* 2011[1]).

Economic Effects

We have categorised the different levels of Gross Value of Product (GVP) for commercial fisheries into six levels to measure their relative economic importance. 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 available.

Consequence Level	Description
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)

To minimise interventions and provide greater certainty for when management adjustments may be required, 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.

To calculate this range a tolerance level establishes for each fishery what range of deviations in annual catch or effort is considered acceptable to meet stock based objectives and/or to meet any sectoral allocations as developed by IFM determinations. These annual tolerances determine at what point additional management review and/or intervention is required. These expected ranges in annual catch levels take into account natural variations in recruitment to the fished stock, which can be expected under a fishing-effort-based management plan.

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/sector 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: For most of the commercial and recreational 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 the projected acceptable range.

Target effort range: 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 (or smaller) expenditure of effort is needed to take the TAC, or the industry fails to achieve the TAC by a significant margin (ie outside of tolerance levels), this may indicate that the abundance of the stock is significantly lower (or larger) 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.

1 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.

Therefore, the statistics in this volume refer either to the financial year 2012/13 or the calendar year 2013, 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 byproducts for individual sectors, and estimating the total value of several fisheries operating on a single resource and the source of the data.

Similarly, the statistics on compliance and educational activities are also for 2012/13, following the analysis of data submitted by Fisheries and Marine Officers.

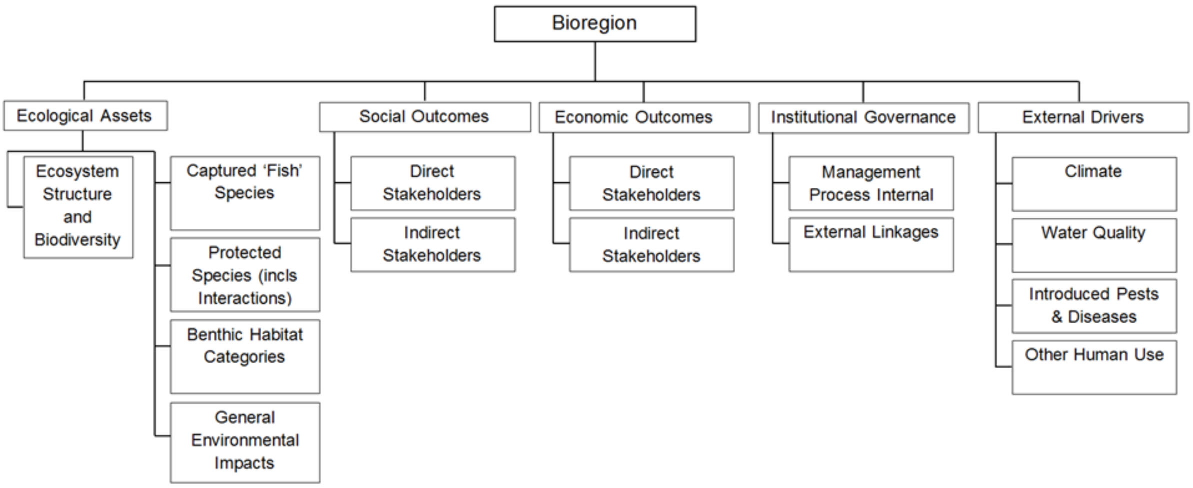
In contrast, the sections on departmental activities in the areas of fishery management, new compliance activities and research summaries are for the current year, and may include information up to June 2014.

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 *Status Reports of Fisheries and Aquatic Resources of Western Australia* 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.

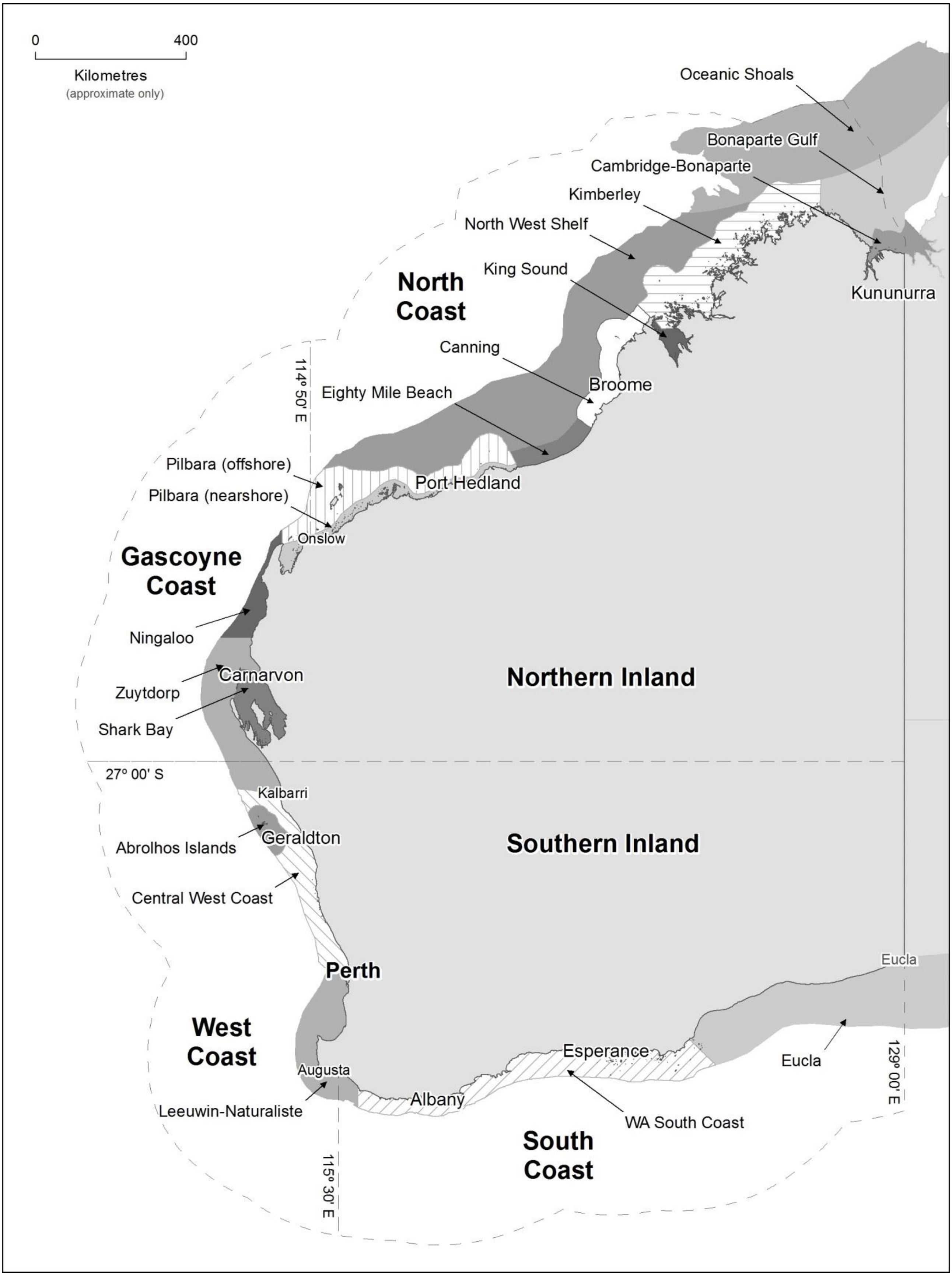
Within the individual fishery status reports, each of these performance measures is shown in a highlighted box to assist the reader. The results are also summarised in Appendix 4.

As fisheries move through the full MSC process some will gain conditions to maintain certification. The status of these conditions will therefore begin to be reported as this process progresses.



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.



INTRODUCTION FIGURE 2

Map of Western Australia showing the general boundaries of the Bioregions referred to throughout this document and the meso-scale ecosystems based on IMCRA 4.0 boundaries[1].

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

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 2013/14.

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 (http://www.fish.wa.gov.au/Documents/annual_reports/annual_report_2013-14.pdf) 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, 28 involve stocks that were considered to either 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 (86 per cent of fisheries). Each of these three 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 outlined in last year's report indicated 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 assisting in the recovery of sandbar sharks.

Of the remaining 14% of 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 further four 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 which was initiated during the marine heat wave event which began in 2011 have continued with some recovery only being shown for Shark Bay crabs. Consequently, these scallop fisheries remained closed for the past season to protect residual stocks and Shark Bay crabs had only limited experimental fishing activity. The stock of crabs in Cockburn Sound is also showing signs of environmental impacts on their growth and recruitment. Therefore, while a total of 14 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%).

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 27 of the 38 fisheries referred to in Overview Table 1, three less than the number used last year. The increase in the number of fisheries not assessed was generated by a combination of ongoing 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 scallop fisheries were again set to zero (0) catches and only very limited experimental fishing for Shark Bay crabs occurred. The setting of zero or very limited 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 27 fisheries where 'target ranges' were available and a material level of fishing was undertaken in 2012/13, ten were catch-quota managed [through a TAC allocated through Individually Transferable Quotas (ITQ)] with 17 subject to effort control management.

Nine of these ten 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). The south coast greenlip/brownlip abalone fishery had an effort level that exceeded the acceptable level and a reduction in TAC will occur in the 2014. In the 17 effort-controlled fisheries, all but two produced catches that were within (9) or acceptably above (1) or below (5) 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. The west coast beach bait fishery catch was well below historical levels prompting a review of its status.

In summary, 24 of the 27 commercial fisheries assessed (89%) 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 close to the target level.

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

Target catch or effort ranges are beginning to be determined for each of the major recreational fisheries 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 by this sector at appropriate levels for both stock sustainability and to meet integrated fisheries management objectives. This is the first time this indicator has been measured.

For the purposes of this indicator, 17 fisheries or stocks have been identified as having a 'material' recreational catch share. Over time, the indicator may need to expand to include reference to fisheries or stocks for which there are other 'material' sectoral shares (e.g. customary fishing). Of these 17 only seven currently have explicit catch ranges developed and another six have implicit ranges that can be used to assess acceptability. For these 13 fisheries, five had catch levels that were within the acceptable catch range, the marron fishery catch was also acceptably below the range and another four without explicit ranges were clearly acceptable. The low levels of recreational catch for the west coast abalone fishery indicate there may be concerns for the reef platform part of this stock following the marine heat wave. In addition, the recreational catch of some demersal scalefish species in the northern sections of both the West Coast Demersal and Gascoyne Demersal fisheries are too high and appropriate management adjustments are in the process of being developed. Consequently the percentage of recreational fisheries with acceptable catch levels was 77%, which is close to the target level of 80%.

Benthic Habitat and Biodiversity

Monitoring

A range 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.

Listed species

In accordance with EBFM principles, risk-based assessment of the impact of commercial and recreational fishing activities on listed 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 listed 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 additional 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 2013/14. 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 2013/14 and Activities of the Biosecurity Research Group 2013/14).

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 applicable, 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 reported[1,2] 2012/13 or 2013	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION					
West coast rock lobster	Size-structured Population Model (Level 5)	Adequate	5,554 (Q)	5640	Acceptable A Total Allowable Commercial Catch (TACC) of 5,554 t was set for the 2013 season. The total landings were slightly greater than the TACC due to a water loss adjustment. Due to the conservative nature of the TACC, egg production is at record high levels.
Roe's abalone	Catch Rates & Direct Survey (Level 4)	Adequate	92.8 (Q) (530 – 640 days)	73.2 (457 days)	Acceptable Catch was less than the quota in Area 5 (50% caught) and Area 6 (60% caught) due to economic reasons (low value of catch) and high cost of accessing these areas. Area 8 fishery remains closed due to catastrophic mortality by marine heat wave. Catch rates in Areas 2 and 7 were below threshold level and 10% reduction in TACC imposed.
Octopus	Catch Rates (Level 2)	Adequate	50 - 250	226	Acceptable Fishery in development phase. Target range to be reviewed following completion of initial assessments.
Abrolhos Islands and mid west trawl	Direct Survey & Catch Rates (Level 4)	Environ. Limited	95 – 1,830 (set to 0 for this year)	0	NA The fishery was not opened due to annual survey indicating low scallop abundance with a catch prediction below the target level for fishing. This has resulted from continued effects of 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.

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[1,2] 2012/13 or 2013	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION (Continued)					
Cockburn Sound crab	Direct Survey (Level 4)	Environ. Limited	Under Revision	61	NA While catch improved from 11/12 juvenile recruitment was very low possibly due to lack of growth of the large juvenile cohort resulting in poor mating success and subsequent low numbers of berried females over the 2012/13 summer. Given low juvenile abundance in 2013, the fishery in 2013/14 was monitored closely and an early closure was recommended.
Estuarine finfish (west coast)	No Assessment	N/A	75 – 220 (Peel-Harvey only)	120 (PH only)	Acceptable Catches of west coast estuarine finfish have been stable since 2000.
West coast beach bait	Catch (Level 1)	Environ. Limited	60 – 275 (whitebait only)	13 (whitebait only)	Not Acceptable Annual whitebait catch fluctuates in response to environmental variations. Catch decline follows recent years of exceptionally warm ocean temperatures. Catch is significantly below acceptable range. Management intervention may be required.
West coast purse seine	Catch (Level 1)	Adequate	0 – 3,000 (Q)	219 t (scaly mackerel and pilchard combined)	Acceptable Continued low catches compared to pre-2005 due to low fishing effort levels. 2013 catch includes catches from the managed fishery and the northern and southern developmental zones. This is the first year that catches from both developmental zones are reported.
West coast demersal scalefish	Catch by sector (Level 1) Fishing Mortality (F) (Level 3)	Recovering	< 450 (Demersal Suite)	395	Not Acceptable The total catch of the demersal suite by all commercial fisheries was within acceptable levels. WCDSIMF catches of snapper in the Mid-west and Kalbarri areas and of WA dhufish in the Mid-west area were too high.

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[1,2] 2012/13 or 2013	Catch (or effort) level acceptable and explanation if needed
GASCOYNE COAST BIOREGION					
Shark Bay prawn	Direct Survey/Catch Rate (Level 4)	Adequate	1,350-2,150	1815	Acceptable King and tiger prawn catches were both within the target ranges.
Exmouth Gulf prawn	Direct Survey/Catch rate (Level 4)	Environ. Limited	771 – 1,276	585	Acceptable The total catch was below target range from poor recruitment of tiger prawns due to environmental conditions. The landings were higher than the extremely low catches in 2012 indicating some recovery.
Shark Bay scallop	Catch Rates and Direct Survey (Level 4)	Environ. Limited	1,250 – 3,000 (fishery closed this year)	0	NA The fishery did not open due to very low recruitment and stock abundance over the past 3 years due to continued influence of the extreme environmental conditions from heat wave events. No recovery observed despite no fishing by the scallop boats and no retention by the prawn trawl sector.
Shark Bay Crabs	Catch Rates/Size Distributions (Level 3)	Environ. Limited	Fishery closed from April 2012 to Sept. 2013. Harvest strategy under development	36 (20 trap + 16 trawl)	NA The fishery remained closed until September 2013 due to poor recruitment and stock levels resulting from extreme environmental conditions. Biomass indices showed partial recovery, which was confirmed by experimental commercial fishing.
Shark Bay beach seine and mesh net	Catch Rates (Level 2)	Adequate	235 – 335	211	Acceptable Total catch remained below the target range due to a further reduction in effort and decline in sea mullet catch; catches of whiting increased to highest level since mid-1980s.

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[1,2] 2012/13 or 2013	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)	140 crystal crab (53,414 potlifts)	Acceptable The catch is within the target catch range, with the standardised catch rate of legal crabs 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)	233 (328 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 and at highest level since mid-1990s.
NORTH COAST BIOREGION					
Onslow prawn	Catch (Level 1)	Adequate	60 – 180	Negligible	NA Minimal fishing occurred in 2013.
Nickol Bay prawn	Catch (Level 1)	Adequate	90 – 300	106	Acceptable Catch of banana prawns were within the target catch range and slightly lower than the predicted catch.
Broome prawn	Catch (Level 1)	Adequate	55 – 260	2	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	154	Acceptable The banana prawn catches were well below the catch prediction and the target range. The effort in the fishery was the second lowest recorded since 1990.
Kimberley gillnet and barramundi	Catch Rates (Level 2)	Adequate	32 – 45 (barramundi)	52	Acceptable The catch of barramundi is slightly above the acceptable range. The harvest strategy needs to be reviewed.

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[1,2] 2012/13 or 2013	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (Continued)					
Northern demersal scalefish	Catch and Catch Rates/ Integrated Model (Level 2 & 5)	Adequate	Under revision	Total 1,228 (goldband 493) (red emperor 131)	NA Total catch is above the upper limit across the fishery due to an increase in catch in Zone A. Catches of goldband snapper and red emperor were both within the acceptable catch range. Full assessments and a review of catch ranges are in progress.
Pilbara fish trawl	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	Adequate	Under revision	1,074	NA Reduced catch due to reductions in effort quota since 2009. Full assessment and review of catch range scheduled over the next 12 months.
Pilbara demersal trap and line	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	Adequate	400 – 600 (trap) 50 – 115 (line)	339 (trap) 85 (line)	Acceptable Trap catch was lower than the target catch range due to reduced effort in the fishery in 2013. The line catch was within the target catch range.
Mackerel	Catch (Level 1)	Adequate	246 – 410 (Q, Spanish Mackerel)	277	Acceptable Catches lower than previous few years but remain within the acceptable range for the fishery.
Northern shark	No Assessment	NA	< 20 (sandbar)	0	NA No fishing effort continued for this year.
Pearl oyster	Catch rate predictions, standardised CPUE (Level 3)	Adequate	754,800 oysters (Q) (14,071 – 20,551 dive hours)	517,653 oysters (11,995 dive hours)	Acceptable Quota this year also included 150,000 large mother-of-pearl (MOP) oysters fished under a research and development permit to explore the potential for an MOP fishery. The Zone 1 quota (115,000 shell) was not fished and some culture shell quota was not fished for economic reasons. Catch rate indices were above threshold levels.

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[1,2] 2012/13 or 2013	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (Continued)					
Beche-de-mer	Catch Rate (Level 2)	Adequate	Sandfish 20 – 100 Redfish 40 - 150	Sandfish 0 Redfish 0	NA There was no fishing for sandfish or redfish in 2013. Industry undergoing restructures. New vessels expected to fish the existing licenses in 2014.
SOUTH COAST BIOREGION					
South Coast crustacean	Standardised Catch Rate (Level 2)	Adequate	50 – 80 (southern rock lobster)	46 (southern rock lobster)	Acceptable While catch was below the target range for southern rock lobster, the standardised catch rate was within its target region and increased from the 2011/12 level. Catch and catch rates of deep sea crabs (secondary target species) is currently being assessed.
Abalone (greenlip/ brownlip)	Standardised Catch Rate plus Fishing Mortality (Level 3)	Adequate	209 (Q) (907 – 1,339 days) (3440 - 5270 hours)	201 (1,558 days) (5,990 hours)	Not Acceptable Effort range (in days) exceeded due to lower abundance. TAC reduced by 10% in the Area 3 fishery for 2014. Effort ranges have been reviewed and will be expressed in hours from 2014 onwards.
Estuarine finfish (south coast)	Catch Rates (Level 2)	Adequate	200 – 500	215 (finfish) 32 (crab) 2 (other)	Acceptable Stock levels of key species are considered adequate.
WA salmon	Catch Rates (Level 2)	Adequate	1,200 – 2,800	232	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.
Australian herring	Fishing mortality (Level 3)	Inadequate	Under revision	251 (south coast only)	NA Formal stock assessment completed in late 2012. Historically low commercial catch reflects poor recent recruitment and low stock abundance. The acceptable catch range is therefore under revision.

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[1,2] 2012/13 or 2013	Catch (or effort) level acceptable and explanation if needed
SOUTH COAST BIOREGION (Continued)					
Albany/King George Sound purse seine	Catch (Level 1)	Adequate	2,683 (Q)	1,513	Acceptable Effort and catches slightly lower than in 2011/12.
Bremer Bay purse seine	Catch (Level 1)	Adequate	1,500 (Q)	Less than three licences operated	Acceptable Effort and catches lower than in 2011/12.
Esperance purse seine	Catch (Level 1)	Adequate	1,500 (Q)	Three licences operated	Acceptable Effort and catches slightly higher than in 2011/12.
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: recovering.	725 – 1,095 (key species only)	750 (key species only)	Acceptable Total catch within target range, similar to previous years and acceptable given effort levels. Dusky catch was slightly below its target range due to decline in effective effort. Catch rate similar to previous year. Whiskery catch has 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	78	Acceptable Catch is below the acceptable range due to reduced effort.

1 Catch figures supplied for latest year/ season available.

2. Where there are three or less licences operating in the fishery annual catch levels are not reported due to confidentiality requirements.

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 may be implemented by the Commonwealth as part of their marine planning zones.

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 2012/14 RESULTING FROM SURVEILLANCE AT MAJOR PORTS

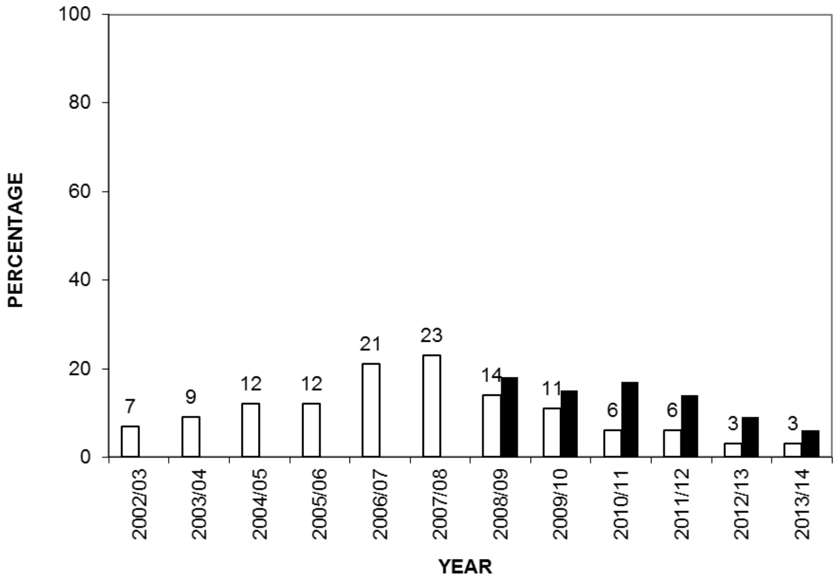
No pest monitoring was conducted in the Gascoyne or South Coast Bioregions in 2013/14.

Bioregion	Common Name	Scientific Name	Type of Organism	Pest status	Year detected
West Coast	Mediterranean fanworm	*Sabella spallanzanii*	Polychaete	Pest	2012/13
	Scallop	*Scaeochlamys livida*	Mollusc	Introduced species	2012/13
	Aeolid nudibranch	*Godiva quadricolor*	Mollusc	Introduced species	2013/14
		Alexandrium catanella	Dinoflagellate	Pest	2012/13
	Ciona	*Ciona intestinalis*	Ascidian	Introduced species	2013/14
	Asian paddle crab	*Charybdis japonica*	Crab	Pest	2013/14
	Ivory barnacle	*Balanus improvisus*	Barnacle	Pest	2013/14
		Balanus pulchellus	Barnacle	Introduced species	2013/14
	Asian green mussel	*Perna viridis*	Mussel	Pest	2013/14
	Asian date mussel	*Arcuatula senhousia* (previously *Musculista senhousia)*	Mussel	Pest	2012/13
		Didemnum perlucidum	Ascidian	Introduced species – pest-like characters	2012/13
North Coast		*Theora fragilis*	Mollusc	Introduced species	2012/13
		Didemnum perlucidum	Ascidian	Introduced species – pest-like characters	2012/13

OVERVIEW TABLE 4

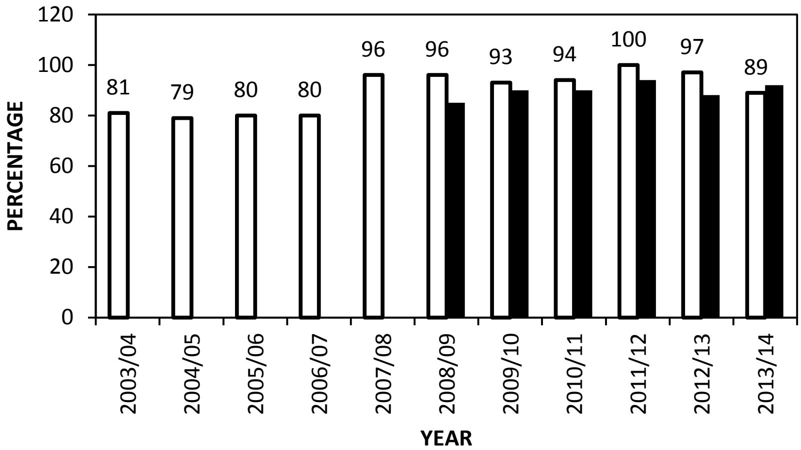
The number of significant fishkills investigated in Western Australia since the last SOE report

Year	Number of FishKills
2007	23
2008	36
2009	18
2010	18
2011	29
2012	34
2013	25
2014	19



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 most of the West Coast Bioregion inside 200 m depth could be classified as one of the marine protected area IUCN categories (Ecosystem Management Table 1; as per Dudley, 2008)[1].

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

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 is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay.

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)[1] 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)[2] 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

Listed 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 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

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

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

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 a series of new initiatives during 2013 – 2014. 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 2013/2014. A large-scale, nationally approved survey of HMAS Stirling was also completed in late 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 fisheries[2]. 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 listed 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 State Waters and all continental shelf waters, out to 200 m depth, which meet the IUCN criteria for classification as marine protected areas.

IUCN category or equivalent	State Waters only ($10,088\ km^2$)				All Waters ($481,488\ km^2$ (including State waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km^2	%	km^2	%	km^2	%	km^2	%
I	0	0	0	0	0	0	0	0
II	1	< 1	171	2	1	< 1	171	< 1
III	0	0	0	0	0	0	0	0
IV	4,500	44	1,900	19	33,600	7	1,900	< 1
V	0	0	0	0	0	0	0	0
VI	3,400	34	116	1	445,700	93	116	< 1

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 *et al.* 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 an 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.

Listed 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., 2012[1]).

Listed species	Species	Risk	Status and Current Activities
Listed 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.
Listed '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.

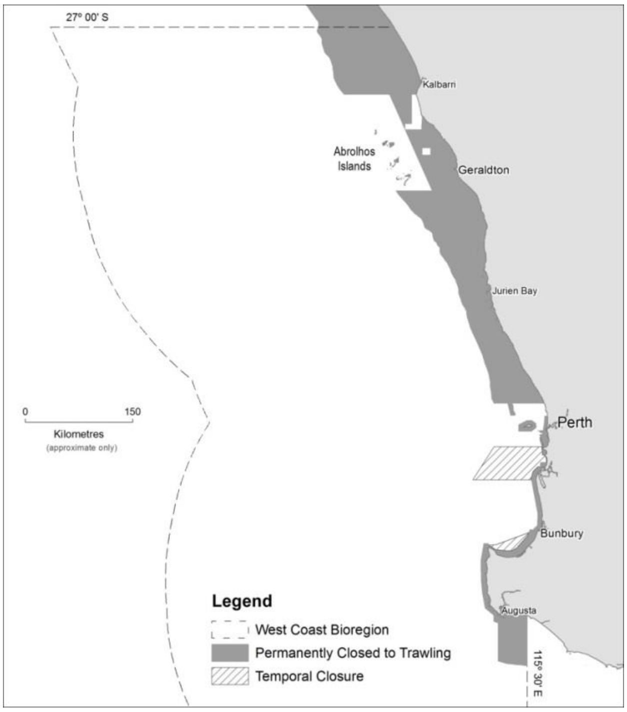
Benthic habitat: Details on the analyses for these scores are located in West Coast Ecosystem Management Table 1 above and in the individual fishery reports.

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 nd 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.

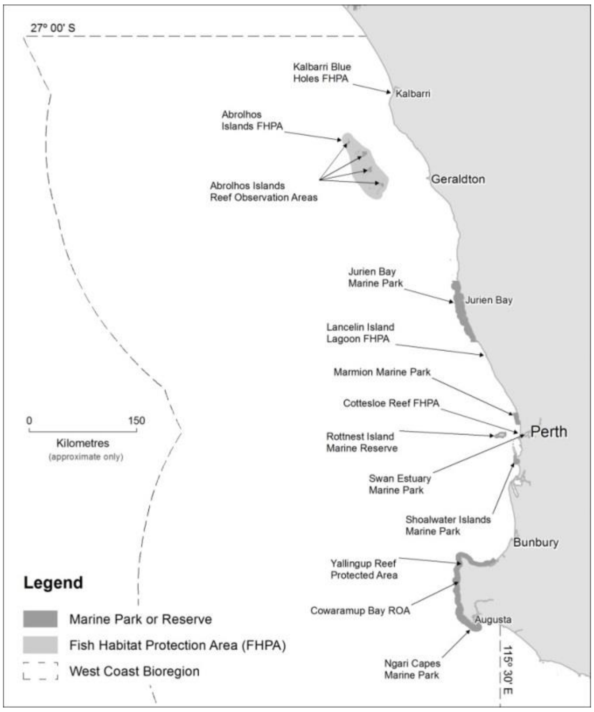
External Drivers: Details on some of the analyses used for these scores are located in the individual fishery reports plus there were whole of region assessments completed in the draft West Coast EBFM report.

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	MODERATE in short term HIGH in medium 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.
Climate	MODERATE in short term HIGH in medium term	Projects to examine potential impacts on this bioregion are now underway or planned. Some climate change impacts on rock lobster biology had already been taken into account in the stock assessment process.



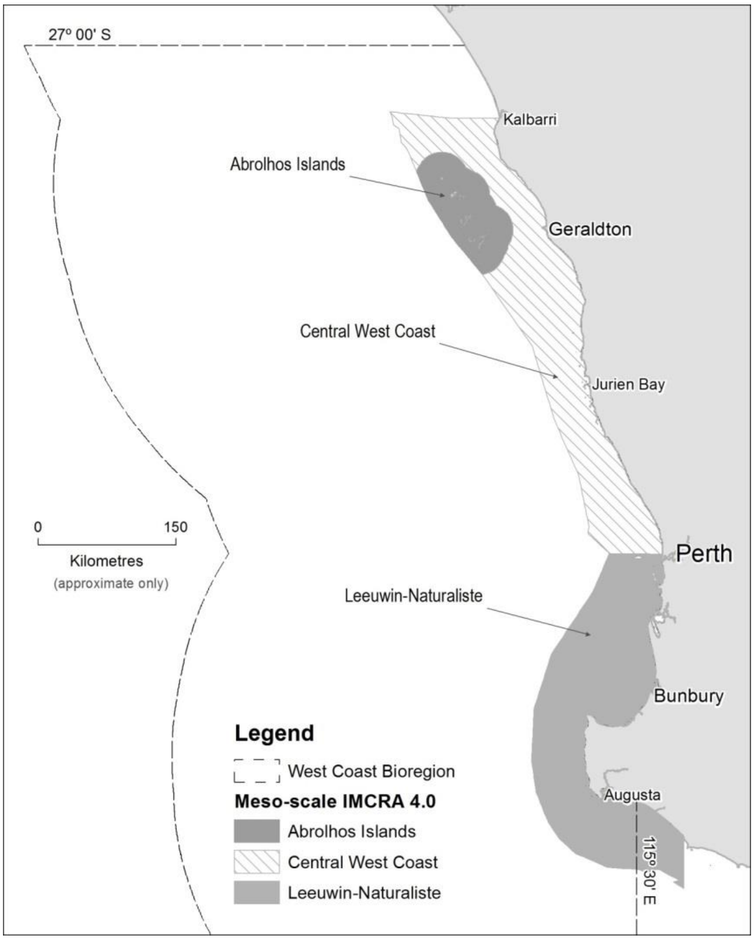
WEST COAST ECOSYSTEM MANAGEMENT FIGURE 1

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

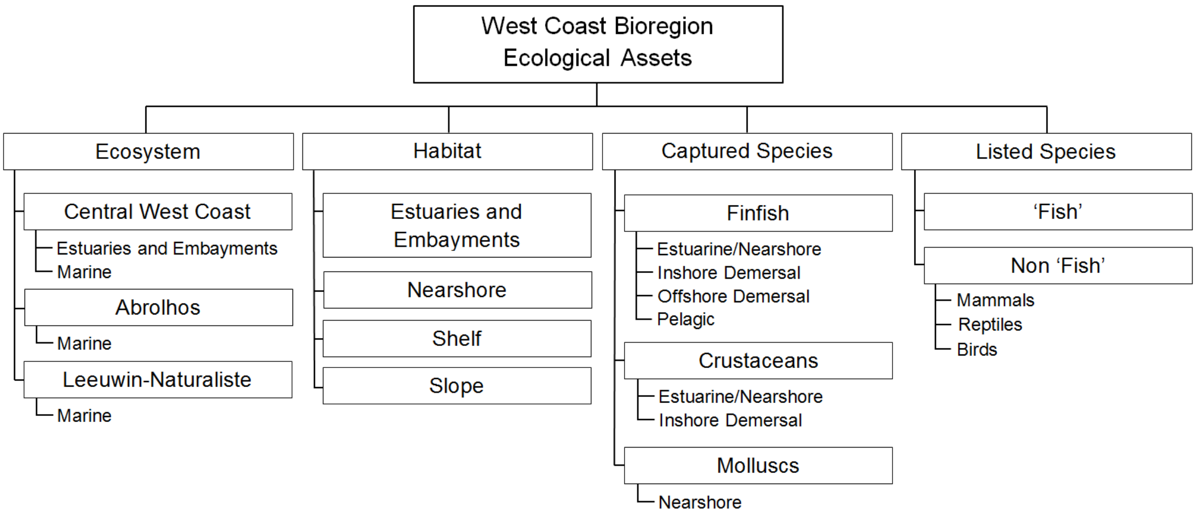
Map showing current and proposed formal marine protected areas in the West Coast Bioregion various areas of which are either consistent with IUCN categories I, II, III, IV or V.



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. There are two key vectors for marine pest translocation: ballast water and hull fouling. The Marine Biosecurity Research and Monitoring group continue to implement a series of biosecurity related projects in the West Coast Bioregion with two aims. The first is to examine the likelihood of inoculation, infection and establishment of compatible marine pests in the West Coast Bioregion from commercial vessel movements (see Bridgwood & McDonald 2014)[1]. The second aim is for early detection of the presence of introduced marine pests (IMPs) using a suite of tools.

From a biosecurity perspective the introduction of a marine pest to any region is based on multiple factors that can be grouped into two themes; the likelihood of inoculation and the likelihood of infection and establishment. Inoculation likelihood assumes that the greater the number of vessel visits from a source with IMPs the greater the risk of IMPs being brought into the recipient port i.e. a positive linear relationship. Based on commercial vessel data from 2011, there were 3135 commercial visits to the West Coast Bioregion and the greatest inoculation risk was from international vessel movements. The infection and establishment likelihood takes into account the sources of IMPs (based on a vessels last port of call (LPOC)), the frequency of visits from those sources and the compatibility between the IMPs salinity and temperature tolerances and West Coast Bioregion's marine environment. There was an 88% compatibility rating of potential inbound IMPs with the environment of the West Coast Bioregion from 40 international last ports (Introduced Pests Figure 1). When the cumulative effect of the number of vessel visits from a LPOC and number of IMPs present at that LPOC is considered, the greatest infection and establishment risk to the West Coast Bioregion was from Singapore, followed closely by China and Indonesia (Introduces Pests Figure 2).

Early detection of IMPs is vital if any attempt at eradication or other management strategies is to be successful. Thus the Marine Biosecurity Research and Monitoring group regularly undertake marine pest monitoring at Fremantle Port and HMAS Stirling (Garden Island). 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 .Whereas the national monitoring adheres to the Australian Marine Pest Monitoring Guidelines and is endorsed by the Commonwealth, the complementary monitoring is a smaller more focussed version designed to target select high risk sites in each port. The complementary monitoring of Fremantle Port was completed in early 2014. The next round of national monitoring for Fremantle Port is scheduled for early 2015. National monitoring at HMAS Stirling was completed in late 2013, with the complementary survey scheduled for late 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 have recently completed four 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. - this project has been published as a Research Report and development of publications is underway;
- Determination of the efficacy of wrapping a recreational vessel hull to eliminate/kill biofouling on the wet areas of the hull- this project has been submitted for publication in a peer reviewed journal ;
- 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* - this project has been submitted for publication in a peer reviewed journal.

The group is currently quantifying the risk associated with recreational vessels for the introduction and translocation of marine pests along our coast by analysing the biofouling associated with recreation vessels in marinas across the state.

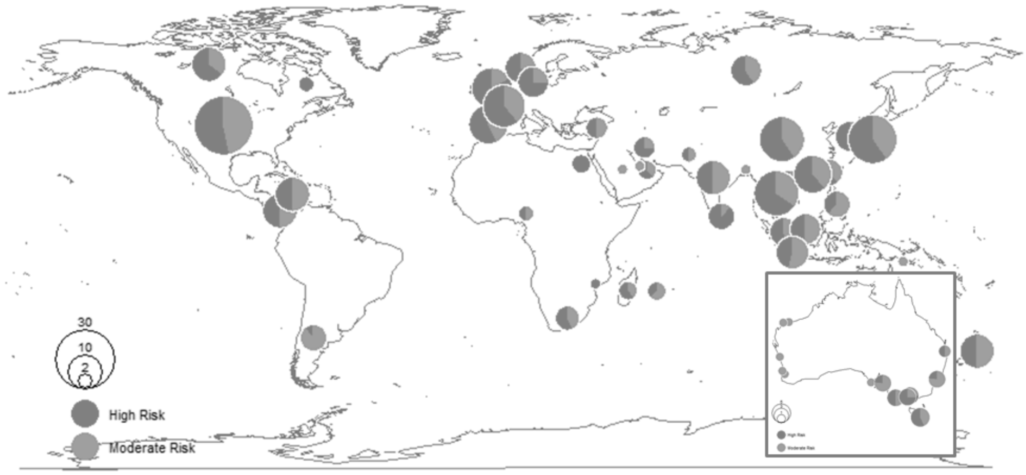
While conducted in this bioregion, the research outputs are designed to be applicable to biosecurity management across the state.

1 Bridgwood, S. and McDonald, J. A likelihood analysis of the introduction of marine pests to Western Australian ports via commercial vessels. Fisheries Research Report No. 259. Department of Fisheries, Western Australia. 212pp.

INTRODUCED PESTS TABLE 1

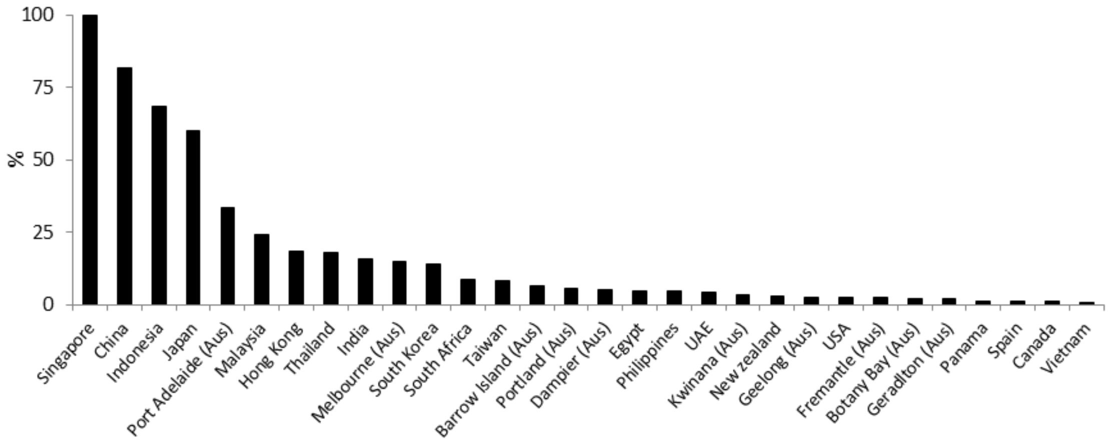
Introduced marine species detected during MBRM activities in this bioregion.

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



INTRODUCED PESTS FIGURE 1

The last port of call locations of compatible IMPs for the West Coast Bioregion.



INTRODUCED PESTS FIGURE 2

Ranking of the infection and establishment risk posed to the West Coast Bioregion by international and domestic last ports of call. Each last port of call value is expressed as a relative percentage of the largest last port of call value (i.e. Singapore 100%).

FISHERIES
West Coast Rock Lobster Fishery Status Report

S. de Lestang, M. Rossbach, G. Baudains and F.Trinnie.

Main Features

Status		Current Landings (Season 2013)	
Stock level	Adequate	Commercial catch	5641t
Fishing Level	Acceptable	Recreational catch (2012/13)	128 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 2009/10 a nominal Total Allowable Commercial Catch (TACC) was introduced. In 2010/11 the fishery began the transition to an Individually Transferable Quota (ITQ) fishery.

The fishery has historically been Australia's most valuable single species wild capture fishery and was the first fishery in the world to achieve Marine Stewardship Certification (MSC). In early 2012 the fishery was 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 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

Other subsidiary legislation

Recreational Fishing Licence

Consultation processes

Commercial

Under the *West Coast Rock Lobster Managed Fishery Management Plan 2012*, it is a requirement that consultation be undertaken with the Western Rock Lobster Council prior to the management plan being amended or revoked. In addition, the Department holds a series of Annual Management Meetings with licensees and security interest holders. These meetings are convened on behalf of the Department by the Industry Consultative Unit within the WA Fishing Industry Council (WAFIC).

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: south of latitude 30° S (C Zone), north of latitude 30° S (B Zone) and, within this northern area, a third offshore zone (A Zone) around the Abrolhos Islands.

Recreational

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

Management arrangements 2013 Season Policy

Commercial

On 15 January 2013, a new management plan, the *West Coast Rock Lobster Managed Fishery Management Plan 2012* came into effect. This new management plan completed the fishery's transition to an ITQ system. Key elements of the management regime in place during the 2013 licensing period (15 January 2013 – 14 January 2014) included:

- a TACC of 5,554 tonnes (1,076 tonnes for Zone A, 1,921 tonnes for Zone B and 2,557 tonnes) for Zone C);
- fishing permitted all year in all zones, no closed season;

- facility for units for more than one zone to be held on a licence;
- separation of access to the Abrolhos Islands and Zone B into separate, individually transferrable units; and
- introduction of Fish Eye, the Department's electronic nomination and quota monitoring system.

In addition, the development of a Harvest Strategy and Control Rules was progressed with a final industry consultation phase commencing in December 2013.

Interactions with listed species, particularly humpback whales, became a significant issue in 2013 with 18 confirmed entanglements of humpback whales in rock lobster gear being recorded. The Commonwealth Government granting the fishery only a two year Wildlife Trade Operation (export approval) where previously five year exemptions had been granted. Several conditions have been placed on the fishery by the Commonwealth Government in relation to the need to take action to mitigate entanglements. A Ministerial Taskforce was formed in the second half of 2013 with a view to overseeing the development and implementation of research and management responses to the whale entanglement issue.

Recreational Fishery 2012/13

The recreational component of the western rock lobster fishery is managed under fisheries regulations. 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. In order to assist the recreational sector in increasing its catch a package of measures was introduced from the 2012/13 season. These changes were:

- an increase in the daily bag limit from six to eight rock lobsters per person;
- a decrease in the escape gap size on recreational pots from 55 mm to 54 mm;
- an increase in the number of recreational rock lobster licenses able to operate from a boat from two to three;
- an increase in the boat limit of rock lobsters to 24 when there are three or more licensed fishers on board;
- an increase in the number of recreational rock lobster pots which may be pulled on a boat trip to six, when there are three or more licensed fishers on board; and
- the removal of the prohibition on diving for rock lobster at the Abrolhos Islands.

Integrated Fisheries Management

In March 2008, through the Integrated Fisheries Management process, the Minister determined that the allocated shares of the sectors of the West Coast Rock Lobster 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.

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 daily catch disposal records which contain a volunteer research section from fishers and monthly returns from processors, 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 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 in deep water (~40 m) off Leeman. Preliminary results of this research indicate a substantial increase in lobster biomass and average carapace length of lobsters within the unfished region. A key output of this research will be a greater understanding of the carrying capacity of deep-water reefs systems within the WRL fishery. A paper from this research was recently presented at the 10th International Conference and Workshop on Lobster Biology and Management in Cancun Mexico (http://www.dmc-cancun.com/icwl2014/index.php/component/content/?view=featured).

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.

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 number of research projects were developed from this workshop to examine the cause of these low settlement levels in recent years. Six projects were subsequently funded by the Fisheries Research and Development Corporation (FRDC) and final reports are available:

Project 1. Identifying factors affecting the low western rock lobster puerulus settlement in recent years (http://www.fish.wa.gov.au/Documents/research_reports/frr255.pdf).

Project 2. Evaluating source-sink relationships of the Western Rock Lobster Fishery using oceanographic modelling (http://www.fish.wa.gov.au/Documents/research_reports/frr209.pdf).

Project 3. Evaluating the potential use of change-in-ratio and index removal techniques for determining harvest rates and efficiency increases in the Western Rock Lobster Fishery (http://www.fish.wa.gov.au/Documents/research_reports/frr234.pdf).

Project 4. Evaluation of population genetic structure in the western rock lobster (http://www.frdc.com.au/research/Documents/Final_reports/2009-020-DLD.pdf).

Project 5. Assessing possible environmental causes behind the reduced colonization of puerulus collectors by a wide suite of species (http://www.fish.wa.gov.au/Documents/research_reports/frr218.pdf).

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 (http://frdc.com.au/research/Documents/Final_reports/2010-047-DLD.pdf).

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 the seven years of lower settlement. A paper on this research was recently presented at the 10th International Conference and Workshop on Lobster Biology and Management in Cancun Mexico and will be submitted to ICES Journal of Marine Science as part of the conference proceedings.

A project to assess the economic performance of the fishery was 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. A report from this project (Decision-support tools for economic optimization of Western Rock Lobster fishery. Fisheries Research Report # 257) will be published in mid-2014.

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 has been acknowledged 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 being different in their fishing behaviour and success than respondents). To reduce the impact of these biases on catch estimates, a phone-diary survey that is considered to suffer less from these biases (Baharthah, 2007)[1], has been conducted in concert with the mail survey for a number of seasons to develop a conversion factor (Thompson, A. 2013)[2]. The resultant conversion factor has been used to standardise catch estimates from the far cheaper mail survey to that of the phone-diary survey.

Retained Species

Commercial landings (season 2013) 5641 tonnes

Lobsters: Trends in the annual catches from the West Coast Rock Lobster Managed Fishery are shown in West Coast Rock Lobster Figure 1. The catch landed by the WCRLF 2013 season (5641 t) was lower than in the previous report because an extended season was in place for 2011/13 (6647 t).

Octopus: Octopus are also caught in rock lobster pots within shallow water (<40 m). The catch rate of 0.009 octopus per pot lift recorded in 2013 in waters <40 m from the new Catch and Disposal Records (CDR) data was below the historical range of 0.02 – 0.045 per pot lift (1985/86 to 2009/10). Historical data was previously based on logbook data which represented both retained and returned octopus, whereas the new CDR data only reports retained catch. The cause of the lower catch rate of octopus may be related to high beach prices being paid for Western Rock Lobster resulting in fishes not bothering to retain octopus for additional income. The current performance indicator for octopus catch rates is therefore no longer applicable and has therefore been modified. A new performance indicator of the catch rates remaining within 10% of historical levels will now be applied. This indicator ensures that large variations in the catch rate of octopus, such as marked declines due to over fishing do not occur.

The catch rate of octopus (incidental landings) is an indicator for this fishery. Currently the catch rate is at 0.009 octopus retained per pot lift. As this is the first record of this index it cannot be compared to any historical catch rate and thus the performance indicator cannot be assessed in the current year. Comparisons will begin for the 2014 fishing season.

Recreational catch estimate (season 2012/13) 128 tonnes

The recreational catch of western rock lobster for 2012/13 was estimated at 128 t (with 95% confidence intervals ranging from 115-142t), with 95t (86-104 C.I.) by potting and 34 t (29-38 t C.I. by diving.

Comparative catch estimates for 2011/12 were 118 t, with 79 t by potting and 39 t by diving. The estimated recreational catch in 2012/13 was therefore 8.5% higher than the 2011/12 catch estimate.

Fishing effort/access level

Commercial

In 2013, 251 vessels fished for lobster which represented a decline of 9% from the 275 vessels that fished during the previous extended 2011/13 season. 2013 season's

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 Thomson, Adrian Wilfred. 2013. An estimator to reduce mail survey nonresponse bias in estimates of recreational catch: a case study using data from the *Panulirus cygnus* fishery of Western Australia. Ph.D. Curtin University, Department of Mathematics and Statistics.

management arrangements limited the maximum number of pots at 50% of a vessel's unit entitlement. In 2013, the fishery recorded 2,903,438 potlifts a 22% decline on the previous extended season's (2011/13) potlifts of 3,737,311. This decline primarily reflects the decreased season length (12 vs 14 months) and also reflects the changing behaviour of fishers as they continue to adapt to fishing under a quota based management system that encourages fishing in periods when the beach price is higher.

Recreational
A total of 39,702 licenses were sold that permitted fishing for lobsters during some part of the 2012/13 season with an estimated 13,529 (34%) 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 2012/13 was 6% higher than the number of active licences in 2011/12.

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 16 and 6 days, respectively during the 2012/13 fishing season. These rates were similar in the 2011/12 fishing season at 15 and 6 days, respectively.

Finally, the average diary-adjusted catch taken by active pot and diving fishers were 20 and 12 lobsters, respectively during the 2012/13 fishing season. In the 2012/13 season the average numbers of lobsters caught by pot and dive fishers were similar at 18 and 13, respectively.

Stock Assessment

Assessment complete: Yes

Assessment method:

Size-structured population model

Breeding stock levels: Adequate

Targeted commercial catch next season (2014):

5859 tonnes TACC[1]

IFM allocated maximum recreational catch next season (2013/14): 418 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 formally used in the harvest strategy 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.

The primary focus of management is 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.

The secondary focus for management is to determine what levels of harvest correspond to maximum economic outcomes, how these harvest rate scenarios affect catch rates and egg production levels and what would be the impacts of removing different biological management measures such as the setose rule.

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)
Another 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).

Historically 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

1 Note this TACC covers a 12 month season.

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 (4.4, 2.0 and 1.6 kg/potlift in zones A, B and C, respectively) are close to record highs, well above the historical long-term levels in each zone (e.g. 2.5, 1.3 and 1.3 kg/potlift in zones A, B and C, respectively).

Recreational

The average recreational pot and diving diary-adjusted catch rates were 1.2 and 2.1 lobsters per person per fishing day in the 2012/13 fishing season. These catch rates are similar to the 1.2 lobsters for potting and 2.3 lobsters for diving calculated for the 2011/12 fishing.

Puerulus settlement

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 2008 identified the onset of spawning as a key factor (see Research Summary above).

The annual indices of puerulus settlement during the 2013/14 collection season increased dramatically and returned to the upper end of the historical range in all coastal sites. The Abrolhos site settlement was similar to last year at the lower end of the historical range.

This represents significant improvement compared with the recent seasons (West Coast Rock Lobster Figure 5). The 2013/14 settlement will mainly affect catch rates during the 2017 fishing season.

Non-Retained Species

By-catch species impact: Low

Commercial western rock lobster fishers were not allowed to retain finfish bycatch during the 2013 fishing season.

Listed species interaction: Sealions (Low)

Leatherback Turtles (Low)

Whale Entanglements (Moderate)

All WCRLF pots fished in waters less than 20 m within approximately 30 km of Australian Sea Lion (ASL) breeding colonies have to be fitted with an approved Sea Lion Exclusion Device (SLED) (see http://www.fish.wa.gov.au/Documents/recreational_fishing/additional_fishing_information/sea_lion_exclusion_devices.pdf). Video trials have indicated that this device is successful in stopping sea lion pups from entering lobsters pots and potentially drowning.

The performance measure for this fishery is that no increase in the rate of capture of sea lions occurs. During the 2013 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. During the 2013 fishing season there were three interactions with turtle and no deaths reported.

The performance measure for the fishery is that there is no increase in interactions with turtles. In 2013 three leatherback turtles were reported to have been entangled in lobster fishing gear. This incident rate is within the historical range of between two and five entanglements per season over the preceding five seasons. The fishery has therefore met this performance measure.

The humpback whale is the predominant species that interacts with the WCRLF, during both its northward migration to the North West Shelf calving grounds from May to August and then during its subsequent southward migration from September to November. Owing to the fishery's historical closed season, there was a limited period for interaction. The combination of an increasing population of humpback whales, and the transition to a quota fishery which has seen a change in fishing effort as the season length increased to year-round, has seen the number of entanglements in commercial rock lobster gear rise to 18 in 2013.

Entanglements are reported by industry and other water users to the Department of Parks and Wildlife (DPaW) whose specialist team attempt to disentangle the animal, with a very high success rate. The western rock lobster fishing industry has developed a code of practice to minimise the interaction with whales in conjunction with DPaW and SeaNet. The Minister for Fisheries initiated a ministerial taskforce which included members of the Department, Minister's office, Industry (WRLC, WAFIC), a commercial fisher and representatives of the federal Department of the Environment (DotE). Its main duty was to identify research projects and provide advice on possible mitigation measures to reduce whale entanglements.

An outcome of this process has been the development of two FRDC research projects, which in combination aim to assess the issue of whale entanglements both through the trial of gear modifications and by improving the collection of spatial and temporal data on the whale migration along the West Australian coast. The outcomes of these projects have and will continue to feed into future management arrangements to reduce whale entanglements.

For the 2014 whale migration season fishers will be required to use modified float rigs on all fishing gear used in waters deeper than 18 m.

The effectiveness of these modifications will be assessed at the conclusion of the 2014 whale migration season and will be used to inform management measures to reduce whale entanglements for the 2015 whale migration season in line with conditions placed on the fishery by the federal DotE.

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 (1990–2012), *commercial lobster fishing has resulted in zero to 13 whale/dolphin interactions per season. Eighteen whale entanglements with lobster gear were recorded during the 2013 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, due to 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 $270 million. Employment is now year round, the fishing season being from 15 January to the following 14 January. During the year, 4 main processing establishments, located in the Perth metropolitan area (3) and Geraldton (1), and Cervantes (1) serviced practically every location where fishing occurred.

Recreational

With around 40,000 licenced to fish, of which about 13,500 people take 256,000 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 2012/13: $271 million

The price that commercial fishers received for the western rock lobster in 2013 was an estimated to be $48.02/kg averaged across all processors and all zones of the fishery. This was 32% increase on the $36.33/kg paid in 2011/13, with the increase due to fishers only landing catch when the advertised beach price was high, the move to a 12-month season and a lower Australian dollar exchange rate. The overall value of the fishery increased from the previous season's value of $241 million for the extended season and higher TACC as a result of the better beach price.

The majority of landed lobsters were exported to China with some product also going to Hong Kong, Taiwan, Japan, United States and some into Europe.

Fishery Governance

Commercial

Current Fishing (or Effort) Level: Acceptable

Commercial catch target (2014):

5859 tonnes (TACC)

Between 1975/76 and 2013 commercial catches averaged 9,697 t with maximum catch of 14,523 t being landed 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. This ensured sufficient catch rates 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 different strategy was adopted for the 2009/10 and 2010/11 seasons, with defined overall catch limits set at 5,500 t ± 10 % and 5,500 t, respectively, being used to reduce catch rather than effort reductions. The 2011/13 season was a 14 month season therefore the catch target (TACC) was been increased in proportion to what previously would have been taken at the start of following season. The 2013 season represented the first season when industry, through the Western Rock Lobster Council, were provided with a range of biologically acceptable TACCs based on an assessment of maximum economic yield. From this range they were able to choose their TACC. For the 2013 season industry choose to take 5554 t. The same process occurred for the 2014 season with industry choosing to catch a TACC of 5859 t.

Recreational
Current Fishing (or Effort) Level **Acceptable**

Target recreational catch limit (2013/14):

388 tonnes

Between 1986/87 and 2012/13 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 2008/09 onwards the commercial and recreational sectors have been managed under the principles of Integrated Fisheries management (IFM), which allocates the commercial and recreational sectors 95 and 5% of the total catch, respectively. Under this arrangement the limit recreational catch for 2013/14 based on a maximum allowable commercial catch (top of the MEY range of acceptable catches) of 7370 t was 388 t. (7370 x 5/95 = 3/8 TARC).

New management initiatives (2014/15)

Following implementation of the West Coast Rock Lobster Managed Fishery Management Plan 2012 which finalised the fishery's transition to quota management, 2013/14 is expected to see the adoption of a harvest strategy and control rules for the fishery. The harvest strategy and control rules will play an essential role in the TACC setting process.

External Factors

The variations in western rock lobster catches both commercially and recreationally are largely a result of variable levels of puerulus settlement. 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.

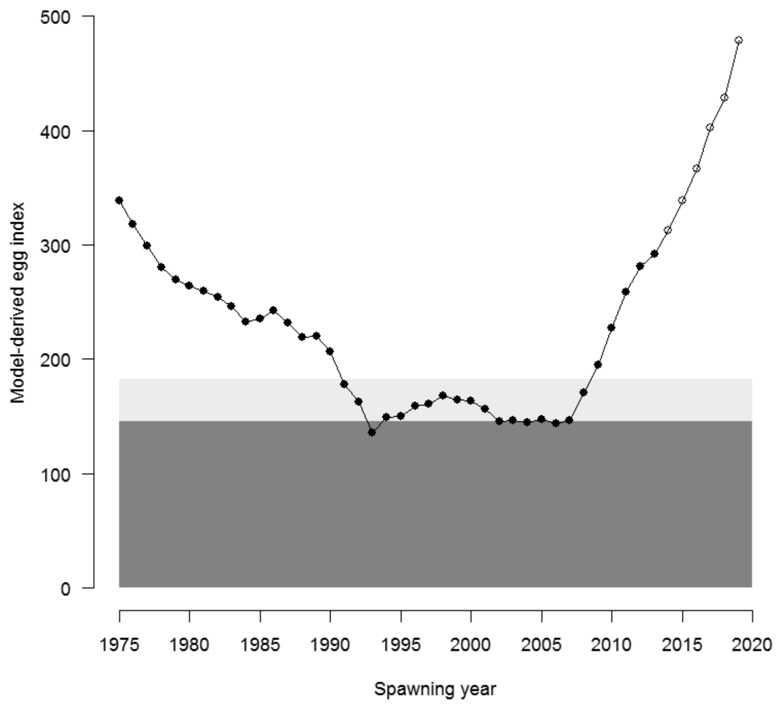
Investigation into the puerulus downturn have identified that when the spawning started early (temperature driven) and was coupled with low numbers of autumn and winter storms, the puerulus settlement was significantly lower and this matched the recent lows. These factors combined were able to explain 70% of the variation in historical puerulus settlement up to 2013/14, including the record low settlement of 2008/09. These environmental factors also explained the above-average settlement in 2013/14.

This new information from the comprehensive FRDC/Department-funded research project is available on the WA Fisheries Website for more detail about the work. http://www.fish.wa.gov.au/Documents/research_reports/frr255.pdf

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 ITQ and a 12-month season.

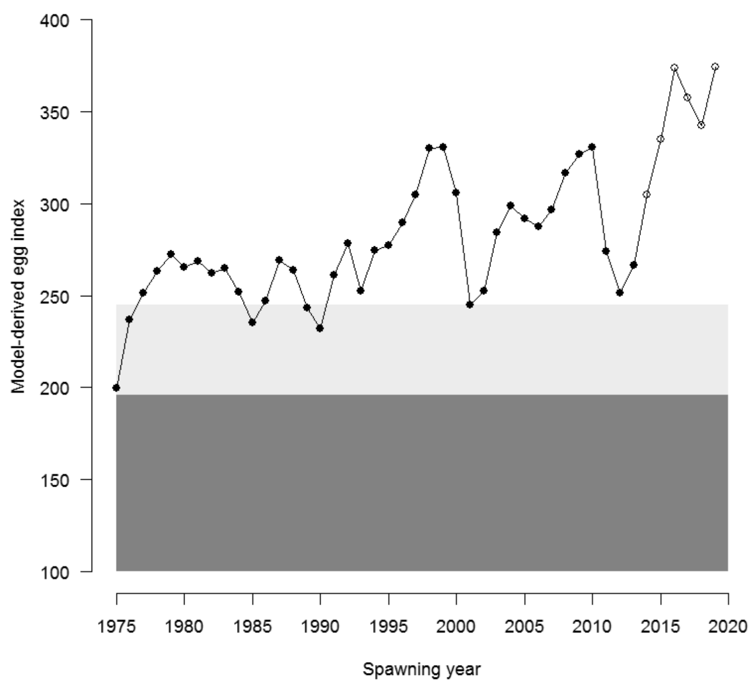
WEST COAST ROCK LOBSTER FIGURE 1

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 2013.



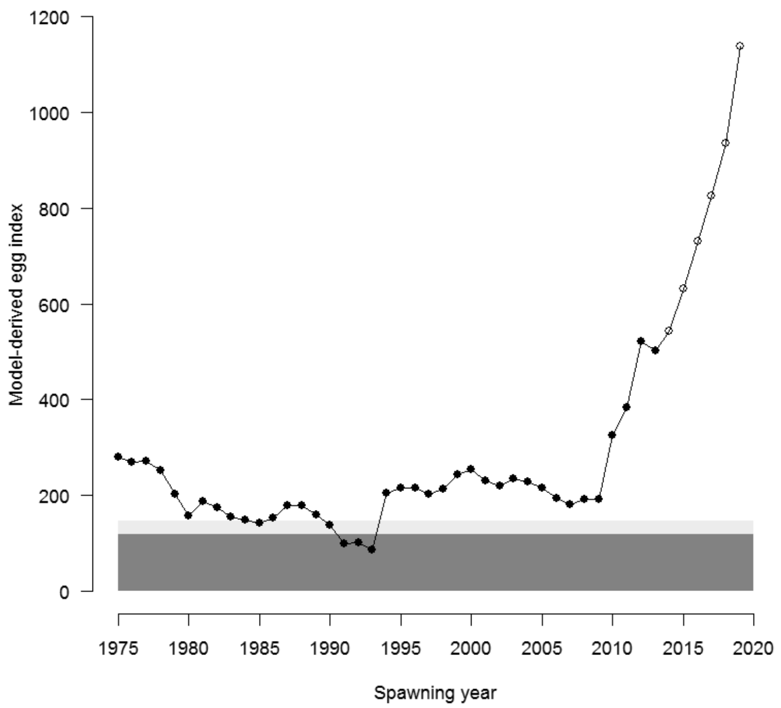
WEST COAST ROCK LOBSTER FIGURE 2

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 light grey region represents the 1980's threshold and the dark grey region the limit reference area.



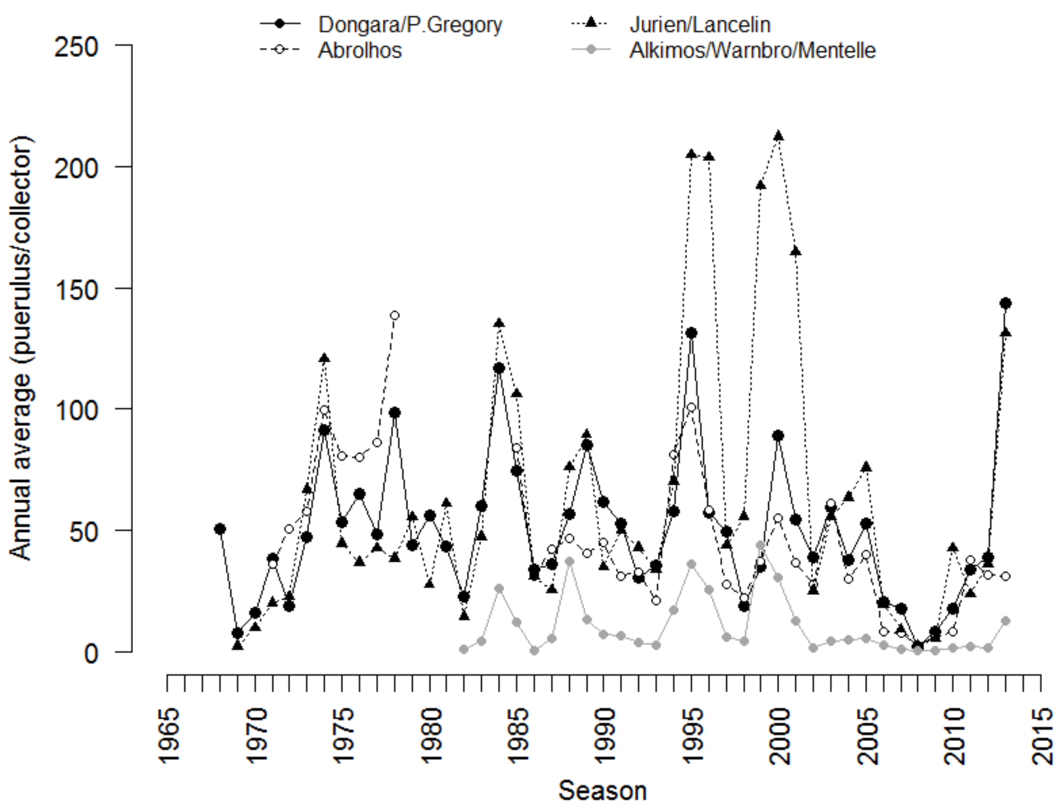
WEST COAST ROCK LOBSTER FIGURE 3

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 light grey region represents the 1980's threshold and the dark grey region the limit reference area.



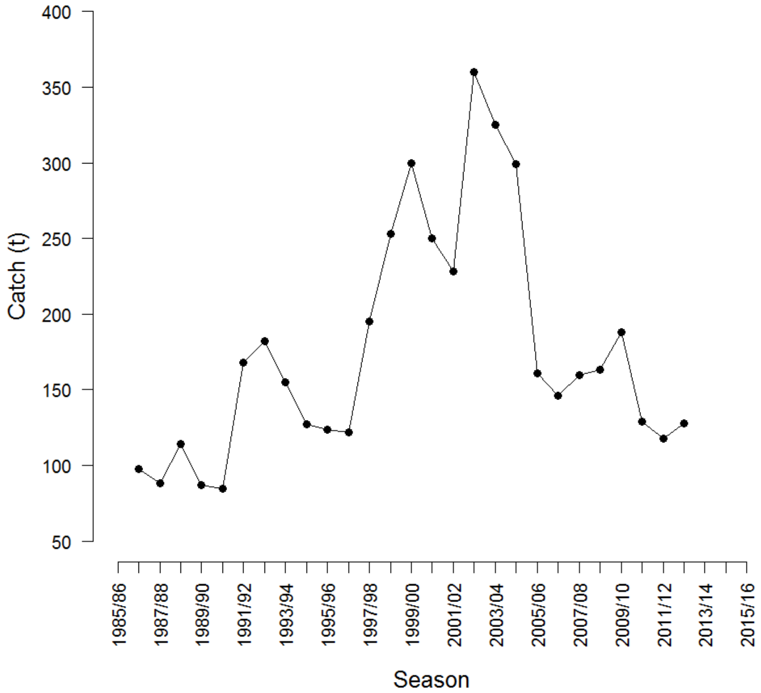
WEST COAST ROCK LOBSTER FIGURE 4

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 light grey region represents the 1980's threshold and the dark grey region the limit reference area.



WEST COAST ROCK LOBSTER FIGURE 5

Annual indices of puerulus settlement from 1968/69 to 2013/14 for the four main regions of the fishery.



WEST COAST 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	
Fishing level	Acceptable	West Coast	36 t
		Other	37 t
		Recreational Catch	
		West Coast	20 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).

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.

Boundaries

Commercial

The Abalone Management Plan covers all Western Australian coastal waters, which are divided into 8 management areas. Commercial fishing for Roe's abalone is managed in 6 separate regions from the South Australian border to Busselton Jetty – Areas 1, 2, 5, 6, 7 and 8 (Roe's Abalone Figure 1).

Recreational

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

Management arrangements

Commercial

The commercial Roe's abalone fishery is managed primarily through output controls in the form of Total Allowable Commercial Catches (TACCs), set annually for each area and allocated to license holders as Individually Transferable Quotas (ITQs).

The overall TACC for 2013 was 92.8 t whole weight (note this small species is generally landed in the whole condition). This was the same TACC as 2012 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 the following year.

The legal minimum length for Roe's abalone is 60 mm shell length in most parts of the fishery. However, an 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 is 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 for the first Sunday of each month from November 2013 to March 2014, five days in total. 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 and possession 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 via statutory returns 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.

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 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 control-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 Yanchep 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 trials with funding assistance from the Seafood CRC are underway to see whether translocation and restocking can assist the recovery of abalone stocks in the Kalbarri region affected by the marine heat wave 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 600 interviews in 2013), 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 statewide 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 the summer season.

Retained Species

Commercial production
Season 2013: 73 tonnes whole weight

Metro only: 36 tonnes whole weight

The TACC for the 2013 quota year was 93 t whole weight for Roe's abalone. The 2013 catch of 73t whole weight (Roe's Abalone Table 1) was 6 tonnes higher than 2012 and about 79% of the TACC. The reductions in catch are driven primarily by economic reasons and difficult weather conditions, particularly on the South Coast. The Area 8 fishery has still not been fished since the 2011 marine heat wave time (Roe's Abalone Figure 1) as annual surveys show no recovery in this area.

Recreational catch
Season 2013: Roe's Metro Fishery 20.1 tonnes

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

(32% of total catch)

The recreational catch for Roe's abalone from the Perth metropolitan area in 2013 was 20.1 t (Roe's Abalone Table 2). This was a slight increase of 8% from 2012 due to better weather conditions and an increase in effort.

Based on the Perth recreational fishery for 2013 (20.1 t), and using the 2007 phone diary estimate for the rest of the state (14 t), recreational fishing represented about 32% of the total (commercial and recreational) Roe's abalone catch (107 t) across the state in 2013.

Fishing effort/access level

Commercial

Total effort for dedicated Roe's abalone divers in 2013 was 457 diver days, an increase in last year's effort of 372 diver days (Roe's Abalone Table 1). However, the SCPUE of 24.1 kg per hour was the lowest on record and driven primarily by economic reasons, as divers targeted the largest sized abalone, which had reduced in abundance since 2011 marine heat wave.

Recreational

For the 2013 season, 15,949 licences were issued allowing abalone fishing which was 2% higher than last year (Roe's Abalone Figure 3). This was the third 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 2013 was 8,512 hours, a 7% increase from 2012 effort of 7,972 hours (Roe's Abalone Table 2) and the second lowest in the 14 years of data collection. This was primarily due to poor weather conditions. Since the introduction of the summer season in 2011/12 the average catch has been 20.3 t, 50% of the allocated TARC. This change to a summer season was part of ongoing adjustments in management as part of the resource sharing 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.

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 for the 2013/14 fishing season was 24.1 kg/hr, which was the lowest it has been (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).

As a consequence of the low SCPUE, TACC was lowered by 10% in the Area 2 and Area 7 fisheries for the 2014 fishing season.

The catch rate of recreational fishers in the Perth metropolitan fishery of 27 abalone/hour in 2013 was greater than the 2012 catch rate of 25 abalone per hour (Roe's Abalone Table 2).

Stock surveys: Densities of sub-legal animals (less than 60 mm in size) on the platform habitat of the fished stocks in 2014 were 18 abalone m^{-2}, a drop of 7 m^{-2} compared with 2013 and a 35% drop since 2010 (Roe's Abalone Table 4). Within the subtidal habitat, densities of sub-legal animals have also decreased and are back to densities recorded in 2008. Densities of legal-sized animals (60+ mm) on the platform habitat are similar in 2014 (7 m^{-2}), compared to 2013 (Roe's Abalone Table 4). With the significant decline in recreational catch in the last three years, legal-size densities should begin to recover towards historical levels.

In the subtidal habitat, legal-sized densities were 7 abalone m^{-2} in 2014, which is similar to 2013 (8 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 approximately 3 times the densities in fished stocks, however have also declined significantly since 2009 (Roes Abalone Table 4). For sub-legal animals on the platform habitat, densities have significantly declined between 2010 (58 m^{-2}) and 2014 (17 m^{-2}) and are now similar to that for fished stocks (18 m^{-2}) (Roes Abalone Table 4). In the sub-tidal habitat of the Waterman's Reserve, the major declines in 2013 have continued into 2014 with both legal (10 m^{-2}) and sub-legal sized stocks (1 m^{-2}) being 50% and 80% lower than in 2012. 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 2013 the standardised CPUEs were within the agreed ranges in most 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 and Area 7 fisheries, due primarily to poor economic and adverse weather conditions. TACC was reduced by 10% in the Area 2 and Area 7 fisheries as the performance indicator was below the threshold reference point.

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.

Listed species interaction: Negligible

The only potential listed 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 15,900 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 2013:

Level 2 - $1 -5 million ($1.9 million)

The estimated average price for Roe's abalone in 2013 was $26.20/kg. This value was slightly higher than the value in 2012. On the basis of the average price, the fishery was worth approximately $1.9 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 largely to the value of the Australian dollar, which increased from $US0.6 in 2000 to >US$1.00 in 2011, and has since dropped back to an average of $0.92 for the 2013 season. 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 457 diver days and SCPUE of 24 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. However abundance of large animals is also considered to have dropped, particularly in the Area 7 fishery, and consequently, TACC has been decreased by 10% in the Area 2 and Area 7 fisheries.

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 ± 2 t around the TARC (Total Allowable Recreational Catch) of 40 t.

The 5-year (2009-2013) moving average for 2013 was 31 t. This was outside the governance range, and was caused by significant reductions in effort from 2011 to 2013, due primarily to poor weather conditions coupled with a new fishing season.

As a result of reductions in legal-sized density of Roe's abalone on the platform habitats in the West Coast fishery (Roe's Abalone Table 4), the target catch range will be reviewed in this fishery during the 2014/15 season.

New management initiatives (2014/15)

The third year of the trial of a summer season for the West Coast Zone of the recreational fishery was undertaken for the 2013/14 summer. The season began on the first Sunday of November 2013 and extended till the first Sunday of March 2014, with fishing taking place between 7 and 8 am on the first Sunday of each month. Evidence from the first three seasons indicates a considerable drop in effort, due primarily to poor weather conditions, but also a reduction in effort, which occurred despite a relatively constant number of licenses, averaging around 15,500. For the 2014/15 season, the same number of fishing days will be kept, however a decrease in daily bag limit from 20 to 15 has been proposed. The objective of the bag limit decrease is to maintain low catches so as to promote an increase in density in the platform habitats, which have experienced significant declines in the last decade (Roes Abalone Table 4).

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

External Factors

During the summer of 2010/11, the West Coast experienced a marine heat wave with sea surface temperatures of up to 3 degrees above average (Pearce *et al.*2011). 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 estimated 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. The effect of the heat wave on the Perth metropolitan area stock is being evaluated.

The other 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	
1992/93	105,000	111,341	735	134	27.6
1993/94	128,000	115,281	832	123	29.3
1994/95	125,960	117,835	908	113	26.6
1995/96	125,960	114,501	1,047	98	27.5
1996/97	125,960	118,715	1,004	106	26.9
1997/98	126,790	118,738	855	120	31.9
1998/99	93,960[5]	86,425	695	108	27.2
1999/00[6]	119,900	112,949	659	149	29.1
2000/01	115,900	107,735	647	144	29.8
2001/02	107,900	99,174	685	126	29.4
2002/03	107,900	100,471	700	125	29.1
2003/04	110,900	96,005	723	118	27.3
2004/05	110,900	107,593	736	126	30.9
2005/06	112,700	96,496	672	131	32.3
2006/07	112,700	98,370	625	136	32.3
2007/08	109,700	90,750	585	132	27.7
2008/09	106,700	93,197	580	133	29.4
2009/10	101,800	92,838	554	140	29.9
2010/11	101,800	91,418	567	134	29.0
2011/12	92,800	81,607	426	157	29.3
2012/13	92,800	67,029	372	147	25.8
2013/14	92,800	73,239	457	133	24.1

Notes

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

ROE'S ABALONE TABLE 2

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

			Field Survey			
Year	Effort (hours)	Catch rate	Catch per fisher	Catch (number)	Catch (tonnes)	Mean weight (g)
1999	16,449	23	17.4	383,600	35.3	92
2000	15,818	21	16.7	330,300	30.2	91
2001	17,727	27	18.8	481,300	44.1	92
2002	18,127	22	17.9	401,500	36.0	90
2003	17,963	26	18.6	442,400	42.6	96
2004	14,614	24	19.0	342,900	31.7	93
2005	12,328	21	17.8	262,700	24.3	92
2006	10,435	29	18.9	297,000	30.2	101
2007	12,433	28	18.4	338,000	34.4	102
2008	14,490	29	18.2	420,000	44.4	106
2009	19,718	27	17.8	517,000	48.6	94
2010	18,010	26	18.7	468,000	43.9	94
2011	11,396	23	17.0	266,000	22.4	84
2012	7,972	25	17.9	205,493	18.6	90
2013	8,512	27	17.4	226,071	20.1	89

ROE'S ABALONE TABLE 3

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

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

1. Both areas are within the West Coast Bioregion.
2. Survey area is South Coast Bioregion (i.e. east of Black Point).

ROE'S ABALONE TABLE 4

Mean densities[&] (abalone/m^2) of sub-legal (<60 mm shell length) and legal-sized Roe's abalone (60 mm and over) from 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	32	25	25	21	2.7	8	7	19
1998	34	18	31	26	2.8	7	9	31
1999	36	18	31	18	2.4	4	8	20
2000	35	16	17	27	1.7	6	6	23
2001	33	16	23	23	2.4	6	6	22
2002	27	19	27	30	2.0	5	5	22
2003	20	16	22	29	2.5	6	3	19
2004	19	12	21	41	2.2	5	3	14
2005	18	11	30	31	3.1	6	7	16
2006	16	10	36	30	3.8	6	4	13
2007	20	10	25	29	3.2	7	6	16
2008	21	11	50	31	3.7	7	4	14
2009	26	10	50	35	4.5	7	7	18
2010	28	8	58	28	5.7	8	6	17
2011	28	7	45	24	4.8	7	5	17
2012	33	6	39	15	5.6	7	8	18
2013	25	7	17	17	4.9	8	4	13
2014	18	7	17	21	3.9	7	1	10

& Note that the GLM model used to estimate density in this report has changed from previous years. The overall trends in density have not altered, however values are approximately 30% lower than in previous reports.

ROE'S ABALONE TABLE 5

Assessment against agreed performance measures for 2013.

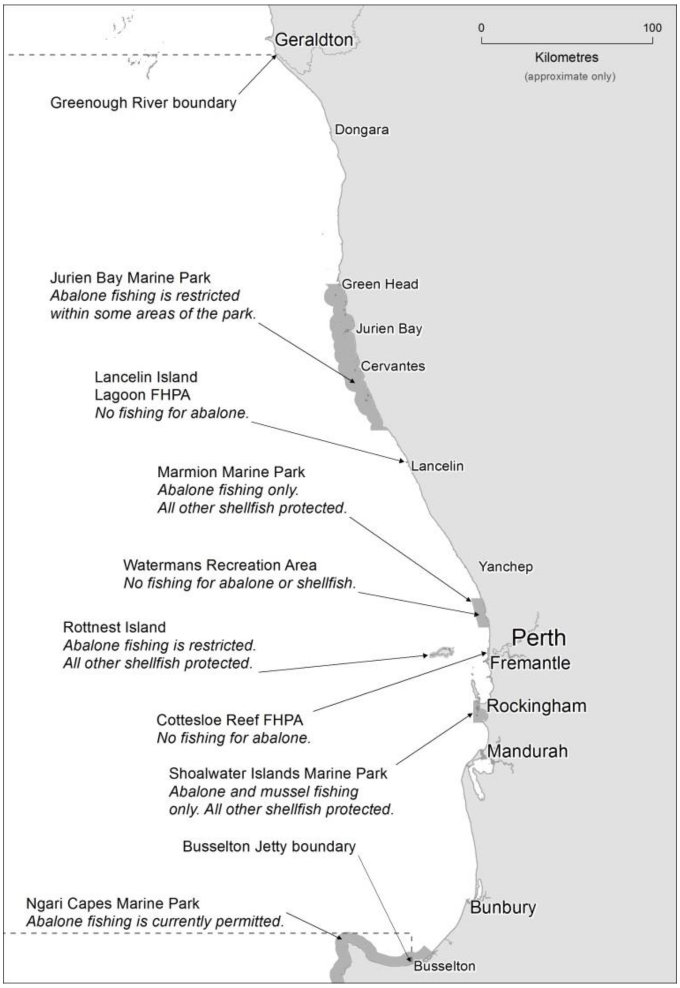
Performance Indicator	Performance Measure[1]	2013 Values	Assessment/Comments
Area 1			
Total catch (TACC)	5,000 kg	1,119 kg	Exploratory quota – limited fishing in 2013.
Effort range (Diver days)	14 – 43	2	See above.
Area 2			
Total catch (TACC)	19,800 kg	18,638	Met – 94% of quota caught.
Standardised CPUE	19 – 29	20	Met
Area 5			
Total catch (TACC)	20,000kg	10,487	Not Met – 52% of quota caught.
Standardised CPUE	15 – 23	17	Met
Area 6			
Total catch (TACC)	12,000 kg	6,992	Not Met – 58% of quota caught.
Standardised CPUE	17 – 25	14	Not Met
Area 7			
Total catch (TACC)	36,000 kg	36,000	Met – 100% of quota caught.
Standardised CPUE	29 – 42	29	Met.
Area 8			
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.

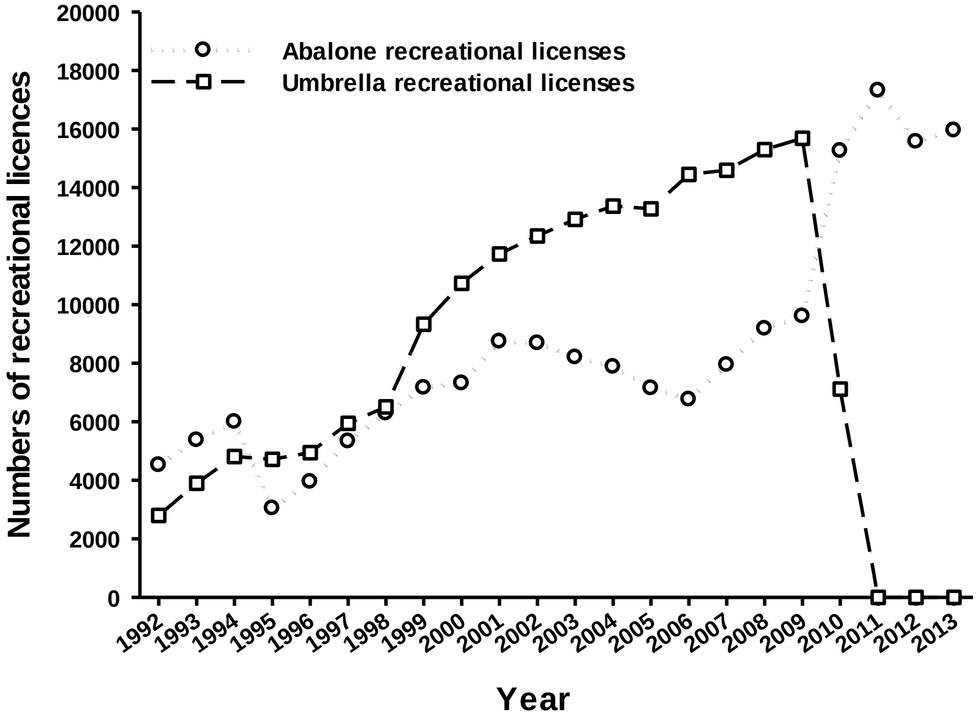
(a)



(b)

ROE'S ABALONE FIGURE 2

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



ROE'S ABALONE FIGURE 3

The number of licences issued in the recreational abalone fishery, by licence type, for the period 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, I. Koefoed, N. Blay, R. Oliver

Main Features

Status		Current Landings	
Stock level	Abrolhos - Environ. Limited	AIMWTMF:	Scallops nil (whole weight)
Fishing level	Acceptable	SWTMF:	Scallops 8 t (whole weight)
			Prawns 4 t
		SCTF:	Scallops 253 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 Managed Fishery 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

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

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

Consultation process

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.

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: An exemption provides for the use of trawl gear to fish for scallops and certain demersal scalefish within the specified waters off the South Coast of the State between 115˚30' east longitude and 125˚ east longitude on the landward side of the 200m isobath.

Management arrangements

AIMWTMF

The AIMWTMF (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 336.5 m (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, each 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 amendment is under development to remove the current headrope unitisation from the management plan and standardise nets in the AIMWTMF. The licence holders which operate in the AIMWTMF, also operate in the Shark Bay Scallop Managed Fishery using the same net configuration (two 12.8 m nets), hence standardising the nets used in the AIMWTMF will make fishing more cost effective for licensees.

In 2013, the AIMWTMF was not opened for scallop fishing for the second consecutive year, due to low scallop abundance triggered by unfavourable environmental conditions.

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 fishing 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 these areas but there are guidelines for exploratory fishing before any commercial trawl fishing can be undertaken.

The Commonwealth Government's Department of the Environment (DotE), has assessed the AIMWTMF under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. A delegate of the Minister for Environment 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 13 MFLs operating in this fishery, with some operating in more than one zone. The fishing season operates between 1 January and 15 November in Zones A and B, while 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. Additional management arrangements for the SCTF are set by conditions within the Instrument of Exemption and are aimed at ensuring the stock and environment are protected via gear restrictions and seasonal closures.

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

DotE has assessed the SCTF under the provisions of the EPBC Act and 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. Some pre-season surveys are also conducted by industry at Rottnest Island (as part of the SWTMF) and the South Coast to assess the abundance of scallops. An assessment of the marine heat wave effect, that commenced in the summer of 2010/11 and continued in the following two summers, on the scallop recruitment and spawning stock has been undertaken.

Retained Species

Commercial landings (season 2013)

AIMWTMF: **Scallops Nil whole weight**

SWTMF: **Scallops 8 tonnes whole weight**

Prawns 4 tonnes

SCTF: **Scallops 253 tonnes whole weight**

AIMWTMF

No scallop fishing occurred in this fishery during 2013 because the annual pre-season scallop survey showed scallop abundance below the limit reference level of the harvest strategy to commence fishing (West and South Coast Scallop Figure 1).

SWTMF

The recorded landings in the SWTMF for the season comprised 4 t of western king prawns and 8 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 after 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 2). Being a multi-species fishery, other products retained included 4 t of mixed whiting spp., and 1 t of blue swimmer crabs (*Portunus armatus*). All other landings (mixed fish) combined totalled 1 t.

SCTF

The scallop catch was 253 t (whole weight), which was higher than last year's catch of 116 t. There is generally low effort expended in this fishery and variable recruitment (West and South Coast Scallop Figure 3). Byproduct species landings were negligible, with Balmain bugs, cuttlefish, squid, octopus and mixed fish comprising a total landed byproduct catch of less than 1 t.

Recreational catch: **Nil**

Fishing effort/access level

AIMWTMF

In 2013 no commercial otter trawl fishing was undertaken in the AIMWTMF (West and South Coast Scallop Figure 4) including the Port Gregory area as a result of low abundance of scallops.

SWTMF

A total of 83 boat days were fished in the SWTMF in 2013; a decrease compared to 2012 (176 boat days). This is very low compared to the effort levels of previous years, especially the period between 1990 and 2003, where typically over 400 boat days per year were recorded. Low effort reflects the availability of boats to fish in this fishery; inclement weather conditions that restrict fishing time; and the rising cost of fishing. There has also been a reduction of boats fishing because of a buy-out of commercial licenses in two zones of the fishery. This allows one licensee to operate one boat whilst owning all three licenses in each zone, resulting in a reduction of effort and improved economic efficiency. There is, however, still potential for effort to increase markedly because of latent effort in this fishery.

SCTF

For the 2013 season five boats fished for scallops between January and July, recording a total of 193 boat days (West and South Coast Scallop Figure 5). 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 (2014)

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 mainly 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, water temperature. A pre-season survey is undertaken annually with very low recruitment since 2011. The 2012 recruitment survey abundance was the lowest observed since 1997, which is believed to be due to environmental conditions such as the La Niña climate pattern, strong Leeuwin Current which are associated with high water temperatures as well as the spawning stock due to the low recruitment the previous year. This low recruitment resulted in predicted landings that were less that the target range (95-1830 t whole weight) and therefore, the fishery was not opened for 2013. The very low recruitment would have also resulted in subsequent low breeding stock in 2012/13. The 2013 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 2014 were again below the target range so the fishery will not open. It may take a number of years of good environmental conditions for the spawning stock and recruitment to improve.

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 2013 fishing season was not fished due to the low stock available, which was all left as 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. Fishing activity is largely dependent on how widespread settlement is each season, with scallops settling on relatively bare sand habitats. The overall extent of the fishery is 3808 square nautical miles, with 2420 square miles (64% of the overall extent) being the permitted trawl area. No fishing was undertaken in 2013.

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

Listed species interaction: Low

While turtles do occur in the Abrolhos Islands, it is towards the southern extent of their range, and they do not breed in the Abrolhos Islands area because water temperatures are generally too low. Consequently, interactions with turtles were always minimal and their capture should be negligible now that grids are compulsory in the fishery. Aside from migrating humpback whales that usually avoid trawl boats; and occasional white sharks, few other endangered, threatened and protected species are sighted in this area. In the SWTMF and SCTF endangered, threatened and protected species do not occur regularly in the fishing areas, despite frequenting the surrounding waters. There were no recorded captures of listed species in 2013 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 is 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 2013 was nil in the AIMWTMF, 6 in the SWTMF and 12 in the SCTF.

Economic Effects

Estimated annual value (to fishers) for year 2013:

AIMWTMF Level 1 - $ Nil

SWTMF: Level 1 - $0.1 million

SCTF: Level 1 - $1.5 million

For the SWTMF and the SCTF the estimated value of the scallop catch is based on the wholesale price per kilogram (beach price) obtained from these fisheries, which is $5.8/kg whole weight respectively. The South West trawl is a niche fishery resulting in the king prawn price being higher value than the major fisheries and was deemed to be $22.50/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 2013.

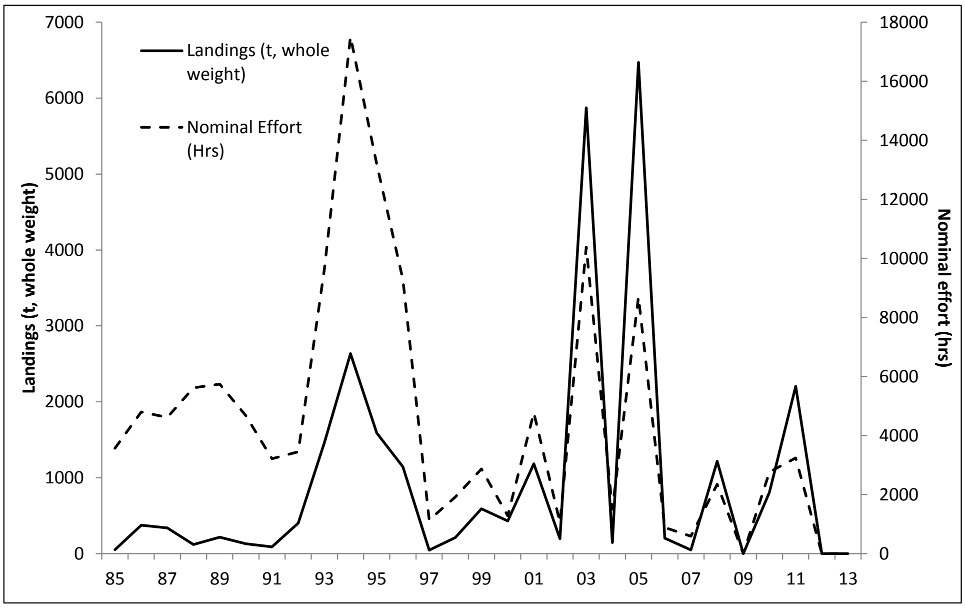
New management initiatives (2014)

Pre-assessment phase for the Marine Stewardship Council approval system is underway for all three fisheries.

The Department is continuing to progress a management plan amendment in consultation with licensees to incorporate changes to gear arrangements for the AIMWTMF to standardise gear specifications with the Shark Bay Scallop Managed Fishery and eliminate the need for the current licence conditions and exemption.

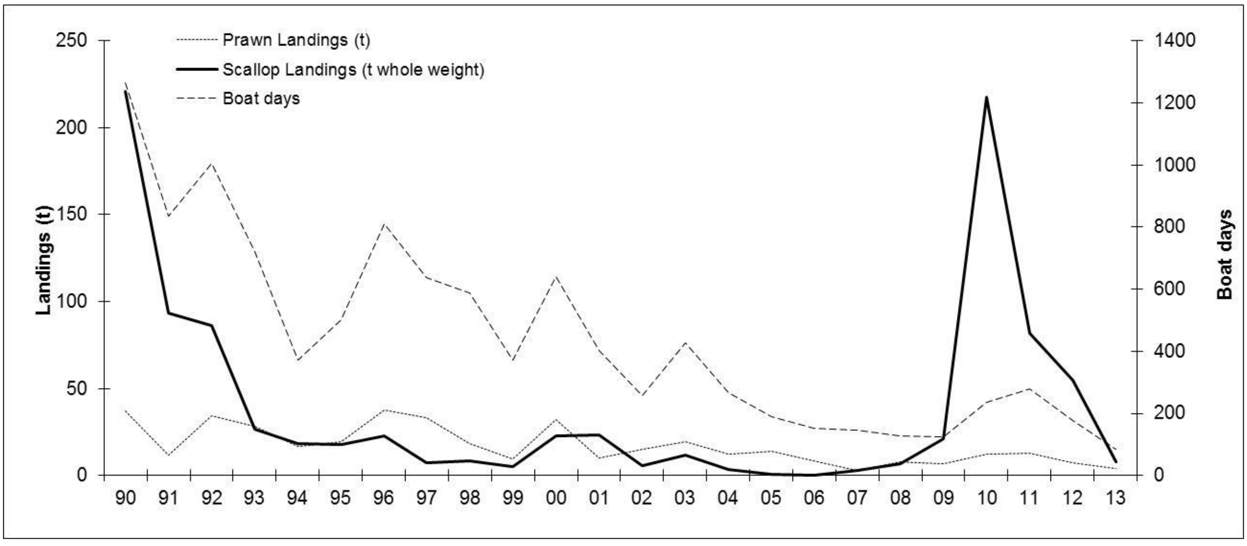
External Factors

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 climate pattern and strong Leeuwin Current. This very low recruitment would have resulted in subsequent low breeding stock in 2011/12. The low 2012 and 2013 recruitments were probably influenced by environmental conditions as well as the continuance of low breeding stock from the previous year. 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, as well as the importance of meat quality and size (for marketing purposes) in the current economic climate also factor in determining the amount of effort expended in these fisheries.



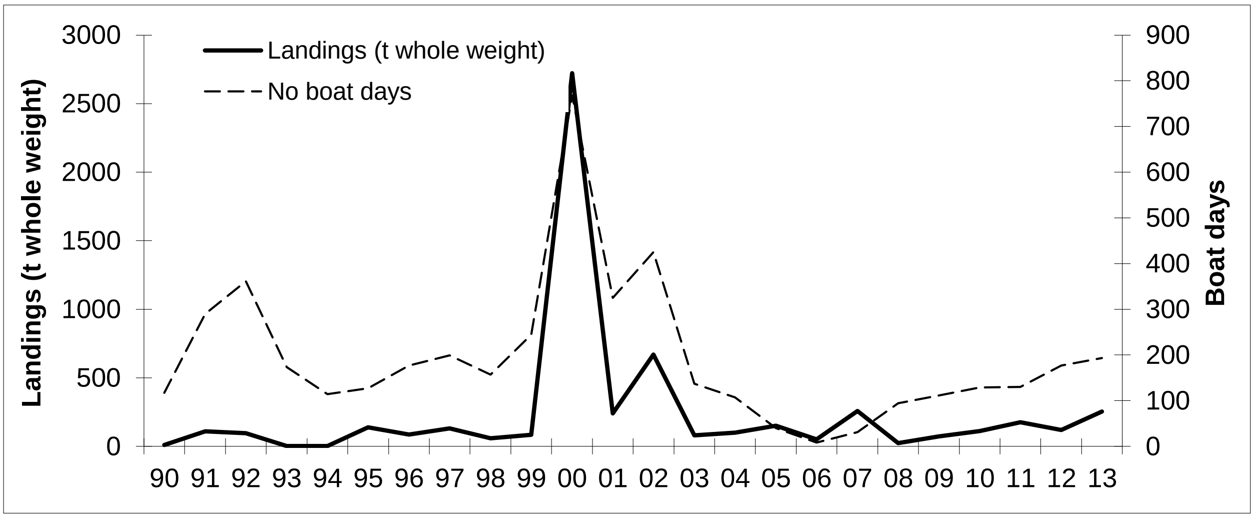
WEST AND SOUTH COAST SCALLOP FIGURE 1

Annual Scallop Landings and Nominal Effort for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985 – 2011. Note no fishing in 2013.



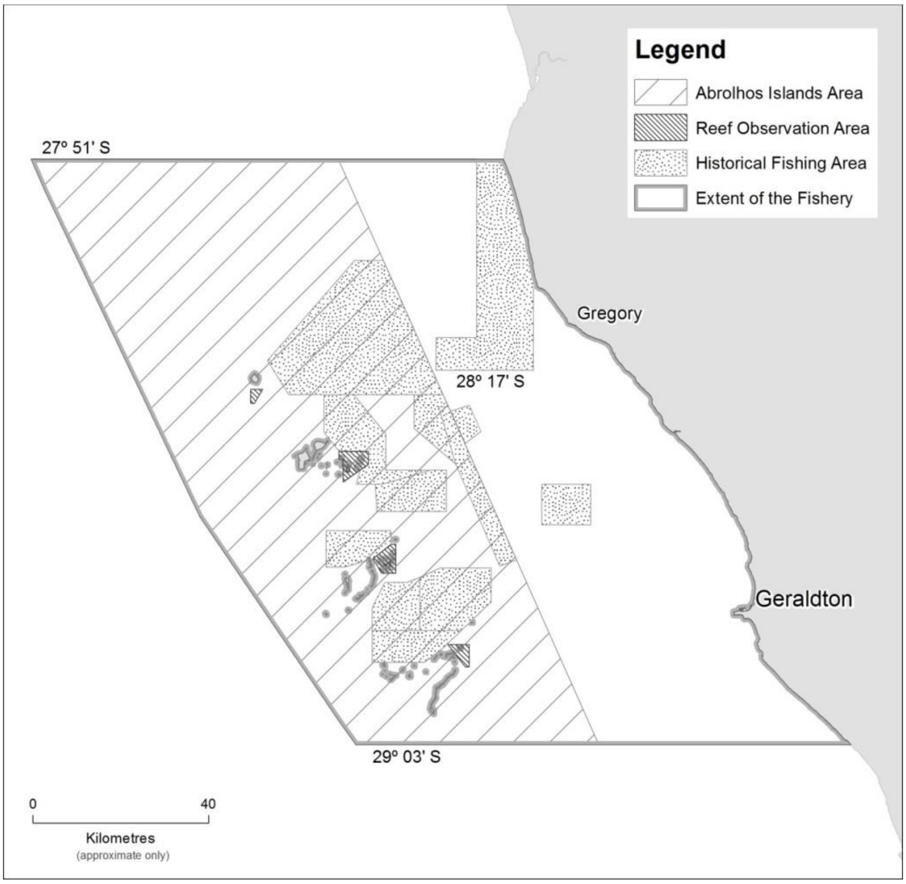
WEST AND SOUTH COAST SCALLOP FIGURE 2

Annual Scallop and Prawn Landings and number of boat days for South West Trawl Fishery, 1990 – 2013.



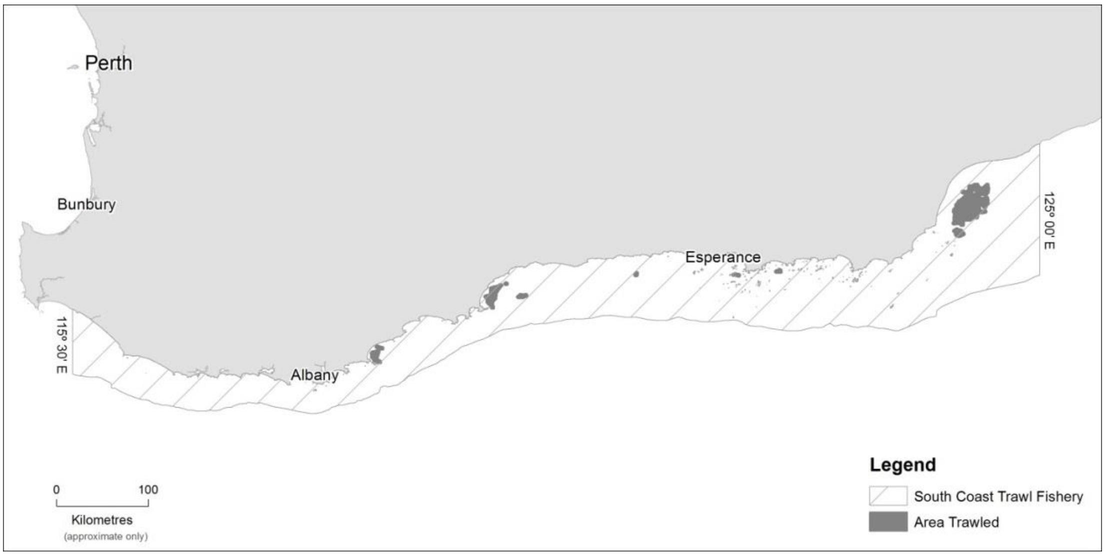
WEST AND SOUTH COAST SCALLOP FIGURE 3

Annual Scallop Landings and number of boat days for South Coast Fishery, 1990 – 2013.



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 2013.



WEST AND SOUTH COAST SCALLOP FIGURE 5
Boundaries of the South Coast Trawl Fishery and extent of fishing in 2013.

West Coast Blue Swimmer Crab Fishery Status Report

D. Johnston, R. Evans, M. Foster, N. Blay and B. Rome

Main Features

Status		Current Landings	
Stock level		Total Commercial catch (2012/13)	215 t
Cockburn Sound	Environmentally Limited	Cockburn Sound	62 t
Peel-Harvey Estuary	Acceptable	Peel-Harvey Estuary	102 t
Fishing Level		Catch by other commercial fisheries	51 t
Cockburn Sound	Acceptable	Total Recreational catch	
Peel-Harvey	Acceptable	West Coast Bioregion (boat-based) (Mar 11 - Feb 12)	87 t
		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 inter-tidal zone to at least 50 metres in depth. However, the majority of the commercially and recreationally fished stock is concentrated in the coastal embayments between Geographe Bay (in the south) and Port Hedland (in the north).

The commercial blue swimmer crab fisheries within the West Coast Bioregion are the Cockburn Sound (Crab) Managed Fishery, the Warnbro Sound (Crab) Managed Fishery, Area 1 (the Swan-Canning Estuary) and Area 2 (the Peel-Harvey Estuary) of the West Coast Estuarine Managed Fishery and Area 1 (Comet Bay) and Area 2 (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 by-product by trawlers operating in Comet Bay (Zone D of the South West Trawl Managed Fishery), and occasionally by trawlers operating in the waters from Fremantle to Cape Naturaliste (Zone 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 1994 and Fish Trap Restrictions Notice 1990

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 (Area 1) and the waters of the Peel Inlet and Harvey Estuary, together with the Murray, Serpentine, Harvey and Dandalup Rivers (Area 2).

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°16´ 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 two 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 address 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 – 130 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) (West Coast Blue Swimmer Crab Table 1).

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 (Crab) Managed 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*., 2011a[1], 2011b[2], 2014[3]; State of Fisheries Reports, 2010, 2011, 2012 and 2013).

1 Johnston, D., Harris, D., Caputi, N. and Thomson, A. 2011a. 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. 2011b. Status of the Cockburn Sound Crab Fishery. Fisheries Research Report No. 219. Department of Fisheries, Western Australia. 104pp.

3 Johnston, D., Chandrapavan, A., Wise, B. and Caputi N. 2014. Assessment of blue swimmer crab recruitment and breeding stock levels in the Peel-Harvey Estuary and status of the Mandurah to Bunbury developing crab fishery. Fisheries Research Report No. 258.

There was slight easing of commercial 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 as 2011/12 season).

The following management controls were implemented:

- a commercial size limit of 130 mm for male crabs and 130 mm for female crabs;
- a recreational size limit of 127 mm;
- a limited commercial season from 15 December 2012 to 15 June 2013; and
- a limited recreational season from 15 December 2012 to 31 August 2013.

In October 2013, a review of the stock status of the crab stock in the Fishery was conducted. The review highlighted a number of concerns with the crab stock, including a low level of recruitment a decrease in the breeding stock and overall abundance of crabs. In response to these concerns an adaptive management approach was introduced at the start of the 2013/14 season. This management approach involved conducting regular on-board monitoring surveys, as well as collecting monthly catch and effort information from the commercial fishery. An additional review of the data from these surveys was conducted in March 2014 resulting in an early closure to the fishery. Commercial fishers voluntarily ceased fishing on 16 April 2014 and a closure to recreational fishing was implemented on 1 May.

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 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 provides information on stock size structure and sex ratios.

In addition, fishery-independent direct surveys generating recruit (0+ year), residual (1+) and breeding stock indices, along with data on the general crab population, have been conducted in Cockburn Sound for approximately 12 years and in the Peel-Harvey for 7 years. The biological indices of abundance have been used in the stock assessment and management of the Cockburn Sound crab fishery for many years. An internal review of the egg production index and the subsequent stock-recruitment-environment relationship is currently underway. In addition, biological parameters such as growth and maturity are under review, and an integrated model will be developed in the future to incorporate the abundance indices along with biological information.

Biological indices of abundance for recruit (catch rate of juveniles as defined by size at maturity males <87.1 mm CW and females <86.9 mm CW) and breeding stock (catch rate of sexually mature females) are being developed for the Peel-Harvey crab fishery for the future stock assessment of this fishery.

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.*, 2011a). 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.*, 2011b). Reports on the population status of the Peel-Harvey Estuary crab stock, and the 2007/08 recreational crabbing survey in the Peel-Harvey Estuary, have been finalised (Johnston *et al.*, 2014). The latest summary of the stock status, current research and stock assessment analyses of crab fisheries in the Swan River, Cockburn Sound, Peel-Harvey, Warnbro Sound, Mandurah-Bunbury and Comet Bay is presented in stock assessment reports generated for the Marine Stewardship Council assessment process.

A new 3-year project funded through the Recreational Fishing Initiatives Fund commenced 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. This project incorporates a logbook program for recreational fishers in each area and through fishery-independent surveys is investigating recruitment and breeding stock in the three areas.

Retained Species

Commercial landings (season 2012/13):

	Total 215 tonnes
Cockburn Sound	**62 tonnes**
Peel-Harvey Estuary	**102 tonnes**
Other west coast commercial fisheries	**51 tonnes**

The total commercial catch from the West Coast Bioregion in 2012/13 was 215 t, representing a 15% increase on the 188 t taken in 2011/12. This increase was primarily due to significant increases in crab catch from Cockburn Sound and the Peel-Harvey Estuary. This catch accounted for 78% of the state commercial blue swimmer crab catch of 277 t for 2012/13 (West Coast Blue Swimmer Crab Figure 1).

The commercial catch from the Cockburn Sound Crab Managed Fishery for 2012/13 was 62 t, a 35% increase from the 46 t caught during the 2011/12 season (West Coast Blue Swimmer Crab Figure 2).

The commercial catch from the Peel-Harvey Estuary (Area 2 of the West Coast Estuarine Managed Fishery) for 2012/13 was 102 t. This represents a 26% increase on the 81 t landed in 2011/12 and similar to the highest catch achieved in 2006/07 (West Coast Blue Swimmer Crab Figure 3).

The Mandurah to Bunbury Developing Crab Fishery (Area 1 and Area 2) reported a total annual catch for 2012/13 of 15 t, representing an 11% decrease on the 17 t reported for the 2011/12 financial year (West Coast Blue Swimmer Crab Figure 4). The trap fishery accounted for 13.5 t thus providing the majority of the Mandurah-Bunbury catch with only 1.6 t being taken by the South West Trawl Fishery.

Recreational catch estimate for West Coast Bioregion (boat-based) (Mar 11 - Feb 12)

87 tonnes

Recreational catch estimate: Peel-Harvey Estuary (boat and shore) (Nov 07 - Oct 08)

107-193 tonnes

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 statewide survey of boat-based recreational fishing in 2011/12 coming from this area (Ryan *et al.* 2013)[1]. The survey was conducted between 1st March 2011 and 29th February 2012 and was collaboration between the Department of Fisheries, Edith Cowan University and Recfishwest. Approximately 3,000 fishers from the "Recreational Fishing from Boat" license database participated in a 12 month phone-diary survey in conjunction with boat ramp surveys of boat-based fishers. Catch data were recorded in numbers of crabs, and have been converted to weight for this report using a mean statewide estimate of 229 g/crab (based on 382 crabs weighed during the boat ramp surveys). The survey provided a statewide boat-based recreational estimate of retained blue swimmer crabs for the 12-month period of 97 t. The boat-based estimate for the West Coast Bioregion was 87 t, compared with total landings of 174 t by the commercial sector over the same period.

A 12-month recreational catch and effort survey in the Peel-Harvey Estuary was completed in October 2008. This survey covered fishing from boats, shore, canals, and houseboats. Recreational catch for the Peel-Harvey Estuary from November 2007 to October 2008 was estimated to be between 107-193 t, compared to the recreational catch estimate of 251-377 t from the last survey 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 (Sumner and Williamson 1999[2]; Sumner and Malseed 2004[3]; Bellchambers *et al.* 2005[4]). However, the recreational catch for the 2005/06 financial year was estimated to be just 4 t (Sumner and Lai 2012[5]). It should be noted that these figures are likely to under-estimate the total recreational blue swimmer crab catch in each of these years, as the surveys commenced at various times between 7am and 9am and finished between 4pm and 8pm so missed any crabbing activity that potentially occurred before or after the survey began or finished.

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 commercial and 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 32º05'S), Shoalwater Bay and the northern half of Warnbro Sound (north of latitude 32º20'S). However, the survey covered only the period during the day between 9am and 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 resulting in a total recreational catch estimate of 34 t. 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 annual boat-based recreational fishing effort as 22,265 fisher days, with 44% of this effort targeting blue swimmer crabs (Sumner and Malseed 2001[6]). The total annual shore-based recreational fishing effort was estimated to be 8,073 fisher days, with only 9% of this effort targeting blue swimmer crabs. The estimated total recreational blue swimmer crab catch between August 1998 and July 1999 was 7.3 t, which 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 low crab stocks, the Cockburn Sound (Crab) Managed Fishery partially re-opened from the 2009/10 fishing season. Commercial fishers in Cockburn Sound reported a total of 78,515 trap lifts for the 2012/13 season, a 3% increase on the 76,190 trap lifts during the 2011/12 season (West Coast Blue Swimmer Crab Figure 2).

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.

2 Sumner , N.R. and Williamson, P.C. 1999. A 12-month survey of coastal recreational boat fishing between Augusta and Kalbarri on the west coast of Western Australia during 1996-97. Fisheries Research Report No. 117. Department of Fisheries, Western Australia. 52 pp.

3 Sumner, N. R. and Malseed, B. E. 2004. Quantification of changes in recreational catch and effort on blue swimmer crabs in Cockburn Sound and Geographe Bay. Final Report on FRDC Project No. 2001/067. Fisheries Research Report No. 147. Department of Fisheries, Western Australia.

4 Bellchambers, L., Sumner, N. and Melville-Smith, R. 2005. Development of stock allocation and assessment techniques in Western Australia blue swimmer crab fisheries. Final Report to the Fisheries Research and Development Corporation on Project No. 2001/068. Department of Fisheries, Western Australia. 205 pp.

5 Sumner, N. and Lai, E. (2012). Boat-based Recreational Fishing Catch and Effort in Cockburn Sound and Owen Anchorage during 1996/97, 2001/02 and 2005/06. Fisheries Research Contract Report No. 23. Department of Fisheries, Western Australia. 16p.

6 Sumner, N. R. and Malseed, B. E. 2001. A 12-month survey of recreational fishing in the Peel-Harvey Estuary of Western Australia during 1998-99. Fisheries Research Report No. 127. Department of Fisheries, Western Australia. 52p.

Commercial fishers in the Peel-Harvey Estuary reported 68,646 trap lifts during the 2012/13 season – representing a 42% increase on the 48,263 trap lifts in the previous year and the second highest on record (West Coast Blue Swimmer Crab Figure 3).

Commercial effort in Area 1 and Area 2 of the Mandurah to Bunbury Developing Crab Fishery decreased by 19% in 2012/13, with a total of 17,178 trap lifts reported compared to 21,172 trap lifts the previous year (West Coast Blue Swimmer Crab Figure 5), primarily due to the decrease in fishing effort in Comet Bay.

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 **Environmentally limited**

Peel-Harvey **Adequate**

Other West Coast fisheries **Adequate**

Catch rates from fisheries within the West Coast Bioregion generally provide an index of abundance that can be used to assess individual fishery performance from year-to-year. 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 approximately twelve years and in the Peel-Harvey for seven years.

Cockburn Sound: Historically, natural variations in stock abundance have resulted in large fluctuations in the annual commercial blue swimmer crab catch from Cockburn Sound. This fluctuation relates largely to variable recruitment dependent on environmental conditions, although the shift by commercial fishers from set nets to crab traps in the mid-1990s initiated a marked increase in effective effort and mean annual crab landings.

Following the second highest annual catch on record in 2000 (326 t) the catch declined over the next few years to the point where the low stock abundance required closure of the fishery (in December 2006) for three years.

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 in 2006 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 gillnets 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 during winter/spring 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 partially re-open the crab fishery for the 2009/10 fishing season.

The catch in 2012/13 of 62 t was higher than the previous year's catch of 46 t from a similar level of effort (78,515 trap lifts) due to the lowering of the minimum size for female crabs from 135 to 130 mm, and the moulting of the majority of sublegal crabs to legal size (130 mm CW) in December and January. The relatively low catch of 46 t in 2011/12 was generated by the very high proportion of undersize crabs present in Cockburn Sound which resulted in only a low proportion of legal-sized crabs being present through the season. The reason for this was suggested to be from a reduced level of moulting.

Nominal CPUE at the beginning of the 2012/13 season were high (January, February and March; 0.9-1.0 kg/traplift) but decreased significantly (to 0.5 and 0.4 kg/traplift) by May and June. These low values of CPUE are similar to those observed in the years immediately preceding the closure of this fishery in 2005 and 2006. This indicated that residual legal stock levels were lower in 2013 compared to the high levels in 2012 but still higher than the low levels occurring up to the mid- 2000s. This was confirmed by information obtained by observers on board commercial vessels which found crab numbers for June in particular, were very low. The overall nominal catch rate for 2012/13 was 0.8 kg/traplift for this fishery.

Juvenile index: Based on the juvenile (0+) catches sampled in research trawls, the recruitment of juvenile crabs within Cockburn Sound in 2013 was very low. The juvenile index for 2013 of 0.15 is considerably lower than the past six years (2007-2012), and similar to the level observed when the fishery was closed in 2006 (West Coast Blue Swimmer Crab Figure 6).

Residual index: The abundance of residual crabs (1+), as observed in commercial monitoring length frequencies, was relatively low in 2013. The RI of 7.2 is lower than the previous four years (2009-2012), but higher than during the period when the fishery was closed between 2006 and 2009 (West Coast Blue Swimmer Crab Figure 6).

Egg Production index: The egg production (breeding stock) index during 2012/13 of 1.17 is lower than the previous three years but higher than the levels (2004/05-2007/08) that resulted in recruitment failure. The low levels of juvenile abundance observed in 2013 suggest, however, that the spawning potential of the breeding stock in the latter half of 2012 and early 2013 may have been impaired (West Coast Blue Swimmer Crab Figure 7).

The total number of sexually mature females (>87 mm CW) observed during commercial monitoring surveys between September 2012 and January 2013 and on the Research Vessel Naturaliste survey (October – December 2013) were within historical range. However, the proportion of berried females observed during commercial monitoring surveys between September 2012 and January 2013 was low compared with historical surveys, and at its lowest level (31%) for Naturaliste surveys undertaken between October and December since sampling began in 2007. Significantly, the cohort with the lowest relative numbers of berried females was that just above size at maturity (>87 mm CW) that would be spawning for the first time. Scaling the nominal egg production index using the proportion of berried females generates a substantially lower effective egg production index in 2012/13, which is consistent with the very low subsequent recruitment observed in 2013. The cause of low proportion of berried females is being investigated, particularly the effect of the lack growth to legal-size observed in the previous summer.

Peel Harvey: Annual commercial catches of blue swimmer crabs in the PHEF since 2000/01 have fluctuated between 45 t from 895 fisher days in 2002/03 and 104 t from 1657 fisher days in 2006/07. Crab catches have remained high in recent years, with a total commercial catch of 102 t (from 1517 fisher days) recorded in 2012/13 (West Coast Blue Swimmer Crab Figure 3).

Since complete gear conversion from nets to traps in 2000/01, annual commercial catch rates have fluctuated between 0.7 and 1.4 kg/trap lift, but have generally remained above 1 kg/trap lift. The nominal annual catch rate for 2012/13 in the Peel-Harvey Estuary was 1.49 kg/trap lift (West Coast Blue Swimmer Crab Figure 3). The 2012/13 catch rate is slightly lower than the 2011/12 catch rate of 1.68 kg/trap lift, which represented the highest catch rate since the fishery converted to crab traps.

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 fishery-independent surveys to complement the commercial logbook and monitoring data.

Mandurah to Bunbury: The Mandurah to Bunbury Developing Crab Fishery (Area 1 Comet Bay and Area 2 Mandurah-Bunbury) reported a total annual catch for 2012/13 of 15 t, representing an 11% decrease on the 17 t reported for the 2011/12 financial year (West Coast Blue Swimmer Crab Figure 4). The trap fishery reported 13.5 t and represents the majority of the Mandurah-Bunbury catch with only 1.6 t being taken by the South West Trawl Fishery.

Mean annual trap catch rates (kg/traplift) in Area 1 and Area 2 of 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 catch rate did decrease in 2010/11 but has remained relatively steady since, with a mean catch rate for 2012/13 of 0.79 kg/trap lift – a 0.6% increase on the 2011/12 catch rate of 0.78 kg/trap lift (West Coast Blue Swimmer Crab Figure 5).

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. This will need to be closely monitored to ensure overfishing the breeding stock does not occur.

Non-Retained Species

Bycatch species impact: Negligible

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

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

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

Listed species interaction: Negligible

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

Ecosystem Effects

Food chain effects: Low

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

Habitat effects: Negligible

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

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

Social Effects

During 2012/13, 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 Geographe Bay region, where they dominate the inshore recreational catch.

Economic Effects

Estimated annual value (to fishers) for year

2012/13: Level 2 - $1-5 million ($2 million)

The commercial blue swimmer crab catch in the West Coast Bioregion for 2012/13 was valued at approximately $2 million, a 21% increase on the $1.65 million generated in 2011/12. Most of the catch from the West Coast Bioregion was sold through local markets. Price data was generated by collecting monthly returns recording prices paid to fishers by fish processors, a weighted average price is then calculated for the financial year from the monthly data collected. Calculations for 2012/13 were set at $9.23 per kg for blue swimmer crabs in Western Australia.

The economic value of the total commercial blue swimmer crab catch for the State of Western Australia for the 2012/13 financial year was estimated to be $2.56 million – a 1% increase on the estimated $2.53 million generated in 2011/12.

Fishery Governance

Current fishing level

Cockburn Sound: Under review

Peel Harvey: 45 - 104 tonnes

Other West Coast fisheries: Under review

A catch range for Cockburn Sound crabs will need to be developed when the management arrangements and stock levels have 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 (2014/15)

In March 2013, the West Coast Estuarine (Interim) Management Plan cessation date was extended to expire on June 2014. The Minister for Fisheries approved transitioning the fishery from an interim managed fishery to a managed fishery and the new *West Coast Estuarine Managed Fishery Management Plan 2014* was gazetted in March 2014 and came into effect on 1 July 2014.

The new management plan increases the scope of the Fishery to incorporate Hardy Inlet and the sole fisher into the managed fishery. The licence holder in the Hardy Inlet has previously operated under an exemption to the Closed Waters Professional Netting (Rivers, Estuaries, Inlets and Lakes South of 23^{o}) and has not operated in the West Coast Estuarine Interim Fishery. The new management plan formalises fishery management arrangements and strengthens access rights for licence holders in the Fishery.

In response to concerns over the stocks within the Cockburn Sound fishery commercial fishers voluntarily ceased fishing on 16 April 2014 and a closure to recreational fishing was implemented on 1 May.

The Department is currently progressing formal management arrangements of the Mandurah to Bunbury Developing Crab Fishery through the development of an (Interim) Management Plan for the fishery. This is scheduled to be completed in early 2015.

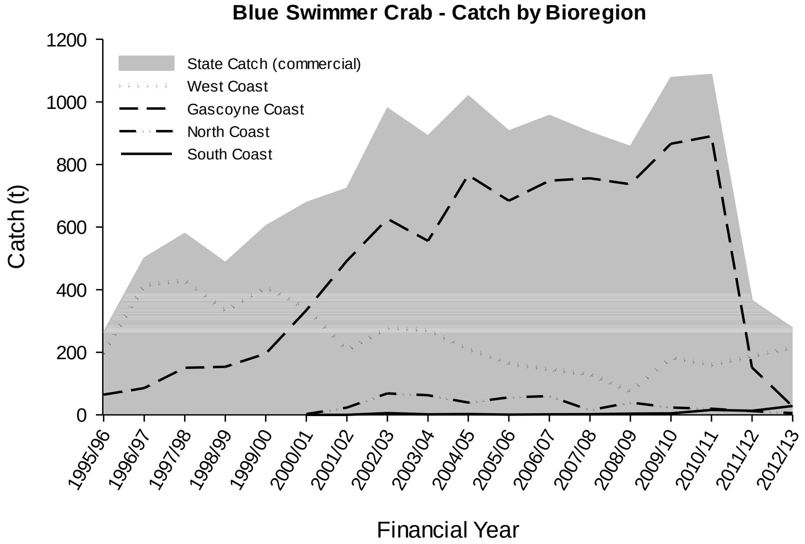
External Factors

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. The climate change implications associated with these environmental variables are also under consideration. The effect of the heat wave in the summer of 2010/11 and above average water temperatures on the following two summers on the spawning and juvenile phase of the crabs will be investigated as well as the cause of the low proportion of berried females in the 2012/13.

WEST COAST BLUE SWIMMER CRAB TABLE 1

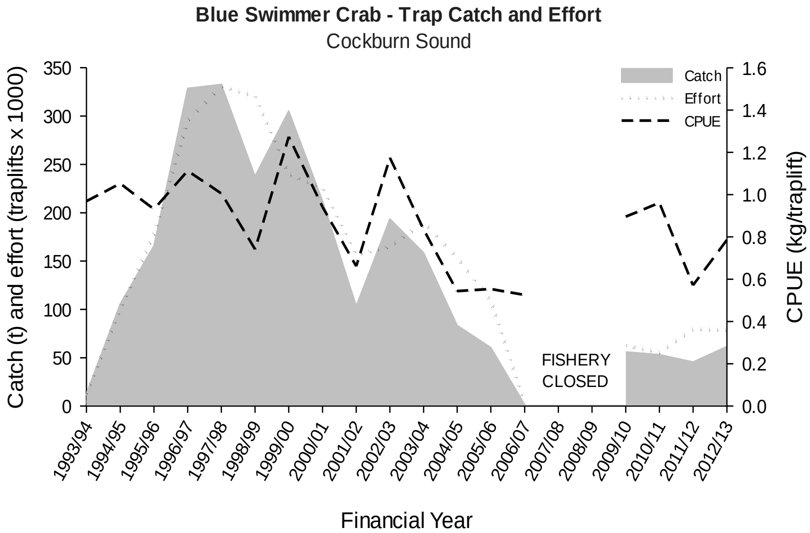
Minimum legal size (carapace width) for the West Coast Bioregion blue swimmer crab fisheries.

West Coast Bioregion Fishery	Minimum Legal Carapace Width
Area 1 of West Coast Estuarine Fishery (Swan-Canning Estuary)	127 mm
Area 2 of the West Coast Estuarine Fishery (Peel-Harvey Estuary)	127 mm
Cockburn Sound (Crab) Managed Fishery	130 mm
Warnbro Sound (Crab) Managed Fishery	127 mm
Mandurah to Bunbury Developing Crab Fishery (Area 1 - Comet Bay; Area 2 - Mandurah to Bunbury)	128 mm



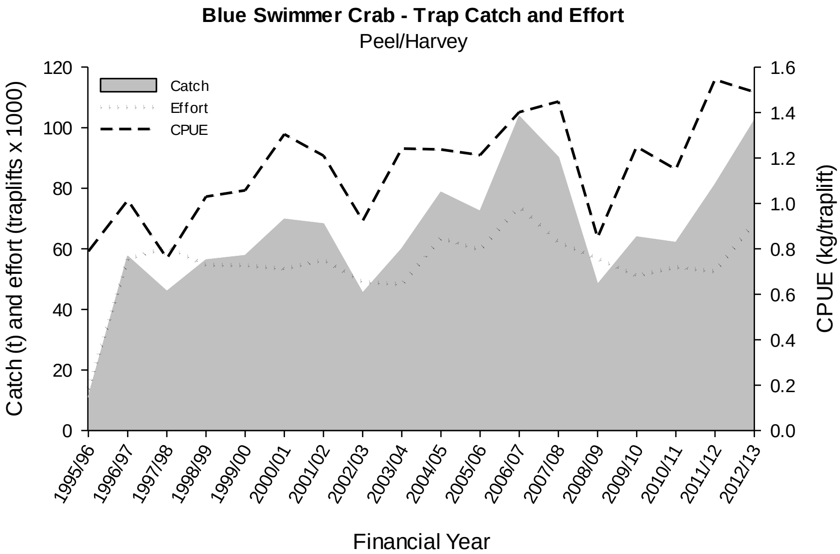
WEST COAST BLUE SWIMMER CRAB FIGURE 1

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



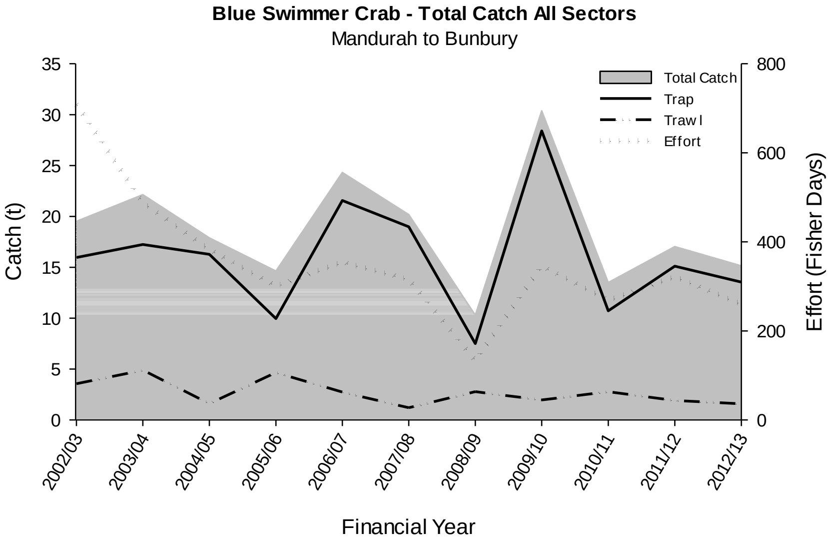
WEST COAST BLUE SWIMMER CRAB FIGURE 2

Blue swimmer crab catch (t), effort (traplifts x 1000) and catch per unit effort (kg/traplift) in the Cockburn Sound (Crab) Managed Fishery using crab traps since 1993/94.



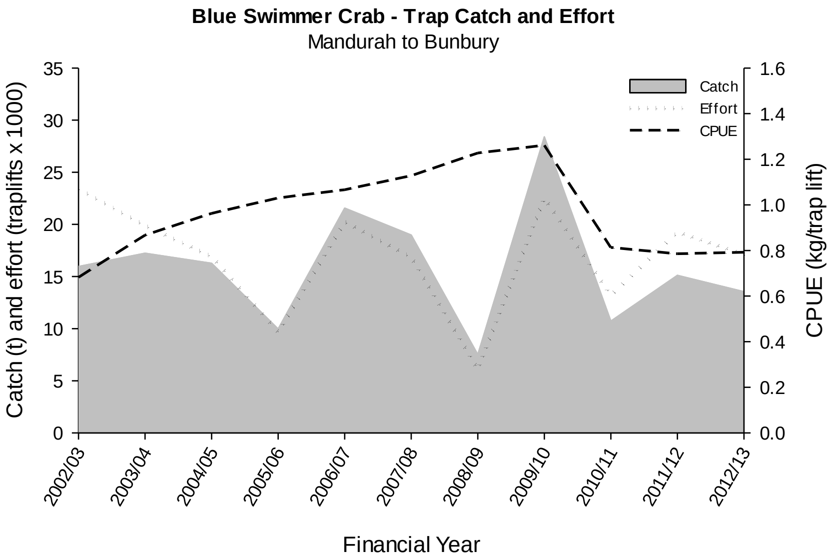
WEST COAST BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (t), effort (traplifts x 1000) and catch per unit effort (kg/traplift) in Area 2 of the West Coast Estuarine Managed Fishery (Peel-Harvey Estuary) using crab traps since 1995/96.



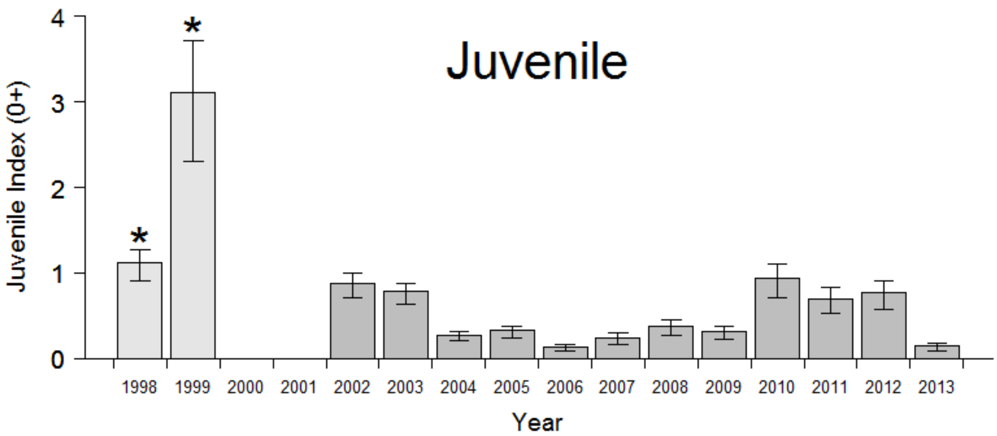
WEST COAST BLUE SWIMMER CRAB FIGURE 4

Blue swimmer crab total commercial catch (t), distinguishing between trap and trawl methods and total effort (fisher days) in Area 1 and Area 2 of the Mandurah to Bunbury Developing Crab Fishery since 2002/03.



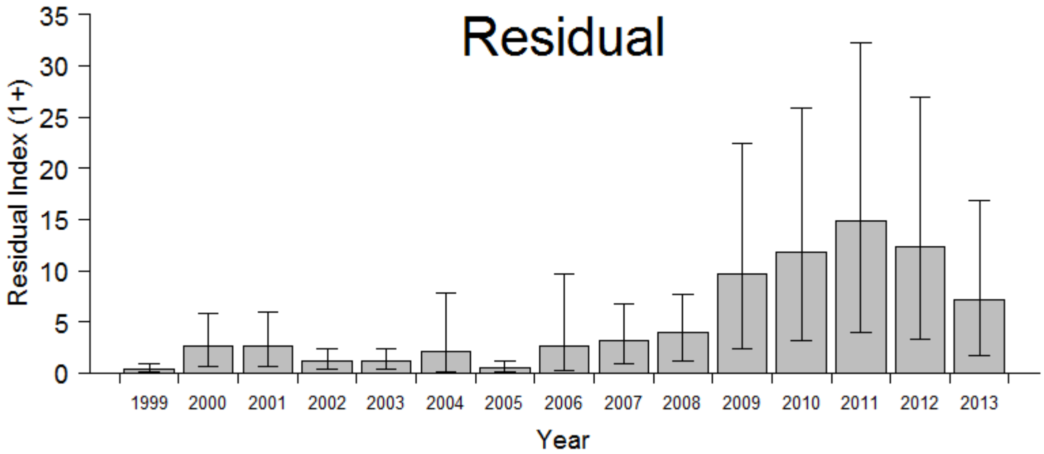
WEST COAST BLUE SWIMMER CRAB FIGURE 5

Blue swimmer crab trap catch (t), effort (traplifts x 1000) and catch per unit effort (kg/traplift) in Area 1 and Area 2 of the Mandurah to Bunbury Developing Crab Fishery since 2002/03.



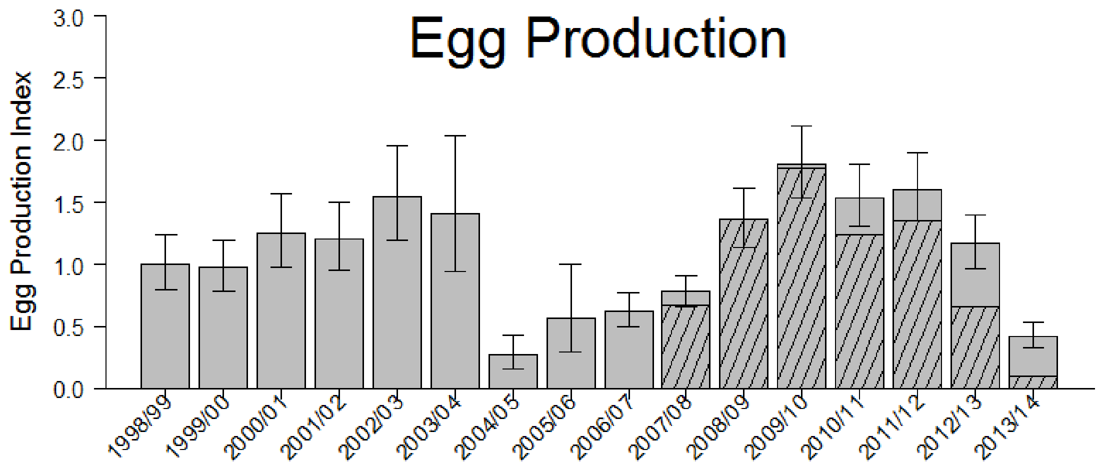
WEST COAST BLUE SWIMMER CRAB FIGURE 6

Annual standardised index of juvenile (0+) recruitment and residual (1+) blue swimmer crabs in Cockburn Sound calculated using data from juvenile research trawl conducted in April, May and June of each year. 95% confidence intervals are shown. * Daytime trawling (conversion factor (5.84) used for comparison with night trawling).



WEST COAST BLUE SWIMMER CRAB FIGURE 7

Annual standardised index of residual (1+) blue swimmer crabs in Cockburn Sound derived from catch monitoring surveys aboard commercial crab vessels in August and September of each year. 95% confidence intervals are shown.



WEST COAST BLUE SWIMMER CRAB FIGURE 8

Annual standardised breeding stock (egg production) index based on female crabs caught during all trawl surveys aboard the *RV Naturaliste* (2001-2013) and all catch monitoring surveys aboard commercial crab vessels in Cockburn Sound (1999-2013). This nominal Egg Production Index (EPI) is based on a size-fecundity relationship which assumes all sexually mature females will contribute to egg production (berried). However the proportion of berried females from Naturaliste surveys between 2007/08 and 2012/13 indicated a maximum of 55% in 2008 and was used as a reference year. An effective EPI was obtained through scaling the nominal EPI by the proportion of berried females relative to the reference year for the years berried data was available (diagonal lines). Note that 2013/14 index is preliminary as the data is only available to April 2014. 95% confidence intervals are shown.

West Coast Nearshore and Estuarine Finfish Resources Status Report

K. Smith, A. Quinn, M. Holtz and K. Nardi

Main Features

Status		Current Landings (2013)	
Stock level:		Commercial total	346 t (finfish only)
Australian herring	Inadequate	South West Coast Salmon Fishery	93 t (salmon only)
Southern school whiting	Adequate	West Coast Beach Bait & South West Beach Seine	
Tailor	Adequate	Fisheries	19 t (whitebait only)
Southern garfish	Inadequate	West Coast Estuarine Fishery	136 t (finfish only)
King George whiting	Adequate	Recreational total	
Sea mullet	Adequate	Most recent survey 2000/01	940 t (key species only)
Whitebait	Environ. Limited	Recreational boat-based	
Black bream (Swan-Canning)	Adequate	Most recent survey 2011/12	108 t (key species only)
Cobbler (Peel-Harvey)	Adequate		
Fishing level:			
Australian herring	Unacceptable		
Whitebait	Unacceptable		
Garfish (Cockburn Sound)	Unacceptable		
Other stocks	Acceptable		

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 gillnets and beach seine nets.

The Cockburn Sound (Fish Net) Managed Fishery uses haul nets in Cockburn Sound. The main target species are southern 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 beach 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

The West Coast Estuarine Managed Fishery (WCEF) operates in the Swan/Canning and Peel/Harvey estuaries, and in the Hardy Inlet. 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 gillnets and seine nets.

Five operators have a condition on their Fishing Boat Licence to operate in the Vasse/Wonnerup Estuary and Toby Inlet. The latter estuary system is only occasionally fished, yielding small quantities of sea mullet. These estuaries are not included in the WCEF 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 Management Plan 2014

West Coast Estuarine 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 - 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.

Commercial - Estuarine

WCEF: The management plan encompasses all estuaries in the West Coast Bioregion between 27º S and 34º22.715´ S. Complex closures exist for both the Swan/Canning and Peel/Harvey commercial fisheries (refer to management plans, related legislation and regulations). Waters of Hardy Inlet and the Blackwood River are open to commercial fishing upstream from a line connecting Point Irwin to the Irwin Street boat ramp to a line drawn across the river from the eastern boundary of Sussex Location 133 (approximately Great North Road).

Leschenault Estuary 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.

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[1]’ 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 gillnets, seine nets and haul nets.

Recreational

Recreational fishers in West Coast Bioregion nearshore and estuarine waters take a diverse array of finfish species. Size

1http://www.fish.wa.gov.au/Documents/recreational_fishing/licences/rec_licence_netting.pdf 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 2011[1]). 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 (*Cnidoglanis macrocephalus)* are indicators for the estuarine finfish suite. Although not indicators, 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 statutory 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, archived biological samples are used to estimate historical F levels to provide information on trends in fishing mortality.

A WA 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). In this project, the species composition of 'whiting' (*Sillago* spp.) landings within the West Coast Bioregion was investigated. 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 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.

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

Retained Species

Total commercial finfish landings (2013):

210 tonnes in nearshore waters

137 tonnes in estuarine waters

Commercial landings by fishery (2013):

South West Coast Salmon:

93 tonnes (western Australian salmon only)

WC Beach Bait + SW Beach Seine:

19 tonnes (whitebait only)

West Coast Estuarine: 136 tonnes (finfish only)

In 2013, 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 (29% by weight), western Australian salmon (27%), Australian herring (14%), whitebait (5%) and yelloweye mullet (5%) (West Coast Nearshore and Estuarine Table 1).

Catches are taken by these fisheries using gillnets, haul nets and beach seines. The minor quantities of the same species taken by other methods (e.g. purse seine, demersal gillnets and long-lines) are not included in Table 1, although the total catch by all methods and fisheries is taken into account during stock assessments.

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 are typically taken in the South Coast Bioregion, with the remaining 10-20% taken in the West Coast Bioregion. Consistent with this pattern, the 2013 South Coast Bioregion catch share was 84% with the majority of commercial landings taken by the ocean beach-based herring trap net fishery (also see South Coast Nearshore and Estuarine Finfish Resources Report). In 2013, this fishery reported 77% of the total commercial herring catch in WA and 91% of the total commercial herring catch in the South Coast Bioregion. In 2013, the remainder of the South Coast commercial catch was taken in estuaries (7%) and in nearshore ocean waters (2%).

Within the West Coast Bioregion in 2013, 51% of Australian herring landings were taken in the Geographe Bay/Bunbury area, 31% taken in Cockburn Sound and 6% taken in the Peel-Harvey Estuary.

In the South Coast Bioregion, the total annual commercial Australian herring catch reached an historical peak of 1,427 t in 1991 and then steadily declined to an historical low of 110 t in 2011 (West Coast Nearshore and Estuarine Figure 1). In

2013, the South Coast total Australian herring catch was 251 t. Recent low catches in the South Coast Bioregion reflect 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 (West Coast Nearshore and Estuarine Figure 1). Annual landings 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) in response to the reduced availability of fish. In 2013, the West Coast total catch was 47 t.

Nationally, commercial landings of Australian herring peaked at approximately 1,800 t per year in the late 1980s and early 1990s and steadily declined thereafter. 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 2013, total WA landings were 298 t. In SA, landings peaked at 498 t in 1987/88 and reached an historical low of 99 t in 2011/12 in SA[1]. 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 40% 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 24 t taken commercially in 2013.

Relatively low quantities of southern school whiting are taken commercially in the West Coast Bioregion (less than 5 t in 2013).

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 2013, the total WA commercial catch of tailor was 31 t, the majority of which was taken in the Gascoyne Coast Bioregion (49% by weight), with the remainder from the West Coast Bioregion (44%) and South Coast Bioregion (7%).

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 2013, the Gascoyne catch was 15 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 14 t in 2013. The majority (89%) of West Coast landings in 2013 were taken in the Peel-Harvey Estuary.

Southern garfish: In 2013, 24% 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. A historic minimum catch of 4 t was taken in 2013. 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 2013).

The long-term decline in Cockburn Sound catch was partly due to a reduction in commercial effort. However, annual effort levels have been stable since 2003, and so the recent catch decline is believed to be due to a decline in the availability of fish driven by a combination of environmental factors and fishing pressure.

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 WA stock.

Annual landings of King George whiting are typically highly variable, mainly reflecting variations in juvenile recruitment due to environmental factors. In 2013, 2 t of King George whiting was taken commercially in the West Coast Bioregion, representing 15% of the total annual commercial catch in WA with the remainder taken in the South Coast Bioregion.

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 2013, the WA total catch was 172 t. In 2013, 57% of the total WA catch was taken in the West Coast Bioregion, 22% in the Gascoyne Coast Bioregion and 21% in the South Coast Bioregion.

1 Fowler, A.J., McGarvey, R., Steer, M.A. & Feenstra, J.E. (2013). The South Australian Marine Scalefish Fishery Status Report - Analysis of Fishery Statistics for 2012/13. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000565-8. SARDI Research Report Series No. 747. 44 pp.

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 3). After 1988, the total annual catch in the West Coast Bioregion gradually declined. The relatively steep decline during 1988-2004 was attributable to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of VFAS (licence buy-backs) operating since 1990. Minor variations in the catch since 2004 are due to annual changes in targeted effort. In 2013, total West Coast Bioregion landings were 97 t. In 2013, 71% of total commercial landings of sea mullet in the West Coast Bioregion were taken in the Peel-Harvey Estuary and the majority of 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 2013, the catch was 37 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 2013, 54% of total commercial landings of sea mullet in the South Coast Bioregion were taken in Wilson Inlet, 27% in Oyster Harbour, 6% in Stokes Inlet, 4% in Beaufort Inlet and 2% in Princess Royal Harbour. Minor sea mullet landings were also reported in 4 other estuaries in 2013.

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. The majority of landings are taken during December-March. 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 2012/13, the total catch was 13 t, all of which was landed in Area 1. This is the lowest whitebait catch since the commencement of the fishery in the early 1970s.

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 2003/04, virtually all (98%) whitebait landings have been in Area 1. Annual landings in this Area followed a relatively stable trend (i.e. non-directional over the long term) from the late 1980s until 2009/10. In the past three years (2010/11 to 2012/13), historically low catches have been reported from Area 1, likely due to low stock abundance. Record high sea temperatures in recent years may have been unfavourable for whitebait recruitment, resulting in low abundances.

Perth herring: Perth herring is endemic to the West Coast Bioregion of WA and constitutes a single stock over this range[1]. 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 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 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 2013, 2 t of cobbler was reported from 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

1 'Perth herring' previously reported from the Gascoyne Coast Bioregion are now believed to be a different species

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 2013, 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 (2013): N/A

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

Boat-based nearshore + estuarine catch (most recent estimate 2011/12): 108 tonnes

The recreational catch levels of finfish in nearshore and estuarine waters of the West Coast Bioregion were not completely estimated for 2013. The statewide surveys of recreational fishing were conducted in 2011/12 and 2013/14 (see below), but these estimated boat-based catches only. Shore-based catches were not included in these surveys and so total recreational catches of nearshore and estuarine finfish are not known.

The most recent complete estimates are from the National Recreational and Indigenous Fishing Survey conducted in 2000/01. 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.

A statewide survey of boat-based recreational fishing was conducted in 2011/12 (Ryan *et al.* 2013[1]). During this survey, nearshore species including southern school whiting (20% of the West Coast catch by number) and Australian herring (16%) were the most common species caught in the West Coast Bioregion. A second statewide survey of boat-based recreational fishing was conducted from May 2013 to April 2014, and the resultant data is being analysed. This statewide survey is scheduled to be repeated biennially in future. It is important to note that this survey provides information on catches from boat-based recreational fishers only. Catches from shore-based fishers, who take the majority of nearshore species, are not estimated. Thus recreational estimates from the statewide survey underestimate recreational catches of nearshore and estuarine species.

In addition to the statewide surveys in 2011/12 and 2013/14, boat-based recreational fishing in the West Coast Bioregion was surveyed in 1996/97, 2005/06, 2008/09 and 2009/10. 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 2).

The Department of Fisheries conducted a pilot study of shore-based fishers in the Perth metropolitan area from April to June 2010 in an attempt to determine the best method to quantify recreational fishing catch and effort from this sector (Smallwood *et al.* 2011[2]). During this survey, the most frequently retained species were Australian herring, southern garfish and whiting (combined species). The same survey of shore-based fishers in the Perth metropolitan area was repeated from April to June 2014. It is anticipated that this 3-month survey will now be repeated at regular intervals to provide information about shore-based recreational catch and effort trends in the West Coast Bioregion.

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.

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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 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. 60 pp.

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 permitted 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 1,200 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 2013 (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. 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 6 in the early 1990s to 1 in 2003 and subsequent years. All effort by this fishery is spent targeting finfish.

Lancelin 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 2013 was 285. In 2013, 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 2 of the 8 teams reported salmon catches in 2013.

West Coast Beach Bait and South West Beach Seine Fisheries: In 2013, 9 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.

Statewide surveys of boat-based recreational fishing were conducted in 2011/12 and 2013/14. 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. Results from the 2013/14 survey are not yet available.

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. Recent surveys of shore-based fishing in 2010 (Smallwood *et al*. 2011) and 2014 (Department of Fisheries, unpublished data) only investigated 3 months of metropolitan recreational fishing and so the results cannot be used to estimate total shore-based effort levels in the Bioregion.

Stock Assessments

Assessments complete: **Yes for key species**

Assessment level and method:

Level 3 - Fishing mortality

Breeding stock levels:

Australian herring	**Inadequate**
Southern school whiting	**Adequate**
Southern garfish (Cockburn Sound)	**Inadequate**

Assessment level and method:

Level 2 - Catch rates

Breeding stock levels:

Tailor	**Adequate**
King George whiting	**Adequate**
Sea mullet	**Adequate**
Whitebait	**Environmentally Limited**
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.* 2013a[1]). 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 F level estimated from data collected in 2009/10 and 2010/11 was well above the limit reference point for this species. Relatively low annual recruitment was also observed in most years over the previous decade. The fishery was found to be catching predominantly young fish, with >50% of total landings (commercial and recreational) 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 (Jones 2013[2]). The assessment recommended a reduction of at least 50% in the total catch of Australian herring.

In 2013, another level 3 assessment of the stock was completed, based on age structure data collected in 2011/12 and 2012/13. This assessment estimated that the F level remained above the limit reference point (and the 95% confidence intervals were entirely above the threshold level), indicating that the stock status had not changed significantly since the previous assessment.

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 ocean warming and the fluctuations in the strength of the Leeuwin 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.* 2011[3]). 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, but then declined in 2013 to the second lowest recorded level.

Southern school whiting: A level 3 assessment of the West Coast Bioregion component of the stock was completed in 2012 (Brown *et al*. 2013[4]). The stock level was assessed as adequate. The rate of fishing mortality (F) was estimated from the age structure of recreational landings in the West Coast Bioregion during 2011. The estimated 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.* 2013b[5]). 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 since then 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, were below their target ranges in 2013, but this is attributed to lack of targeting rather than low stock abundance (see *Inner Shark Bay Scalefish Fishery Status Report*). Tailor in Shark Bay are believed to be part of the same breeding stock as those within the West Coast Bioregion.

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.* 2002[6]) 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.* 2009[7], 2010[8]). 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 the limited data from the shore-based component of the fishery. 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 2005[9]). For these reasons, the sustainability of garfish in Cockburn Sound is at higher risk than other populations in WA.

A level 3 assessment of the Cockburn Sound stock was

1 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.

2 Jones, K. (2013). Review of report on the "Status of nearshore finfish stocks in south-western Western Australia: Australian herring and tailor" prepared by Keith Jones, Sillago Research Pty Ltd for the Department of Fisheries, Western Australia. Fisheries Occasional Publication No. 116. Department of Fisheries, Western Australia. 52 pp.

3 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.

4 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.

5 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.

6 Donnellan, S., Haigh, L., Elphinstone, M., McGlennon, 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.

7 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.

8 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.

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

completed in 2013. The rate of fishing mortality (F) was estimated from the age structure of commercial landings during 2010 and 2011. The estimated F and 95% confidence intervals were well above the limit reference point for this stock. Other available evidence also suggests the stock level is inadequate. During 2010 and 2011, the majority (~95%) of the current Cockburn Sound garfish catch (commercial and recreational) was comprised of mature fish. However, the average size of fish in the commercial catch had declined since the late 1990s (the trend in the recreational catch is unknown). Commercial catch rates suggest the abundance of garfish in Cockburn Sound has been declining gradually since 1996 (West Coast Nearshore and Estuarine Figure 6). Recreational catch rates in the Perth region, available since 2006, also suggest a decline (West Coast Nearshore and Estuarine Figure 7). Catch rates dropped sharply between 2011 and 2012, and remained very low in 2013, which suggests a negative impact arising from the 2011 'heatwave' event.

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 8). The annual commercial catch rate in Oyster Harbour suggests an increase in the availability of sea mullet in the South Coast Bioregion since 2000. This increase coincides with a period of ocean warming around south-western Australia, including a strong spike in abundance after the 2011 heatwave event. In the Gascoyne Coast Bioregion, catch rates in Shark Bay are used as an index of local sea mullet 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 were historically correlated with the strength of the Leeuwin Current in the previous year and with rainfall (Gaughan *et al.* 1996[1]). The total commercial catch of 13 t in 2012/13, which was taken entirely within Area 1 (i.e. around Bunbury), was the lowest since the commencement of the commercial whitebait fishery in the early 1970s (West Coast Nearshore and Estuarine Figure 4). The 2012/13 catch rate in Area 1 was also the lowest recorded (West Coast Nearshore and Estuarine Figure 9).

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 persistent low abundance of whitebait in the Perth area in recent years due to poor juvenile recruitment (West Coast Nearshore and Estuarine Figure 4). Until recently, the annual catch and catch rate trends in the Bunbury area suggested a relatively stable long term abundance of whitebait in this area (West Coast Nearshore and Estuarine Figure 4). However, recent catch and catch rates suggest sharply declining stock abundance over the past 3 years the Bunbury area, reaching a historically low level in 2012/13.

The onset of the decline coincided with a 'heatwave' event along the west coast in autumn 2011 (Pearce *et al.* 2011). It is possible that this event contributed to spawning failure by whitebait in winter 2011, which (when accompanied by fishing mortality) could explain the sudden decline in stock level. Whitebait has a lifespan of only 3-4 years, and so trends in stock level (and catches) are strongly linked to recruitment variability.

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 2006[2]). Voluntary recreational logbook fisher catch rates suggest stable availability of black bream in this estuary from 2004 to 2013 (West Coast Nearshore and Estuarine Figure 10). 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 2013 was stable (i.e. non-directional) (West Coast Nearshore and Estuarine Figure 11). 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

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

2 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.

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.

Listed species interaction: Negligible

Interactions with listed species by the fishing gear used in these commercial fisheries are 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 listed species.

Recreational fishers using line-fishing methods are unlikely to capture listed 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 primarily due to environmental factors. 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.* 2012[1]).

Habitat effects: Low

The operation of gillnets 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 2013, 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 2013, there were 2 licensees (involving up to 10 fishers) operating within the West Coast Salmon Fishery during the western Australian salmon season. There were 6-30 commercial fishers per month employed in various fisheries targeting Australian herring during 2013. Australian herring and western Australian salmon fishers in the West Coast Bioregion supply local bait and human consumption markets.

Commercial - estuarine

In 2013, there was an average of 14 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 2013:

Level 1: <$1 million (finfish only)

Fishery Governance

Commercial
Current Fishing (or Effort) Level:

West Coast Estuarine Fishery Acceptable

Cockburn Sound (Fish Net) Fishery

Not Acceptable

South West Salmon Fishery Acceptable

West Coast Australian herring fisheries

Under review

1 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.

Whitebait (West Coast Beach Bait + South West Beach Seine Fisheries) Not 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 in 2013, and MSC pre-assessments for all West Coast and South Coast Bioregion fisheries in 2014, management arrangements, governance, and catch ranges will be reviewed. However, the 2013 catches are reported (below) against their current governance arrangements.

In the Peel-Harvey Estuary, the commercial catch of finfish in 2012 was 120 t, which was within the target range.

In the Cockburn Sound Fish Net Fishery the total catch of finfish in 2013 was below the target range. The Cockburn Sound finfish catch has been below the target range for 6 of the past 8 years.

The total catch of western Australian salmon (West Coast and South Coast landings combined) in 2013 (229 t[1]) was well below the target range. The catch has now been below the target range for 7 consecutive years.

The West Coast herring catch by all fisheries in 2013 (47 t) was below the target range. The West Coast herring catch has been below the target range for 9 of the past 10 years (similar to the trend in the South Coast herring catch, which has been below the target range for 11 consecutive years). Recent research outcomes regarding stock status are being used as a basis for reviewing management arrangements to ensure the sustainability of this iconic species.

In 2012/13, the commercial catch of whitebait (13 t) was well below the target range. Management arrangements are being reviewed to ensure the sustainability of this species.

Recreational
Current Fishing (or Effort) Level NA

Target catch range: Not developed

New management initiatives (2014/15)

The Department of Fisheries is in the process of consulting with Recfishwest, the Western Australian Fishing Industry Council and relevant licence holders regarding management responses to ensure the long-term sustainability of the Australian herring stock.

The West Coast Estuarine (Interim) Management Plan expired on 30 June 2014. The new West Coast Estuarine Management Plan was gazetted in March 2014 and came into effect on 1 July 2014. The new management plan incorporated Hardy Inlet into the Fishery. It also formalised fishery management arrangements and strengthened access rights for licence holders in the Fishery.

West Coast nearshore and estuarine fisheries underwent pre-assessment for Marine Stewardship Council (MSC) certification. Outcomes are expected during late 2014. In addition, the sea mullet and blue swimmer crab fisheries within the Peel-Harvey Estuary were undergoing MSC full assessment at the time of writing.

An application to the Commonwealth Department of the Environment has been submitted to maintain export accreditation for the western Australian salmon fisheries (South Coast Salmon Managed Fishery and South West Coast Salmon Managed Fishery), effectively declaring these fisheries exempt from Part 13 and 13A of the EPBC Act for a period of 5 years. The current exemption expires on 15 November 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*. 2008[2]). 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 recruitment into each fishery (Lenanton *et al*. 2009[3]).

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 appears to have affected the catch levels of these species in 2011 and in subsequent years. Trends in catch and catch rates suggest that the distribution and abundance of southern garfish, whitebait, Australian

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. & 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.

3 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.

herring, western Australian salmon and sea mullet were affected by the 2011 heatwave.

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 2005[2]). 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.

WEST COAST NEARSHORE AND ESTUARINE TABLE 1

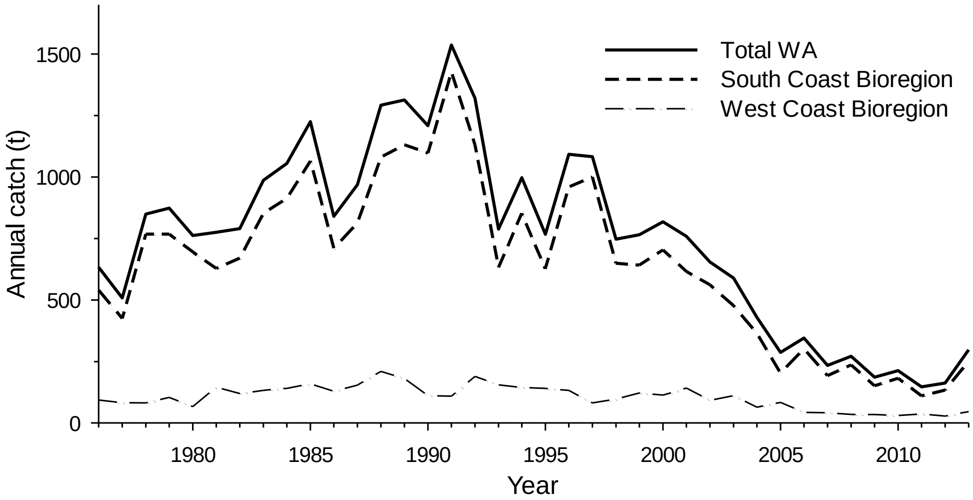
Total annual catches of finfish (except sharks and rays) from the estuarine and beach-based nearshore commercial fisheries in the West Coast Bioregion, 2009 to 2013.

Species	Scientific name	Catch (tonnes)				
		2009	2010	2011	2012	2013
Australian salmon	*Arripis truttaceus*	494.6	69.0	6.3	47.1	92.7
Whitebait	*Hyperlophus vittatus*	139.6	100.6	34.8	65.7	18.6
Sea mullet	*Mugil cephalus*	103.0	102.1	77.7	103.0	100.1
Australian herring	*Arripis georgianus*	34.6	30.6	36.3	28.4	47.1
Yellow-eye mullet	*Aldrichetta forsteri*	26.1	24.7	16.2	22.5	18.6
Whiting species	*Sillago* spp.	23.9	22.5	24.6	19.6	25.8
Southern sea garfish	*Hyporhamphus melanochir*	15.7	15.8	19.2	5.8	4.3
Cobbler	*Cnidoglanis macrocephalus*	9.2	5.4	7.4	5.2	1.8
Perth herring	*Nematalosa vlahmingi*	1.6	0.1	0.4	1	1.5
Tailor	*Pomatomus saltatrix*	7.1	4.8	7.2	8.8	14.2
Hardyheads/Silversides	Atherinidae	-	4.1	4.7	3.5	1.2
Scaly mackerel	*Sardinella lemura*	-	0.9	-	3	5.7
Trumpeters/Grunters	Teraponidae	-	0.5	1	1.6	2.8
King George whiting	*Sillaginodes punctata*	2.0	5.9	5.1	3.7	2
Trevally	Carangidae	2.1	3.5	2.4	2.3	2.8
Yellowtail scad	*Trachurus novaezelandiae*	1.2	0.9	1.2	0.9	1.5
Black bream	*Acanthopagrus butcheri*	1.1	2.6	0.7	1.4	1.3
Blue sprat	*Spratelloides robustus*	7.1	0.1	0.3	0.3	0.8
Other finfish	Teleostei	0.2	0.2	0.3	0.1	3.4
TOTAL		869.1	394.3	245.8	323.9	346.2

WEST COAST NEARSHORE AND ESTUARINE TABLE 2

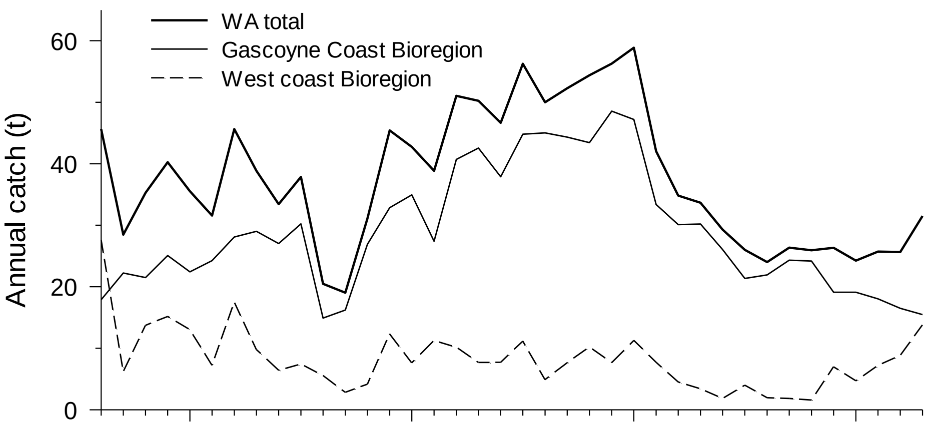
Annual catches of key nearshore finfish species in the West Coast Bioregion by boat-based recreational fishers, estimated by various surveys conducted by the Department of Fisheries. (*estimated to be ~90% southern school whiting)

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



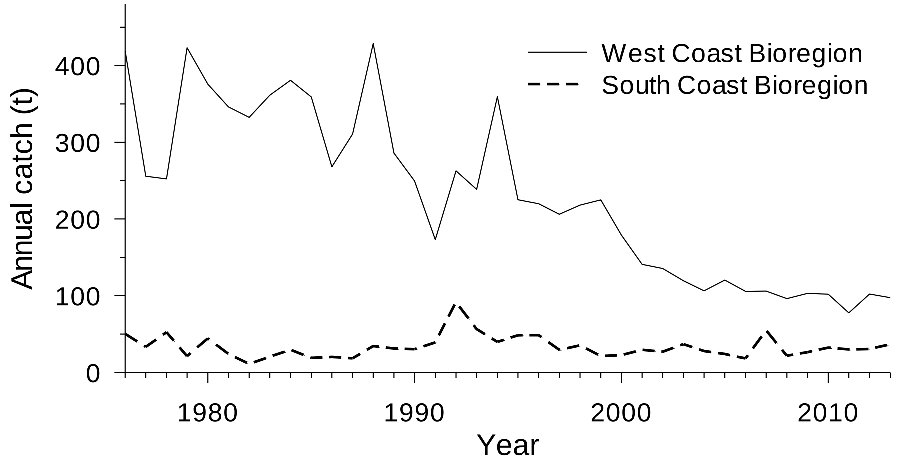
WEST COAST NEARSHORE AND ESTUARINE FIGURE 1

Annual commercial catches of Australian herring, by Bioregion, 1976 –2013.



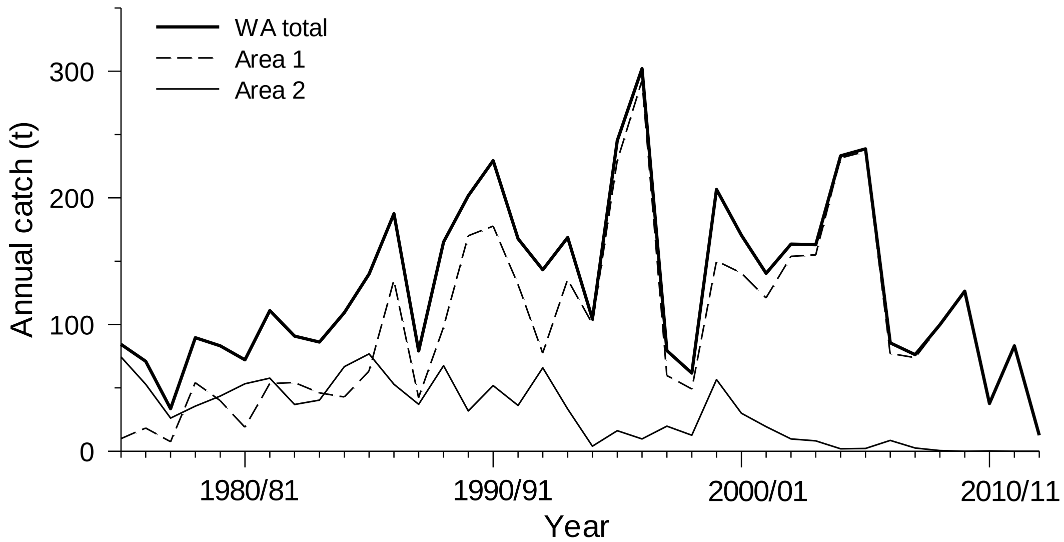
WEST COAST NEARSHORE AND ESTUARINE FIGURE 2

Annual commercial catches of tailor, by Bioregion, 1976 –2013. Minor catches in South Coast Bioregion are not shown, but are included in WA total.



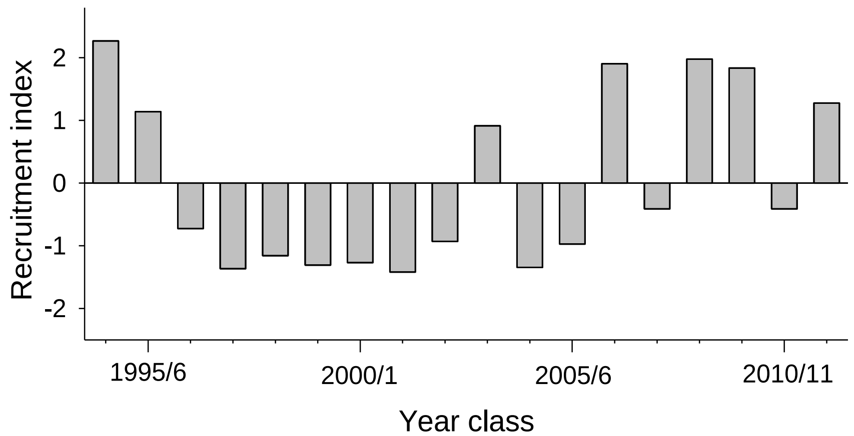
WEST COAST NEARSHORE AND ESTUARINE FIGURE 3

Annual commercial catches of sea mullet, by Bioregion, 1976 –2013.



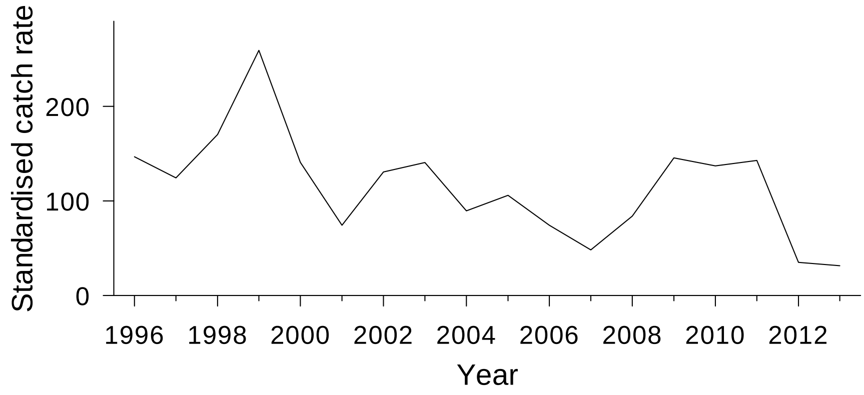
WEST COAST NEARSHORE AND ESTUARINE FIGURE 4

Annual commercial catches of whitebait in West Coast Bioregion, by fishing area, 1975/76 –2012/13. Area 1 = Bunbury; Area 2 = Perth/Mandurah.



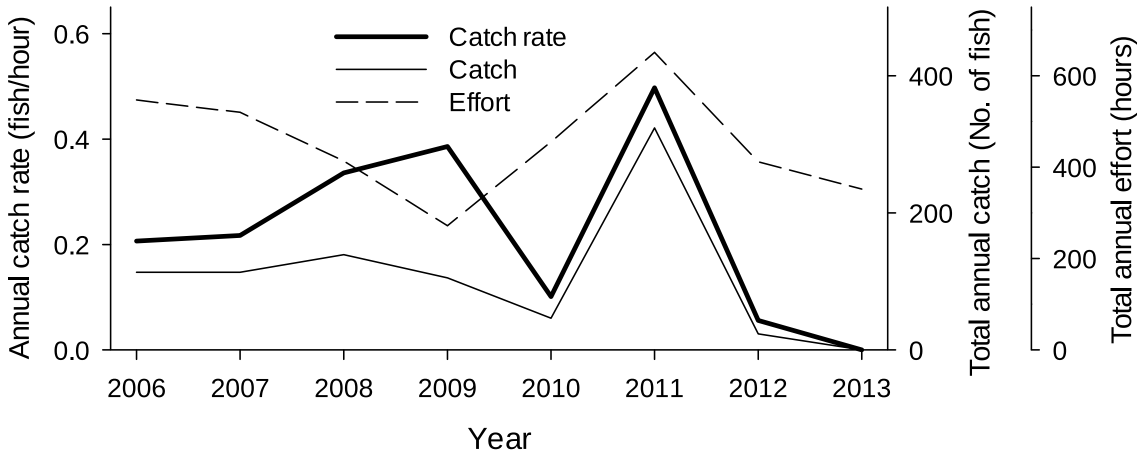
WEST COAST NEARSHORE AND ESTUARINE FIGURE 5

Annual recruitment index for tailor in the West Coast Bioregion, 1996 – 2013, 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



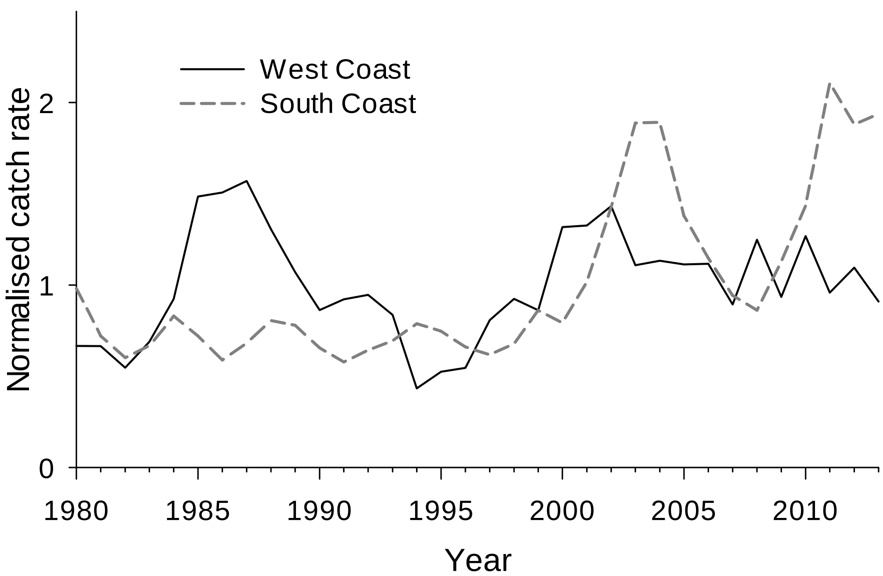
WEST COAST NEARSHORE AND ESTUARINE FIGURE 6

Annual commercial catch rate of southern garfish in Cockburn Sound, 1996 – 2013.



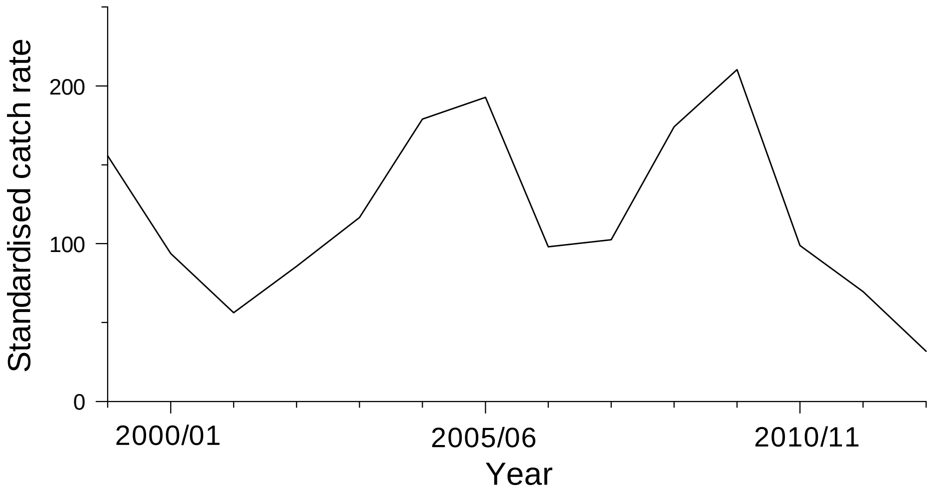
WEST COAST NEARSHORE AND ESTUARINE FIGURE 7

Total annual catch, effort and catch rate of southern garfish by shore-based voluntary recreational logbook fishers in the Perth metropolitan area, 2006 – 2013.



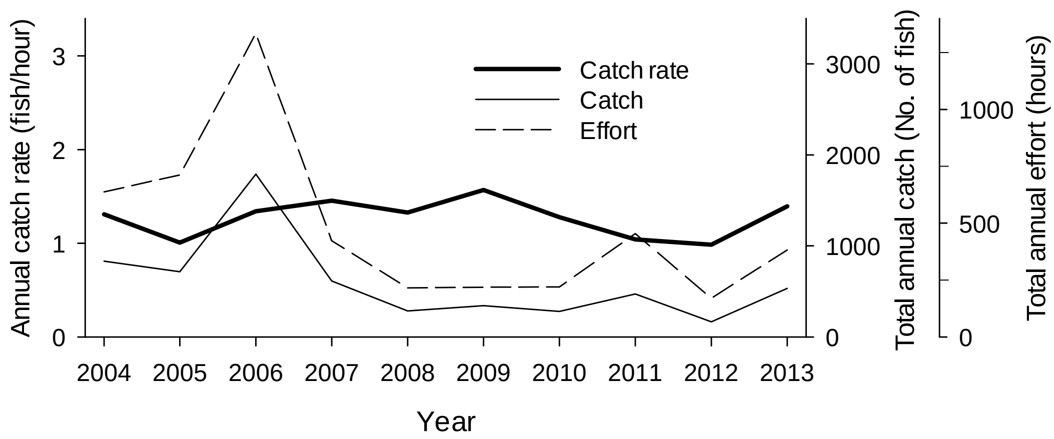
WEST COAST NEARSHORE AND ESTUARINE FIGURE 8

Annual commercial catch rates of sea mullet in West Coast and South Coast Bioregions, 1980 – 2013.



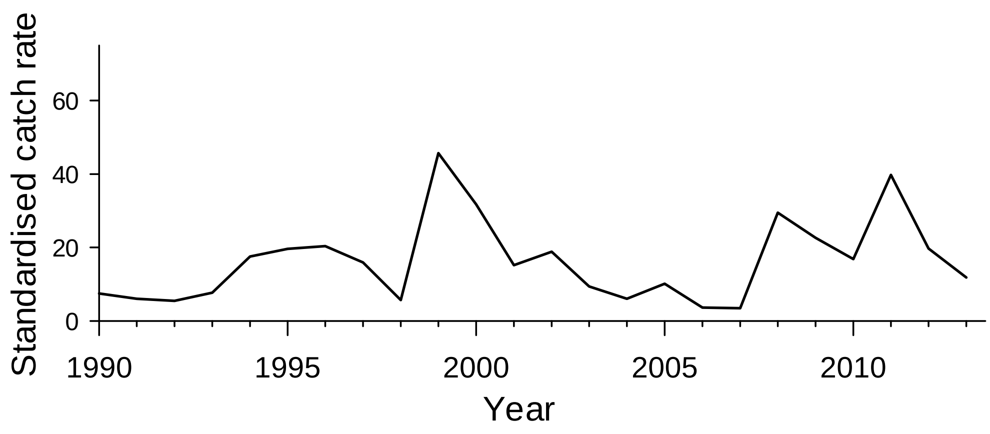
WEST COAST NEARSHORE AND ESTUARINE FIGURE 9

Annual commercial catch rate of whitebait in Area 1 (Bunbury) 1999/2000 – 2012/2013.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 10

Total annual catch, effort and catch rate of black bream by voluntary recreational logbook fishers in the Swan-Canning Estuary, 2004 – 2013.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 11

Annual commercial catch rate of cobbler in the Peel-Harvey Estuary, 1990 – 2013.

West Coast Purse Seine Fishery Report: Statistics Only

B. Molony, E. Lai, M. Holtz and S. Walters

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 Limited Entry Fishery Notice 1989*. Both pilchards and sardinella are the main target species in the Metropolitan fishery. There are three fishing boat licences with a specific condition that permits the taking of fish using a purse seine net that is hauled by the use of a power block within specific waters of the Southern Development Zone. Two of those fishing boat licences may also retain pilchards. A further three Fishing Boat Licences permit the taking of fish using a purse seine net that is hauled by the use of a power block in the Northern Development Zone and sardinella is the main target species.

Currently, a notional combined Total Allowable Catch (TAC), covering both the Perth metropolitan fishery and the Southern Development Zone, is set for pilchards and another for other small pelagic species. For the 2010/11 licensing period (1 April 2010 – 31 March 2011) a notional TAC of 2,328 t for pilchards, with a 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: 705 tonnes

For the 2013 reporting year, catches from all zones of the West Coast Purse Seine Fishery are reported. Fishery effort and catches are not reported separately for each zone as fewer than 3 vessels fished in a single zone. Thus effort and catch levels reflect total fishery effort and catches.

Effort levels again increased in 2013 to 522 fishing days undertaken by seven vessels. Total catches of pilchards and sardinella exceeded 705 t in 2013. The 2013 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, 689.7 t) with approximately 16 t of pilchards landed. Approximately 7.5 t of other species were landed, mainly comprising yellowtail scad.

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*. 2012) 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 at low levels in recent years.

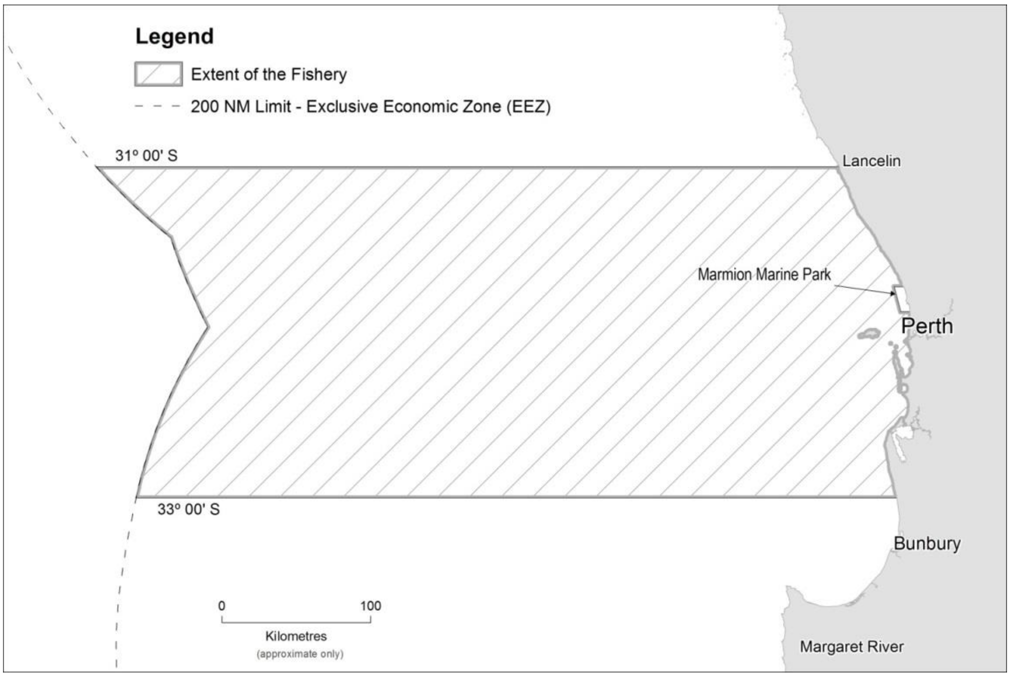
New management initiatives (2014/15)

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.

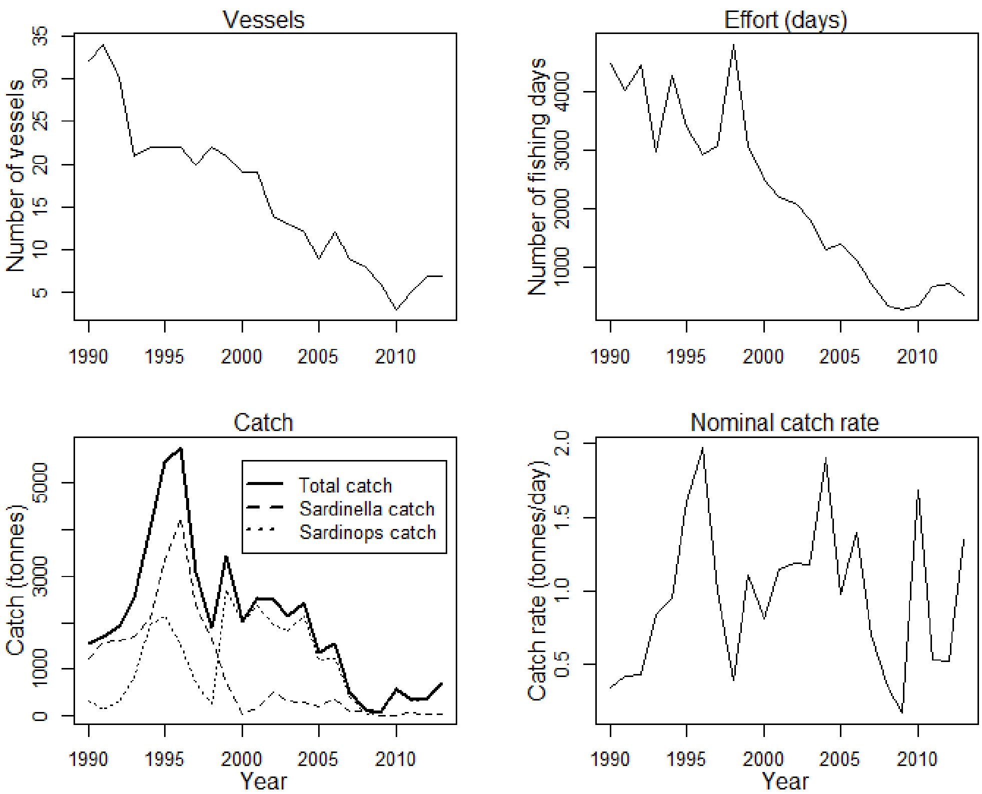
This fishery is scheduled to undergo MSC pre-assessment in mid 2014.

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

Number of vessels, total effort (days), annual catches of pilchards *(Sardinops)* and sardinella and nominal daily catch rate in the West Coast Purse Seine Fishery, 1975 –2013.

West Coast Demersal Scalefish Resource Status Report

D. Fairclough, E. Lai, M. Holtz, T. Nicholas and S. Walters.

Main Features

Status		Current Landings		
Stock level	Recovering	Commercial sector		
Fishing Level		All scalefish:		
Commercial:	Not Acceptable (Pink snapper)	WCDSIMF (2013)		379 t
Recreational:	Not Acceptable (Pink snapper and baldchin groper)	Demersal suite:		
		WCDSIMF (2013)		357 t
		Other (TDGDLF, WCRLF, CSLPF, SWTMF; 2013 or 2012/13)		38 t
		Total demersal suite		395 t
			WCDSIMF	Other
		Indicator species	(2013)	(2013 or 2012/13)
		West Australian dhufish	63 t	9 t
		Pink snapper	185 t	9 t
		Baldchin groper	11 t	< 1 t
		Redthroat emperor	44 t	< 1 t
		Bight redfish	14 t	< 1 t
		Boat-based recreational fishers (2011/12)		
		Top 15 species:		159 t
		Indicator species:		
		West Australian dhufish		74 t
		Pink snapper		33 t
		Baldchin groper		29 t
		Redthroat emperor		1 t
		Bight redfish		1 t
		Charter fishers (2012/13)		
		Top 15 species		42 t
		Indicator species:		
		West Australian dhufish		13 t
		Pink snapper		9 t
		Baldchin groper		10 t
		Redthroat emperor		< 1 t
		Bight redfish		1 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 West Australian dhufish (*Glaucosoma hebraicum*) and Pink snapper (*Chrysophrys 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 (TDGDLF), target sharks and rays but also retain demersal scalefish. Other commercial fisheries that may take a small amount of demersal species in the WCB under exceptions to the West Coast Demersal Scalefish (Interim) Management Plan 2007. These include the West Coast Rock Lobster Managed Fishery (WCRLF), the Cockburn Sound Line 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 who 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 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 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 TDGDLF 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 management objective for the WCDSIMF is to maintain the catches of all scalefish and 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 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 (TDGDLF, 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 percentage (~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*.

Since August 2013, fishers in the WCRLF have been permitted exceptions to prohibitions in the WCDSIMF Management Plan to retain and transport demersal scalefish caught in rock lobster pots for personal consumption only, i.e. not permitted to be sold or retained for a commercial purpose.

Fishing and Aquatic Tour Industry (Charter)

There are two types of fishing tour licence categories.

Fishing Tour Operators Licence: The focus of a tour is on fishing activities, after which fish can be taken home.

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 statewide 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) will be used in future assessments. Annual Level 1 assessments of catch are also used to monitor these species and the indicator species for the West Coast Demersal Offshore Suite (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 are calculated and stock status determined. The third stock assessment of West Australian dhufish, Pink snapper and Baldchin groper was completed in 2013 (see Fisheries Management Paper 262[1] and Fairclough *et al*., 2014[2]).

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 (TDGDLF, 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 (Ryan *et al.*, 2013[3]). A second survey is underway and is due for completion in late 2014. 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 in 2011/12 with previous boat ramp surveys (i.e. creel surveys).

Surveys of the numbers of Pink snapper eggs present in Cockburn Sound during the annual spawning aggregations may in the future be capable of producing estimates of spawning stock biomass for this embayment using a daily egg production model (DEPM). A study using molecular methods is underway to validate the visual identification of snapper eggs (given visually similar eggs of other species are present in this region), before spawning stock biomass can be estimated with this approach.

A State Natural Resource Management (NRM) -funded project, focused on juvenile West Australian dhufish (< 150 mm in length), has identified the habitat types that juvenile dhufish occupy. A final report is due in late 2014.

A State NRM funded project to assess the stock status of indicator species (Bight redfish, pink snapper and Blue morwong) for the demersal suite in the South Coast Bioregion is due for completion at the end of 2015. This includes an assessment of the stock status of Bight redfish in the South-west Management Area of the WCB.

Retained Species

Commercial production

All scalefish	
WCDSIMF (2013)	**379 tonnes**
Demersal suite	
WCDSIMF (2013)	**357 tonnes**
TDGDLF, WCRLF, CSLPF, SWTMF	
(2013 or 2012/13)	**38 tonnes**
Total	**395 tonnes**
Indicator species	
WCDSIMF (2013)	
West Australian dhufish	**63 tonnes**
Pink snapper	**185 tonnes**
Baldchin groper	**11 tonnes**
Redthroat emperor	**44 tonnes**
Bight redfish	**14 tonnes**
TDGDLF, WCRLF, CSLPF, SWTMF	
(2013 or 2012/13)	
West Australian dhufish	**9 tonnes**
Pink snapper	**9 tonnes**
Baldchin groper	**< 1 tonne**
Redthroat emperor	**< 1 tonne**
Bight redfish	**< 1 tonne**
Total	
West Australian dhufish	**72 tonnes**
Pink snapper	**194 tonnes**
Baldchin groper	**12 tonnes**
Redthroat emperor	**44 tonnes**
Bight redfish	**14 tonnes**

Landings

Catches are reported from the most recent complete season of statutory return data for each commercial fishery that lands demersal species in the WCB. This includes 2013 for the WCDSIMF, CSLPF and SWTMF and 2012/13 for the TDGDLF and WCRLF. Note that the WCRLF were only permitted to retain pot-caught demersal scalefish after 23 August 2013, when the *West Coast Demersal Scalefish (Interim) Management Plan 2007* was amended to allow the retention of such fish for personal consumption only.

Catches of all scalefish by the WCDSIMF decreased by 10 t from 389 t in 2012 to 379 t in 2013. Catches of inshore demersal species fell from 352 t in 2012 to 347 t in 2013, while offshore demersal species' catches increased marginally, from 9 t in 2012 to 10 t in 2013. The 2013 catch of about 7 t of nearshore/estuarine species and 15 t of pelagic species each fell by about 3 t from their respective 2012 catches.

In 2013, the catch of demersal species by the WCDSIMF in the Kalbarri Area was 156 t, an increase of 23 t from the 133 t landed in 2012. In contrast, the WCDSIMF catch of 159 t of demersal species in the Mid-west Area in 2013 fell by 17 t from 176 t in 2012. Similarly, in the South-west Area, catches of demersal species fell by 11 t, i.e. from 43 t in 2012

1 Department of Fisheries Western Australia (2013). Key findings of the 2013 West Coast Demersal Scalefish Resource stock assessment. Fisheries Management Paper No. 262. Department of Fisheries, Western Australia. 36 pp.

2 Fairclough, D.V., Molony, B.W., Crisafulli, B.M., Keay, I.S., Hesp, S.A., Marriott, R.J. (2014). Status of demersal finfish stocks on the west coast of Australia. Fisheries Research Report No. 253. Department of Fisheries, Western Australia. 96 pp.

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, Perth.

to 32 t in 2013.

The WCDSIMF catch in 2013 comprised 73 scalefish species or species groups, fifty four from the inshore and offshore demersal suites and 19 from the pelagic and nearshore/estuarine suites. Four demersal species/species groups comprised 81 % of the total catch of the WCDSIMF, i.e. Pink snapper (185 t), West Australian dhufish (63 t), Redthroat emperor (44 t) and redfish species (*Centroberyx* spp., 16 t). As in previous years, catches of offshore demersal species were low, i.e. Hapuku, 5 t, Eightbar grouper, 3 t; Bass groper, Blue-eye trevalla and Ruby snapper, each ≤ 1 t.

Catches of demersal scalefish by the TDGDLF in the WCB decreased to 37 t in 2012/13 from 45 t in 2011/12. Less than 1 t was landed by the other commercial fisheries combined.

West Australian dhufish: The total catch of West Australian dhufish by the WCDSIMF was essentially the same in 2013 (63 t) as in 2012 (64 t). In the Kalbarri Area, catches of WA dhufish in 2013 were similar to 2012, i.e. about 4 t. In the Mid-west Area, catches increased to 47 t in 2013, from 44 t in 2012, while in the South-west Area, catches fell from 16 t in 2013 to 13 t in 2012 (West Coast Demersal Scalefish Figure 2). Catches of WA dhufish by the TDGDLF remained steady at 9 t in 2012/13, while the SWTMF and CSLPF did not report any landings of this species.

Pink snapper: The total catch of Pink snapper by the WCDSIMF increased from 170 t in 2012 to 185 t in 2013. This was due predominantly to the catch of Pink snapper in the Kalbarri area increasing from 78 t in 2012 to 105 t in 2013. In contrast, catches of Pink snapper in 2013 decreased from those in 2012 in both the Mid-west Area and South-west Area, i.e. from 87 t to 77 t and 4 t to 3 t, respectively (West Coast Demersal Scalefish Figure 3). The 9 t of Pink snapper caught by the TDGDLF in the WCB in 2012/13 fell slightly from the 10 t landed in 2011/12. As in recent years, Pink snapper landings by the other commercial fisheries combined were very low (< 1 t).

Baldchin groper: The WCDSIMF reported landings of 11 t of Baldchin groper in 2013, a decrease of 5 t from the 16 t caught in 2012 (West Coast Demersal Scalefish Figure 4). The vast majority of this catch was taken in the Kalbarri and Mid-west Areas. Almost 6 t of the catch was taken in the Abrolhos Zone A of the WCRLF, a decrease from 10 t in 2012. Less than 1 t of Baldchin groper was caught in the most recent season of fishing (2013 or 2012/13) by the other commercial fisheries combined.

Redthroat emperor: A total of 51 t of emperors (Lethrinidae) was landed by the WCDSIMF in 2013, which was less than the 55 t landed in 2012. The catch of emperors by the WCDSIMF comprises predominantly Redthroat emperor, with 44 t landed in 2013 and 46 t in 2012 (West Coast Demersal Scalefish Figure 5). In 2013, 29 t of the WCDSIMF Redthroat emperor catch was taken in the Kalbarri Area and 15 t in the Mid-west Area, which was similar to the 32 t and 14 t landed in 2012 in those areas, respectively. Catches of Redthroat emperor by other commercial fisheries in 2013 were less than 1 t.

Bight redfish: A total of 16 t of redfishes (Berycidae) was landed by the WCDSIMF in 2013, which was less than the 24 t landed in 2012. The catch of redfishes by the WCDSIMF comprises predominantly Bight redfish, which is taken almost exclusively in the South-west Area. 14 t of Bight redfish were landed by the WCDSIMF in 2013, which is less than the 21 t landed in 2012 (West Coast Demersal Scalefish Figure 5). Catches of Bight redfish by other commercial fisheries in 2013 were less than 1 t.

Charter fishing (2012/13)

Top 15 demersal scalefish species/species groups	**42 tonnes**
Indicator species	
West Australian Dhufish	**13 tonnes**
Pink snapper	**10 tonnes**
Baldchin Groper	**9 tonnes**
Redthroat emperor	**< 1 tonne**
Bight redfish	**1 tonne**

A total of 42 t of the top 15 demersal species/species groups were landed by charter fishers in 2012/13, which is similar to the 41 t landed in 2011/12 (see West Coast Demersal Scalefish Figure 6). The catches of each of the indicator species in 2012/13 were also similar to 2011/12, i.e. West Australian dhufish: 13 t in both years, Pink snapper: 9 t in 2012/13 vs 10 t in 2011/12, Baldchin groper: 10 t vs 9 t, Redthroat emperor: < 1 t in both years, Bight redfish: ca 1 t in both years. As in 2011/12, charter catches in 2012/13 in the WCB comprised ≤ 1 t of offshore demersal species, such as Eightbar grouper.

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**
Redthroat emperor	**1 tonne**
Bight redfish	**1 tonne**

The catch by boat-based recreational fishers in the WCB of the top 15 demersal species/species groups was estimated to be about 159 t in 2011/12 (West Coast Demersal Scalefish Figure 6). Estimated catches of the indicator species in 2011/12 included 74 t of West Australian dhufish, 33 t of Pink snapper, 29 t of Baldchin groper and 1 t each of Redthroat emperor and Bight redfish. These results were determined via an integrated phone-diary survey and are not directly comparable with previous estimates of catch derived using different survey methods. Less than 1 t of offshore demersal species was estimated to have been landed in 2011/12.

Fishing effort/access level

Commercial

In 2013, 44 licensed fishing boats fished in the WCDSIMF. Twelve vessels fished in the Kalbarri Area, 36 in the Mid-west, 8 in the South-west and 13 nominated to fish 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 on which fishing occurred by all vessels in the WCDSIMF in 2013 (1,381) declined from that reported in the previous two years (about 1,570 days), in conjunction with a decrease in the amount of fishing entitlement (hours) consumed from 67 % to 61 %. This was reflected in the decrease in the total number of hours fished (hours searching + hours fishing) from 18,800 h in 2012 to 16,000 h in 2013. Entitlement consumed in the Kalbarri Area increased from 77 % in 2012 to 80 % in 2013, while in the Mid-west Area it decreased from 64 % in 2012 to 61 % in 2013. Similarly, in the South-west Area, entitlement consumed fell from 51 % in 2012 to 38 % in 2013 and in the Offshore Area it decreased from 86 % to 49 %.

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*.

Recreational

Fishing effort by boat-based recreational fishers during 2011/12 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 three charter licenses were reported to have undertaken fishing operations in 2012/13, which is one less than in 2011/12. In contrast, the number of fisher days increased from about 21,500 in 2011/12 to 23,500 in 2012/13.

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 three inshore demersal indicator species (West Australian dhufish, Pink snapper and Baldchin groper) in the WCB and its different management areas was conducted in 2013. This was an assessment of fishing mortality rates (*F*) 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. Assessments of Redthroat emperor and Bight redfish will form part of the next full assessment of demersal indicator species in the WCB. Methods for estimating *F* included some that have previously been independently reviewed and additional new methods, which have fewer assumptions, but have also been peer-reviewed (O'Neill, 2009; Fisher, 2012; Fairclough *et al.*, 2014)[1]. The *F* estimates were compared with internationally accepted biological reference points to determine the change in status of stocks over time. Estimates of spawning potential ratios (*SPR*) were also determined.

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 the time of the current assessment, stocks had not yet recovered to an appropriate level, i.e. the threshold, where *F* is equivalent to the rate of natural mortality. The recovery trend was consistent among management areas for both species. However, the level of *F* for Pink snapper stocks in the northern management areas (Kalbarri and Mid-west) is higher than in the southern management areas (Metropolitan and South-west), indicating better status of stocks in the southern half of the WCB.

The *F* estimate for Baldchin groper was beyond the limit reference point and thus at unacceptable levels. The *F* and *SPR* levels have not changed significantly 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 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.

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. In addition, some aggregate to spawn and most suffer barotrauma when caught due to the depths in which they are fished (> 250 m). Spawning by Eightbar grouper does not occur in the WCB and stocks are reliant on recruits dispersing to the WCB from spawning in the northern bioregions (Wakefield *et al*., 2013[2]). However, given the current low level of catches, risks to the biological sustainability of the stocks of each 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*., 2010[3]). The inshore suite still has high risks associated with meeting social and

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.

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/

2 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

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

economic objectives for the community. This combination of factors means that this suite of species still has a high priority for the Department with the inshore demersal suite requiring continued close monitoring and assessment. The offshore demersal suite is currently considered to have a medium level priority.

Non-Retained Species

Bycatch species impact **Medium**

Line fishing for demersal species using baited hooks is highly selective[1] for demersal fishes. Other demersal species that are caught but not normally retained during demersal fishing activities (including inedible species, e.g. Silver Toadfish, and small species, such as wrasses) are often susceptible to the effects of barotrauma and may not survive. Note, that while they are not bycatch species, post-release survival of target species, such as West Australian dhufish and Pink snapper decreases when caught in waters > about 30 m deep[2], and this is likely to be similar for many species caught but not retained in this fishery.

Listed species interaction **Negligible**

As line fishing is highly selective for demersal fishes, interactions with listed species by commercial, charter and recreational fishers in the WCDSF are minimal. Commercial WCDSIMF and charter fishers are required to record listed species interactions in their statutory returns. During 2013, one white shark and two grey nurse sharks were caught by the WCDSIMF and all released alive. In 2012/13, charter fishers caught one grey nurse shark and two Estuary cod (greater than the maximum legal size limits of 1 m or 30 kg). Each was released alive.

Ecosystem Effects

Food chain effects **Low**

An FRDC study[3] 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.

1 Bycatch interactions of the gillnet and longline sector are presented in the relevant report.

2 see Fisheries Research Report No. 191 http://www.fish.wa.gov.au/Documents/research_reports/frr191.pdf

3 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.

Social Effects

Commercial

The total number of crew members (excluding the skipper) employed per trip on permitted vessels that fished in the WCDSIMF in 2013 ranged from zero to six, with the majority employing two or three. Over 100 people are therefore directly employed by this fishery.

Fishing and Aquatic Tour Industry (Charter)

In 2012/13, 99 charter operators were licensed to operate in the WCB via a Fishing Tour Operators Licence, compared with 100 in 2011/12. Sixteen held a Restricted Fishing Tour Operators Licence in 2012/13 vs 17 in 2011/12. The number of people employed in the charter industry has not been estimated.

Recreational Fishing

Approximately 134,000 Recreational Fishing from Boat Licenses were current in Western Australia as at 30th June 2013.

Economic Effects

Estimated annual value (to fishers) for 2013:

Level 2 - $1-5 million

The estimated economic value of the WCDSIMF in 2013 was in the range of $1-5 million, as in 2012.

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 **410 tonnes**

All fisheries combined (WCDSIMF, TDGDLF,

WCRLF, CSLPF, SWTMF) **450 tonnes**

The primary management objectives for the WCDSIMF are to reduce the total catch of all scalefish, of the demersal suites and of each of the indicator species, i.e. West Australian dhufish, Pink snapper and Baldchin groper, by at least 50 % (the 'benchmark') of those caught by wetline fishers in the WCB during 2005/06. This is also proposed for the two newly-adopted indicator species, Redthroat emperor and Bight redfish. In addition, catches of the demersal suites in the WCB by all fisheries, i.e. WCDSIMF, TDGDLF, WCRLF, CSLPF and the SWTMF, should remain at or below 50 % of those in 2005/06.

In 2013, catches of all scalefish (379 t) and of the suite of demersal species (357 t) by the WCDSIMF remained below 50 % of those of 2005/06, i.e. 449-469 t and 410 t, respectively. The total catch of demersal species in a full year of fishing (either 2012/13 or 2013) by the WCDSIMF, TDGDLF, WCRLF, CSLPF and the SWTMF was 395 t, which is below the 450 t benchmark.

Although the WCDSIMF catch of 63 t of West Australian dhufish in the WCB in 2013 was below the 72 t benchmark, the catch of 47 t in the Mid-west Area was slightly above the benchmark of 44 t. As in previous years, the WCDSIMF catch of Baldchin Groper (11 t) in 2013 remained below the benchmark of 17 t. Catches of both Redthroat emperor and Bight redfish have remained at around or below their respective 50 % of 2005/06 catches, i.e. proposed as 95 t and 37 t, since the commencement of the WCDSIMF in 2008. However, the catch of 185 t of Pink snapper in 2013 was above the 120 t benchmark for the whole fishery and has been consistently greater than the benchmark since 2010. This catch was comprised of 77 t in the Mid-west Area and 105 t in the Kalbarri Area, each of these being above the benchmark for each area of 43 t and 65 t, respectively.

In 2013, as in previous years, WCDSIMF entitlements were not fully utilised. This latent effort leaves potential for further increases in effort and therefore catches in subsequent years if catch rates remain similar or increase. As stocks begin to recover, catches of Pink snapper and the other indicator species will need to be monitored closely to determine whether this trend continues. The effect of any changes to management to reduce catch will also need to be monitored closely to ensure they have that effect and allow continuation of stock recovery.

Charter/recreational
Current Fishing level

Demersal suite **Acceptable**

Catch (or effort) limit range:

250 tonnes (from adjusted IFAAC values)

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 250 t (50 % of 2005/06 catches, as adjusted by the Integrated Fisheries Allocation Advisory Committee, IFAAC, 2013[1]).

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 for 2005/06 (plus those from charter fishers) are now being used for comparison.

The estimated catch of the top 15 species/species groups by both 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 the 2005/06 catch of 126 t, as were catches of Redthroat emperor and Bight redfish. 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.

1 Integrated Fisheries Allocation and Advisory Committee (2013). West Coast Demersal Scalefish Allocation Report. Fisheries Management Paper No. 249. Department of Fisheries, Western Australia. 60 pp.

New management initiatives (2014/15)

Commercial

A new management plan to transition the WCDSIMF to a managed fishery is planned to be progressed following impending changes to the WCDSIMF management arrangements in response to outcomes of the 2013 stock assessment of key indicator species in the WCB and current catches of snapper in relation to their current management targets.

Formal catch management guidelines are being developed to establish clear and specifically articulated performance levels and associated management actions designed to achieve agreed objectives for the ecological/aquatic resources and relevant fishery sectors. The catch management guidelines determine how the various target catch adjustments by the different sectors that take demersal species will be most efficiently achieved.

The WCDSIMF is currently undergoing Marine Stewardship Council pre-assessment. Outcomes are expected in late 2014.

The *West Coast Demersal Scalefish (Interim) Management Plan 2007* was amended on 23 August 2013 to allow the retention and transport of demersal scalefish caught in commercial rock lobster pots for personal consumption only.

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 boat based fishers 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 was undertaken during 2013, following the results of the Statewide Recreational Boat Fishing Survey and the outcomes of the stock assessment of indicator species. It was considered that the current management arrangements should be maintained to ensure recovery is achieved. On 1 February 2013 a simplified set of statewide recreational fishing rules were implemented. The major changes being a reduction from 13 to four 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 2010[2]. The Minister for Fisheries has 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

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

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 in the fishery are characterised by strong and weak recruitment years, which may influence catch rates. This is likely to be similar for other long-lived demersal species in the WCB.

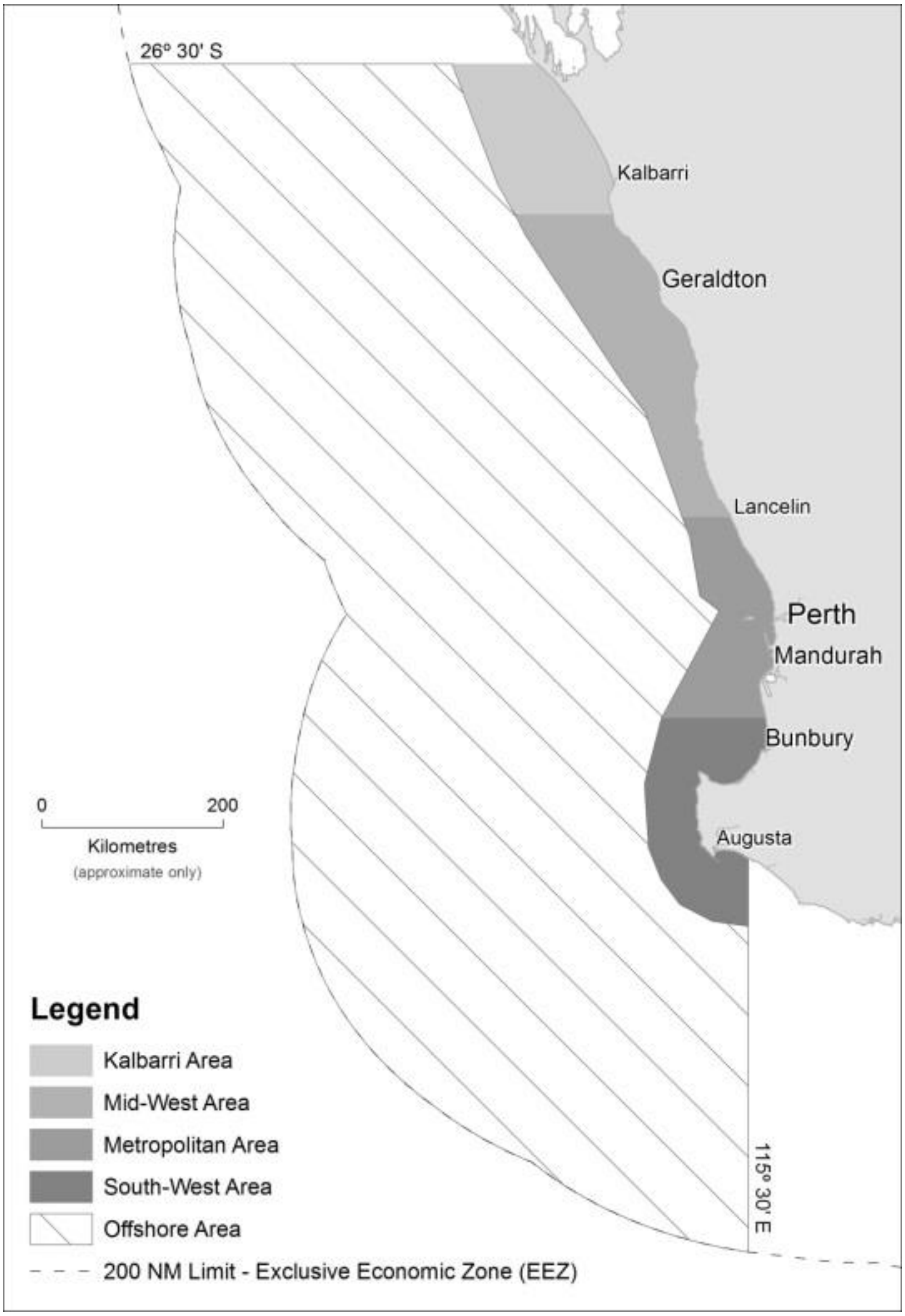
Cockburn Sound is the only known spawning aggregation location for Pink snapper in the WCB. Juveniles also use the area as a nursery for approximately one and a half years following settlement, before leaving Cockburn Sound. Ongoing industrial development in the area may have detrimental effects on the 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 are very small in the WCB. A current WA NRM funded 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 proposed 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. 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. However, although the management plans for the Commonwealth's South-West Marine Bioregional Plan were intended to come into effect on 1 July 2014 they are currently under review.

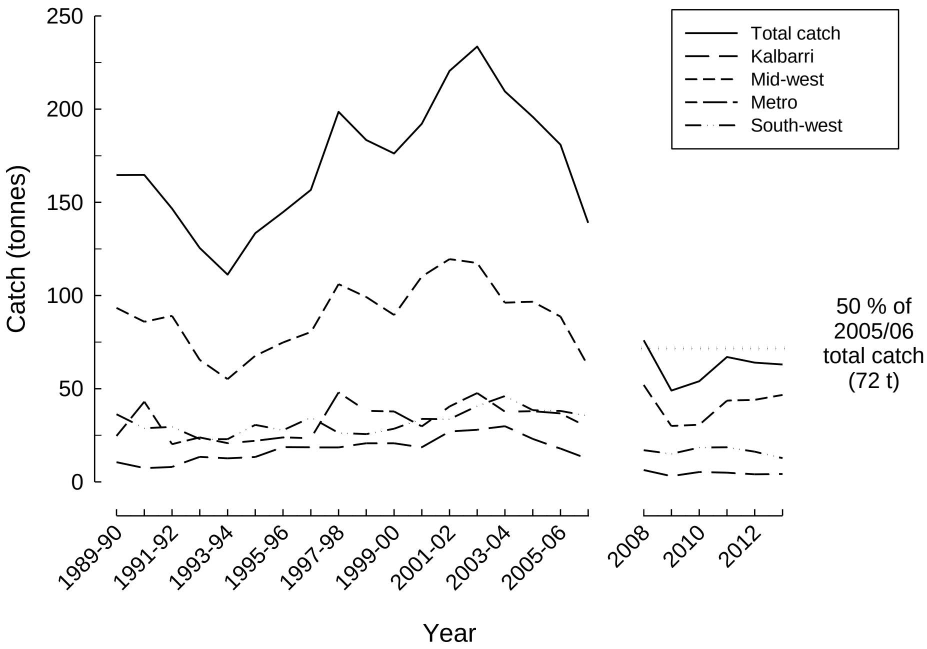
Climate change may lead to a range of impacts (e.g. increased water temperatures, acidification) which could influence aspects of the biology of demersal species, such as spawning success, settlement patterns and thus recruitment patterns. Extreme events, such as the marine heatwave in 2011[1], may have severe negative effects, including increased mortalities.

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



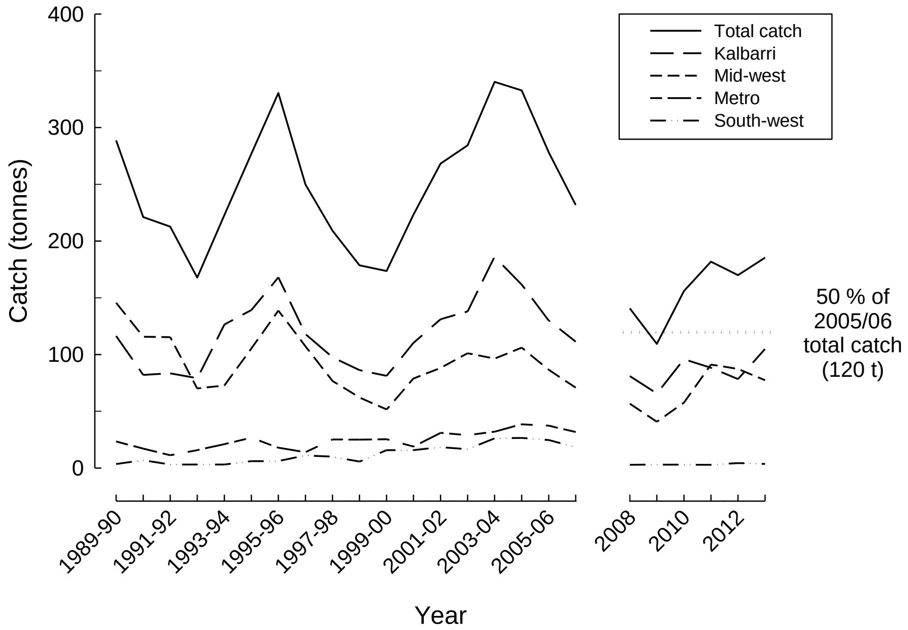
WEST COAST DEMERSAL SCALEFISH FIGURE 1

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 and from 26°30’ S to 115°30’ E. Note the Metropolitan Area is currently closed to fishing by the WCDSIMF.



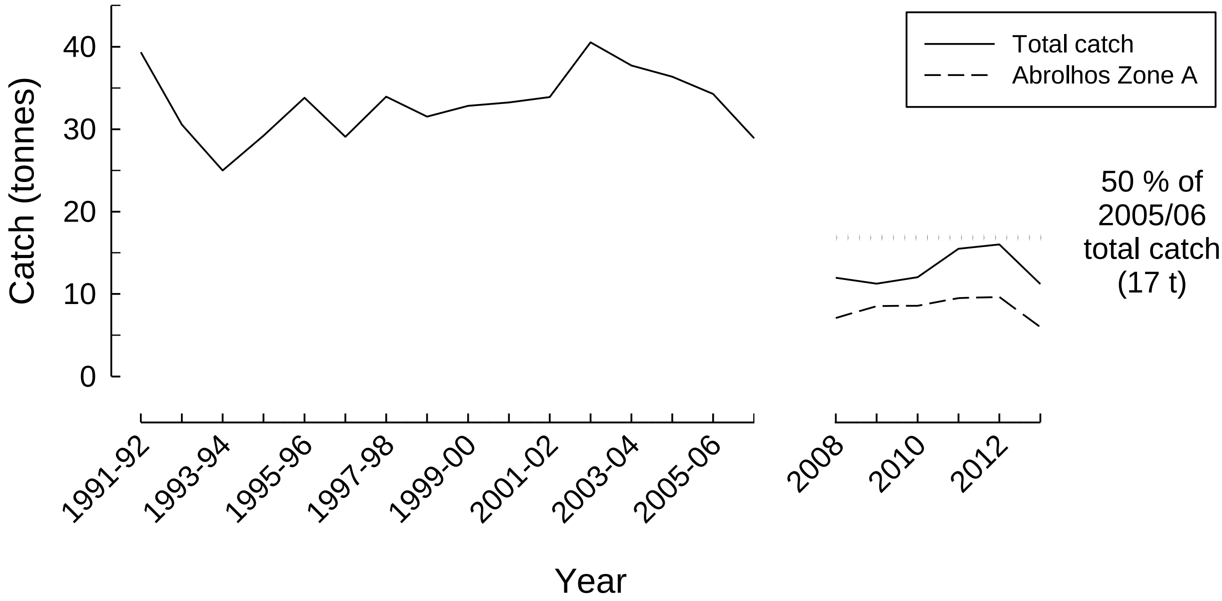
WEST COAST DEMERSAL SCALEFISH FIGURE 2

Total catch and catch by area of West Australian dhufish *Glaucosoma hebraicum* by commercial wetline fishers in the West Coast Bioregion between 1989/90 and 2006/07 and in the West Coast Demersal Scalefish (Interim) Managed Fishery between 2008 and 2013.



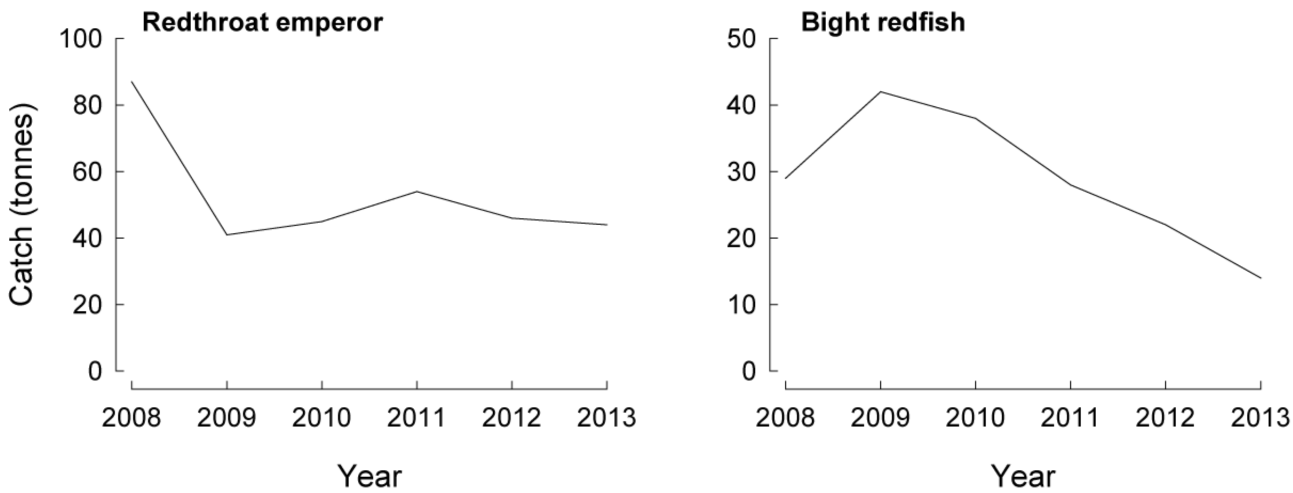
WEST COAST DEMERSAL SCALEFISH FIGURE 3

Total catch and catch by area of Pink snapper *Chrysophrys 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 2013.



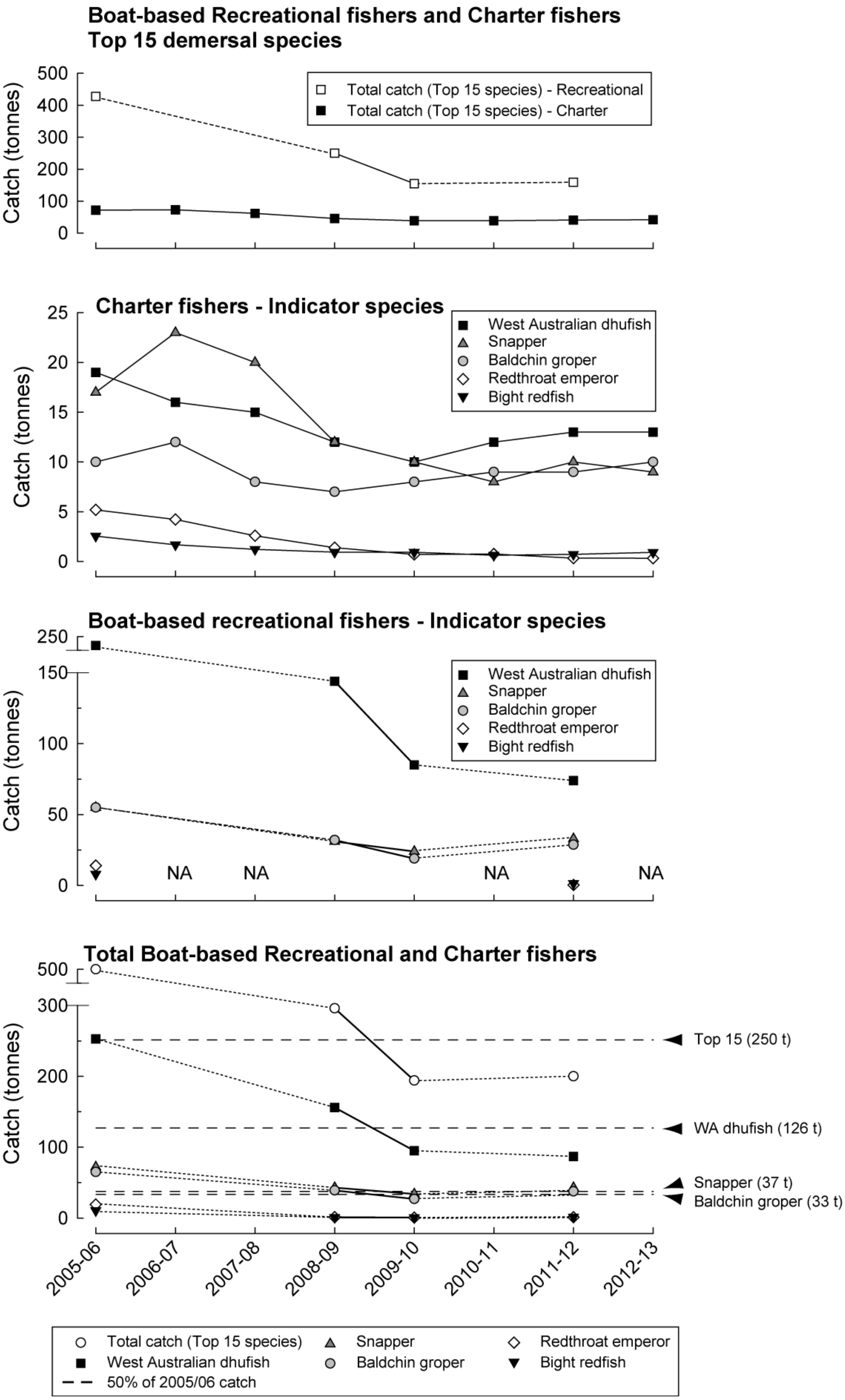
WEST COAST DEMERSAL SCALEFISH FIGURE 4

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 2013.



WEST COAST DEMERSAL SCALEFISH FIGURE 5

Total catches of Redthroat emperor *Lethrinus miniatus* and Bight redfish *Centroberyx gerrardi* in the West Coast Bioregion by the West Coast Demersal Scalefish (Interim) Managed Fishery between 2008 and 2013. Note: catches of each species in the WCB prior to the WCDSIMF commencing in 2008 are not shown, as emperors and redfish species were reported using a range of common names and name groups and thus cannot be accurately estimated.



WEST COAST DEMERSAL SCALEFISH FIGURE 6

Catch of the top fifteen demersal species and of the indicator species (West Australian dhufish, Snapper, Baldchin groper, Redthroat emperor and Bight redfish) by boat-based recreational and charter fishers in the West Coast Bioregion between 2005/06 and 2012/13. N/A, catch estimates not available. Estimates not available for boat-based recreational catch of Redthroat emperor and Bight redfish in 2008/09 and 2009/10.

Octopus Fishery Status Report

A. Hart, D. Murphy, L. Joll, S. Walters, L. Pickles

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial – Statewide	226 t
Fishing level	Acceptable	Recreational – Statewide (2011/12 estimate)	1.4 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.

Governing legislation/fishing authority

Commercial

Cockburn Sound (Line and Pot) Limited Entry Fishery Notice 1995

Cockburn Sound (Line and Pot) Managed Fishery Licence

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

West Coast Rock Lobster Managed Fishery Management Plan 2012

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 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

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 the South Australian border. 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. It is expected that pot allocations for the DOF will be finalised in 2014.

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 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 recently completed a research project with funding from the Fisheries Research and Development Corporation (FRDC). The project was titled "FRDC 2010/200: Innovative development of the *Octopus tetricus* fishery in Western Australia". Results from this project are being used to advise industry and government on sustainable harvest levels and pot allocations appropriate for an expansion of the octopus fishery into the future. Methods of assessing the Octopus fishery were also developed as part of this project and will be employed in future stock assessments. These methods include age estimation techniques, fishery independent surveys, and age-based per recruit methods that account for semelparity.

Retained Species

Commercial landings (season 2013):

226 tonnes (live weight)

Recreational catch estimate (season 2011/12):

1.4 tonnes (live weight)

Landings

Commercial: In 2013 the total commercial octopus catch was 226 t live weight, a 10% increase over last year's catch of 206 t (Octopus Figure 1).

On a sector-specific level, octopus catch from the WCRLF declined between 2011 and 2013, from 38 to 23 tonnes. Catch from the CSLP has the most dramatic increase; up by 100 % (41 t in 2013) from 2012 (20 t). Catch from the DOF has increased by 380% between 2009 (33 t) and 2013 (160 t; Octopus Figure 1).

The DOF has steadily risen from 4% of the total catch in 2001 to an average of 70% between 2010 and 2013 (Octopus Table 1). At the same time, share of catch from the lobster fishery has declined from 86% to 10%, primarily as a result of effort reductions, which have occurred in that fishery.

Recreational: Annual estimates of recreational catch by boat-based fishers at both the statewide 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. It must be noted that this estimate represents a decrease from the 2012 estimate of 17 t. The 17 t figure was derived from the national recreational and indigenous fishing survey[1] wide estimate conducted 15 years ago (2001), and this estimate is considered no longer valid for WA.

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. Days fished is a reasonable indicator of effort in the DOF and CSLP fisheries, but not in the WCRLF because octopus is bycatch in that fishery.. Days fished in the CSLP and DOF were 398 and 988 respectively, an increase of 73% and 7% respectively, from 2012 (Octopus Table 1).

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 3.7 kg/day, which was a 19% reduction from 2012 (Octopus Figure 2). The large increases in octopus CPUE from 2009 to 2011 in the WCRLF 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 the increases in CPUE are 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, and 2011 to 2013. There is a clear anomaly in SCPUE for trigger pots in 2010, with a significantly high level. This is hypothesized to have been 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 stock assessment will include a more in-depth assessment using techniques currently under development.

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.

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.

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.

Listed species interaction: Low

In 2013 there were three reported whale entanglements (Humpback whale: *Megaptera novaeangliae*) in octopus fishing gear. This was the same amount as reported in 2012. 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 2013, ~ 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, 6 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 2013:

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

The estimated annual value for 2013 was $2.1 million based on the total catch of 226 t and an average product price of $9.31 /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 226 tonnes is within the target range. The fishery governance ranges will be reviewed in 2014 using outcomes of FRDC project 2010/200 "Innovative development of the *Octopus* (cf) *tetricus* fishery in Western Australia".

New management initiatives (2014/15)

The Department is currently in the process of developing an interim management plan for the DOF, following the recommendations of the Independent Panel on access and allocation. It is anticipated that that allocation process will be finalised in late 2014 and the interim plan in place in 2014/15.

The CSLP limited entry fishery notice is currently under review following the Minister for Fisheries' decision on octopus pot entitlement allocation in the CSLPF. The Department of Fisheries is aiming to implement management plan amendments to introduce an octopus pot entitlement scheme during 2014 in preparation for the start of the 2015 season.

Also in 2013, the Department approved exemptions to commence trials on two new traps; a recreational trigger trap, and commercial trap prototype known as a "Sliding Door Trap" or SDT. In 2015 the Department intends to conduct a review of the new traps 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

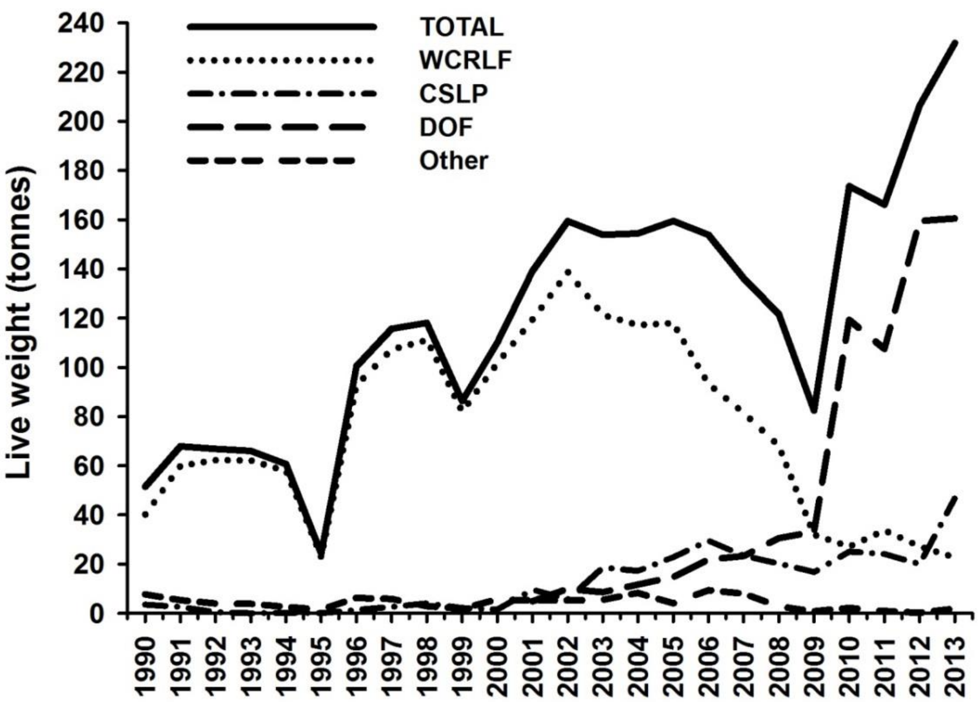
Cephalopods in general, including octopus, are known to be subject to large environmentally-driven fluctuations in abundance. If the fishery expands to reach a catch level approaching maximum sustainable yield, this year-to-year variability in abundance may prove a significant issue for the fishery. In particular, a "marine heatwave" experienced on the West Coast in the summer of 2010/11, where water temperatures reached 3 degrees Celsius 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 WCRL fishery remains a low % of the overall catch.

OCTOPUS TABLE 1

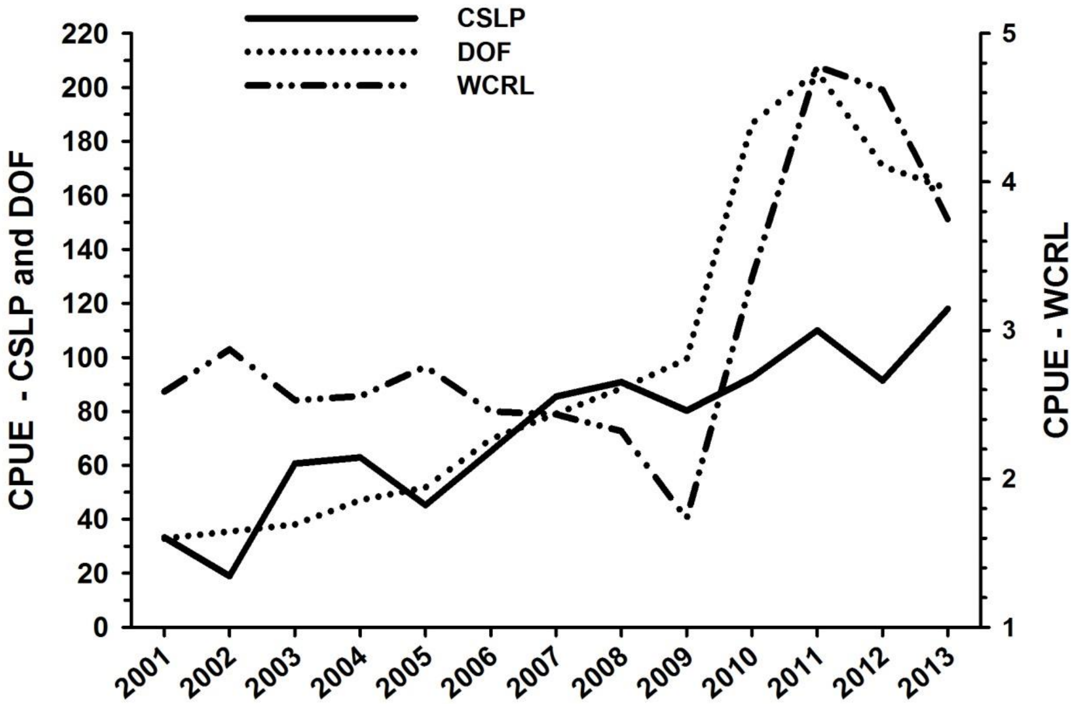
Percentage of octopus catch and total days fished from different sectors of the fishery. – WCRLF (West Coast Rock Lobster Fishery), CSLPF (Cockburn Sound Line and Pot), DOF (Developing Octopus Fishery) and Other, which is bycatch from trawl and miscellaneous pot fisheries.

Year	WCRLF	CSLPF	DOF	Other	CSLPF	DOF
	Percentage of total catch				Effort (total days fished)	
2001	86	6.9	3.5	3.8	287	149
2002	87	3.6	6.2	3.2	300	278
2003	79	12.1	5.6	3.6	306	225
2004	76	11.1	7.6	5.3	273	249
2005	74	14.3	9.2	2.5	505	284
2006	62	19.7	11.6	6.3	451	250
2007	63	18.1	12.9	6.1	274	211
2008	61	18.0	19.0	2.4	222	241
2009	39	20.3	40.0	1.0	256	248
2010	16	14.4	68.7	1.2	271	639
2011	20	14.5	64.7	0.5	218	522
2012	13	11	76	0.1	230	927
2013	10	18	71	1.0	398	988



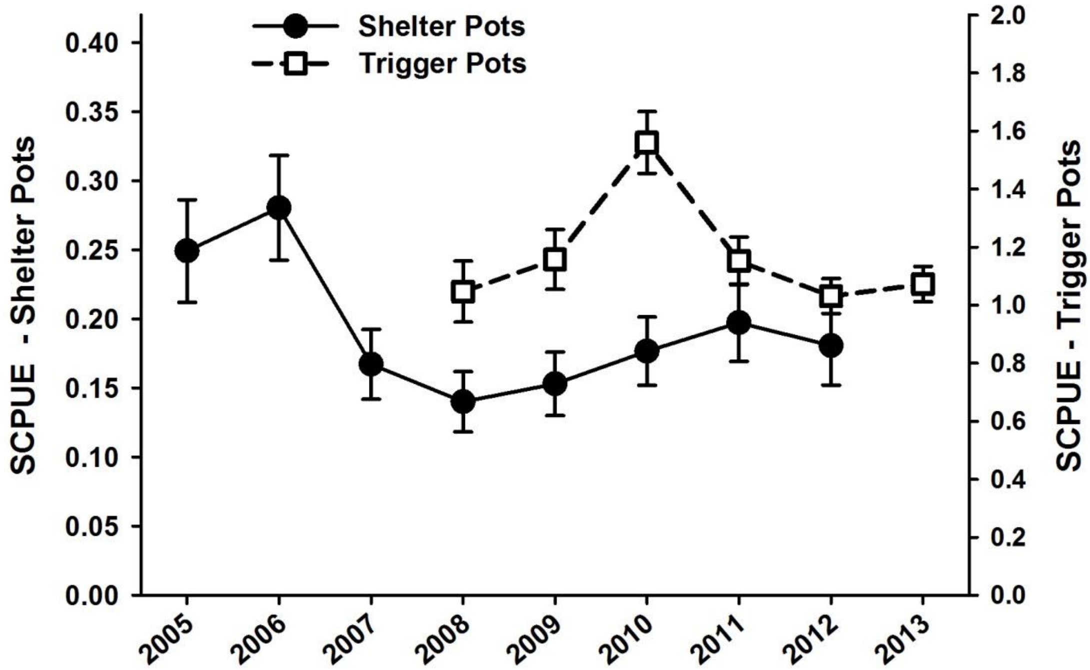
OCTOPUS FIGURE 1

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) (±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 then Department of Environment and Conservation. 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). The Department has provided 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 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.

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.

A second-stage project, which has recently received funding through the Royalties for Regions Regional Grants Scheme package, will trial the grow-out of up to 30,000 yellowtail kingfish. A collaboration between the Marine Fishfarmers Association and Indian Ocean Fresh Australia Pty Ltd, and being undertaken on behalf of the Mid West Development Commission, the trial will be located at a licensed aquaculture site in Champion Bay.

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 progressing well and the initial sampling work in the identified study areas started on schedule in May 2014.

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

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

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education in commercial and recreational fisheries in the West Coast Bioregion is undertaken by Fisheries and Marine Officers (FMOs) based at the Busselton, Bunbury, Mandurah, Rockingham, Fremantle, Hillarys, Lancelin, Jurien, Dongara and Geraldton offices, statewide mobile patrol units and officers aboard the large ocean-going patrol vessels P.V’s Houtman and Walcott. The Department’s community 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 volunteers based in some regional centres within the Bioregion.

Services provided by land-based officers include processing inspections, landing and gear inspections, licensing checks, wholesale/retail checks and 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), Shoalwater and Marmion Marine Parks (Metropolitan), and Jurien Bay Marine Park (Midwest). These functions are primarily related to the integrity of management arrangements for the different zoning within the Parks.

Activities during 2012/13

During 2012/13, Fisheries and Marine Officers delivered a total of 24,428 hours of compliance and community education services in the field (West Coast Bioregion Compliance Table 1). This represents a 2.5% decrease 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 on this fishery. In addition to the rock lobster fishery, FMOs 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 third quota year for the rock lobster fishery was the introduction of FishEye, electronic 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.

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.

Overall, compliance in the West Coast Bioregion by commercial fishers was good, however there were increases in the number of prosecutions from 60 to 70, infringements from 18 to 41 and infringement warnings from 47 to 90 compared to 2011-12.

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, marron, blue manna crabs and minor finfish species. Demersal scalefish closures and fishing within the bioregion is supported by statewide recreational mobile patrol units.

Field contacts with the recreational fishing community decreased from 88,162 to 82,531. Overall compliance was good with decreases in prosecutions from 295 to 227, infringements from 1,004 to 841 and infringement warnings from 1,476 to 1,227.

The Department continues to work collaboratively with the Department of Parks and Wildlife (DPaW) 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 DPaW 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 Parks and Wildlife in the disentanglement of whales in the West Coast Bioregion. 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, FMOs provided support to incident responses and other program activities.

Initiatives in 2013/14

The fourth year of the Quota Management System commencing on 15 January 2014 in the West Coast Rock Lobster fishery will see the introduction of gear restricitons to mitigate against whale entanglements. The Department will undertake a significant field education and compliance program to support this initiative.

The increased focus on recreational fishing compliance will continue, particularly with the ongoing operation of the recreational mobile patrols operating within the bioregion. Compliance and management personnel will continue to refine compliance planning to deliver greater efficiencies and outcomes through the use of risk assessments and intelligence processes. One significant change in the bioregion will be the extension of the West Coast Rock Lobster season for recreational fishers. Another is the deployment of artificial reefs off Bunbury and Dunsborough in the South West around April 2013. 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 Parks and Wildlife and the community, in planning both compliance and educational activities.

WEST COAST COMPLIANCE TABLE 1

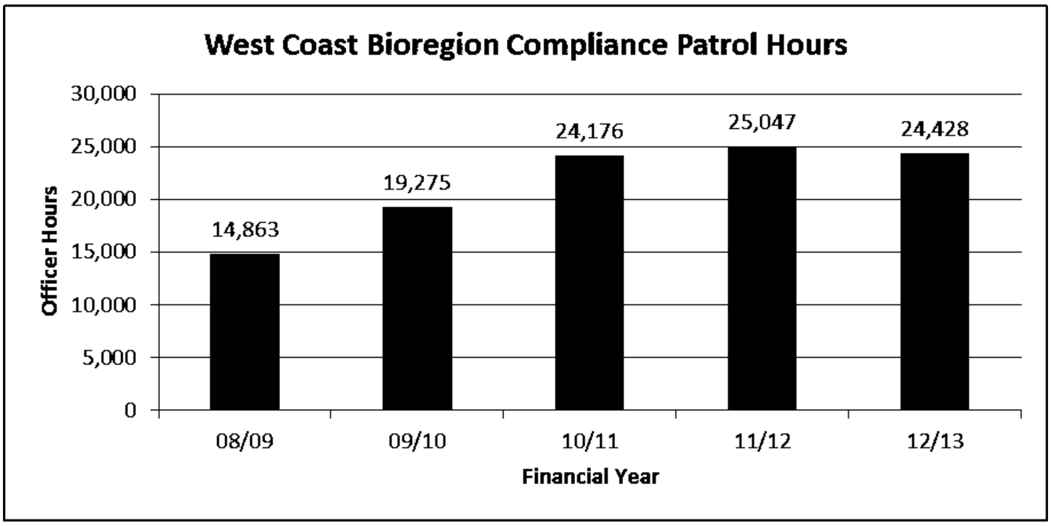
Summary of compliance and educative contacts and detected offences within the West Coast Bioregion during the 2012/13 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	24,428 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY[1]	
Field Contacts by Fisheries & Marine Officers	1,970
Letters of warning	91
Infringement warnings	90
Infringement notices	41
Prosecutions	70
Fishwatch reports[2]	33
VMS (Vessel Days)[3]	18,048
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	82,531
Infringement warnings	1,227
Infringement notices	841
Prosecutions	227
Fishwatch reports	680
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY	
Field Contacts by Fisheries & Marine Officers	6,232
Fishwatch reports	24

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 and PV Walcott while they were operating in the Bioregion.

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 COMPLIANCE FIGURE 1

“On Patrol” Officer Hours showing the level of compliance patrol activity delivered to the West Coast Bioregion over the previous 5 years. The 12/13 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. and any services delivered by the Department’s large Patrol Vessels: *PV Walcott, PV Houtman* and *PV Hamelin*).

GASCOYNE COAST BIOREGION

ABOUT THE BIOREGION

The marine environment of the Gascoyne Coast Bioregion (Gascoyne Overview 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.

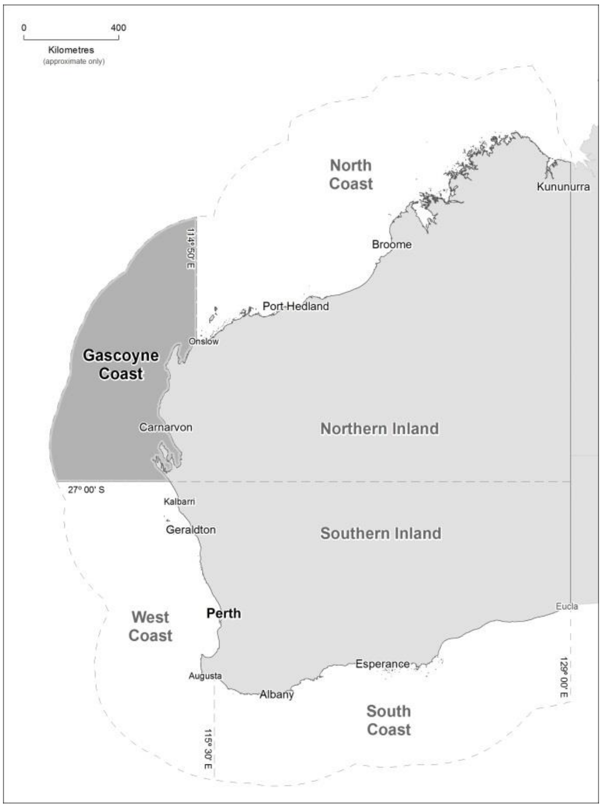
The coastline is characterised by high cliffs in the southern half changing to fringing coral reefs in the north. Coastal waters are generally high-energy in terms of wave action due to the strong trade wind system. The Exmouth Gulf section of the Gascoyne Coast Bioregion is seasonally influenced by 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 hyper-saline, 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.

SUMMARY OF ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

Climate Change

Some of the key environmental trends that may be affecting ecosystems in WA include:

- Increasing frequency of El Niño/Southern Oscillation (ENSO) events;
- More years with a weaker Leeuwin Current;
- Increase in water temperature off the lower west coast of WA;
- Increase in salinity, which includes some large annual fluctuations;
- Change in the frequency and location of storms (and rainfall) affecting the lower west coast; and
- Change in the frequency of cyclones (and summer rainfall) affecting the north-west coast.

The Gascoyne Coast Bioregion is predicted to be at enhanced risk from the effects of climate given that it spans a transitional zone between tropical and temperate regions. The variables expected to drive climate change impacts include changes in water temperature, ocean currents, winds, rainfall, sea level, ocean chemistry and extreme weather conditions.

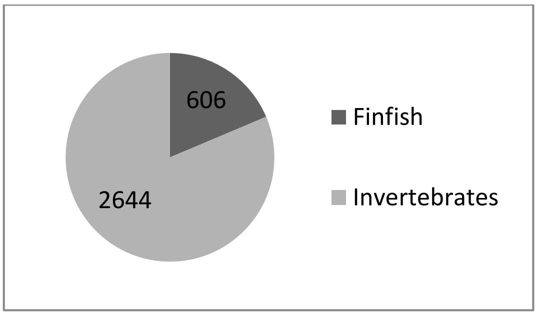
It is apparent that climate change will impact the biological, economic, and social aspects of many fisheries, and both positive and negative impacts are expected. Climate change can influence biological systems by modifying the timing of spawning, range and distribution, composition and interactions within communities, exotic species invasions and impacts, and the structure and dynamics of communities, including changes in productivity. Species distribution shifts are the most commonly reported changes and are often the easiest to recognise and measure, and are being monitored in a national citizen-science program (www.redmap.org.au) that the Department is collaborating in.

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 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 COAST OVERVIEW FIGURE 2

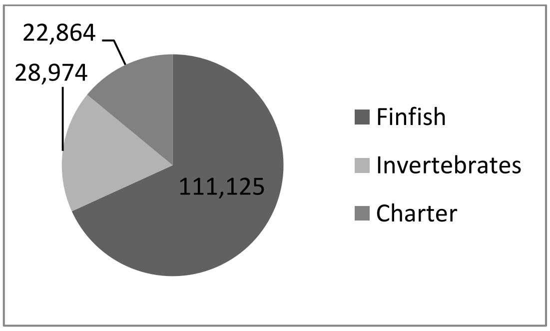
Relative contribution of finfish and invertebrates to the total commercial wild fishery catch originating from the Gascoyne Bioregion. Numbers represent total catch (in tonnes).

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, cods, trevallies and other game fish and blue swimmer crab and squid. Some temperate species at the northern end of their ranges, such as (pink) snapper, tailor and whiting, provide significant catches, particularly in Shark Bay. (Gascoyne Coast Overview Figure 3)

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 COAST OVERVIEW FIGURE 3

The Gascoyne Coast Bioregion finfish and invertebrate catch numbers as assessed in the integrated survey of boat-based recreational fishing in WA 2011/12, and the charter boat catch numbers for the 2013 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.

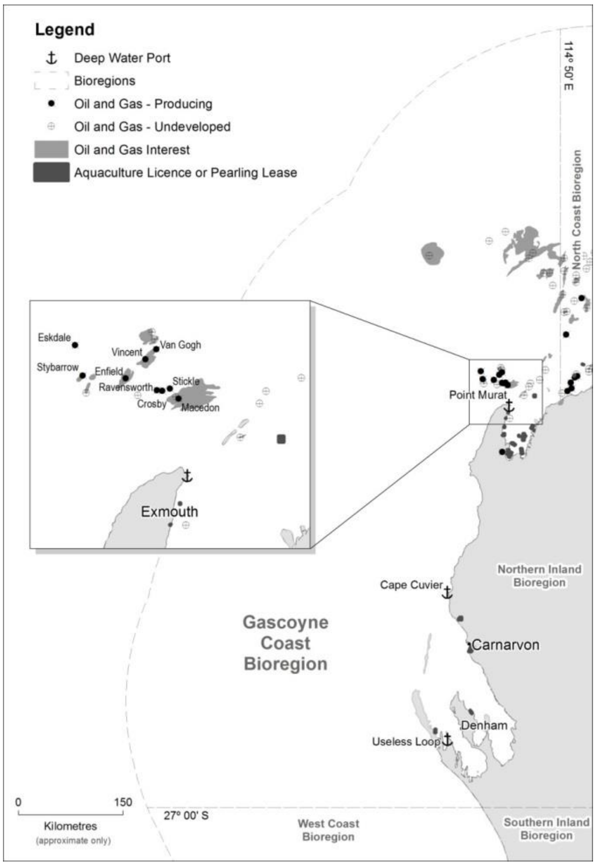
The main disturbances associated with oil and gas exploration and production include noise pollution from seismic surveys, potential for fish movement/impact arising from seismic surveys, disturbance to the marine habitat through drilling and/or dredging activities, release of produced formation water,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

Shipping and Maritime Activity

There are three deepwater port facilities currently operating in the Gascoyne Coast Bioregion: Useless Loop,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.



GASCOYNE OVERVIEW FIGURE 4

Exmouth Sub-basin offshore oil and gas production sites and Aquaculture Licences and Pearling Leases.

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:

Climate Change

Work is being finalized as part of a three-year FRDC-funded project (2010/535) that aimed to assess the effects of climate change on the marine environment and key fisheries, as well as management implications. The first phase of the project was 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 was to look at historical trends and possible future scenarios of WA 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 on fish stocks. The Department is also a key collaborator in the National RedMap (Range Extension Database & Mapping project) project (www.redmap.org.au) which uses a citizen-science approach to document range extensions of a number of key identified climate-change affected species. Understanding shifts in populations is likely to be increasingly important to adaptive fisheries management.

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 Overview Figure 5). The extent of these areas means that most of the West Coast Bioregion inside 200 m depth could be classified as one of the marine protected area IUCN categories (Gascoyne Ecosystem Management Table 1; as per Dudley, 2008[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 Overview Figure 6). 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.

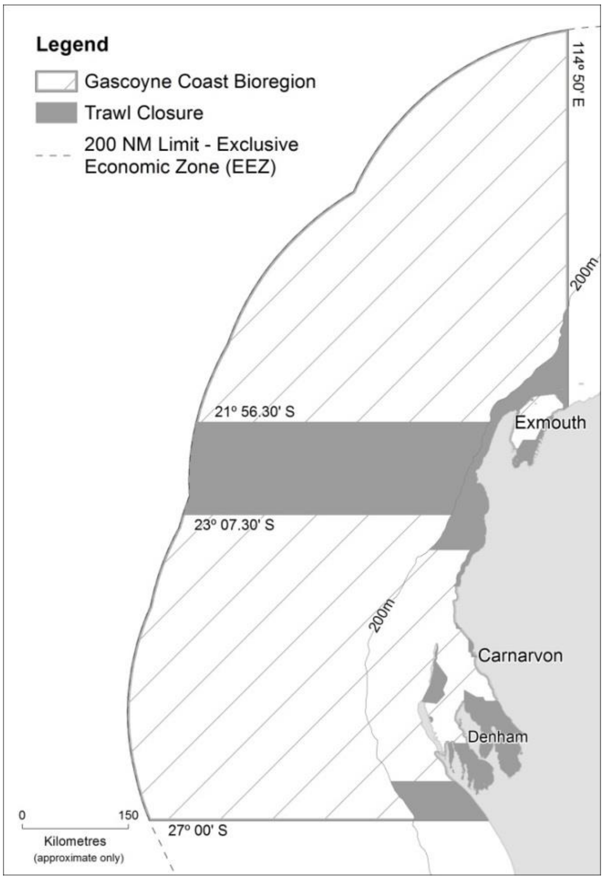
The Commonwealth Government is also undertaking a process of identifying additional protected areas for Commonwealth waters between Shark Bay and the Northern Territory border.

GASCOYNE ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the Gascoyne Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which meet the IUCN criteria for classification as marine protected areas.

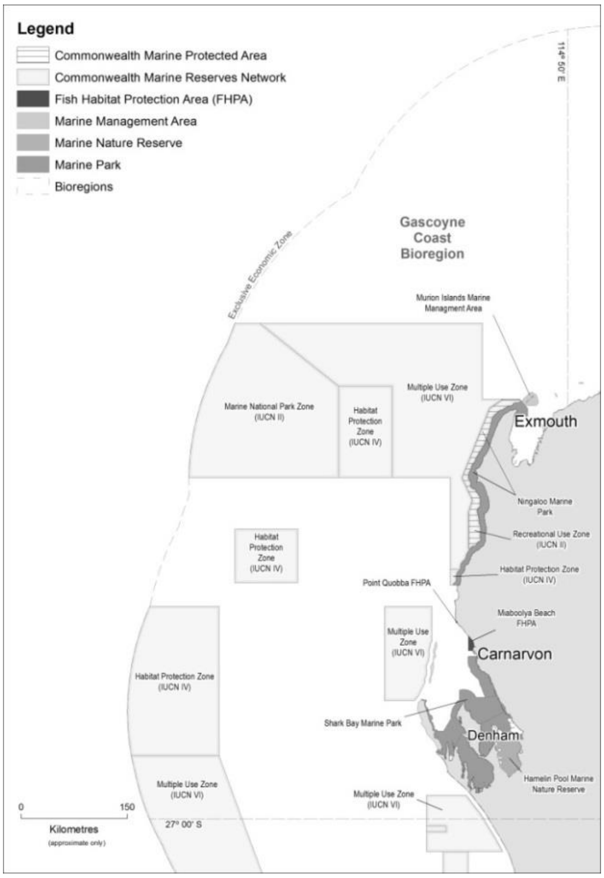
IUCN category or equivalent	State Waters only (24,100 km2)				All Waters (416,300 km2 (including State waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km2	%	km2	%	km2	%	km2	%
I	0	0	0	0	0	0	0	0
II	0	0	2,500	10	0	0	5,000	1
III	0	0	0	0	0	0	0	0
IV	3,100	13	6,400	27	13,200	3	6,400	2
V	0	0	0	0	0	0	0	0
VI	9,500	39	2,600	11	389,100	93	2,600	1

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



GASCOYNE OVERVIEW FIGURE 5

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.



GASCOYNE OVERVIEW FIGURE 6

Map showing the Gascoyne Coast Bioregion and current and proposed state and commonwealth marine parks and reserves along the northern WA coast.

Management of Commercial Fisheries

There is a high degree of ecosystem management and protection for the ecological assests 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 listed 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
- Monitoring of fishing activities using the Vessel Monitoring System (VMS)

The State is currently employing a bioregional approach to the pre-assessment of all its fisheries for potential third party certification according to the sustainability criteria developed by the Marine Stewardship Council (http://www.msc.org/). The progression of a number of fisheries to full certification is underway. This process will ensure independent assessment of the sustainability and effective management of assessed fisheries to an internationally recognised standard.

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 statewide recreational 'fishing from boat' license was also introduced.

A number of recreational fishing surveys have been undertaken in the region, including a recent statewide 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

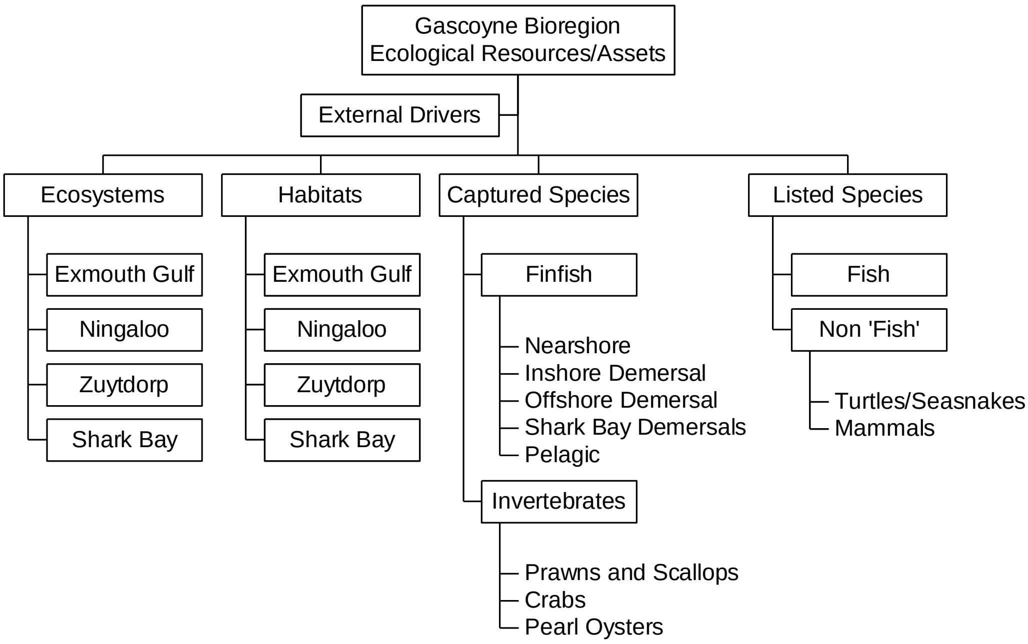
The main focus of the Department of Fisheries in the Gascoyne continues to be on the regulation of the regional pearling industry, including the blacklip oyster *Pinctada margaritifera*, which now complements the major State industry sector built on the silver lip pearl oyster (*Pinctada maxima*). A 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) (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 Gascoyne Overview Figure 7 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 7

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 Leuwin 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 °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 .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 is being completed 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 was 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 was to 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. The Department recently completed 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 2013/14".

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 statewide benthic habitats out to the 200 m depth contour are, in practical terms, fully protected and may never have been trawled (Ecosystem Management Table 1). 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 listed 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 Figure 5).

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 Figure 2).

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.

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 nm^2) 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 nm^2 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 north-western 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 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 km^2 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 DPaW, 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 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

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.

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 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. 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. The Department 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.

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.

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 km^2 waters contained within the fishery boundary, 1100 km^2 is closed to trawling but a further 900 km^2 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 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

Listed species

A variety of endangered, threatened and protected[1] (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

Listed species	Risk
Fish	LOW

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

Non-Fish

Listed species	Ecological Risk
Turtles/seasnakes	LOW
Mammals	LOW

While listed 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 listed species list does not automatically indicate that a species is either threatened or endangered.

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. There are two key vectors for marine pest translocation: ballast water and hull fouling. The Marine Biosecurity Research and Monitoring group has undertaken a research project to investigate the likelihood of a marine pest being introduced into the Gascoyne Coast Bioregion by commercial shipping (see Bridgwood & McDonald 2014[1]).

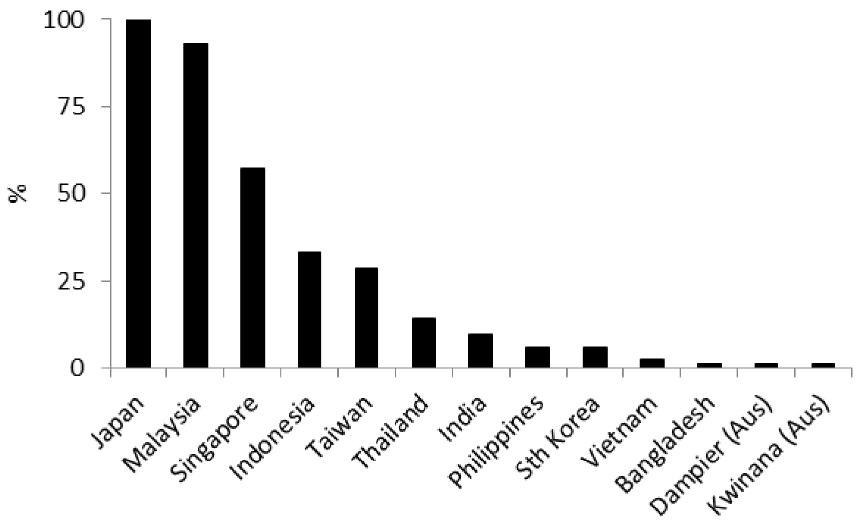
From a biosecurity perspective the introduction of a marine pest to any region is based on multiple factors that can be grouped into two themes; the likelihood of inoculation and the likelihood of infection and establishment. Inoculation likelihood assumes that the greater the number of vessel visits from a source with introduced marine pests (IMP) the greater the risk of IMPs being brought into the recipient port i.e. a positive linear relationship. Based on available commercial vessel data (Useless Loop Port only) from 2011, there were 189 commercial visits to the Gascoyne Coast Bioregion and the greatest inoculation risk was from international vessel movements. The infection and establishment likelihood takes into account the sources of IMPs (based on a vessels last port of call (LPOC)), the frequency of visits from those sources and the compatibility between the IMPs salinity and temperature tolerances and Gascoyne Coast Bioregion. There was a 68% compatibility rating of potential inbound IMPs with the environment of the Gascoyne Coast Bioregion from 11 international LPOCs (Introduced Pests Figure 1). When the cumulative effect of the number of vessel visits from a LPOC and number of IMPs present at that LPOC is considered, the greatest infection and establishment risk to the Gascoyne Coast Bioregion was from Japan (Introduced Pests Figure 2).

To date the Marine Biosecurity Research and Monitoring have not undertaken any introduced marine pests monitoring in the Gascoyne Coast Bioregion. Given the increase in vessels movements associated with the significant oil and gas mining activity offshore there is a real possibility of the introduction of marine pests into this bioregion.

INTRODUCED PESTS FIGURE 1

The last port of call locations of compatible IMPs for the Gascoyne Coast Bioregion

1 Bridgwood, S. and McDonald, J. A likelihood analysis of the introduction of marine pests to Western Australian ports via commercial vessels. Fisheries Research Report No. 259. Department of Fisheries, Western Australia. 212pp.



INTRODUCED PESTS FIGURE 2

Ranking of the infection and establishment risk posed to the Gascoyne Coast Bioregion by international and domestic last ports of call. Each last port of call value is expressed as a relative percentage of the largest last port of call value (i.e.Japan 100%)

FISHERIES

Shark Bay Prawn and Scallop Managed Fisheries Status Report

E.Sporer, M. Kangas, I. Koefoed, R. Oliver

Main Features			
Status		Current Landings	
Stock level		King Prawns	1139 t
Prawn	Adequate	Tiger Prawns	660 t
Scallop	Inadequate (non-fishing)	Endeavour Prawns	15 t
Fishing level		Scallops	Nil
Prawn	Acceptable		
Scallop	Acceptable		

Fishery Description

The Shark Bay Prawn Managed Fishery (SBPMF) is the highest producing Western Australian fishery for prawns. It targets the western king prawn (*Penaeus latisulcatus*) and brown tiger prawn (*Penaeus esculentus*), but also takes a variety of smaller prawn species including endeavour prawns (*Metapenaeus* spp.) and coral prawns (various species).

The Shark Bay Scallop Managed Fishery (SBSMF) catches the saucer scallop (*Amusium balloti*), and is usually WA's most productive scallop fishery. These two fisheries are managed through limited entry, gear controls (both use low opening, otter trawls as the fishing method) and 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 also licensed to retain scallops under the SBSMF.

Governing legislation/fishing authority

Shark Bay Prawn Managed Fishery Management Plan 1993

Shark Bay Prawn Managed Fishery Licence

Shark Bay Scallop Managed Fishery Management Plan 1994

Shark Bay Scallop Managed Fishery Licence

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

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

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 Management Meetings are convened by the WAFIC.

Boundaries

The boundaries of the SBPMF and the SBSMF 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 2013 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 the total net headrope capacity for the scallop fleet is 358.4 metres (196 fathoms).

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 Act 1994* (FRMA) is the overarching legislation for the 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 environmental impacts of the fishery.

The key harvest strategy for these fisheries is ‘constant escapement’ through 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 target catch rates. The Vessel Monitoring System (VMS) monitors the location of all activities by licensed fishing boats in these fisheries and adherence to permanent closures.

The Commonwealth Government’s Department of the Environment (DotE), has assessed the fisheries under the provisions of the *Environmental Protection and Biodiversity Conservation Act 1999* and accredited both fisheries for a period of five years (re-assessment in 2018), allowing product from the fisheries to be exported from Australia. The comprehensive Ecological Sustainable Development 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, listed 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 2013 prawn season, the fishing arrangements included an opening date of 11 March and closing date of 15 October, providing a total of 175 nights fishing. During this season, the fishing strategy involved voluntary rolling area openings, based on assessments of the sizes and abundance of king and tiger prawns obtained through fishery-independent surveys. The tiger prawn spawning area (TPSA) was closed on 29 June.

The 2013 scallop season did not open because of environmentally-induced low scallop abundance and is the second successive year of no scallop fishing.

Research summary

Research and monitoring activities in the Shark Bay region is separated into two regions, Northern Shark Bay and Denham Sound, as they represent separate stocks of prawns and scallops. Research activities continue to focus on stock assessment and annual monitoring of the target stocks, by fishery-independent surveys and commercial catch rates, 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 season. 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 target prawns at optimum sizes for market requirements and 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 2013, the moon closures ranged from four to nine days per month 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. The closure of the ENA was implemented in 1983 but the tiger prawn spawning stock abundance within this area was never assessed during the key spawning period until 2013. 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.

During October, trawling was permitted in a limited area below the Snapper Trawl Line (STL) in Denham Sound for a maximum period of 10 days. Fishery independent surveys undertaken in these waters prior to fishing indicated that the risk to juvenile pink snapper stock was very low, however access to this area in future years will be subject to prawn catch rate level and pink snapper numbers.

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 by providing prawn size structure information, which allows industry the opportunity to harvest prawns at market size.

Scallops

The opening date of the scallop fishing season is 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 target estimated scallop catch level for Denham Sound and northern Shark Bay has also been set to determine if commercial fishing can commence in either area each season. The catch prediction from the annual pre-season survey in November 2012 indicated a very low scallop abundance that was well below the target catch level for fishing to commence in either region, therefore, the fishery remained closed for 2013.

Retained Species

Commercial production (season 2013)

Prawns **1815 tonnes**

Scallops **Nil**

Landings

Prawns

The total landings (whole weight) of major prawn species for this fishery was 1815 tonnes, comprising 1139 tonnes of king prawns, 660 tonnes of tiger prawns and 15 tonnes of endeavour prawns (Shark Bay Prawn and Scallop Figure 3). Both king and tiger prawns were above last year's catch of 1075 and 494 t, respectively. In addition, 122 t of coral prawns (various species, but mainly *Metapenaeopsis crassissima*) were landed. The total landings of major prawn species were within the new target catch range (set in 2009) of 1350 to 2150 t. The new catch range reflects the change in the expected level of king prawn landings (950 to 1350 t) which has been reviewed to reflect current fishing/harvesting strategies and effort levels under normal environmental conditions.

King prawn landings (1139 t) were within their revised catch range. Tiger prawn landings (660 tonnes) were also within the historical target catch range (400-700 tonnes).

Scallops

No landings of scallops were allowed in 2013 due to low abundance.

Byproduct

Byproduct landings from the prawn fleet included 15.8 t of blue swimmer crab (*Portunus armatus*), 5.8 t of squid, 20.7t of cuttlefish, 3.2 t of bugs (*Thenus australiensis* and *T. parindicus*), < 1 t of octopus and 13 t mixed finfish species.

The total season landings of blue swimmer crabs by the prawn boats were low as there was a maximum retention of only one tonne of crabs per boat on a voluntary basis. The fleet retained crabs from 28 May and ceased on 21 July due to the low stock abundance of crabs in Shark Bay (see Gascoyne Coast Blue Swimmer Crab report for more details). Not all boats achieved their one tonne of crab catch.

Fishing effort/access level

Eighteen prawn boats operated in 2013. 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 2013 adjusted effort being 35,897 hours (twin-gear equivalent). This adjusted effort is approximately 8% higher than 2012 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 also reduced effort. The 2013 prawn season arrangements provided 175 nights fishing, however, a maximum of 160 nights were fished.

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 are 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. Two standard spawning stock surveys are generally undertaken around the third moon phase in July and August, in the Tiger Prawn Spawning Area (TPSA). For 2013 the surveys were planned for end of June and July (third moon phase) but the surveys were actually undertaken in July and September due to commercial boat availability and therefore the TPSA could not be assessed on the appropriate moon phase directly after closure. In 2013 the survey was also extended to include the Extended Nursery Area (ENA). The ENA survey was implemented to undertake an additional assessment of the spawning stock (spawning condition and abundance) for tiger and king prawns around the same lunar phase as the TPSA is sampled, during the key spawning period. In future it is planned that the surveys be undertaken during August and September when the ENA and the TPSA are both closed. This will require an adjustment of spawning index time series to take into account the sampling months. The TPSA was closed to fishing on 21 June to maintain a level spawning stock of tiger prawns between 20 and 25 kg/hr (the target level is 25 kg/hr based on 22 fathoms net headrope length in quad gear configuration).

Catch rate assessment

The overall king prawn catch rate of 31.7 kg/hr (for adjusted effort equivalent to twin gear units) was slightly lower than in 2012 (32.4 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 18.4 kg/hr was higher than in 2012 (14.9 kg/hr) and also higher that the previous 10 years mean catch rate (11.3 kg/hr). These catch rates show that the fishing fleet is fishing efficiently and abundance levels are acceptable.

Survey assessment and breeding stock levels

For 2013, the king and tiger prawn mean survey catch rates during the combined recruitment surveys (March and April) were 47.6 kg/hr and 47.5 kg/hr respectively and the catch predictions for king and tiger prawns were 880 t (705 to 1055 tonnes) and 500 t (400 to 600 tonnes) respectively. The actual landed catches of both species were above 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). The catch rates for tiger prawns in the TPSA were 20.2 kg/hr and 7.9 kg/hr in July and September respectively. The tiger prawn spawning stock level in the TPSA in July was below the target level of 25 kg/hr, which is based on July-August catch rates but considerably higher than that observed in July 2012 (6.6 kg/hr). The lower catch rate in September was expected as the catch rate level generally declines by this time because the prawns migrate through this area. The TPSA is an important area for tiger prawn spawning stock from June, the early stages of the key spawning period, to maintain adequate stock abundance because it is significant for egg production at this time. By September/October the tiger prawn abundance generally declines to a low level, therefore, this time may not provide an appropriate measurement of the entire spawning stock.

Conversely, the ENA becomes an important area for spawning after it closes from August. This area maintains some prawn abundance (both tiger and king prawns) and spawning stock throughout the latter part of the key spawning period. The surveys conducted in July and September 2013 showed tiger prawn catch rates of 21.0 kg/hr and 39.7 kg/hr respectively with a mean catch rate of 30.5 kg/hr. The overall catch rate from the TPSA and ENA combined may better represent the total spawning stock level of tiger prawns but cannot be directly compared to previous spawning stock surveys which were just done in the TPSA. In the future a revised index will be determined for these two areas combined and will be used in stock assessment and harvest strategy. The king prawn catch rates during the spawning stock survey in the TPSA in July and September were 75.8 kg/hr and 23.1 kg/hr respectively with a mean catch rate of 49.4 kg/hr, which is above the historical range for this species (16-29 kg/hr) at this time of year. 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 low.

Projected prawn catch range next season (2014): King prawns 725-1085 tonnes

Tiger prawns 430-645 tonnes

The recruitment survey results for March-April 2014 were similar to 2013 and therefore similar predicted catch range for king and tiger prawns are derived.

The main performance measures for the prawn fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2013, the breeding stock indicator for tiger prawns was slightly below the target level of 25 kg/hr. However, the 2014 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 2013. Examination of the 2013 logbook data for the spatial distribution and abundance of tiger prawn spawning stock indicates the stock was concentrated well south of the TPSA. The king and tiger prawn annual landings were within the revised king prawn target range and the historical tiger prawn 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 season's recruits.

The 2013 catch predictions based on the fishery-independent survey in November 2012, were extremely low for both Denham Sound (10 t) and northern Shark bay (20 t). These very low overall catch predictions for the fishery meant that all the available stock needed to be protected as spawning stock and the fishery remained closed. This low recruitment appears due to continued poor environmental conditions (e.g. warm water temperatures) for recruitment and in part the low abundance of spawning stock resulting from the extreme environmental conditions in late 2010 and early 2011 in Shark Bay due to the very strong La Niña, strong Leeuwin Current and record-high water temperatures.

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. This will assist in assessing whether recruitment variability is due to environmental factors alone or if it is also impacted by trawling on the spawning stock and/or subsequent recruitment.

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 2013 season to allow all scallops to contribute to the spawning stock. Despite no fishing in 2012 and 2013 the spawning stock is at record-low levels and hence is likely to negatively impact on the recruitment even if environmental conditions improve.

Projected scallop catch next season (2014):

Nil tonnes (whole weight)

The catch projection for the 2014 season is based on the November 2013 annual survey results and were extremely low (3 – 4 t meat weight) for both northern Shark Bay and Denham Sound. As the catch prediction for the fishery is so low all the available stock should again remain for spawning with no scallops to be taken. Three consecutive years of low recruitment means that the spawning stock in 2014 will again be well-below average.

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 2013.

Listed species interaction: Low

Although listed 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 listed 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.

For the 2013 prawn fishing season,36 turtles were recorded as caught in nets in the prawn fishery with 35 being recorded as returned to the sea alive . With improved reporting of listed species interactions, 363 sea snakes were reported as caught with 351 returned to the sea alive.

Ecosystem Effects

Food chain effects: Low

Although the harvest rates of the retained target species are high, such species have very high natural mortality rates and make up a relatively small proportion of the 'fish' biomass on the trawl grounds. Thus, most prawn and scallop predators are opportunistic due to these natural variations in prawn and scallop populations. Consequently, it is considered unlikely that the commercial take of prawns and scallops impacts significantly on the upper trophic levels within the Shark Bay ecosystem. The reduced levels of effort now used by the fishery, combined with the modifications to gear to reduce unwanted catch, will have further reduced the potential for indirect food chain impacts to occur.

Habitat effects:

Prawn fishery Moderate

Scallop fishery Low

There are extensive permanent and temporary closures in the Shark Bay trawl fisheries. The total area inside Shark Bay is 4652 nm^2 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 nm^2 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 2013 the performance measure was met as the total area trawled within inner Shark Bay by the prawn fleet was approximately 798 square nautical miles or 17% of inner Shark Bay.

Social Effects

These industries are a major contributor to regional employment. During 2013, approximately 100 skippers and other crew were employed in the prawn fishery. There are also approximately 55 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 2013:

Prawns Level 5 - > $20 million ($22.9 million)

Scallops Level 0 - Nil

The value of the fishery including blue swimmer crabs, coral prawns, cuttlefish, squid and bugs to the prawn fleet is $23.3 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	$12.33/kg
Tiger prawns	$13.33/kg
Coral prawns	$3.33/kg
Endeavour prawns	$7.27
Crabs	$9.23/kg

Fishery Governance

Target catch range:

Prawns (New 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 resulting in a shift in effort 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 with tiger prawns 400 – 700 t and endeavour prawns 1 – 30 t, remaining at the same level. Because of the change to the king prawn catch range, a revised overall range has been calculated as 1350 -2150 tonnes. This range will be adopted in 2014 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 exclude 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 2014 (<10t whole weight), based on a pre-season survey, is below the target catch range and the fishery remains closed.

New management initiatives (2014)

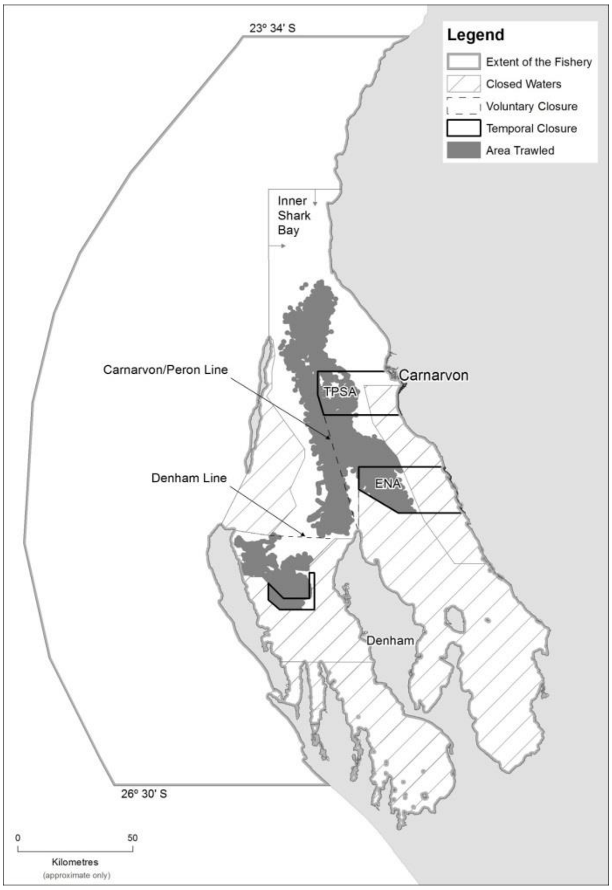
The pre-assessment phase for the Marine Stewardship Council approval system has been completed for both fisheries, with the Shark Bay Prawn Managed Fishery undergoing full assessment during 2014-15.

External Factors

Increasing costs of fishing and lower returns due to the global economic climate and competition from imported and locally aquacultured 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 provided the prawn industry the opportunity to maximise the return from all species taken in the fishery where possible, particularly scallops and blue swimmer crabs. Fishing in the early part of the season and short moon closure periods at this time tends to increase the take of smaller size and soft prawns (particularly king prawns) and to some extent, reduces the value of the fishery.

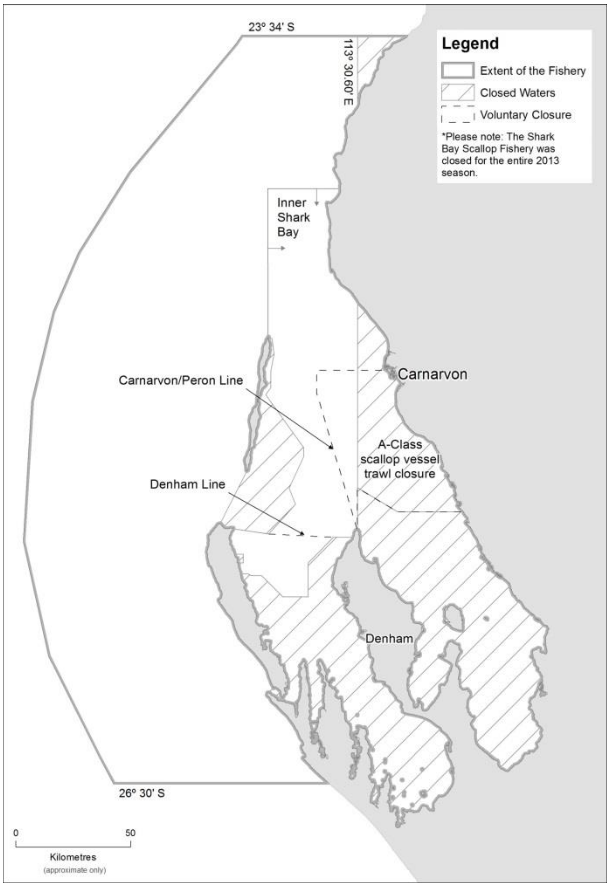
The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment. A relationship between current strength (as measured by Fremantle sea level) and king prawn catches has been identified and may be used to indicate broad catch trends. The 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 (and warmer water temperatures) 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.



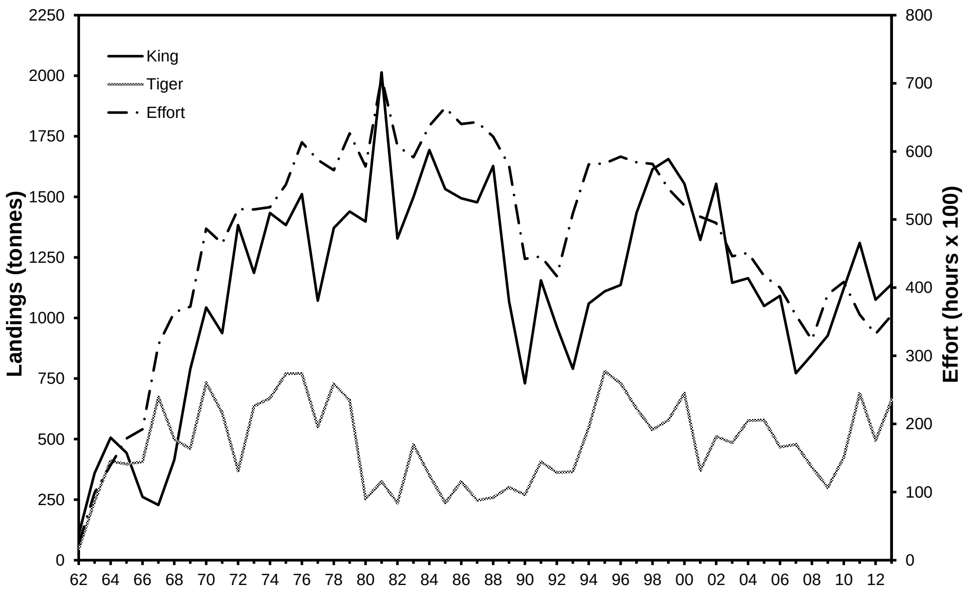
SHARK BAY PRAWN AND SCALLOP FIGURE 1

The main boundaries of the Shark Bay Prawn Managed Fishery, Inner Shark Bay, TPSA, ENA, trawl closures, permitted trawl area (extends out to the 200m isobath) and area trawled in 2013.



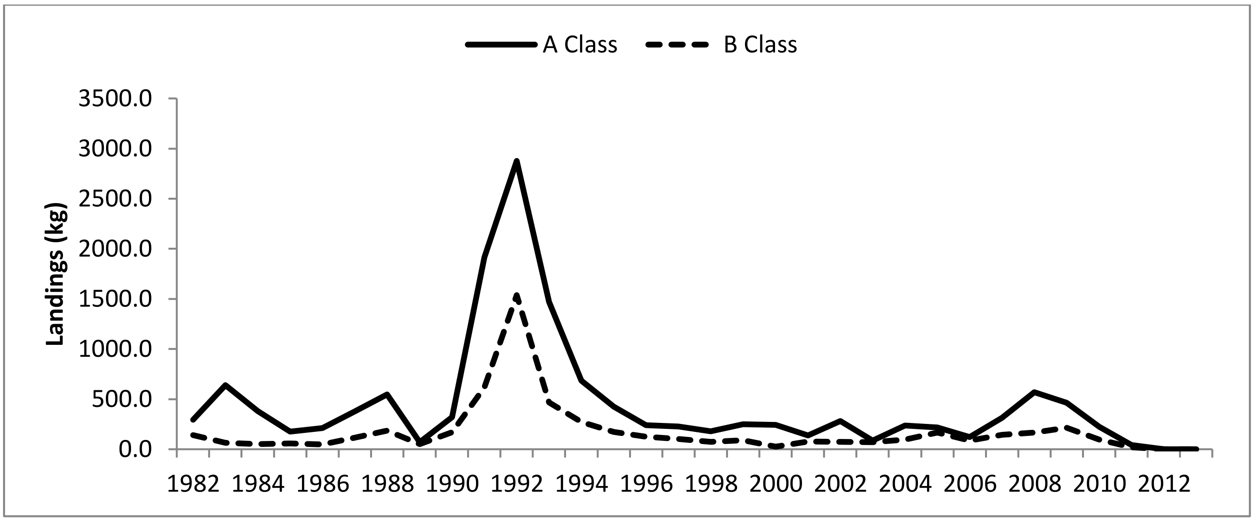
SHARK BAY PRAWN AND SCALLOP FIGURE 2

The main boundaries of the Shark Bay Scallop Managed 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 quad gear units) 1962 – 2013.



SHARK BAY PRAWN AND SCALLOP FIGURE 4

Shark Bay Scallop Managed Fishery annual landings 1983 – 2013.

Exmouth Gulf Prawn Managed Fishery Status Report

E. Sporer, M. Kangas, I. Koefoed, R. Oliver

Main Features

Status		Current prawn Landings	
Stock level	Adequate	Tiger	95 t
Fishing level	Acceptable	Kings	331 t
		Endeavours	85 t
		Banana	74 t

Fishery Description

The Exmouth Gulf Prawn Managed Fishery uses low opening, otter prawn trawl systems within the sheltered waters of Exmouth Gulf to target western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*).

Governing legislation/fishing authority

Exmouth Gulf Prawn Managed Fishery 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.

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 2013, 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.

Within this fishery, effort is primarily controlled through the maximum headrope units (capacity of the fishery) and the duration of the season. The maximum headrope allocation for the fleet is set at 394.8 m (216 fathoms), which is a 10% reduction of the original headrope since 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 has allowed industry to maximise economic efficiency, whilst maintaining overall and stock sustainability.

In recent seasons, management arrangements have provided for a fishing period of about 200 nights with a minimum of 28 non-fishing nights for moon closures during the period. For the 2013 season, official opening and closing dates were set at 8 April and 14 November, providing a maximum of 185 nights fishing. This is a flexible arrangement and the season actually commenced on 15 May based on results from pre-season surveys and fishing ceased 10 November (144 days fished). There were spatio-temporal closures during the early part of the season (May to 26 July) to avoid fishing on small prawns to maximise the value of the limited tiger prawn stock available in 2013.

Stringent measures are in place to ensure that spawning stock levels for tiger prawns are maintained at adequate levels and 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. This certification allows licensees to export product to the US market. A review of the conditions, of its BRD-compliancy, for reducing the potential for turtle captures by the US Department of State will be undertaken in 2014. Because of the increase in the size of the net headrope and the body of the net to accommodate the reduction of boat numbers (from 9 to 6) the actual size of the grids and the grid escape opening were required to be increased in line with the U.S standards. 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 the Environment (DotE), assessed the fishery in 2013 under the provisions of the *Environmental Protection and Biodiversity Act 1999* (EPBC Act), and has accredited the fishery for a period of five years (re-assessment in 2018), allowing product from the fishery to be exported from Australia. The comprehensive ESD assessment of this fishery made a number of recommendations that required management action to ensure adequate performance, including status of the target stock, listed species interaction and bycatch monitoring. 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 surveys of king prawns (established in 2002). These surveys also provide prawn size structure information to assist with harvesting strategies (these are detailed above in the management arrangements) and understanding of prawn movement in this fishery. An annual catch prediction for both tiger and king prawns is also provided using an index derived from the recruitment surveys. In 2013 two pre-season recruitment surveys were undertaken for both tiger and king prawns.

Monitoring of fishing activity is undertaken in real time and using target 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. Research into the cause of the low tiger prawn recruitment in 2012 and 2013 is currently underway.

Retained Species

Commercial production (season 2013):

585 tonnes

Landings

The total landings of major penaeids for the 2013 season were 585 t, comprising 95 t of tiger prawns, 331 t of king prawns, 85 t of endeavour prawns and 74 t of banana prawns. The tiger prawn landings were well below the normal catch range (250-550 t) but an improvement on the 2012 catch of 46 t. The king prawn landings were slightly below the target catch range (350-500 t). The king prawn landings increasing trend has continued since the low recorded landings of 97 t in 2011. Endeavour prawn landings were below the normal catch range of 120-300 t but an improvement on last year's catch of 51 t. Banana prawn landings were the highest on record in 2013.

Recorded landings of byproduct were; 2 t of blue swimmer crab *(Portunus armatus)*, 3 t of squid, 1 t of bugs (*Thenus australiensis*), 2 t of coral prawns, 3 t of cuttlefish and <1 t of octopus. Landings of blue swimmer crabs were slightly below the historical range (8 to 58 t). The low effort in locations where crabs are abundant, were reflected in the low catches which were similar to the 2012 season. 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).

Fishing effort/access level

In 2013 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 boats cannot tow the larger nets.

Total nominal effort for the 2013 season was 9503 hours, a slight increase compared to the extremely low nominal effort recorded in 2012 (7042 hours). The adjusted effort (to twin gear) in 2013 was 17,124 hours. Fishing effort (in hours) in 2013 was the second lowest in 40 years but also reflects the low prawn abundance. Generally the effort on king prawns is targeted at the latter part of the season when their abundance peaks during late August to end September. Fishing effort normally continues into November, and also did in 2013 year mainly because of the low effort during the early part of the season (a combination of banana and tiger prawn fishing in the Central area) and shifting effort to the latter part of the season. The season ceased on 10 November with 144 days actually fished, only 27 more fishing nights compared to 2012.

Stock Assessment

Assessment complete: **Yes**

Assessment level and method:

Level 4 - Direct survey/catch rate

Breeding stock levels: **Adequate**

Projected catch next season (2014):

275 (220-330) tonnes tiger prawns

125 (100-150) 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 need to be reviewed in the future and possibly adjusted for the current fishing harvesting strategy. The tiger and king prawns stocks are also assessed each year using standardised recruitment and breeding stock surveys.

Catch assessment

The preliminary adjusted annual catch rate of 5.6 kg/hr for tiger prawn was lower than the reference catch rate of 10 kg/hr. As in 2012, the low catch rate of tiger prawns reflect their low abundance. The likely cause of the continued low abundance (low recruitment levels) may be a result of three years of very high water temperatures since 2010/2011 (highest observed in 2013) and its possible continued impact on the spawning stock and/or inshore structured habitats. During 2013 fishing on the tiger prawn stock was again conservative and only parts of the Central area was open to fishing. Fishing for tiger prawns was undertaken from 15 May to 26 July after which the TPSA closed. There were six subsidiary openings in the Central area whilst the Eastern area remained closed for the entire season. When fishing ceased according to the target catch rate level for tiger prawns on 26 July the TPSA was not re-opened to fishing for the remainder of the season.

The adjusted catch rate 19.3 kg/hr for king prawns is above reference catch rate level of 11.7 kg/hr. There is still, however, some concern for the king prawn stock as total landings were below the acceptable catch range even though there was an increase in the total landings compared to 2011 and 2012 seasons. Fishing effort does not appear to be the main cause of the decline in annual landings at current effort levels, however, there may need to be a consideration of implementing a small area closure during the spawning season to provide protection to some of the spawning stock. Fishery-independent surveys are undertaken to measure the recruitment strength and spatial distribution and catch and effort information from logbooks is used during the spawning phase to assess the stock status and to understand the distribution of king prawns in the northern gulf. The season commenced on 15 May, almost 1 month earlier than in 2012, as a result of improved king prawn recruitment. King prawns were fished conservatively during the early part of the season and effort in the northern area (the main king prawn fishing grounds) was focused mainly in the latter part of the season. Also in the early part of the season, areas where small size king prawns were located, were closed to fishing to ensure that size and quality were maintained.

All prawn fishing ceased in 2013 following 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 an improved abundance level compared to 2012 and predicted tiger prawn catch range for 2013 was 170 to 250 tonnes. For the 2013 season the annual total landings were below the prediction range, probably as a result of conservative levels of fishing. 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).

For the 2013 season it was difficult (as it was in 2012) 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, the presence of banana prawns in the Central area which fishers sometimes targeted instead of tiger prawns. When boats shift effort between areas, monitoring tiger prawn catch rates on a daily basis is problematic. Also, the low number of boats (6) in the fishery does not provide a full coverage of all the fishing areas with only hot spots being primarily fished. For this reason a survey was undertaken on 3 July to obtain standardised fishery-independent tiger prawn catch rate information east of the spawning area. The Central area was closed between 2 and 15 July and re-opened for a limited fishing time within a restricted area between 16 and 25 July. When fishing ceased on 26 July the TPSA was not re-opened to fishing for the remainder of the season.

Three standardised tiger prawn breeding stock surveys are carried out in August, September and October each year. The 2013 survey results showed an average quad gear CPUE for all three surveys of 14.7 kg/hr and 30.4 kg/hr in the spawning areas (Q1 and Q2 respectively) with an overall mean catch rate of 22.6 kg/hr compared to 17.3 kg/hr in 2012. This level is an increase on the spawning stock abundance observed in 2012 and is above the limit (15 kg/hr) and threshold reference points (20 kg/hr) but is slightly below the target level (25 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 abundance information. The combined pre-season surveys (March and April) provided a catch prediction of 315 t with a range between 250 and 380 t. The annual landing of 331 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 mean tiger prawn spawning stock catch rate of 22.6 kg/hr was slightly below the target level. Stocks of king prawns are monitored using catch levels which were slightly below the target catch range but within the predicted catch range. However, there is a conservative harvesting strategy in place for this species. 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 2013 was a slight increase compared to the 2012 season (the lowest since 1970) the second 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 (with only six boats now operating) and implementation of BRDS in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.

Listed species interaction: Low

While listed 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 correct reporting of interactions with listed species by fishers. In 2013 ten turtles (2 green, 1 loggerhead and 7 unidentified) were reported as captured in nets and returned to the sea alive. One hundred and eleven sea snakes (unidentified) were reported as captured and were reported as returned to the sea alive. Fourteen sawfish were reported as captured but their status was unknown and 1 seahorse was 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. The spatial extent of area fished in the last two years has also been reduced with the area trawled below 25% of the fishery compared to around 30% in past years.

Performance measures for habitat impact relate to the spatial extent of trawling within the licensed area of the Exmouth Gulf fishery. In 2013 the performance measure was met as the total area trawled, at approximately 247 square nautical miles (21.7%) per cent of Exmouth Gulf, was below the 40% level.

Social Effects

The estimated employment in the fishery for the year 2013 was 18 including skippers and other crew. Twenty three additional support staff are also based in Exmouth Gulf and additional support staff in Fremantle for refit of boats. 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 2013: Level 3 - $5 - 10 million

($6.8 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 ($6.8 million). This reflects an increased value of the fishery compared to the low 2012 season value, however, below the expected value of the fishery between 8 and 11 million dollars. Estimated prices for prawns were as follows:

King prawns	$12.33/kg
Tiger prawns	$13.33/kg
Banana prawns	$ 9.33/kg
Endeavour prawns	$7.27/kg
Coral prawns	$3.33/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 585 t is 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 (95 t) while below the catch prediction (170-250 t) was not unexpected due to the low effort that triggered the early cessation of fishing on tiger prawns. The king prawn survey catch rates indicated an abundance (315 t) slightly below the long term catch range. The annual landings (331 t) were below the catch range but within the predicted range (250 to 380 t).

New management initiatives (2014)

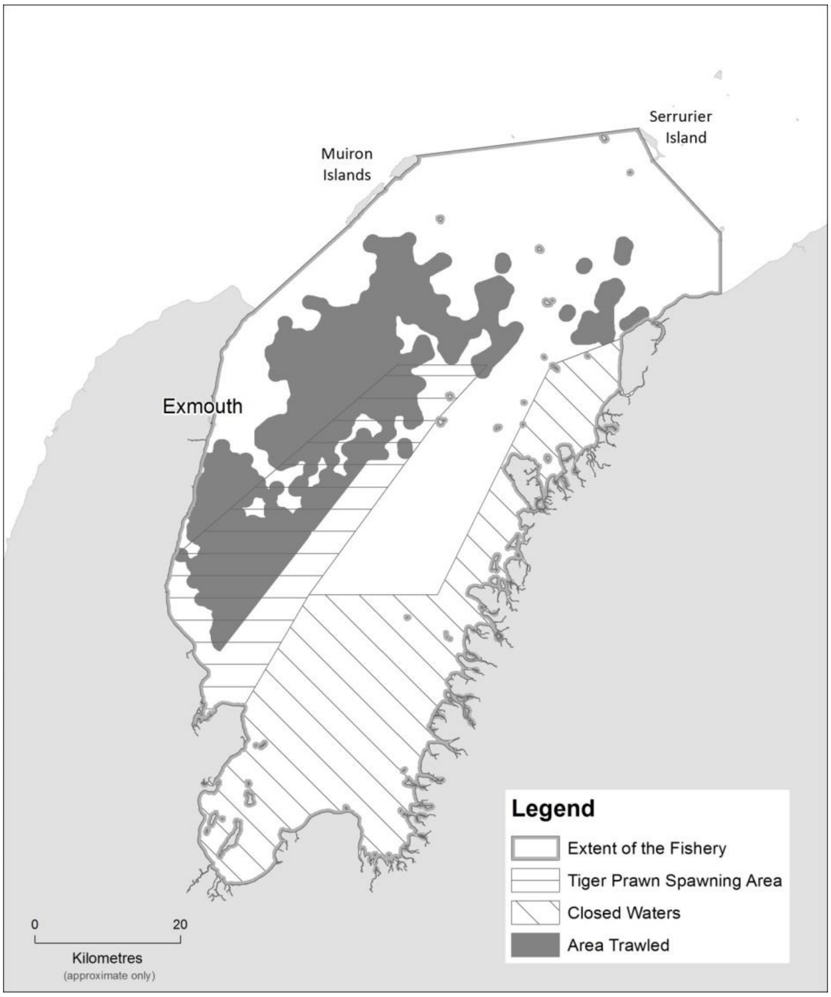
The Department is still progressing an amendment to the management plan in consultation with licensees to incorporate changes to gear arrangements in this fishery. The fishery completed the Marine Stewardship Council pre-assessment during mid-2013 and is undergoing full assessment in 2014/15.

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, however, product to the export markets are maintained but at lower profit margins.

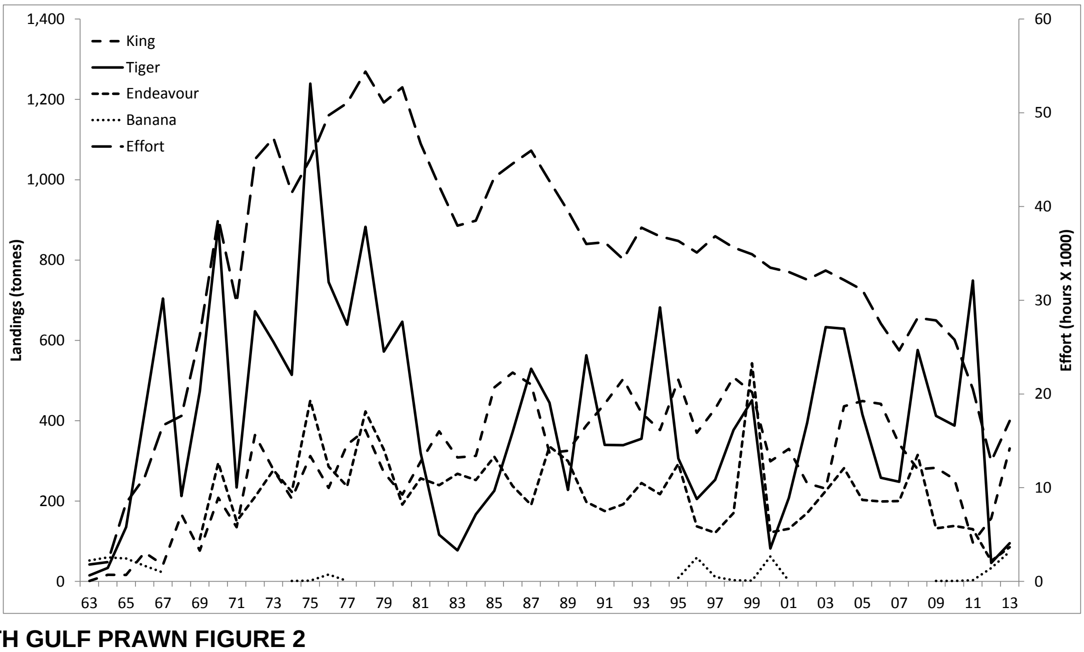
Cyclones appear to have a significant effect on the productivity of Exmouth Gulf. Cyclone impacts can be either positive or negative. Early (December to January) cyclones can have a negative impact (high mortality) on small size prawns in the shallow nursery areas. The positive effect is that the water 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. In 2013 there was some improvement in recruitment. The cause of the low recruitment is being investigated in regard to sea temperatures and funding is being sought to further investigate impacts on inshore habitats.



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 2013.



EXMOUTH GULF PRAWN FIGURE 2

Exmouth Gulf Prawn Managed Fishery annual landings and adjusted effort (twin-gear), 1963 – 2013.

West Coast[1] Deep Sea Crustacean Managed Fishery Status Report

J. How and K. Nardi

Main Features			
Status		Current Landings	
Stock level	Adequate	Crystal Crabs	140 t
Fishing Level	Acceptable		

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 and Gascoyne Bioregions.

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 interim 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 are 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.

A recent pre-assessment of the fishery for Marine Stewardship Certification has been the focus of the research for this fishery. It has resulted in the development of a proposed harvest strategy and control rules framework, and a re-assessment of the model for standardisation of the catch rates. There has also been considerable work undertaken to gain a better understanding of the catches, particularly undersize and berried females which are currently only estimates by fishers recorded through the volunteer logbookprogram. This assessment includes remote video / on-board monitoring and industry catch sampling. All methods are currently being assessed for future monitoring protocols.

1 Note: This is the official name of the fishery. Boundaries include Gascoyne, see above.

Retained Species

Commercial landings (season 2013):

Crystal crab **139.5 tonnes**

Giant crab **0.0 tonnes**

Champagne crab **0.0 tonnes**

The catch of 139.5 tonnes of Crystal crab in 2013 was similar to all years since the introduction of 140 t. quota in 2008 (Deep Sea Crab Figure 1). There was no catch of 'B" class quota (Champagne or Giant crab). The lack of Champagne crab catch is likely due to low market demand, and there being no targeted fishing for Giant crabs. 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 2013) **Nil**

Fishing effort/access level

Nominal commercial effort decreased by 1 % from an estimated 54,028 pot lifts in the 2012 season to 53,414 pot lifts in the 2013 season. The standardised commercial effort similarly decreased from 68,483 pot lifts in the 2012 season to 62, 807 pot lifts for the 2013 season, a 8% reduction. 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 and the standardised catch rate for the standardised effort.

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 139.5 t, which is within the target catch range (100-140 t). The standardised catch rate of legal crabs increased by 9% in 2013 to 2.22 kg/pot compared with 2.03 kg/pot in 2012 (Deep Sea Crab Figure 2). The 2013 standardised catch rate represents the highest in a decade (Deep Sea Crab Figure 2), and is above the current notional upper target reference point .

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 and remains above the current notional threshold reference point (Deep Sea Crab Figure 3a). There was a progressive decline in the standardised catch rate of undersized crabs with the catch rate reaching a low in 2010. Since then the standardised catch rate has increased and in 2013, the level is above the notional threshold level and is similar to the level in 2012 (Deep Sea Crab Figure 3b)

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).

Both of the measures were met.

Non-Retained Species

The fishery just completed a Marine Stewardship Certification pre-assessment, and all aspects associated with non-retained species were scored such that they pose little-no effect on the bycatch or listed 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.

Listed species interaction **Negligible**

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

Ecosystem Effects

The fishery just completed a Marine Stewardship Certification pre-assessment, and all aspects associated with ecosystem effects were scored such that they pose little-no effect on the ecosystem.

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 km^2. 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 2013.

Economic Effects

Estimated annual value (to fishers) for 2013

Level 2 - $1 - 5 million ($2.3 million)

The beach value of the fishery was about $2.3 million in 2013 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.

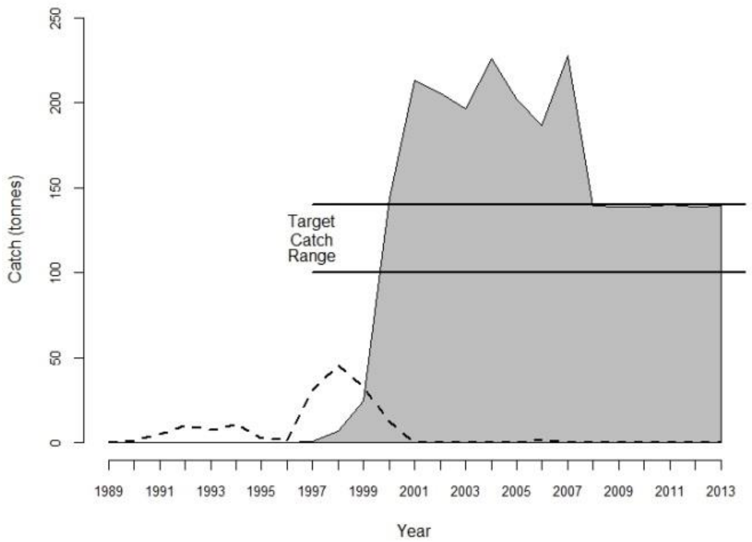
A preliminary effort range to achieve the TAC had been generated as 70,000–100,000 pot lifts but with the current nominal effort (2009-13) of 76,370- 53,414 pot lifts all below this level. The effort range was subsequently revised to 50,000-80,000 pot lifts. A proposed harvest strategy is currently being 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 (2014)

It is planned that the proposed harvest strategy currently before industry will be formally incorporated into the management plan of the fishery. It should be noted that the management plan for the fishery was introduced on 1 January 2013.

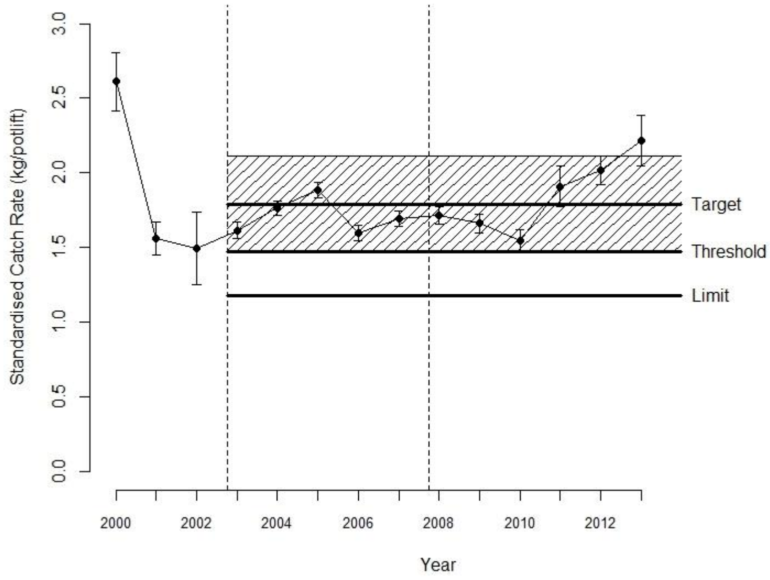
External Factors

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



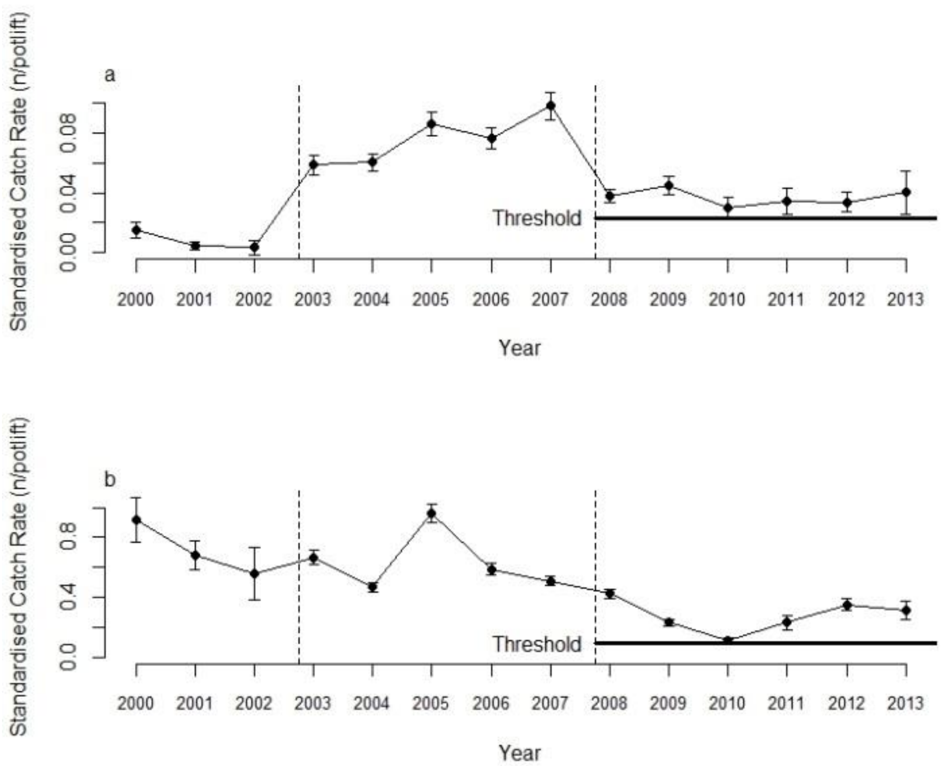
WEST COAST DEEP SEA CRUSTACEAN FIGURE 1

Annual catches of Crystal (grey) and Champagne (dotted line) crabs since 1989. Annual giant crab catches have always been small, and they have therefore been excluded. Heavy lines represents the target catch region for crystal crabs (100-140t).



WEST COAST DEEP SEA CRUSTACEAN FIGURE 2

Standardised catch per unit effort (±95CI) since 2000 for crystal crabs. Area between vertical dashed lines indicate period when management required fishing in all zones. Horizontal lines represents the current notional target (solid line) and target range (hashed region), threshold and limit reference points for crystal crabs in the fishery. The method of standardizing catch rates was revised this year which has resulted is minor changes to the annual values.



WEST COAST DEEP SEA CRUSTACEAN FIGURE 3

Standardised catch per unit effort (±95CI) since 2000 for a) berried and b) undersized crystal crabs relative to their respective notional threshold reference point

Gascoyne Demersal Scalefish Fishery Status Report

G. Jackson, R. Marriott, E. Lai and H. Zilles

Main Features

Status		Current Landings (2013)	
Stock level		Pink snapper:	
Pink snapper	Adequate	Commercial	233 t
Goldband snapper	Adequate	Recreational	30 t
Spangled emperor	Adequate	Charter	11 t
Fishing Level		Goldband snapper:	
Pink snapper	Acceptable	Commercial	73 t
Goldband snapper	Acceptable	Recreational	7 t
Spangled emperor		Charter	8 t
North Gascoyne	Unacceptable	Spangled emperor:	
South Gascoyne	Acceptable	Commercial	2 t
		Recreational	35 t
		Charter	4 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 (*Chrysophrys 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 multidens*), 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 (Epinephelidae including Rankin cod, *Epinephelus multinotatus* and goldspotted rockcod, *E. coioides*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicus*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).

A limited number of licensed charter vessels and a large number of recreational vessels fish out of Denham, Carnarvon and around the Ningaloo area (Gnaraloo Bay, 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). GSDF vessels are not permitted to fish in inner Shark Bay. No state-licensed commercial vessels are permitted to fish between 21°56' and 23°07'30"S ('Point Maud-Tantabiddi Well' closure). Management arrangements for the West Coast Demersal Scalefish Fishery (WCDSF) permit a limited number of commercial vessels to operate in Gascoyne waters up to the southern boundary of the GDSF (26°30'S).

Recreational (includeing Charter)

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 5,142 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 *Shark Bay Snapper Management Plan 1994*.

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 will be in 2015). This fishery along with all other commercial fisheries in the Gascoyne underwent Marine Stewardship Council (MSC) pre-assessment in 2013.

Minimum legal lengths apply to many of the commercial target species (e.g. pink snapper, red emperor and emperors).

Recreational (includeing Charter)

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. Daily bag limits in the Gascoyne were revised in 2013 as a result of a statewide recreational fishing review which was designed to simplify recreational fishing rules across the state. Key changes included the introduction of a mix species bag limit of five demersal finfish as well as limits for individual species that include: three pink snapper; three cods; three emperors and one coral trout. Recreational fishers can no longer transport fish by unaccompanied means (e.g. courier).

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 2012-13 licensing period for the GDSF, i.e. 1 September 2012 – 31 August 2013 (referred to as 'season 2013'). 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 statewide 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 (based on boat ramp interviews) 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 Coast Bioregion, pink snapper, goldband snapper and spangled emperor are the indicator species for the inshore demersal suite with ruby snapper and eightbar grouper (*Epinephelus octofasciatus*) the indicator species for the offshore demersal suite (DoF 2011[3]).

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 2014).

Goldband snapper: Comprehensive research on goldband snapper commenced in 2007 as part of a Gascoyne Integrated Fisheries Management (IFM) project. Goldband snapper in

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 Gascoyne Coast Bioregion are managed as a single stock. The risk-based 'weight of evidence' assessment has been externally reviewed and published (Marriott *et al*. 2012). Monitoring of catches from the commercial, recreational and charter sectors and population age structure is on-going and further research is planned to refine estimates of the key biological parameters.

Spangled emperor: Comprehensive research on spangled emperor commenced in 2007 also as part of the Gascoyne IFM project. Spangled emperor in the Gascoyne Coast Bioregion are managed as a single stock. The risk-based 'weight of evidence' assessment has been externally reviewed and published (Marriott *et al*. 2012). In addition to the monitoring of commercial, recreational and charter catches, limited biological monitoring of recreational catches landed at fishing tournaments and public fish cleaning stations for this species is on-going.

Retained Species

Commercial landings (season 2013):

Total	**366 tonnes**
Pink snapper	**233 tonnes**
Goldband snapper	**73 tonnes**
Spangled emperor	**2 tonnes**
Other species	**58 tonnes**

The total commercial catch taken by the GDSF in the 2013 season was 366 t which is similar to the catch level in 2012 (Gascoyne Demersal Scalefish Fishery Figure 2). The catch comprised 233 t of pink snapper (oceanic stock, TACC = 277 t), plus 133 t of other species including 73 t of goldband snapper, 2 t of spangled emperor and 58 t of other scalefish species (Gascoyne Demersal Scalefish Table 1).

Recreational catch estimate (includes charter sector):

Pink snapper	**ca. 40 tonnes**
Goldband snapper	**ca. 15 tonnes**
Spangled emperor	**ca. 40 tonnes**

In 2013 the recreational catch of pink snapper (oceanic stock) reported by licensed charter boats was 11 t (same as in 2012). 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 2013 decreased to 8 t (11 t in 2012). 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 15 tonnes.

The recreational catch of spangled emperor reported by charter boats in 2013 was 4 t (5 t in 2012). 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 2013 season with 16 vessels actively fishing (18 in 2012). 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 748 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 181 boat days during June-July in 2013 (223 in 2012).

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 (2013)
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 2014) indicated that the spawning biomass in 2013 was above the threshold level (30% of the unexploited spawning biomass) and just below the target level (40% of the unexploited spawning biomass).

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 2013 season, the pink snapper catch rate reached 710 kg pink snapper/standard boat day, the highest level since the mid-1990s (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 2013, the catch rate was 710 kg pink snapper/standard boat day well above the threshold and the highest level since 1995.

Goldband snapper: Historical monthly 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 risk-based '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 2013 remained below the preliminary maximum commercial catch limit recommended for this species in the Gascoyne Coast Bioregion (100-120 t, see Marriott *et al.* (2012) for details). Breeding stock levels and fishing level are currently assessed as adequate.

Spangled emperor: Historical monthly commercial catch rate data for spangled emperor were found to be uninformative as an index of abundance. A risk-based '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 that the current level of fishing on the spangled emperor population in the North Gascoyne exceeded sustainable levels and were higher than from a previous assessment done in 1989-91 (Moran *et al.* 1993[1]). 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 Marriott *et al.* (2012) for further 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.

Listed species interaction — Negligible

As line fishing is highly selective, interactions with listed species by commercial, charter and recreational fishers in the GDSF are low. Commercial GDSF and charter fishers are required to record all listed species interactions in their logbooks. During 2013, commercial fishers in the GDSF reported no interactions with listed species. No interactions were reported in 2013 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

1 Moran, M. Edmonds, J., Jenke, J., Cassels, G. & Burton, C. (1993). Fisheries biology of emperors (Lethrinidae) in North-West Australian coastal waters. FRDC Project 89/20 Final Report. Department of Fisheries, Western Australia.

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 2013 was similar to previous years and reflects the focus on pink snapper during the peak season and fishing in deeper waters offshore for other species at other times of the year.

In 2013, 16 vessels fished during the entire season, 6 of which 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 2013):

Acceptable

Current catch level Goldband (season 2013):

Acceptable

Target catch (and effort) range:

Pink snapper **277 tonnes/380-540 days**

Goldband snapper **100-120 tonnes (preliminary maximum catch limit)**

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.

In 2013, GDSF vessels with pink snapper quota required 328 boat days to catch 233 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 710 kg pink snapper/boat day during the peak season for the 2013 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 2013 was below the preliminary maximum commercial catch limit.

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 was occurring north of Point Maud outside of the sanctuary zones.

New management initiatives (2014/15)

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 all other demersal scalefish species. The development of an entitlement framework with the capacity to regulate catches of these other ‘non-pink snapper’ scalefish species that can work in combination with the existing ITQ system for pink snapper is scheduled for implementation in 2015.

All commercial fisheries in the Gascoyne Coast Bioregion, including the GDSF, underwent Marine Stewardship Council (MSC) pre-assessment in 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 2012/13 season, total effort in this fishery was less than 70 hours trawled with no reported catches of pink snapper taken by WDWTF vessels fishing off the Gascoyne coast (AFMA unpublished data).

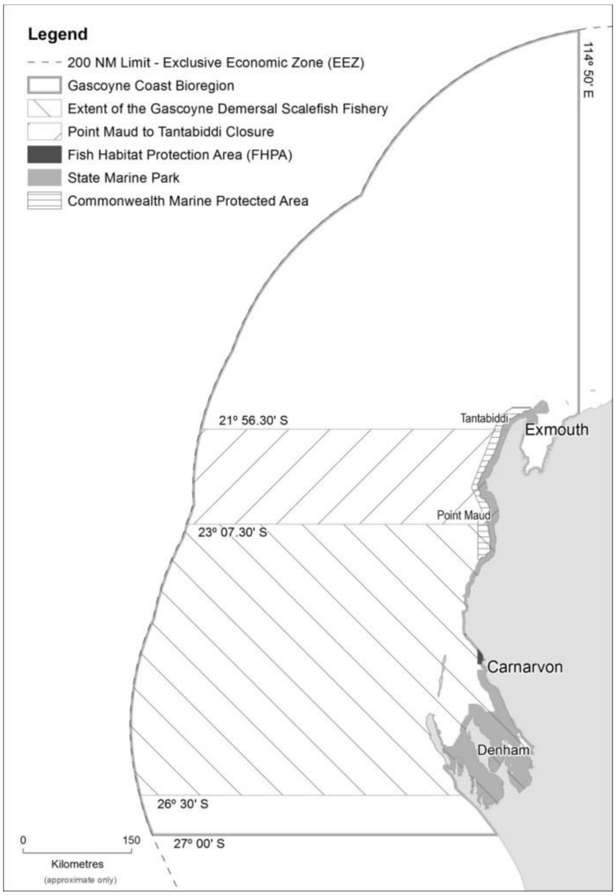
Climate change has the potential to impact fish stocks in range of ways. The effects of climate change may include increasing sea surface temperatures, changes in major ocean currents (e.g. Leeuwin Current), sea level rise and ocean acidification. A review of the impacts and responses to marine climate change in Australia was undertaken by CSIRO in 2009. More recently, a 3-year FRDC-funded project to assess the effects of climate change on key fisheries in Western Australia has now been completed (Caputi *et al.* 2014). Pink snapper was considered as a case study species within this project with potential impacts of climate change likely to include a southward shift in the centre of geographic distribution; changes to spawning patterns; changes in individual growth and stock productivity, and through projected impacts on the Leeuwin Current, changes in larval dispersal.

GASCOYNE DEMERSAL SCALEFISH FISHERY TABLE 1

Total commercial catch of demersal scalefish species other than pink snapper taken in Gascoyne waters between

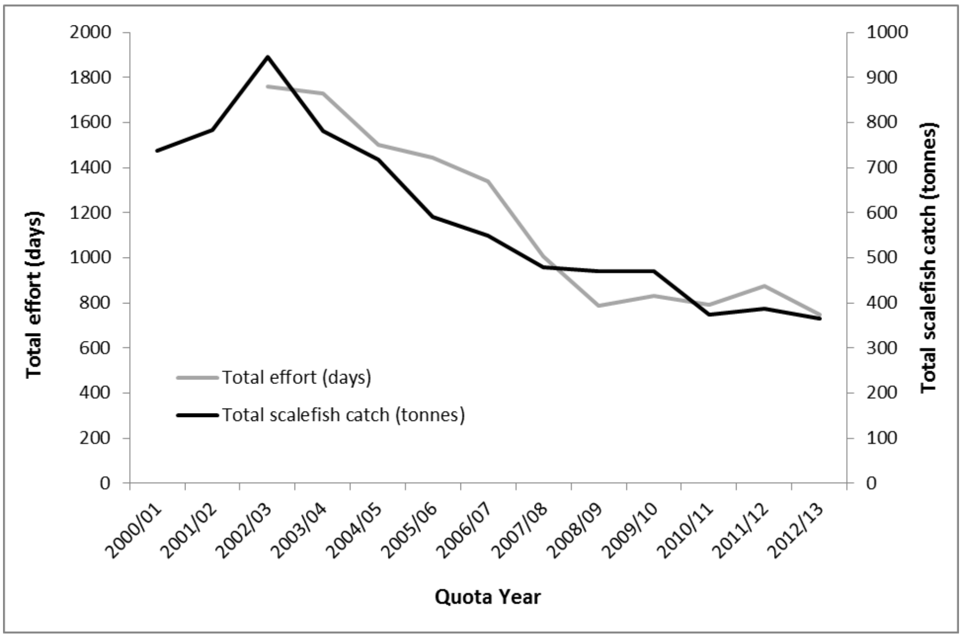
Species	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Goldband snapper	239.8	105.8	107.2	121.1	143.8	104.6	53.2	64.2	73.2
Red emperor	18.5	19.4	17.0	12.8	11.7	9.8	8.2	13.1	7.9
Spangled emperor	13.5	18.1	7.0	7.0	3.3	3.8	3.7	4.3	2.3
other emperors	31.8	29.2	34.3	26.8	13.8	9.2	10.4	11.6	5.1
Cods	27.9	21.9	21.5	15.0	9.5	13.4	11.4	21.1	14.0
Other	82.0	78.1	77.1	65.8	64.8	72.9	50.7	38.9	30.8
Total	413.5	272.5	264.1	248.5	246.9	213.7	137.5	153.0	133.4

2003/04 and 2012/13 (excludes mackerels, sharks and tunas). Units are tonnes.



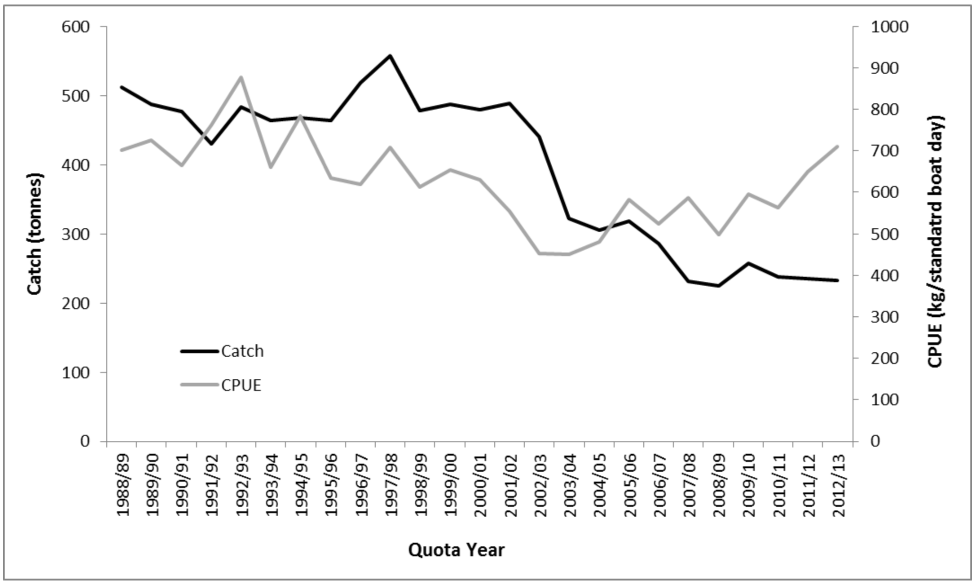
GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 1

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 2012/13



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 3

Gascoyne pink snapper catch and catch per unit effort by quota year from 1988/89 to 2012/13. 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 Brown, J. Norriss and H. Zilles

Main Features

Status		Current Landings	
Stock level:		Commercial (2013)	
Whiting	Adequate	Whiting	142 t
Sea mullet	Adequate	Sea mullet	32 t
Tailor	Adequate	Tailor	15 t
Western yellowfin bream	Adequate	Western yellowfin bream	18 t
Pink snapper	Eastern Gulf - Adequate	Pink snapper	0.4 t
	Denham Sound – Adequate	Recreational (Pink snapper only)	
	Freycinet Estuary – Recovering	Eastern Gulf	4 t (2010)
Fishing Level:		Charter	1 t (2013)
Whiting	Acceptable	Denham Sound	6 t (2010)
Sea mullet	Acceptable	Charter	1.5 t (2013)
Tailor	Acceptable	Freycinet	1.5 t (2010)
Western yellowfin bream	Acceptable	Charter	0 t (2013)
Pink snapper	Eastern Gulf – Acceptable		
	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 in Shark Bay is boat-based using rod & line or handline with some netting for bait and sea mullet. The key recreationally caught species are pink snapper *(Chrysophrys auratus)*, grass emperor (black snapper or blue-lined emperor, *Lethrinus laticaudis*), western butterfish *(Pentapodus vitta)*, whiting (*Sillago* spp.), Queensland school mackerel *(Scomberomorus queenslandicus)*, tailor, blackspot tuskfish (bluebone, *Choerodon schoenleinii*) and goldspotted rockcod (estuary or slimy cod, *Epinephelus coioides*). A limited number of licensed charter vessels operate out of Denham and Monkey Mia.

Governing legislation/fishing authority

Commercial

Shark Bay Beach Seine and Mesh Net Limited Entry Fishery 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 that convenes every 3 years).

Boundaries

The areas covered by this report are shown in Inner Shark Bay Fishery Figure 1. Fishing is not permitted in the Hamelin Pool Nature Reserve 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. Boat-based fishers also require a statewide recreational boat fishing licence while net fishers require a statewide recreational net fishing licence. For pink snapper more complex arrangements apply, including seasonal closures, within the Eastern Gulf, Denham Sound and Freycinet Estuary where a quota tag system also applies (Inner Shark Bay Fishery Figure 1). These stocks are managed separately with explicit Total Allowable Catch (TAC) targets. In 2013, 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 Department of Fisheries uses an indicator species approach to monitor and assess the status of the finfish resources throughout the State (DoF 2011[1]). These indicators were selected to represent the nearshore/estuarine (waters of 0-20 m depth), inshore (waters of 20-250 m depth) and offshore (waters greater than 250 m depth) demersal, and pelagic finfish suites using a risk-based approach based on the relative vulnerability of the species/stock to fishing activities.

In the Gascoyne Coast Bioregion, tailor and yellowfin whiting are indicators for the nearshore suite while pink snapper is one of three indicators for the inshore demersal suite. While not indicators, the status of sea mullet, western yellowfin bream and grass emperor is also reported here because these species are significant components of the commercial and recreational catch in the inner Shark Bay.

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 (Level 5) 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 (next assessment scheduled for late 2014).

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)[2]. The first integrated survey of boat-based recreational fishing in WA was conducted during 2011/12 (Ryan *et al.* 2013)[3]. This survey was developed to provide statewide 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. This fishery along with all other commercial fisheries in the Gascoyne Coast Bioregion underwent Marine Stewardship Council (MSC) pre-assessment in 2013.

Research on pink snapper in the inner gulfs is now limited to a monitoring level that involves trawl surveys to monitor juvenile recruitment each year and daily egg production method (DEPM) surveys to estimate spawning biomass every 3 years. Most recently, DEPM surveys were undertaken in the Eastern Gulf in 2012 and in Denham Sound and the Freycinet Estuary in 2013. Stock assessments for these three pink snapper stocks will be updated prior to the next scheduled Inner Gulf Pink Snapper Working Group meeting (scheduled for October 2014).

Level 2 assessments based on trends in commercial catch and catch rates (CPUE) obtained from compulsory monthly fisher returns are conducted for the main target species of the SBBSMNF (i.e. yellowfin whiting, sea mullet, tailor and western yellowfin bream). For yellowfin whiting only, a level 3 (*F*-based) assessment has also recently been undertaken following the MSC pre-assessment of the SBBSMNF. A level 3 assessment was conducted for grass emperor based on data collected in 2005.

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.

2 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

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.

Retained Species

Commercial landings (season 2013):

Whiting	**142 tonnes**
Sea mullet	**32 tonnes**
Tailor	**15 tonnes**
Western yellowfin bream	**18 tonnes**
Pink snapper	**0.4 tonnes**

The total catch taken by SBBSMNF licensed vessels in 2013 was 219 t which represents an approximate 13% increase on the total catch taken in 2012. This total catch comprised 142 t of whiting, 32 t of sea mullet, 15 t of tailor, 18 t of western yellowfin bream and 12 t of other mixed scalefish species that included 0.4 t of pink snapper (taken as bycatch in net fishing gears).

Recreational catch estimates (including charter, 2013)

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 for pink snapper in Shark Bay, including the introduction of TAC-based management in 2003, contemporary recreational catches of pink snapper are much lower than were taken in the 1980s and 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).

In 2013, licensed charter vessels landed approximately 1.5 t of pink snapper in Denham Sound and approximately 1 t in the Eastern Gulf; 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 2013.

Fishing effort/access level

Commercial
In 2013, of the 10 SBBSMNF licenses, seven vessels were routinely involved in fishing. Following the sharp declines in recent years, total fishing effort in 2013 (646 boat days) was at a similar level to that in 2012 (692 boat days).

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). More recent estimates of recreational fishing effort in Shark Bay are currently not available from the first statewide 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 (2013)**
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 total catch overall (not shown) and for each target species (Inner Shark Bay Fishery Table 1).

In 2013, the total commercial catch (all species) taken by the SBBSMNF was 219 tonnes, an increase of 31 tonnes from 2012, whilst fishing effort (boat days) declined slightly from 664 days to 646, to the lowest reported level for the fishery (Inner Shark Bay Scalefish Fishery Figure 2).

In 2013, the catch of whiting (142 tonnes) was just above the target catch range and the CPUE (220 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 both catch and 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. A research study is currently investigating the species and age-composition of the whiting catch.

The catch of sea mullet (32 tonnes) and the CPUE (50 kg/boat day) in 2013 were at historically low levels and below their respective target and threshold levels (Inner Shark Bay Scalefish Fishery Figure 4). The decrease in the sea mullet catch is partly explained by the fleet targeting the higher-value whiting species, but may also be attributable to a change in the distribution ('latitudinal shift') of sea mullet due to warming waters; lower catches have been observed in the northern fisheries (i.e. SBBSMNF and Exmouth Gulf Beach Seine Fishery) and increased catch rates in the southern fisheries (i.e. West Coast Nearshore Net Fishery, Peel-Harvey Estuarine Fishery, South West Beach Seine Fishery and the South Coast Estuarine Fishery – See reports in the West Coast and South Coast Bioregions sections).

In 2013, the tailor catch (15 tonnes) was again below the target range and the CPUE (23 kg/boat day) was around the threshold level (Inner Shark Bay Scalefish Fishery Figure 5). The low landings of tailor that have become a feature of the fishery in recent years are mostly attributed to local processing restrictions.

The catch (18 tonnes) and CPUE (28 kg/boat day) of western yellowfin bream in 2013 had doubled from 2012 levels and were above the target catch range and the threshold catch rate, respectively (Inner Shark Bay Scalefish Fishery Figure 6). These increases can likely be attributed to another strong year class entering the fishery, as has previously occurred during the period 2002-2007.

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 2013. 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 trends in 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.

Listed species interaction **Negligible**

As nets are actively set and hauled, if any listed species such as dugongs, dolphins or marine turtles are caught (rare events) they are immediately released. Commercial fishers are required to report any interactions with endangered, threatened and protected (ETP) species. In 2013, no interactions with ETP species were reported.

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 14 commercial fishers are employed in the SBBSMNF based on seven 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 2013 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 (2013): **Acceptable**

Target catch range (2013):

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 was 646 boat days in 2013. The total commercial catch (ex. pink snapper) in 2013 at 219 t was below the lower limit of the target catch range (235–335 tonnes), however, this needs to be viewed against the background of the historically low levels of effort and increasing trend in catch of whiting. 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 2013 were either nil or significantly below their allocation within the respective pink snapper TACs (0.4 tonnes in Denham Sound, nil catch in Eastern Gulf and Freycinet Estuary).

Recreational
Target catch range (2013):

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 2011-2013) and therefore within the respective TACs in each area.

In 2013, a total of 565 applications (first and second rounds) were received for Freycinet Estuary pink snapper quota tags with all the tags available (total 1,050) allocated to recreational fishers.

New management initiatives (2014/15)

As an outcome of the 'Wetline Review' (see Fisheries Management Paper No. 224 for details), a management plan is proposed 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, have been through a Marine Stewardship Council (MSC) pre-assessment in 2013.

External Factors

While the inner Shark Bay system has been considered relatively stable as a result of its typically low-rainfall and 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 and scallops) (see Fisheries Research Reports 222[1] & 250[2]). 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. The effects of climate change may include increasing sea surface temperatures, changes in major ocean currents (e.g. Leeuwin Current), sea level rise and ocean acidification. A review of the impacts and responses to marine climate change in Australia was undertaken by CSIRO in 2009. More recently, a 3-year FRDC-funded project to assess the effects of climate change on key fisheries in Western Australia has now been completed (Caputi *et al.* 2014[3]). Pink snapper and tailor were both considered as case study species within this project.

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.

2 Caputi et al. (2014). The marine heatwave off Western Australia during the summer of 2010/11 - 2 years on. Fisheries Research Report No 250. Department of Fisheries, Western Australia, Perth.

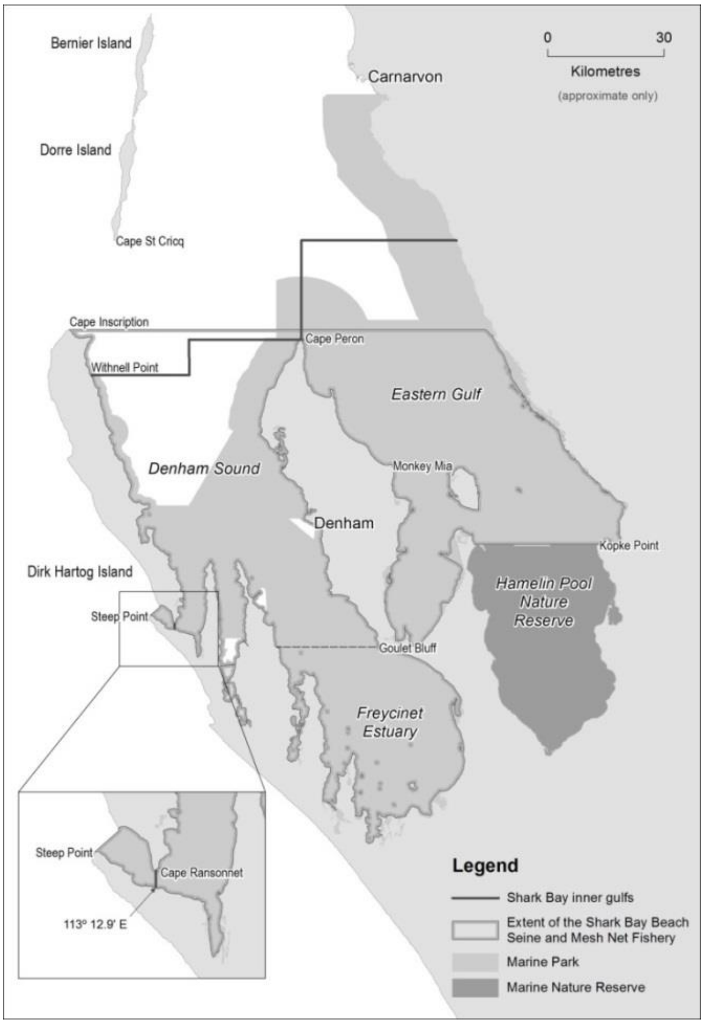
3 Caputi et al. (2014). Management implications of climate change effect on fisheries in Western Australia: Parts 1 &2. FRDC Project 2010/535 Final Repot. Department of Fisheries, Western Australia, Perth.

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 2004-201

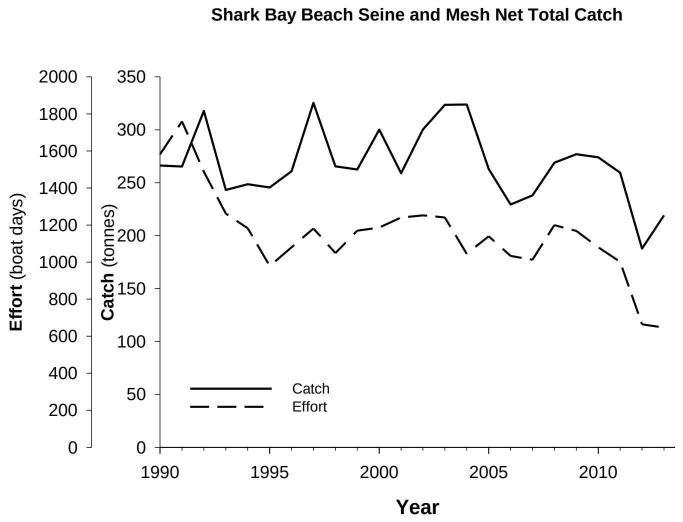
Species	Acceptable catch range	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Whiting	93-127	119	116	113	102	117	115	118	105	116	142
Mullet	77-144	143	85	62	91	107	124	117	116	40	32
Tailor	25-40	24	19	21	23	23	19	19	17	16	15
Bream	7-15	27	27	23	14	8	8	10	9	9	18

Species	Trigger level	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Whiting	75	114	102	110	100	98	100	112	105	175	220
Mullet	62	137	74	60	90	89	106	107	116	61	50
Tailor	21	23	17	20	22	19	16	17	17	25	23
Bream	5	26	23	22	14	6	7	10	9	14	28



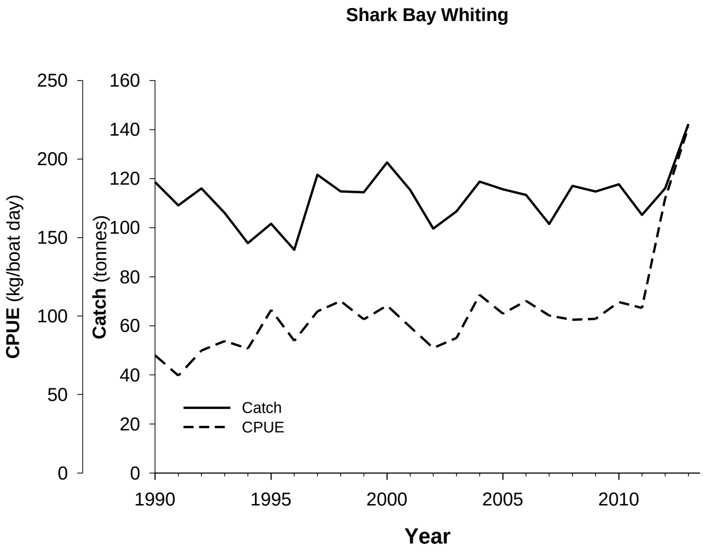
INNER SHARK BAY SCALEFISH FISHERY FIGURE 1

The commercial (scalefish) and recreational fishing areas of inner Shark Bay.



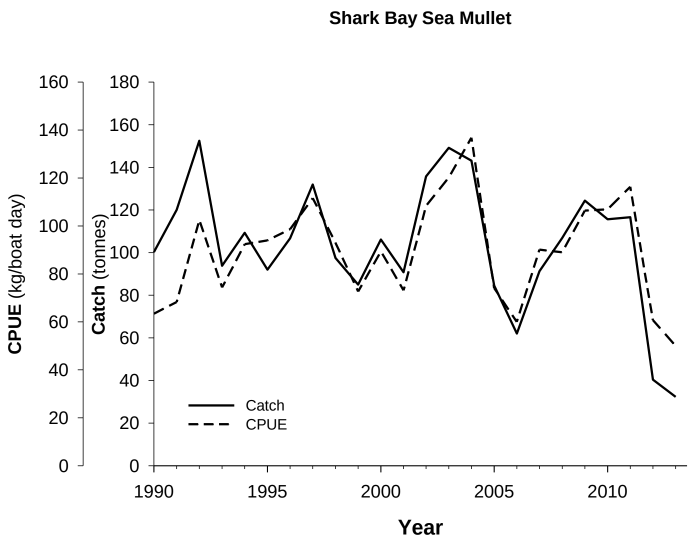
INNER SHARK BAY SCALEFISH FISHERY FIGURE 2

The total annual catch and effort for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2013.



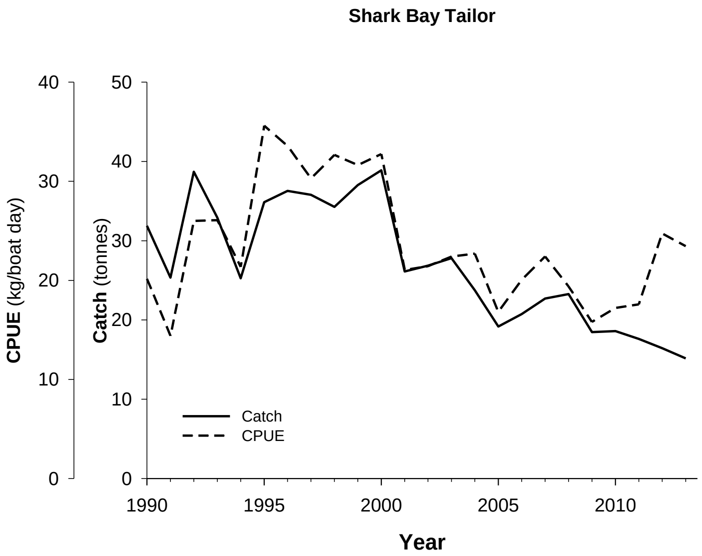
INNER SHARK BAY SCALEFISH FISHERY FIGURE 3

The annual whiting catch and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2013.



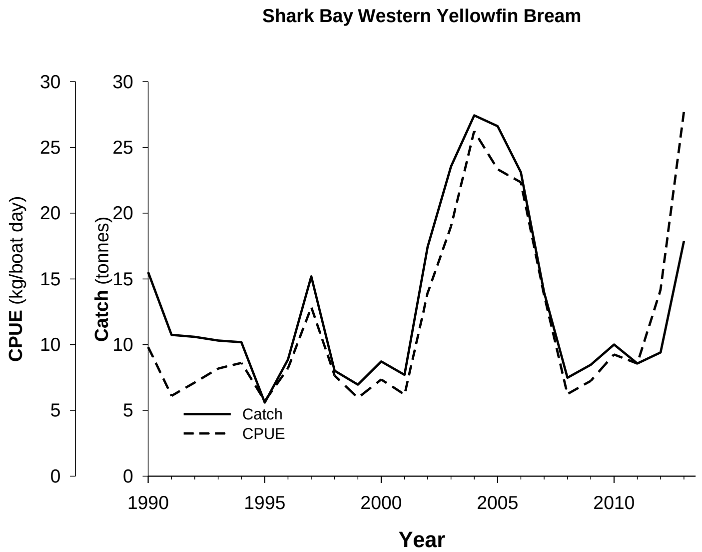
INNER SHARK BAY SCALEFISH FISHERY FIGURE 4

The annual sea mullet catch and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2013.



INNER SHARK BAY SCALEFISH FISHERY FIGURE 5

The annual tailor catch and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2013.



INNER SHARK BAY SCALEFISH FISHERY FIGURE 6

The annual western yellowfin bream catch and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2013.

Shark Bay Blue Swimmer Crab Fishery Status Report

A. Chandrapavan, E. Sporer, S. O'Donoghue and S. Blazeski.

Main Features			
Status		Current Landings	
Stock level	Environmentally limited	Commercial catch (experimental fishing trial)	36 t
Fishing level:		Shark Bay trap fleet	20 t
Voluntary commercial closure since April 2012	(experimental fishing only)	Shark Bay trawl fleet	16 t
		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 small 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 with multiple flooding events during the summer of 2010/11. Commercial fishing for blue swimmer crabs in Shark Bay ceased in April 2012 on a voluntary industry-agreed basis to facilitate stock rebuilding. Given the extremely small recreational catch levels in this region, restrictions on the recreational sector were considered unnecessary. Since the closure, intensive monitoring of the resource and its recovery has been undertaken using a combination of trawl and trap based surveys.

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 Management 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 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.

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 currently 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 (as per a voluntary industry agreement) is designed to ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

There are five crab trap permits with combined total of 1,500 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 permits 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) licences authorised 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 the Environment (DotE) 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

Historically 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. Since the fishery closure, rigorous fishery-independent trap and trawl based data collections are undertaken to address knowledge gaps in some of the biological and life-history parameters, spatial distribution of stock and recovery rates and patterns and models to determine sustainable harvest levels. A preliminary harvest strategy and control rules have been developed for evaluation of the stock and the management of the fishery.

Retained Species

Commercial landings (season 2012/13): 36 t

Shark Bay trap fleet 20 t

Shark Bay trawl fleet 16 t

An exemption for an experimental commercial crab fishing trial was granted in June 2013 as a result of some improvement in the crab stock indicators and to assess the effect of a short-term commercial fishing on the crab stock. Trap fishing up to a maximum of 400 pots per day was allowed for 30 days with a catch limit of 18 tonnes. The trawl sector was also allowed to retain 18 tonnes of crabs (males and females ≥ 135 mm) (1 t per boat). The trap fishing in total produced 20 t due to additional days of fishing granted to allow for a commercial monitoring survey. The trawl sector fished for crabs over several months and caught 16 t in total.

Recreational catch:
Shark Bay < 1 % of total

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. The 2011/12 statewide recreational fishing from boat survey found only 4% of the state's blue swimmer recreational catches came from the Gascoyne region.

Stock Assessment

Assessment complete:

Shark Bay: Yes

Assessment level and method:

Level 4 - Direct survey/Catch rate/Size Distributions

Breeding stock levels:

Shark Bay: Environmentally limited

There was a significant decline in the blue swimmer crab stock within Shark Bay following the marine heat wave and other climatic events which occurred in the summer of 2010/11. This decline led to the voluntary closure of both trap and trawl commercial sectors of the crab fishery in April 2012. Since the closure, intensive monitoring of the resource and its recovery has been undertaken using a combination of trawl and trap-based surveys. These surveys were designed to target key deep-water trawl grounds and inshore trapping grounds that have historically been used to commercially target crabs. However new survey sites have also been added to explore non-traditional crab regions to further understand stock distribution and movement at the lower abundances that currently exist. Data collected from these surveys will contribute towards a greater understanding of stock dynamics and biology of this stock and also provide performance indicators that are being used in developing a harvest strategy for this fishery.

A detailed statistical analysis on the effects of monthly water temperatures on annual commercial catch rate was undertaken. This analysis showed that that warm temperatures during the autumn/winter spawning appears to be beneficial to recruitment, however warm temperatures during the juvenile phase in the summer when the crabs are mainly in the shallow water areas appears to have a negative effect. This suggests that the cause of the low recruitment to the fishery in 2011/12 was a combination of a very cool winter in 2010 followed by the heat wave in the summer of 2010/11. The winter SST in 2011 and 2012 have returned to within historic levels but the summer SST in 2011/12 and 2012/13 have remained above average but lower than the record high level of 2010/11. Therefore an improvement in commercial catch rates was expected in 2012/13 and 2013/14. While there was no commercial fishing in 2012/13, fishery-independent surveys have demonstrated an improvement in abundance but not a full recovery to historic levels.

Indices of legal, sublegal, spawning, and recruitment biomass for the first half of 2013 were much improved compared to biomass levels observed for latter half of 2012. However higher biomass levels, particularly of legal-sized crabs (> 135 mm CW) have only been recorded within inshore waters (< 10 m depths). The level of recovery in the deeper depths, those most accessible to the trawl sector, remains much lower but steadily improving.

Improvements in the recovery of the inshore stock led to a short-term commercial crab fishing trial in June 2013 for the assessment of the effect of limited commercial fishing on the recovering crab stock. The average trap CPUE from the fishing trial was 1.95 kg/traplift and in general, daily catch rates were above the historical June daily catch rates (logbook data) and there was no clear sign of stock depletion over this time period. Sustained recovery of the stock and positive results of the fishing trial led to considerations of a partial reopening of the Shark Bay crab commercial fishery for 2013/14 season based on a conservative TACC of 400 t.

The performance measure for the Shark Bay crab fishery requires legal crab abundance be maintained above a performance measure of 1.0 kg/traplift. There are currently trap and trawl based research surveys programs in place to monitor the recovery of the Shark Bay crab stock from which biomass indices of legal, sublegal and spawning levels have been developed to assess stock recovery to historical threshold levels.

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 (e.g. Snapper 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.

Listed species interaction **Negligible**

The crab trap longline system used in the targeted crab fisheries has little possibility of interacting with listed 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 during 2012/13 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 fishing for blue swimmer crabs in the Gascoyne Coast Bioregion and additional employment for some 30-35 workers through the development of post-harvest processing of the crab catch were inactive.

Economic Effects

Estimated annual value (to fishers) for 2012/13

Level 1 - < $1 million ($332 280)

The average beach price for uncooked crabs across WA was $9.23/kg. During the commercial fishing trial, fishers were allowed to retain and sell their crab product which was worth $332 280.

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. A precautionary TACC of 400 t was set for the 2013/14 season.

Current fishing (or effort) level:

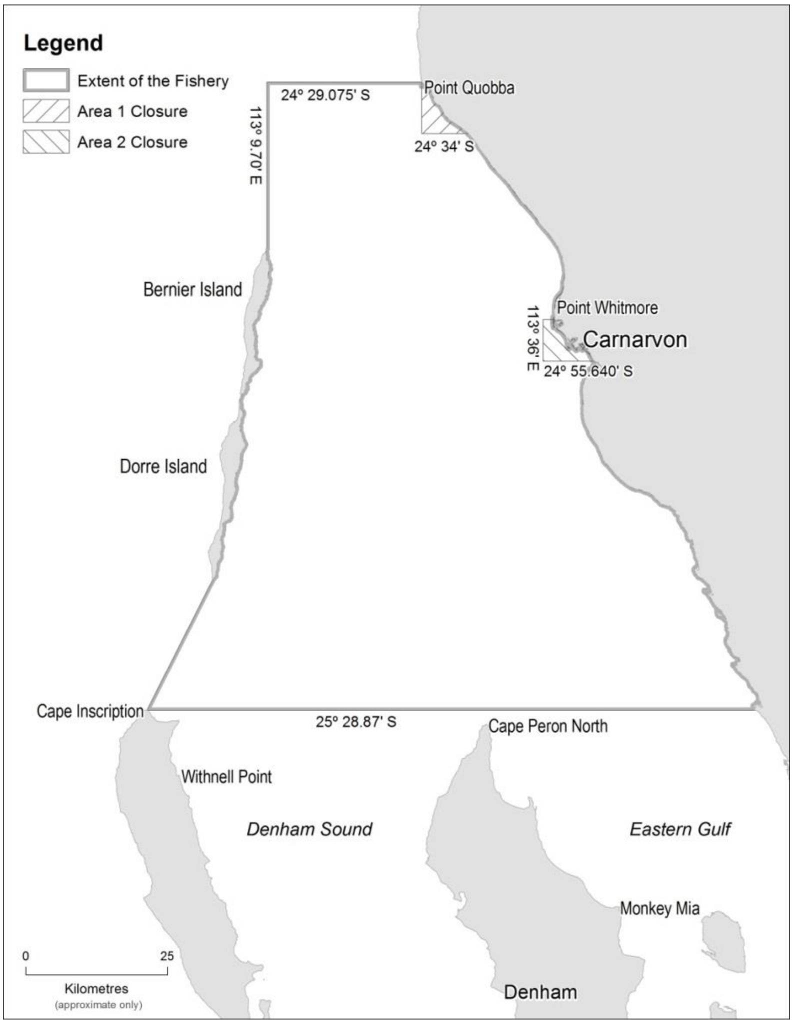
Not Applicable as fishery closed

New management initiatives (2014/15)

A Ministerial decision on allocating catch shares within the commercial sectors was made in June 2013 (trap – 66%, prawn trawl 33.8%, scallop trawl sector 0.2%). Approval was also given by the then 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 expires on 31 August 2016. The development of the new management plan is in progress with consultation regarding the key components of the legislation ongoing. It is envisaged that the new management plan will be implemented in 2015.

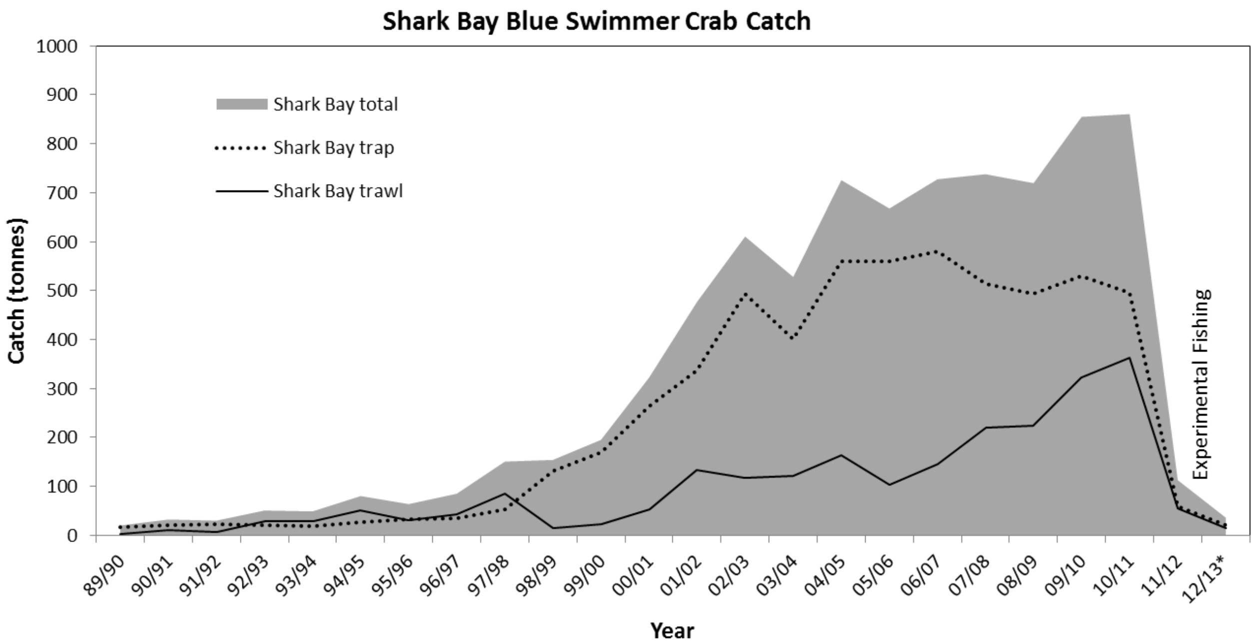
External Factors

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.



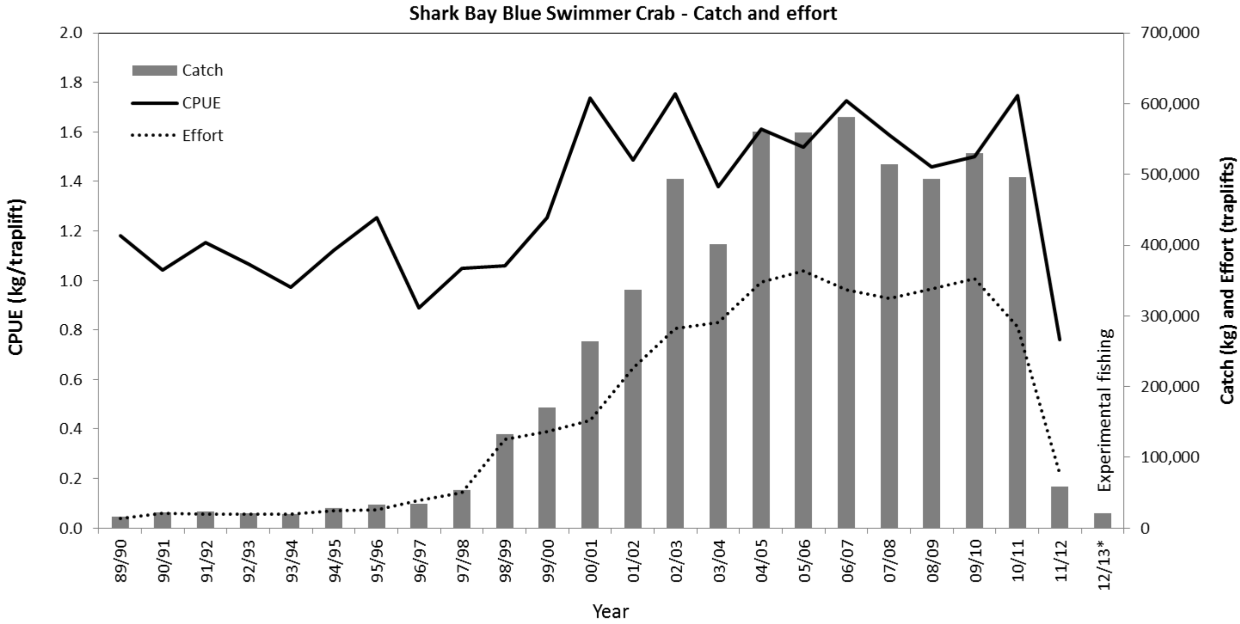
SHARK BAY BLUE SWIMMER CRAB FIGURE 1

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. *The catch for 2012/13 is generated from the experimental commercial fishing trial.



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.
*The catch for 2012/13 is generated from the experimental commercial fishing trial.

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 imbricata.* 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 land-based facility previously used for small-scale production of finfish species for local markets will be redeveloped as a specific-pathogen-free hatchery for marine prawns, subject to applications for translocation and a variation to add marine prawn species to the aquaculture licence being approved.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services in the Gascoyne Coast Bioregion are delivered by Fisheries and Marine Officers (FMOs) and associated management and administrative support staff based at District Offices in Denham, Carnarvon and Exmouth. During 2012/13 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 90 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 Fishery. FMOs conduct patrols the length of the Gascoyne and target offenders in all of the recreational and commercial fisheries based on intelligence gathered by FMOs 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.

Activities during 2012/13

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 2012/13 year using this model. 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 OCPs 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 within the framwork of 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.

During 2012/13 the Gascoyne Bioregion was pre-assessed by the Marine Stewardship Council (MSC) and information provided by the DoF allowed for the successful progression of the assessment process to the final stages for the Shark Bay Prawn Fishery and the Exmouth Gulf Fishery.

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 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 2012/13. “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 2013/14

For the 2013/14 year a number of initiatives across the Gascoyne Bioregion have been planned. These include:

- Final pre -assessment of the Gascoyne Bioregion commercial and recreational fisheries by the Marine Stewardship Council.
- Finalisation of position requesting Ministerial approval for statutory consultation of Stage two of the Gascoyne Demersal ScaleFish Management Plan
- Development and implementation of new statewide marine park Collaborative Operational Plans with the Department of Environment and Conservation (DEC)
- Improve recruitment and retention practises to attract and retain staff in the Gascoyne.

GASCOYNE COAST COMPLIANCE TABLE 1

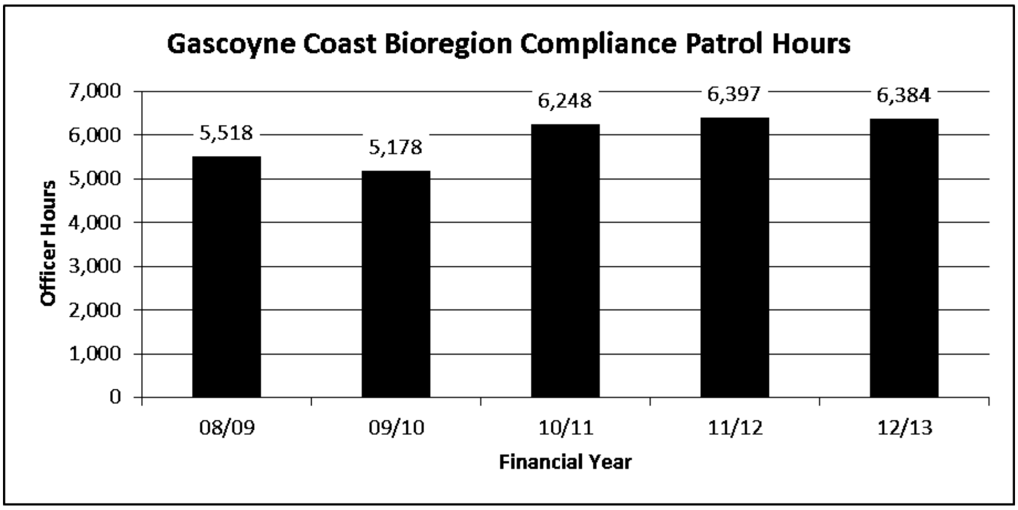
Summary of compliance and educative contacts and detected offences within the Gascoyne Coast Bioregion during the 2012/13 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	6,384 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	115
Infringement warnings	1
Infringement notices	6
Prosecutions	2
Fishwatch reports**	0
VMS (Vessel Days)***	7,614
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	16,752
Infringement warnings	88
Infringement notices	175
Prosecutions	14
Fishwatch reports	34
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	2,722
Fishwatch reports	2

*Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "Other" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of these contacts are recreational in nature (e.g. personal contacts in Marine Parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises etc. are also included in this category.

** 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 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 12/13 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. and any services delivered by the Department's large Patrol Vessels: *PV Walcott, PV Houtman* and *PV Hamelin*).

NORTH COAST BIOREGION

ABOUT THE BIOREGION

The oceanography of the North Coast Bioregion (North Coast Overview Figure 1) 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.

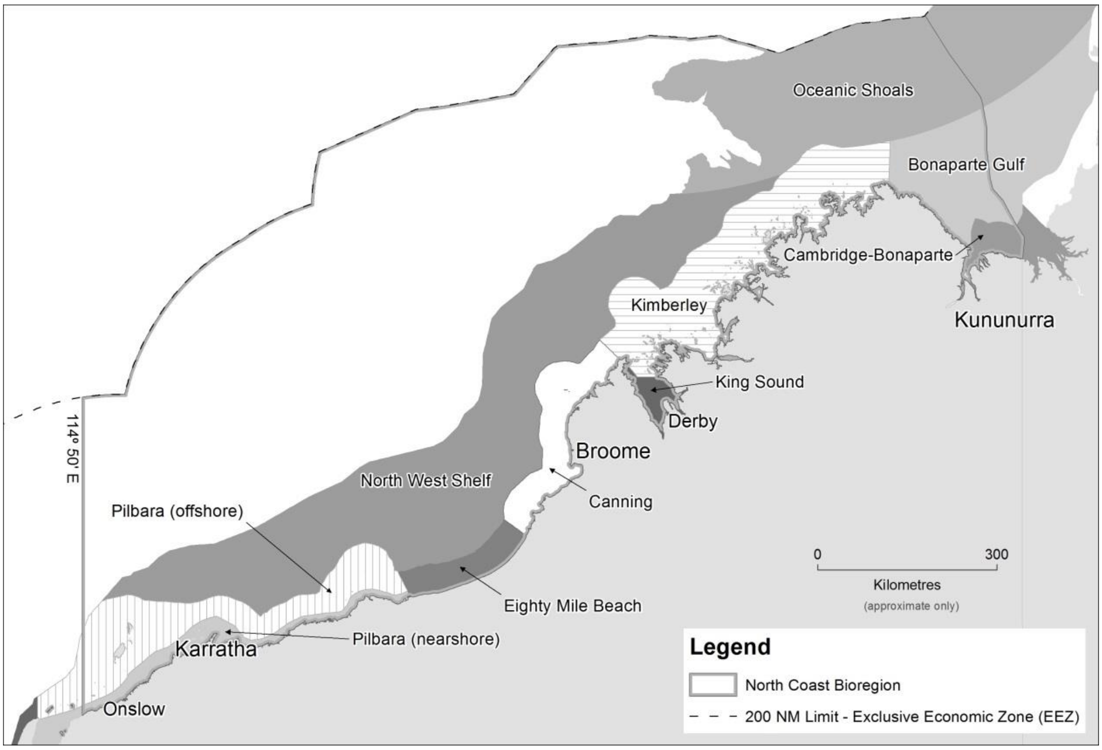
Coastal waters are generally low-energy in terms of wave action, but are seasonally influenced by infrequent but intense tropical cyclones, storm surges and associated rainfall run-off. These cyclone events generate the bulk of the rainfall, although the Kimberley section of the coastline does receive limited monsoonal thunderstorm rainfall over summer.

Significant river run-off and associated localised coastal productivity can be associated with cyclone events, with run-off ceasing during winter. Despite localised areas of high productivity the region is generally oligotrophic and larges areas of the coastline receive no riverine input. 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.

Other significant factors influencing coastal waters include the macro- tidal regime related to the wide continental shelf and the convergence of ocean currents,. Spring tides range from greater than 11 metres along the Kimberley section of the coast down to more than 2 metres in the West Pilbara.

As a result of these factors, the generally tropical low-nutrient offshore waters can, in the few small 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 in areas locally 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.



NORTH COAST OVERVIEW FIGURE 1

Map showing the North Coast Bioregion and IMCRA (V 4.0) meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley.

SUMMARY OF ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

Climate Change

Some of the key environmental trends that may be affecting ecosystems in WA include:

- Increasing frequency of El Niño/Southern Oscillation (ENSO) events;
- More years with a weaker Leeuwin Current;
- Increase in water temperature off the lower west coast of WA;
- Increases in salinity, which includes some large annual fluctuations;
- Change in the frequency and location of storms (and rainfall) affecting the lower west coast; and
- Change in the frequency of cyclones (and summer rainfall) affecting the north-west coast.

The North Coast Bioregion is predicted to have relatively minor impacts from climate change, especially in the coming decade, compared to more southerly locations (Fletcher and Santoro 2012). The variables expected to drive climate change impacts include changes in water temperature, ocean currents, winds, rainfall, sea level, ocean chemistry and extreme weather conditions.

It is apparent that climate change will impact the biological, economic, and social aspects of many fisheries, and both positive and negative impacts are expected. Climate change can influence biological systems by modifying the timing of spawning, range and distribution, composition and interactions within communities, exotic species invasions and impacts, and the structure and dynamics of communities, including changes in productivity. Species distribution shifts are the most commonly reported changes and are often the easiest to recognise and measure. Changes in the distribution of key indicator species are being monitored in a national citizen-science program (www.redmap.org.au) that the Department is collaborating in.

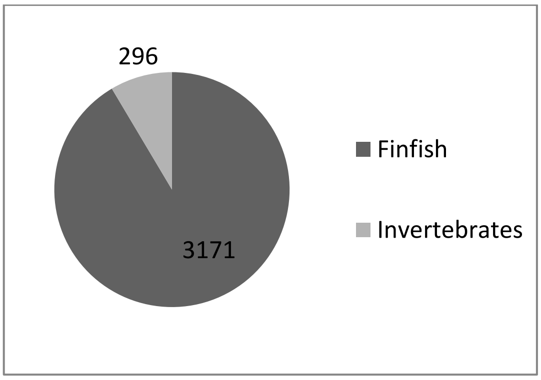
Commercial fishing

There are 15 different state-managed commercial fisheries that operate within the North Coast Bioregion. These fisheries target a variety of species including finfish, crustaceans, molluscs and echinoderms (North Coast Overview Figure 2). The principal commercial fisheries in the North Coast Bioregion focus 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 at least $12 million, the most valuable finfish sector in the State. A number of other finfish fisheries operate in the BBioregion, including near-shore beach seining and gillnetting for barramundi and threadfin salmon (the Kimberley Gillnet and Barramundi Managed Fishery) and surface trolling for Spanish mackerel (the Mackerel Managed Fishery).

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. These fisheries include the Onslow, Nickol Bay, Broome and Kimberley Prawn Managed Fisheries (collectively referred to as the North Coast Prawn Managed Fisheries). Two small trap-based crab fisheries also exist in the Bioregion, targeting blue swimmer crabs in the Pilbara (the Pilbara Developing Crab Fishery) and mud crabs in the Kimberley (the Kimberley Developing Mud Crab Fishery). Sea cucumbers (also known and bêche-de-mer or trepang) are collected by hand by divers and waders throughout the Kimberley region as part of the Bêche-de-Mer Fishery. Catches are mainly comprised of two species, sandfish (*Holothuria scabra*) and redfish (*Actinopyga echinites*). The Trochus Fishery is a small fishery based on the collection of a single target species, *Tectus niloticus* from King Sound and the Buccaneer Archipelago. This fishery is operated by the Bardi Jawi and Mayala Aboriginal Communities, who have been collecting trochus in this area since the 1960s.

A traditional artisanal fishery also exists in an area around Roti Island, known as the MOU box.The MOU Box is an area within the Australian EEZ over which there is a bilateral agreement between Australia and Indonesia. The MOU allows Indonesian fishers to fish using traditional methods within Australian waters and has been operation al since 1974.

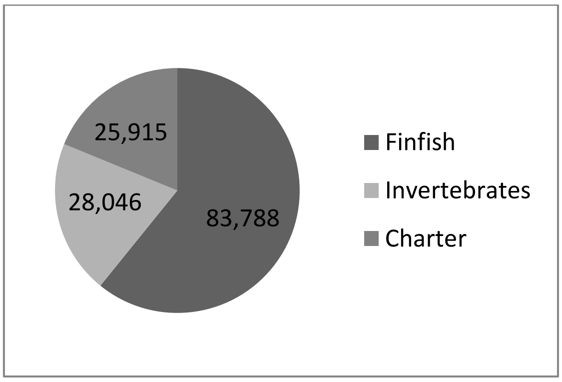


NORTH COAST OVERVIEW FIGURE 2

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

Recreational Fishing

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 may have been added to by the increased recreational fishing resulting from 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 finfish species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, cods and catfish, and invertebrate species including blue swimmer crabs, mud crabs and squid (North Coast Overview Figure 3). Offshore islands, coral reef systems and continental shelf waters provide recreationally caught species including tropical snappers, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish.

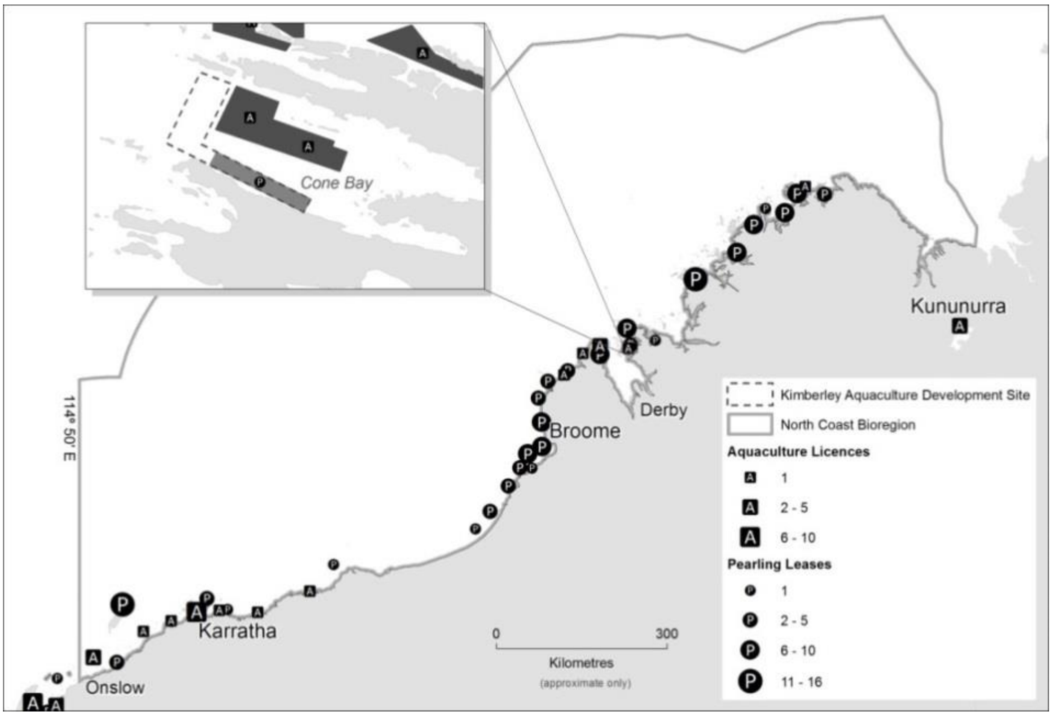


NORTH COAST OVERVIEW FIGURE 3

The North Coast Bioregion finfish and invertebrate catch numbers as assessed in the integrated survey of boat-based recreational fishing in WA 2011/12, and the charter boat catch numbers for the 2013 period.

Aquaculture

Aquaculture development in the North Coast Bioregion is dominated by the production of pearls from the species *Pinctada maxima*. An overview of aquaculture activities in the Bioregion is detailed in North Coast Overview Figure 4. 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. Marine production of barramundi is focussed in Cone Bay where an operator is currently licensed to produce 2,000 tonnes per annum. Establishment of an aquaculture zone (further described under the regional aquaculture research and development section in this chapter) has been funded in this area in which the Department of Fisheries will secure strategic environmental approvals, thereby streamlining the approvals processes for commercial projects and providing an "investment ready" platform for prospective investors. This is expected to lead to the development of further aquaculture operations in the region. A company developing a project culturing marine microalgae for the production of bio-fuels, omega-3 lipid and protein biomass previously established a demonstration facility near Karratha. The company is currently assessing alternative sites for the project. 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. An indigenous project at One Arm Point operates a marine hatchery that focuses on a variety of ornamental and edible marine species.



NORTH COAST OVERVIEW FIGURE 4

Overview of aquaculture activity in the North Coast Bioregion, detailing locations of licensed finfish aquaculture facilities and pearling leases. Also indicated is the Kimberley Aquaculture Development Zone that is under development.

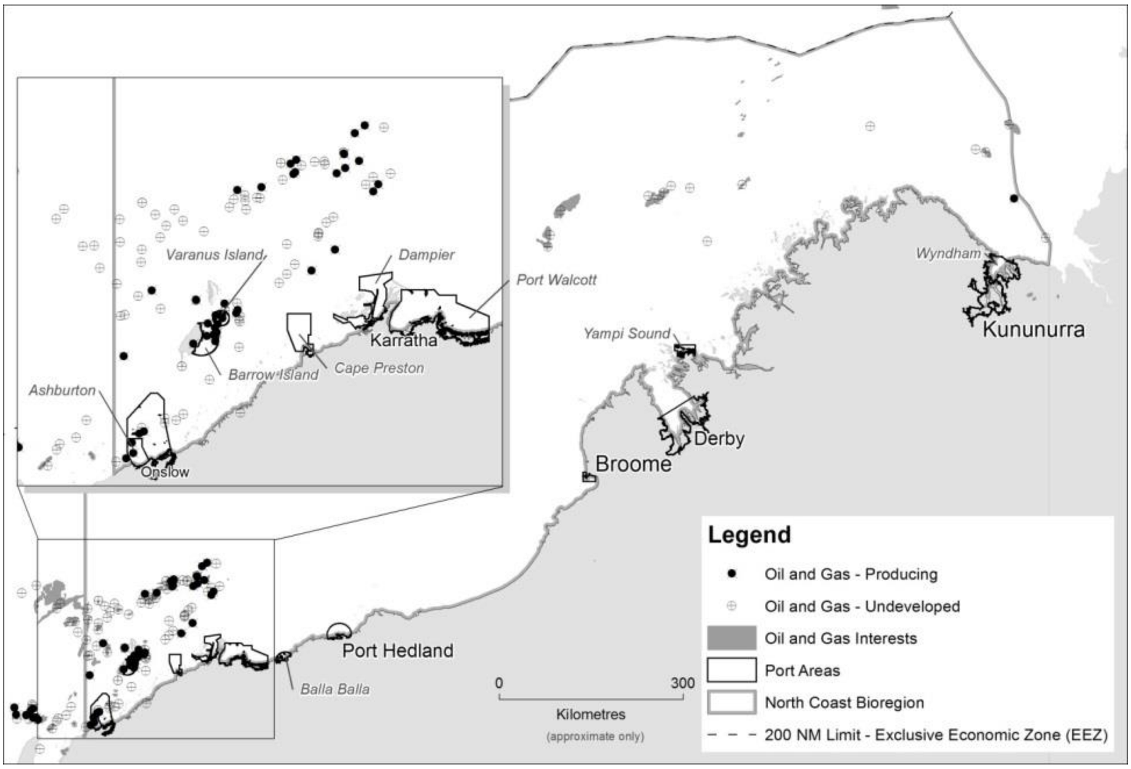
Tourism

The marine tourism industry has experienced significant growth within the North Coast Bioregion, particularly along the Kimberley coast. As coastal access is limited, tourists generally access the coast by boat from major population centres, such as Broome and Wyndam. Activities include charter fishing, diving, snorkeling, whale, turtle and dolphin watching, and sightseeing cruises.

Sites of greatest interests to tourists include places to fish, areas for sightseeing and secluded locations for general relaxation. Luxury cruises take tourists along the coastline and increasingly out to isolated coral atolls for fishing and diving. Primary dive locations include the Rowley Shoals, Scott Reef, Seringapatam Reef, Ashmore Reef and Cartier Island.

Oil and Gas Activity

Offshore oil and gas is a large and rapidly growing industry in the North Coast Bioregion. Within the Bioregion, the Northern Carnarvon, Browse and Bonaparte Basins hold large quantities of gas, and multiple projects are in various stages of development, production and exploration (North Coast Overview Figure 5). 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.



NORTH COAST OVERVIEW FIGURE 5

North Coast offshore oil and gas production sites and major ports.

Shipping and Maritime Activity

There are three major ports in the North Coast Bioregion: Broome, Dampier and Port Hedland (North Coast Overview Figure 5). The Port of Broome provides vital support for the Browse Basin offshore oil and gas industry. Other business includes livestock export, cruise liner servicing, coastal trading vessels, pearling, fishing and tourism charters. The Port of Dampier services both the land-based iron ore reserves and the offshore gas fields of the Carnarvon Basin. The Port of Port Hedland is the world’s largest bulk exporter, with 99 % of the total cargo volume constituting exports. The port primarily exports iron ore, along with salt, livestock and petroleum products. There are eight other non-port authority ports in the North Coast Bioregion. In general, these ports and related export facilities are operated by resource companies. Most handle raw bulk commodity exports such as iron ore, crude oil and salt. An increase in shipping and port expansion associated with growth of the resources sector has potential implications for the marine environment. Potential threats include loss or contamination of marine habitats as a result of dredging and sea dumping, oil spills, interactions between vessels and listed species and the introduction of marine pests.

ECOSYSTEM MANAGEMENT

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

Climate Change

Work is being finalized as part of a three-year FRDC-funded project (2010/535) that aimed to assess the effects of climate change on the marine environment and key fisheries, as well as management implications. The first phase of the project was 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 was to look at historical trends and possible future scenarios of WA marine environments using climate model projections. Lastly, existing management arrangements were 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 on fish stocks.

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch also recently completed a pilot project aimed at establishing resource condition monitoring protocols for the Pilbara and Kimberley. The establishment of standardised long term resource monitoring programs is fundamental to understanding and thus mitigating the impacts of climate change on marine resources. 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. 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 is also a key collaborator in the National RedMap (Range Extension Database & Mapping project) project (www.redmap.org.au) which uses a citizen-science approach to document range extensions of a number of key identified climate-change affected species. Understanding shifts in populations is likely to be increasingly important to adaptive fisheries management.

Spatial Closures

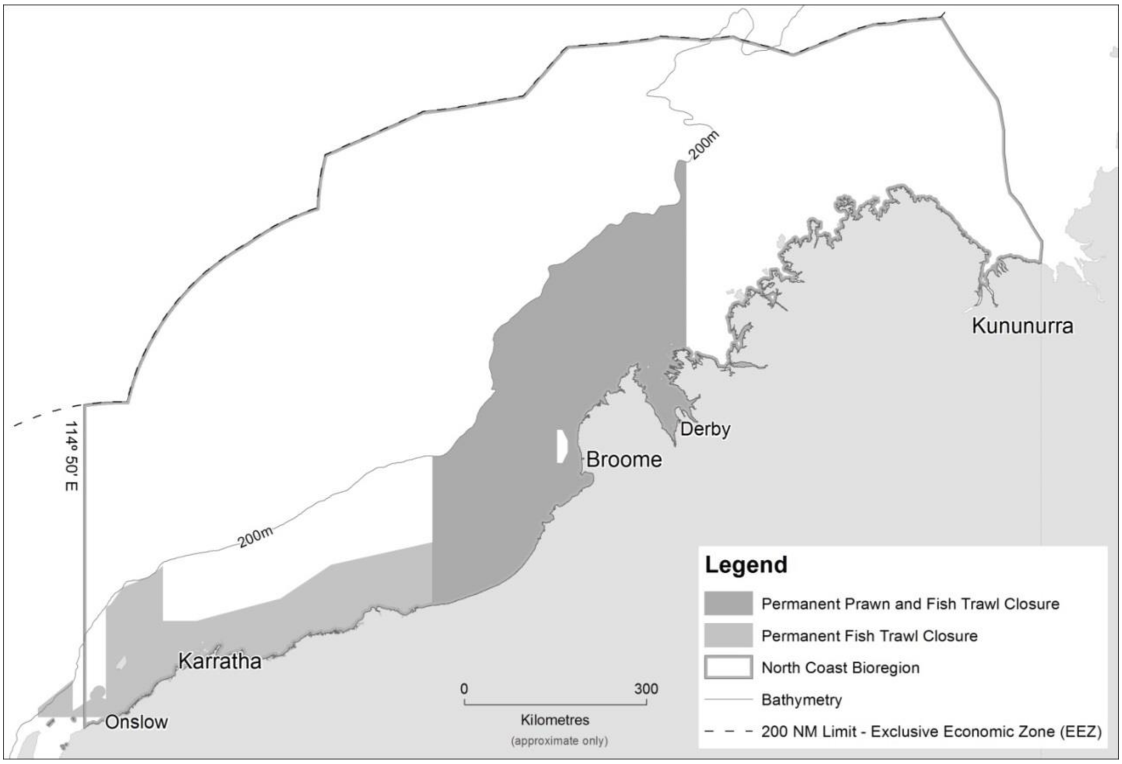
Extensive fisheries closures in coastal and most offshore waters have been introduced to manage finfish trawling by Australian vessels (North Coast Overview Figure 6). However, trawling is still permitted in a small number of limited locations, which in total represent less than 11% of the shelf waters (North Coast Ecosystem Management Table 1; 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 the 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 or higher (as per Dudley, 2008[1]; North Coast Ecosystem Management Table 1).

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the North Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which meet the IUCN criteria for classification as marine protected areas.

IUCN category or equivalent	State Waters only (65,400 km2)				All Waters (837,500 km2 (including State waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km2	%	km2	%	km2	%	km2	%
I	0	0	0	0	0	0	1,300	< 1
II	0	0	1,900	3	0	0	1,900	< 1
III	0	0	0	0	0	0	0	0
IV	19,100	29	3,500	6	149,200	18	3,500	< 1
V	0	0	0	0	0	0	0	0
VI	36,800	56	4,100	6	677,500	81	4,100	< 1

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

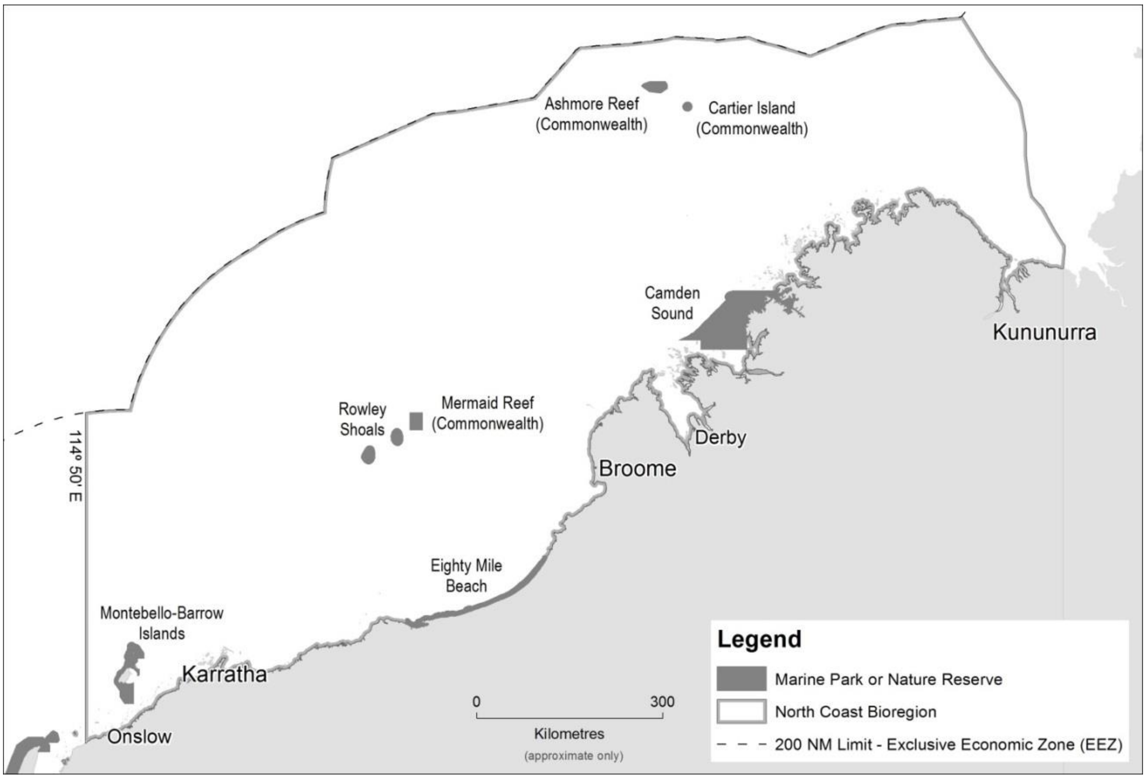


NORTH COAST OVERVIEW FIGURE 6

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

In addition to these habitat related marine protected area closures, the Bioregion has a number of other marine protected areas with various management objectives, summarised in North Coast Overview Figure 7. These include 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 Department of Fisheries has also 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 proposed Dampier Archipelago marine conservation reserves are still under consideration by Government. 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 Western Australian Marine Science Institute (WAMSI) Kimberley Marine Research Program projects.

The Commonwealth Government 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 had announced a final reserve network proposed for the North-West which spans the North Coast and Gascoyne Bioregions but this is under review by the current Government



NORTH COAST OVERVIEW FIGURE 7

Map showing the North Coast Bioregion and current and proposed state and commonwealth marine parks and reserves along the northern WA coast.

Management of Commercial Fisheries

There is a high degree of ecosystem management and protection for the ecological assets that are located within the North 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 listed 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 of invertebrates);
- Permanent and seasonal area closures to preserve sensitive habitats that are essential nursery areas;
- Temporal general closures;
- Primary and secondary bycatch reduction devices (BRDs) and excluder devices;
- Total Allowable Catch limits;
- Target catch ranges;
- Minimum commercial size limits;
- Protection of berried females (invertebrates); and
- Monitoring of fishing activities using the Vessel Monitoring System (VMS).

The State is currently employing a Bioregional approach to the pre-assessment of all its fisheries for potential third party certification according to the sustainability criteria developed by the Marine Stewardship Council (http://www.msc.org/). The progression of a number of fisheries to full certification is underway. This process will ensure independent assessment of the sustainability and effective management of assessed fisheries to an internationally recognised standard.

Management of Recreational fisheries

Recreational fishing in the North Coast Bioregion 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. All recreational fishing activities, including those of the charter sector, are subject to the closures associated with marine protected areas detailed above. In 2010, a statewide recreational 'fishing from boat' license was also introduced. A number of recreational fishing surveys have been undertaken, including a recent statewide recreational fishing from boat survey in 2011/12 (Ryan *et al.*, 2013)[1]. 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. A second biennial survey is currently being completed.

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 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 is the lead agency with responsibility for marine biosecurity in the State. 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. 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.

The Marine Biosecurity Research and Monitoring group have implemented a series of biosecurity related projects during 2013 – 2014. 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 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. In addition the group has analysed the likelihood of IMPs being introduced into North Coast ports as a result of commercial vessel movements. 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.

Management of Aquaculture

The main focus of the Department of Fisheries in the North Coast Bioregion continues to be on the regulation of the pearling industry based on the silver lip pearl oyster (*Pinctada maxima*) and the barramundi finfish aquaculture sector. The Department manages risks associated with aquaculture which include disease, the potential introduction of marine pest species and the impact of escapes. In recognition of the positive contribution aquaculture can have on wild stock sustainability, the economy and regional communities, the Department has recently engaged in a project to establish an aquaculture zone in the Kimberley with the aim of encouraging investment in sustainable finfish aquaculture through providing streamlined approval processes. The Department manages the impact of aquaculture via implementation of a comprehensive suite of conditions associated with aquaculture licences and through the legislative framework provided by the *Fish Resources Management Act 1994* (FRMA).

Management of Tourism

The Department has responsibility to manage the impacts of tourism where they may have a direct impact on fish resources. This is achieved through the measures detailed above aimed at managing recreational fishing. In addition to this regulation, formal management arrangements were also introduced for the charter sector in 2001 which include a 'cap' on the total number of operators statewide. Licensed operators that are engaged in extractive fishing are required

1 Ryan et al., 2013. An integrated system to survey boat-based recreational fishing in Western Australia 2011/12, December 2013. Fisheries Research Report 249.

to submit trip-by-trip catch and effort records. Otherwise, charter fishing is subject to the same regulation as private recreational fishers.

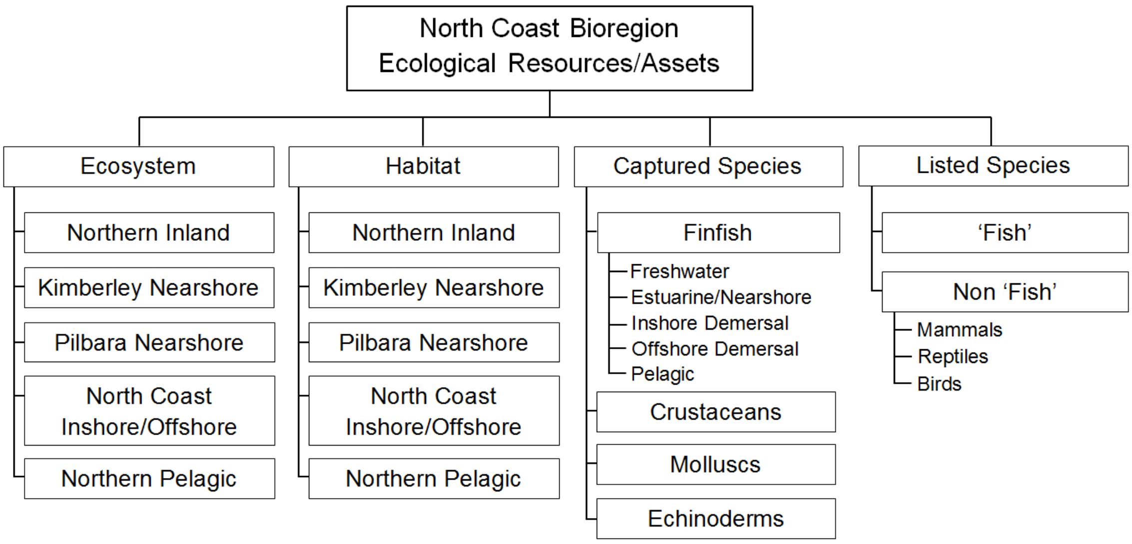
Management of Oil and Gas Impacts

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 Montara oil spill that occurred in this region highlights the potential risks to this area from oil and gas production.

ECOSYSTEM MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the North 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 North Coast Bioregion are identified in Figure 8 and their current risk status reported on in the following sections.



NORTH COAST OVERVIEW FIGURE 8

Component tree showing the ecological assets identified and separately assessed for the North Coast Bioregion. Under the integrated marine and coastal regionalisation for Australia scheme, the Bioregion has been divided into 6 meso-scale regions (See Introduction Fig. 1): Kimberly Nearshore, Kimberley Inshore, Pilbara Nearshore, Pilbara Inshore, Offshore Oceanic Shoals and Northern Pelagic (imcra, v 4.0, 2006) which have been adopted for sub-regional management within an EBFM framework.

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

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 North Coast Bioregion include climate, introduced pests and diseases and oil and gas development activities.

Climate

External Driver	Current Risk Status
Climate	LOW

The North Coast Bioregion is predicted to have relatively minor impacts from climate change, especially in the coming decade, compared to more southerly locations. Cheung *et al.* (2012)[1] examined the effects of climate change on the distribution of 30 species of marine fish and invertebrates along the Western Australian coast. Important North Coast Bioregion species included western king prawns (*Penaeus latisulcatus*), blue swimmer crabs (*Portunus armatus*), redthroat emperor (*Lethrinus miniatus*), Spangled emperor (*Lethrinus nebulosus*), common coral trout (*Plectropomus leopardus*), rosy snapper (*Prestipomoides filamentosus*), goldband snapper (*Pristipomoides multidens*) and scaly mackerel (*Sardinella lemuru*). Changes in distribution were simulated using outputs from both a Regional Oceanographic Model and a Global Circulation Model. Results indicated a median shift of around 19 km per decade towards higher latitudes and 9 m deeper per decade by 2055 relative to 2005. As a result of these shifts, the temperate coast of Western Australia is expected to experience a 'tropicalisation' of the marine community, with an increased dominance of warmer-water species, resulting in shifted fishing grounds and unexpected trophic effects (Cheung *et al*. 2012).

Introduced Pests and Diseases

External Driver	Current Risk Status
Introduced Pests and Diseases	HIGH

The increase in international shipping movement and dredging activity associated with resource development in the North Coast 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. In 2012/13 the Department responded to a number of detections of potentially invasive marine pests species in the Bioregion. The Department recently completed a likelihood analysis which evaluated the relative risk to each port based on a number of parameters including vessel visitation (volumes, types, volume, origin and last port of call), pest species likely to be introduced and their likelihood of establishment (based on biological compatibility with the receiving environment). The report identified ports in the Bioregion to be at greatest inoculation risk (described as the vessel origin that poses the greatest risk) from vessels that travelled within state waters (intrastate), whereas for the other Bioregions the greatest risk was from international vessels. There was a very high compatibility between the potential incoming marine pests and the environments of the North Coast with the greatest infection and establishment risk to the North Coast coming from China (Bridgwood & McDonald 2014)[2]. The Department implements a range of monitoring and research activities in the Bioregion, focussed on early detection of potential marine pests at key high risk ports. Further detail may be found in the Appendix section entitled "Activities of the Marine Biosecurity Research Unit during 2013/14".

Oil and Gas Development Activity

External Driver	Current Risk Status
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 planned or in place.

Ecosystems and Habitats

Coastal geography is extremely variable within the North Coast Bioregion and its identified meso-scale ecosystems include a range of key habitats 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) which include:

- *Mangroves*: Mangroves occur throughout the Bioregion, and within the Kimberley, are considered to be very well developed and relatively pristine. The mangrove communities of Roebuck Bay and Eighty Mile Beach have been listed as Ramsar Wetlands of International Significance mainly due to the numbers of migratory wading birds they support.
- *Seagrasses:* Seagrasses are mainly tropical species. Twelve species have been identified throughout the North Coast Bioregion, including one endemic species (*Cymodocea angustata*). Within the Bioregion, seagrasses are generally found in shallow water environments near the mainland coast and offshore reefs and shoals.
- *Algae:* Algal growth is restricted by the limited presence of hard substrates on the North West Shelf. Throughout

1 Cheung, W., Meeuwig, J., Feng, M., Harvey, E., Lam, V., Langlois, T., Slawinski, D., Sun, C., and Pauly, D. (2012). Climate-change induced tropicalisation of marine communities in Western Australia. *Marine and Freshwater Research* 63: 415-427.

2 Bridgwood, S. and McDonald, J. A likelihood analysis of the introduction of marine pests to Western Australian ports via commercial vessels. Fisheries Research Report No. 259. Department of Fisheries, Western Australia. 212pp.

the Kimberley, the effects of strong tidal currents and high turbidity result in low macroalgal diversity. Surveys in the Kimberley have identified 72 species of macroalgae in the southern Kimberley and 90 species (not including coralline algae) in the northern Kimberley, most of which are widespread tropical taxa.

- *Sponges and Filter-Feeding Communities:* Sponges are found from tidal areas to the deep waters of the Abyssal Plain and generally occur as part of a mixed filter-feeding community. Species richness varies considerably throughout the Bioregion, with both relatively low-diversity communities (< 25 species, e.g. Rowley Shoals) and exceptionally rich communities (> 250 species, e.g. Dampier-Port Hedland regions). Sponge communities throughout the Bioregion are also broadly different. For example, a study by the Western Australian Museum found more than half the sponges identified at Mermaid, Scott and Seringapatam Reefs were unique to a single reef (WAM, 2006).
- *Coral Reefs:* Coral reefs in the Bioregion fall into two general groups: the fringing reefs around coastal islands and the mainland shore and large platform reefs, banks and shelf-edge atolls on the mid and outer shelf. North of Cape Leveque, the Kimberley supports extensive nearshore reef systems . Areas of fringing reef development include islands in the Buccaneer Archipelago, the Heyward island group, islands of the Bonaparte Archipelago and off mainland shores of Cape Voltaire and Cape Bougainville. Coral diversity is typically high, with surveys of the Buccaneer Archipelago) having recorded 280 species of coral from at least 55 genera. Coral reefs are also well developed around offshore island such as Ashmore, Cartier, Hibernia, Seringapatam and Scott Reefs, Browse Island and the Rowley Shoals.
- *Sand/Mud:* Embayments along the Kimberley are known to have extensive muddy tidal flats and the majority of the offshore area is dominated by soft sediment seabeds, which are mainly sand/mud with occasional patches of coarser sediments.

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.

A high level of protection of the ecosystems and habitats within the North Coast Bioregion is ensured based on the limited area of the Bioregion that is available to commercial trawl fishing activity (North Coast Bioregion Overview Figures 6 and 7) . The Department manages commercial, charter, recreational and indigenous fishing in State coastal waters (generally to 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). If the areas that are not trawled is taken into account, 89 % of statewide benthic habitats out to the 200 m isobath are, in practical terms, fully protected and may never have been trawled (North Coast Ecosystem Management Table 1). In addition to fisheries-related closures, the North Coast Bioregion has a number of marine protected areas described under the preceeding "spatial closures" section.

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.

Kimberley Nearshore

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Kimberley nearshore ecosystem	Estuarine	LOW (non-fishing)
Kimberley nearshore ecosystem	Marine	LOW
Kimberley nearshore habitat	Estuarine Sand/Mud Mangroves	LOW (non-fishing)
Kimberley nearshore habitat	Marine Sand/Mud Sponge Reef Mangroves	LOW

The Kimberley Nearshore Ecosystem (KNE) includes coastal waters to 20 m depth from Cape Missiessy at the northern end of Eighty Mile Beach (19° 03' S; 121° 31' E) to the Northern Territory border. This ecosystem includes the nearshore sections of five of the IMCRA-identified Bioregions: Canning, King Sound, Kimberley, Cambridge-Bonaparte and Bonaparte Gulf.

Ecosystem

Estuarine (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

The main fisheries in the region are selective and based on trap (Kimberley Demersal Mud Crab Fishery; KDMCF), gillnet (Kimberley Barramundi Gillnet Fishery; KBGF) and hand collection (Kimberley Beche-de-Mer Fishery; KBMF).The current level of fishing by all methods in the Kimberley Nearshore Ecosystem does not appear to have noticeably affected the trophic systems and/or community structure of the ecosystem. The majority of catch from each fishery is comprised of the main target species, and catches of these species have remained relatively stable throughout the history of each fishery, excepting where effort has dropped due to market demands (i.e. the Trochus Fishery). The target species for each fishery have wide distributions beyond the fishing areas, and their removal at current rates is unlikely to seriously or irreversibly alter community structure.

Habitat

Estuarine (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

The main fisheries in the region are selective and based on trap (Kimberley Demersal Mud Crab Fishery; KDMCF), gillnet (Kimberley Barramundi Gillnet Fishery; KBGF) and hand collection (Kimberley Beche-de-Mer Fishery; KBMF) and thus constitute a minimal disturbance to benthic habitats. The majority of these fishing activities occur in mud/sand habitats in estuaries, tidal creeks and embayments. In general, mud/sand areas are less affected by disturbances than sensitive habitats, i.e. corals and seagrasses. In the case of the KDMCF, fishing with traps results in limited habitat disturbance, and the large mesh size used prevents the capture of benthic organisms. The sheltered, shallow mangrove environment is protected from wind and waves, and there is minimal dragging of traps on the sea bottom during retrieval. Fishing activities associated with the KBGF mainly take place over sandy habitats in nearshore, shallow waters, which are subject to extreme tidal currents and associated effects. Gillnets have a relatively low seafloor impact, and the Fishery is considered to be a low risk to benthic habitats. Fishers in the BDMF catch bêche-de-mer by diving or wading, with collection by hand only. Divers collect bêche-de-mer as they drift over the bottom and are careful not to contact the seabed during fishing activities. The spatial distribution of all fishing activities are also managed through the use of seasonal and area closures to protect sensitive habitats.

Pilbara Nearshore

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Pilbara nearshore ecosystem	Estuarine	LOW (non-fishing)
Pilbara nearshore ecosystem	Marine	LOW
Pilbara nearshore habitat	Estuarine Sand/Mud Mangroves	LOW (non-fishing)
Pilbara nearshore habitat	Marine Sand/Mud Sponge Reef	LOW

The Pilbara Nearshore Ecosystem (PNE) is defined as coastal waters to 20 m depth from Cape Missiessy at the northeastern end of Eighty Mile Beach (19° 03’ S; 121° 31’ E) to the North Coast Bioregion boundary just south of Onslow (114° 50’ E). This region includes the nearshore sections from three IMCRA-identified Bioregions: Pilbara Inshore, Pilbara Offshore and Eighty Mile Beach.

Ecosystem

Estuarine (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

The current level of removal of all retained species is considered to have only minor impacts on the trophic structure of the Pilbara nearshore ecosystem. The current level of fishing by all methods in the Pilbara nearshore ecosystem does not appear to have noticeably affected the trophic systems and/or community structure of the ecosystem. The majority of catch from each fishery is comprised of the main target species, and catches of these species have remained stable throughout the history of each fishery. The majority of the retained catch for both the Onslow Prawn Managed Fishery (OPMF) and the Nikol Bay Prawn Managed Fishery (NBPMF) is comprised of various prawn species, with target prawn species comprising on average 80 % of the total catch in the OPMF and 74 % in the NBPMF for the past 10 years. None of the main target species are known to be involved in any strong ecological interactions and their removal at current rates is unlikely to seriously or irreversibly alter community structure. Prawns have a very high natural mortality and turnover rate, such that a large percentage of the yearly recruits are naturally removed from the system (either by death or predation) by the end of the fishing season regardless of fishing activities. As a result of this naturally high variation, the effect of removing prawns at current levels through fishing would be minimal. Additionally, the management of spatial and seasonal closures ensures that an adequate spawning stock of all species of prawns survive to reproduce recruits for the subsequent season.

Habitat

Estuarine (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

The majority of fishing activities take place over mud and sand habitats. Trawl activities are considered to have the highest relative impact of the methods used within the Pilbara nearshore ecosystem which also includes low impact activities of trap (eg Pilbara Developing Crab Fishery) and hand collection (eg Pearl Oyster Managed Fishery) based fisheries. However, the spatial extent of trawling activities is small, and there are a variety of measures in place to manage any impacts. Both the Onslow Prawn Managed Fishery (OPMF) and the Nikol Bay Managed Prawn Fishery (NBMPF) fisheries use otter trawl systems, which have been demonstrated to have the least impact of all forms of trawling Within Onslow Area 1, a study of biodiversity found no significant differences in the fish and invertebrate abundance, species richness, evenness or diversity between trawled and untrawled areas (Kangas *et al*. 2007)[1]. These findings indicate that trawling does not have a significant impact on the faunal community, which also suggests that trawling has not significantly impacted on the benthic habitats where

1 Kangas et al., 2007. Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia, December 2007. Fisheries Research Report No 160.

trawling occurs. The trawl grounds of the OPMF and the NBPMF are largely separated, on a geographical and depth basis, from other sensitive habitats, such as coral and sponge communities. Trawlers focus their activities in areas of high western king, brown tiger and/or banana prawn abundance, which is typically mud and sand areas outside of dense soft coral/sponge habitats.

Kimberley Inshore (Shelf)

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Kimberley inshore ecosystem	Marine	LOW
Kimberley inshore habitat	Marine Sand/Mud Sponge Reef	LOW

The Kimberley Inshore Ecosystem comprises the broad North West Shelf area off the Kimberley coast and includes all waters seaward of the 20 m depth contour to depths of 250 m and includes a number of mid-shelf islands. The Kimberley Inshore Ecosystem includes sections of five IMCRA Bioregions: Canning, Kimberley, Cambridge-Bonaparte, Bonaparte Gulf and the northern section of the North West Shelf.

Ecosystem

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. Assessments of the community structure and trophic level of all commercially caught fish species in the Pilbara and Kimberley regions over the past 30 years found no evidence that there have been any systematic changes. Therefore, there is no indication that the fish faunas have been impacted by the development of the scalefish fisheries to the extent that ecosystem function in the Kimberley Inshore Ecosystem has been affected (Hall and Wise 2011).The majority of catch from each fishery is comprised of the main target species, and catches of these species have relatively remained stable throughout the history of each fishery, excepting where effort has dropped due to economic factors (i.e. the Broome Prawn Managed Fishery). None of the main target species are known to be involved in any strong ecological interactions, and their removal at current rates is unlikely to seriously or irreversibly alter community structure.

Habitat

Trawl activities are considered to have the relatively highest habitat impacts of the methods used within the Kimberley Inshore Ecosystem; however, the majority of trawling takes place of sand/mud bottom habitats, and only occurs over a small area of the ecosystem with most of this region being closed to trawling. Additionally, the spatial extent and intensity of fishing activities in both the trawl and trap (e.g. the Northern Demersal Scalefish Managed Fishery) fisheries are monitored annually using daily logbooks and VMS.

Prawn trawling by the Broome Prawn Managed Fishery and the Kimberley Prawn Managed Fishery occurs predominantly over mud and sand habitats and both fisheries use otter trawl systems, which have been demonstrated to have the least impact of all forms of trawling. The spatial distribution of fishing activities in these fisheries is monitored using VMS, to ensure fishing activities remain outside sensitive habitats, as well as monitor the intensity of fishing activities in any one location.

Pilbara Inshore (Shelf)

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Pilbara inshore ecosystem	Marine	LOW
Pilbara Inshore habitat	Marine Sand/Mud Sponge Seagrass Reef	MODERATE (fishing) LOW (non-fishing)

The Pilbara Inshore Ecosystem comprises the broad North West Shelf area off the Pilbara coast and includes all waters seaward of the 20 m depth contour to depths of 250 m and includes a number of mid-shelf islands. The Pilbara Inshore Ecosystem includes sections of three IMCRA Bioregions: Pilbarra Offshore, Eighty Mile beach and the southern part of the North West Shelf.

Ecosystem

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. Assessments of the community structure and trophic level of all commercially caught fish species in the region over the past 30 years found no evidence that there have been any systematic changes. Therefore, there is no indication that the fish faunas have been impacted by the development of the scalefish fisheries to the extent that ecosystem function in the Pilbara Inshore Ecosystem has been affected (Hall and Wise 2011).The majority of catch from each fishery is comprised of the main target species, and catches of these species have remained stable throughout the history of each fishery. None of the main target species are known to be involved in any strong ecological interactions and their removal at current rates is unlikely to seriously or irreversibly alter community structure. The total catch of the largest demersal scalefish fishery, the Pilbara Fish Trawl Fishery Interim Managed Fishery has declined from annual average catch levels of close to 2500 t during 1995 – 2004, to an average of 1200 t per annum since 2008. This is considered to be due to effort restrictions that were imposed by the trawl industry in 2008 and the Department in 2009. It is unlikely that total removals would significantly disrupt the trophic dynamics of the region, as most species in the catch are generalist carnivores that consume a wide range of fish and invertebrates from demersal habitats. Additionally, there are other species of medium-sized carnivores in the Pilbara Inshore Ecosystem that are not caught in significant quantities by the Fishery and contribute to the total biomass of carnivores in the region. These non-target species play a similar trophic role to targeted species and are likely to compensate for the effect of removals by the fishery.

Habitat

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. Trawl activities are considered to have the highest habitat impacts of the methods used within the region; however, the majority of trawling takes place of sand/mud bottom habitats, and there are a variety of measures in place to manage any impacts. A number of measures are in place to manage the impact of the Pilbara Fish Trawl Fishery Interim Managed Fishery on benthic habitats including gear restrictions, effort restrictions and spatial closures. All trawl nets are required to have rubber discs (max. diameter of 350 mm) attached to the ground rope which allow the net to fish slightly off the bottom and ride over obstructions, such as sponges. The maximum diameter of the rubber discs is aimed at restricting the movement of trawlers to areas of soft/flat seabed. There are also spatial constraints throughout the Fishery, including depth restrictions and closed areas. Trawling is only permitted in waters deeper than 50 m, which provides an inshore refuge area for attached benthos from which recruitment onto the trawl area is possible. Large areas over the 0 – 200 m depth range within the fishing boundaries are also closed to trawling. The location of fishing activities are reported in daily logbooks and monitored with VMS. Fishing levels are such that the fished area of the Pilbara Demersal Scalefish Fishery (PDSF; trawl, trap and line sectors) between depths of 30 and 120 m should remain at or below 60 % of the total fishing area. With the current spatial restrictions on fishing activities (see above), only 46 % of the PDSF area and less than 5 % of the NorthWest Shelf is accessible to trawl vessels. Plots of trawl activity from VMS data indicate that the actual area trawled is significantly less than this. The most likely potential impacts to the habitat in this area are from oil and gas infrastructure development and operation.

Offshore Oceanic Shoals

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Offshore Oceanic Shoals Ecosystem	Marine	LOW (non-fishing)
Offshore Oceanic Shoals Habitat	Marine Sand/Mud Reef	LOW (non-fishing)

The Offshore Oceanic Shoals Ecosystem (OSE) includes the waters beyond the shelf break, with depths greater than 250 m. This ecosystem includes one IMCRA v.4 Bioregion, the Offshore Oceanic Shoals.

Ecosystem

There are 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 low risk that the ecosystem will be altered measurably. The majority of fishing activities is focused around islands, reefs and shoals, which are known to be areas of localised productivity. The area around Ashmore Reef, Cartier Island and Scott and Seringapatam Reefs is an important area for traditional fishers from Indonesia and can be accessed by the fishers through a Memorandum of Understanding (MoU), which was agreed between the Australian and Indonesian Governments in 1974. In 1983, Ashmore Reef and Cartier Island were declared nature reserves, and by 1989, the collection of trepang was prohibited following overfishing from Indonesian fishers. Currently, traditional fishing activities are spatially restricted and fishers are permitted to obtain a maximum finfish catch for immediate consumption and one days sailing only. The Northern Demersal Scalefish Fishery and the Mackerel Managed Fishery also operate in the area around these reefs and islands, including at Woodbine and Johnson Banks. The cumulative ecological impacts from these fishing activities are minimal, as there is no significant commercial effort in the Offshore Oceanic Shoals Ecosystem.

Habitats

The main threat to benthic habitats in this ecosystem is from oil and gas development at Scott Reef. A small amount of line fishing occurs around these offshore shoals and reefs but is likely to have a negligible impact on the benthic habitat.

Northern Pelagic

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Northern Pelagic Ecosystem	Marine	LOW

The Northern Pelagic Ecosystem includes the pelagic waters and suite of species found within the North Coast Bioregion ‘above’ the inshore demersal and offshore demersal suites.

Ecosystem

Historical fisheries in the region include the Northern Shark Fishery (NSF) and Mackerel Managed Fishery (MMF) which operate in the pelagic component of the North Coast Bioregion and are based on based on gillnet/ longline and trolling gear types respectively. The NSF has, however, not operated since 2009. The main species targeted and caught by the MMF are fast swimming, pelagic carnivores. In 2012, 332 t of mackerel and other pelagic species were retained by the fishery with Spanish mackerel comprising over 99 % of the total catch. Spanish mackerel are generalist carnivores and consume a wide range of fish and invertebrate species from both pelagic and demersal habitats. Therefore, the impact of any reduction in abundance of mackerel species would be spread across many prey species. Additionally, mackerel are just one of many medium-sized carnivore species in the northern waters of WA, and any reduction in mackerel abundance would have little impact on the total biomass of carnivores in each region.

Habitats

The fishing gear used in the Northern Pelagic Ecosystem does not contact the sea bed during fishing operations. Within the Mackerel Managed Fishery (MMF), fishing trips may last for several days, during which time the vessels anchor overnight in sheltered locations. The main impact on the benthic habitat in the fishery is likely to be from this anchoring activity, however, anchors are typically set over naturally dynamic sandy habitats and any impacts from anchoring are wide spread throughout the fishing area.

Captured Species

Finfish

The principal fisheries in the North Coast Bioregion focus on tropical finfish, particularly the high-value emperors, snappers and cods. These species are taken by the Pilbara Demersal Scalefish Fishery (trawl, trap and line sectors) and the Northern Demersal Scalefish Fishery. The typical catch is in the order of 3000 t annually at an estimated annual value of around $ 12 million, making these fisheries the most valuable finfish sector in the state. A number of other finfish fisheries operate in the Bioregion, including near-shore beach seining and gillnetting for barramundi and threadfin salmon (the Kimberley Gillnet and Barramundi Managed Fishery) and surface trolling for Spanish mackerel (the Mackerel Managed Fishery). The Department manages commercial, charter, recreational and indigenous 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). Indicator species which reflect the characteristics of the broader exploited stocks are monitored in order to assess ecological risk to the ranges of species targeted.

Estuarine/ Nearshore (0-20m depth)

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

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) is the only commercial fishery operating in the nearshore and estuarine zones of the North Coast Bioregion. 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 primary target species are barramundi and threadfin salmon. The KGBF is managed through input controls in the form of: limited entry; seasonal closures; area closures; and gear restrictions (e.g. net length and mesh size). Access to the Fishery is limited to five licence holders since two in Roebuck Bay bought out. There is no indication that the fish faunas have been impacted by the development of the scalefish fisheries to the extent that ecosystem function in the ecosystem has been affected (Hall and Wise 2011). Stocks of barramundi and threadfin salmon are considered to be at acceptable levels.

Inshore (shelf) Demersal (20-250 m depth)

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

There are four State-managed commercial fisheries in the Inshore Demersal region, which use multiple methods to target demersal fish stocks. These fisheries include: The Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF); The Pilbara Trap Managed Fishery (PTMF); The Pilbara Line Fishery (PLF); and The Northern Demersal Scalefish Managed Fishery (NDSF).

These fisheries all target the tropical demersal scalefish suite in the Pilbara and Kimberley Inshore Ecosystem and are collectively referred to as the Pilbara Demersal Scalefish Fisheries (PDSF) and Kimberley Demersal Saclefish Fisheries (KDSF). The trawl fisheries land the largest component of the catch, comprising more than 50 scalefish species. 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

Captured Species	Aquatic zone	Ecological Risk
Finfish	Pelagic	MODERATE

The Spanish Mackerel stock in this region targeted by the Mackerel Managed Fishery is at acceptable levels, and there are few other pelagic fish that are impacted.

Invertebrates

A significant commercial invertebrate fishery in this Bioregion, is the Pearl Oyster Managed Fishery, which is based on the collection of pearl oysters (*Pinctada maxima*) for use in the aquaculture production of pearls. These are collected from the fishing grounds primarily off 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 around 700 t annually and valued at around $10 million. These fisheries include the Onslow, Nikol Bay, Broome and Kimberley Prawn Managed Fisheries (collectively referred to as the North Coast Prawn Managed Fisheries).Two small trap-based crab fisheries also exist in the Bioregion, targeting blue swimmer crabs in the Pilbara (the Pilbara Developing Crab Fishery) and mud crabs in the Kimberley (the Kimberley Developing Mud Crab Fishery). Sea cucumbers (also known and bêche-de-mer or trepang) are collected by hand by divers and waders throughout the Kimberley region as part of the Bêche-de-Mer Fishery. Catches are mainly comprised of two species, sandfish (*Holothuria scabra*) and redfish (*Actinopyga echinites*). The Trochus Fishery is a small fishery based on the collection of a single target species, *Tectus niloticus* from King Sound and the Buccaneer Archipelago. This fishery is operated by the Bardi Jawi and Mayala Aboriginal Communities, who have been collecting trochus in this area since the 1960s.

Estuarine/Nearshore

Captured Species	Aquatic zone	Ecological Risk
Crabs	Estuarine/ Nearshore (0-20 m depth)	LOW
Trochus	Nearshore	LOW
Pearl Oyster	Nearshore	LOW
Bêche-de Mer	Nearshore	LOW

There is a small amount of fishing for mud crabs and blue swimmer crabs in some estuarine and inshore areas and its ecological risk is considered to be low.

The North Coast Trochus Fishery in King Sound is an indigenous fishery targeting the commercially important gastropod shell *Tectus niloticus*, 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.

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.

Inshore (shelf)

Captured Species	Aquatic zone	Ecological Risk
Prawns	Inshore (shelf)	MODERATE

There are a number of separate prawn stocks and fisheries within this Bioregion and 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.

Listed species

A number of endangered, threatened and protected[1] (ETP) species can be found within the North Coast Bioregion, including cetaceans, dugongs, marine turtles, sea snakes, elasmobranchs, seahorses and pipefish, crocodiles and seabirds and migratory shorebirds. These species are protected by various international agreements and national and state legislation. International agreements include:

- Convention on the Conservation of Migratory Species of Wild Animals 1979 (Bonn Convention);
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES);
- The Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974 (JAMBA)[2];
- The Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 (CAMBA)[2];
- The Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds 2007 (ROKAMBA)[2]; and
- Any other international agreement, or instrument made under other international agreements approved by the environment minister including the EBPC Act 1999.

Primary pieces of national and Western Australian legislation include the Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act), the Western Australian Wildlife Conservation Act 1950 (WC Act), and the Fish Resources Management Act 1994 (FRMA).

The only fisheries in the region that have reported any interactions with ETP species are the two trawl fisheries, the Onslow Prawn Managed Fishery (OPMF) and the Nikol Bay Prawn Managed Fishery (NBPMF) and the Kimberley Gillnet Barramundi Fishery (KGBF). ETP interactions with the trawl fisheries are few, due to fishing arrangements, such as the use of bycatch reduction devices and the separation of trawling activities from most ETP species' primary habitat. Similarly, Fishers in the KGBF actively avoid capturing ETP species; however, a small amount of interactions have been reported with saltwater crocodiles and sawfish.

Fish

Listed species	Risk
Elasmobranch	MODERATE
Syngnathids and Solenotomids	LOW
Other Fish	LOW

The sawfish (Pristidae), speartooth shark (*Glyphis glyphis*) or the northern river shark (*Glyphis garricki*) 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.

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

1 Note that being on a listed species list does not automatically indicate that a species is either threatened or endangered.

2 Further information on the CMS, JAMBA, CAMBA and ROKAMBA is provided at www.environment.gov.au/biodiversity/migratory/index.html

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.

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 (*Epinephelus tukula*), 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.

Non-Fish

Listed species	Ecological Risk
Turtles/Seasnakes	LOW
Crocodiles	LOW
Dolphins	MODERATE
Sea/Shore Birds	LOW

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.

Crocodiles are occasionally captured in nearshore/ freshwater fisheries' nets and most often are released alive.

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 trialled. The Pilbara fish trawl fishery recently secured a three year WTO with further conditions around dolphin and sawfish interactions and monitoring.

Anecdotal information from Lake Argyle fishers suggests that interactions with birds and crocodiles 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.

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. There are two key vectors for marine pest translocation: ballast water and hull fouling. The Marine Biosecurity Research and Monitoring group continue to implement a series of biosecurity related projects in the North Coast Bioregion with two aims. The first is to examine the likelihood of inoculation; infection and establishment of compatible marine pests in the North Coast Bioregion from commercial vessel movements (see Bridgwood & McDonald 2014). The second aim is for early detection of the presence of introduced marine pests (IMPs) using a suite of tools.

From a biosecurity perspective the introduction of a marine pest to any region is based on multiple factors that can be grouped into two themes; the likelihood of inoculation and the likelihood of infection and establishment. Inoculation likelihood assumes that the greater the number of vessel visits from a source with IMPs the greater the risk of IMPs being brought into the recipient port i.e. a positive linear relationship. Based on commercial vessel data from 2011, there were 8195 commercial visits to the North Coast Bioregion and the greatest inoculation risk was from intrastate vessel movements. The infection and establishment likelihood takes into account the sources of IMPs (based on a vessels last port of call (LPOC)), the frequency of visits from those sources and the compatibility between the IMPs salinity and temperature tolerances and North Coast Bioregion's marine environment. There was a 90% compatibility rating of potential inbound IMPs with the environment of the North Coast Bioregion from 23 international last ports (Introduced Pests Figure 1). When the cumulative effect of the number of vessel visits from a LPOC and number of IMPs present at that LPOC is considered, the greatest infection and establishment risk to the North Coast Bioregion was from China (Introduced Pests Figure 2).

Early detection of IMPs is vital if any attempt at eradication or other management strategies is to be successful. Thus the Marine Biosecurity Research and Monitoring group undertake marine pest monitoring at the ports of Dampier and Port Hedland. 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. Whereas the national monitoring adheres to the Australian Marine Pest Monitoring

1 Bridgwood, S and McDonald, J. 2014. A likelihood analysis of the introduction of marine pests to Western Australian ports via commercial vessels. Fisheries Research Report No. 259. Department of Fisheries, Western Australia. 212pp.

Guidelines and is endorsed by the Commonwealth, the complementary monitoring is a smaller more focussed version designed to target select high risk sites in each port. The complementary monitoring of Dampier and Port Hedland ports was completed in early 2014. The next round of national monitoring for these ports is scheduled for early 2015.

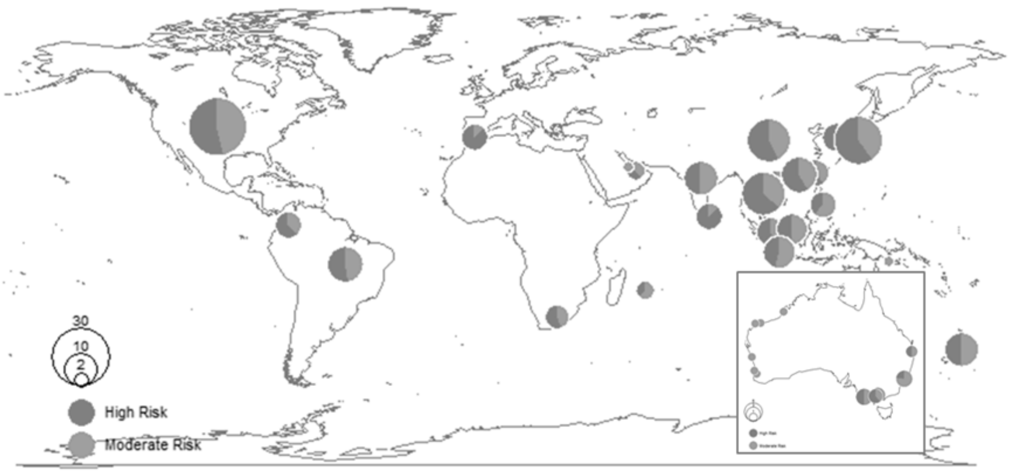
In addition the Marine Biosecurity Research and Monitoring group, with financial and *in-kind* assistance from Dampier and Port Hedland Port Authorities and stakeholders, is running an Early Warning System program using *in-situ* sampling arrays to aid in the early detection of marine pests in both ports.

Through this combined surveillance the species that have been detected in this region are reported in Introduced Pests Table 1.

INTRODUCED PESTS TABLE 1

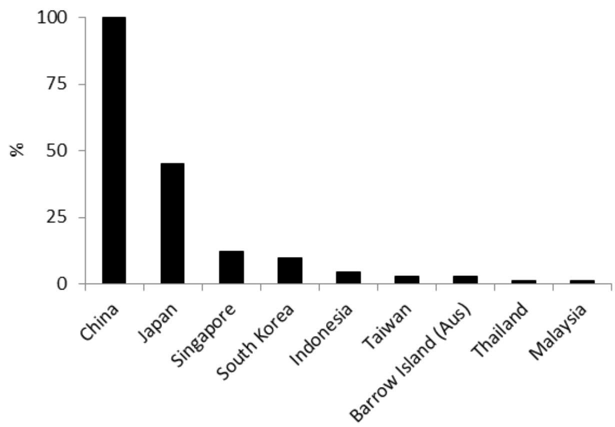
Introduced marine species detected in this bioregion.

Common name	Scientific name	Type of organism	IMS/IMP listing
	Theora fragilis	Mollusc	Introduced species
	Didemnum perlucidum	Ascidian	Introduced species – likely pest



INTRODUCED PESTS FIGURE 1

The last port of call locations of compatible IMPs for the North Coast Bioregion



INTRODUCED PESTS FIGURE 2

Ranking of the infection and establishment risk posed to the North Coast Bioregion by international and domestic last ports of call. Each last port of call value is expressed as a relative percentage of the largest last port of call value (i.e. China 100%

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:	<1 t
Fishing level	Acceptable	Nickol Bay:	106 t
		Broome:	2 t
		Kimberley:	154 t

Fishery Description

The 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 merguiensis*).

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 merguiensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*).

Governing legislation/fishing authority

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Broome Prawn Managed Fishery Management Plan 1999

Broome Prawn Managed Fishery Licence

Kimberley Prawn Fishery Management Plan 1993

Kimberley Prawn Managed Fishery Licence

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

Consultation process

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 114º39.9' 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 2013 season officially opened on 8 April and closed on 19 October with subsidiary openings and closings of SMFG's. The specific SMFG openings were as follows:

Areas 1, 2, 3	08 April – 19 October
Fortescue SMFG	01 June – 30 September
Ashburton SMFG	02 May – 30 June
Weld Island SFMG	02 May– 31 August
Mangrove Island SFMG	02 May –19 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 2013 season opened on 18 March and closed on 19 October with subsidiary openings and closings of SMFG's. The specific SMFG openings were as follows:

Nickol Bay	26 May – 30 September
(Day fishing only 26 May – 9 June)	
Extended Nickol Bay SMFG	26 May –19 October
Depuch SMFG	26 May – 30 September
De Grey SMFG	26 May – 19 October

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 of the five licences in this fishery has an equal allocation and the maximum total headrope length for the entire fleet is 365.8 metres (200 fathoms). The Fishery opened on 1 June and officially closed on 12 October, providing for 133 fishing nights.

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 2013 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 the Environment (DotE) 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 2013 limited commercial fishing was undertaken. 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 three boats 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.

A preliminary harvest strategy with control rules has been developed for these fisheries.

Retained Species

Commercial production (season 2013):

Onslow: 0.5 tonnes

Nickol Bay: 106 tonnes

Broome: 2 tonnes

Kimberley: 154 tonnes

Landings

OPMF: The total recorded landings that occurred in the OPMF were <1 t comprising of tiger prawns, banana prawns and king prawns (Northern Prawn Figure 5).

NBPMF: The total recorded landings of major penaeids for the 2013 season were 106 t, comprising: 106 t of banana prawns (96 t from the Nickol Bay fishery, and 10 t from Onslow, Area 3), < 1 tonne combined recorded landings of king prawns, endeavour prawns and tiger prawns. The landings of banana prawns was lower than the predicted catch of 150 t and catch range (120 to 180 t) (Northern Prawn Figure 6). Less than 1 t of all byproduct was landed which included bugs, blue swimmer crab and mixed finfish.

BPMF: Recorded landings for target species were very low at 2 t for king prawns and less than 1 t of coral prawns (Northern Prawn Figure 7). There were also very low landings of byproduct species (<1 tonne) including cuttlefish and bugs.

KPMF: The total recorded landings in the KPMF were 154 t, comprising 144 t of banana prawns, 6 t of tiger prawns, 4 t of endeavour prawns and < 1 t of king prawns (Northern Prawn Figure 8). Banana prawn landings were below their target catch range (200-450 t) and below the projected catch range (230 to 350 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 2013 but effort was low, possibly reducing total catches for these species. Negligible quantities of by-product were reported.

Recreational component: Nil

Fishing effort/access level

OPMF: One boat fished during the 2013 season.

NBPMF: Six boats fished during the 2013 season for an aggregated total of 178 boat days (Northern Prawn Figure 6). 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 11 nights of fishing effort was expended by one boat in 2013 (Northern Prawn Figure 7). The low effort (and number of boats operating) in the fishery has been due to uncertainty of the prawn abundance available at the start of the season and economics of fishing (high fuel costs and crew wages). Generally one boat 'trials' fishing during the early part of the season to determine if catch rates are viable and other licensees make an economic decision based on these catch rates before sending boats to this fishery.

KPMF: Twelve boats fished during 2013 for an aggregated total of 314 boat days (Northern Prawn Figure 8). This low effort reflects 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 2012.

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 (2014):

NBPMF: 145 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: There was limited commercial fishing undertaken in 2013. The total landings of prawns were extremely low. There has been disruption and disturbance to the most productive Area 1fishing grounds. This has 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 little catch and also effectively no effort on the tiger prawn stock 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: In 2013, the annual catch was within the target catch range, despite low effort, indicating adequate overall stock (and breeding stock) abundance. King and tiger prawn landings were extremely low and below the target catch ranges. Whether these low catches are due to low stock levels, very limited targeting on these species or due to environmental factors is not known at this stage. 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 2013 and March 2014 (at Roebourne) was 222.5 mm and the predicted catch for 2014 is around 145 t with a range of 115 –170 t of banana prawns.

BPMF: The very low fishing effort that occurred was reflected in the low king prawn landings of 2 t. While no stock assessment was completed in 2013, the average king prawn catch rate of 14.7 kg/hr is at the lower end of the acceptable catch range for viable commercial fishing and reflect the very low catch and effort levels under the current economic conditions. Because of the low effort only part of the fishery was exploited to its potential total catch.

KPMF: The total landings of banana prawns were below the target catch range, 200 to 450 t and the projected range (230 – 350 t). Both tiger and endeavour prawn landings were very low and below their target range, which is likely to be effort related.

Throughout the history of the fishery, the stock of banana prawns in the Kimberley has been assessed using the annual catch (tonnes) and effort (boat fishing days). This is consistent with a DoF Level 1 assessment. The catch is compared against specified reference levels for catch, i.e. a target catch range (200 – 450 t) and we now also propose a catch limit reference point of 100 tonnes, provided the effort also remains within the historical range. The target historical catch range spans the observed catches in most years, apart from four years where the catch was below the target range. The 2013 landings are the lowest recorded since 1980. Effort is also low but not as low as recorded in 2011 when 145 t of banana prawns were caught.

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 (which was 597 mm in 2014). The predicted catch of banana prawns in 2014 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 2013 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 extremely low fishing effort was applied resulting in very low total prawn landings in this fishery.

The breeding stock indicator for banana prawns in the NBPMF was met because the landings were within the target catch 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 not met as the landings were below the target range and the projected range. Tiger and endeavour prawns were below the target range. This likely to be due to low levels of effort expended on these species as their behaviour is quite different to that of the aggregating behaviour of the banana prawns and generally are taken in the latter part of the season thus more effort could result in fishing for a longer time at low catch rates.

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 of schools of banana prawns results in relatively low effort and minimal bycatch compared with other trawl fisheries. The impact on bycatch in the OPMF and the BPMF was negligible due to very low effort. All trawl nets have grids to exclude large fish and listed species.

Listed species interaction:

OPMF, BPMF: Nil

NBPMF, 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.

NBMF: In 2013 no turtles were recorded as captured. Two sea snakes were reported as caught and released alive, one seahorse/pipefish, 10 sawfish (status unknown) were reported as landed.

KPMF: 124 sea snakes were reported as captured and all but two were returned to the sea alive. Two sawfish were reported as captured, and returned to the sea alive.

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 2013 the area fished in the three northern fisheries where fishing took place ranged from 1.4% in the Kimberley fishery to <1% in the Nickol Bay, Broome and Onslow fisheries, within the overall area of these fisheries (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 limited fishing activity in the OPMF the habitat effects was changed from low to negligible.

Social Effects

Estimated employment in these fisheries for 2013 was 40 to 60 including skippers and other crew with additional people involved in local processing.

Economic Effects

Estimated annual value (to fishers) for 2013:

OPMF/NBPF/BPMF/KPMF:

Level 2 - $1 - 5 million ($2.5 million)

Fishery Governance

OPMF Target catch range: 60 – 180 tonnes

Current fishing level: Negligible

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 (2014): None

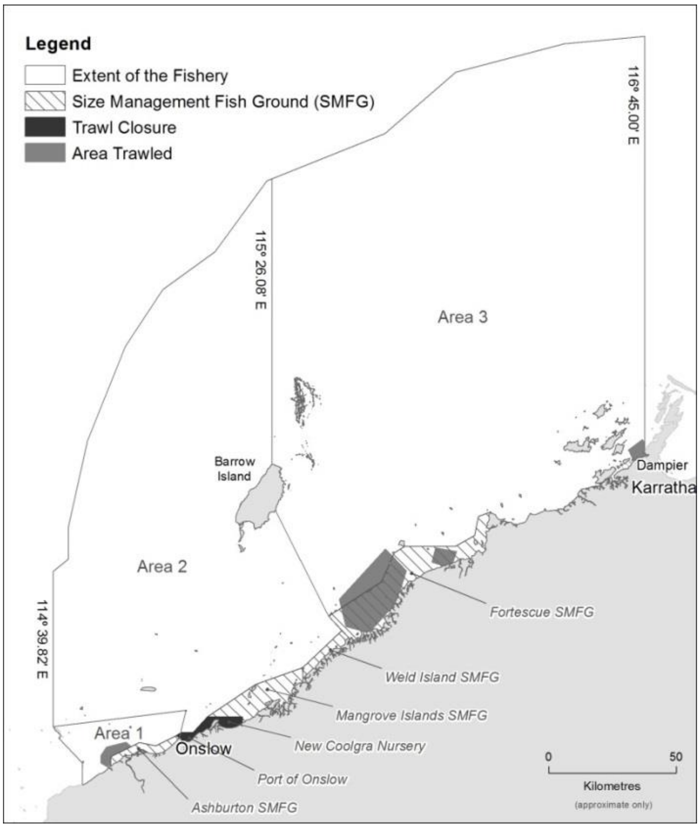
External Factors

The resource industry developments in the OPMF during 2013 have created uncertainty about the access to prawn abundance in traditionally high catching fish grounds and overall viability of operations.

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.

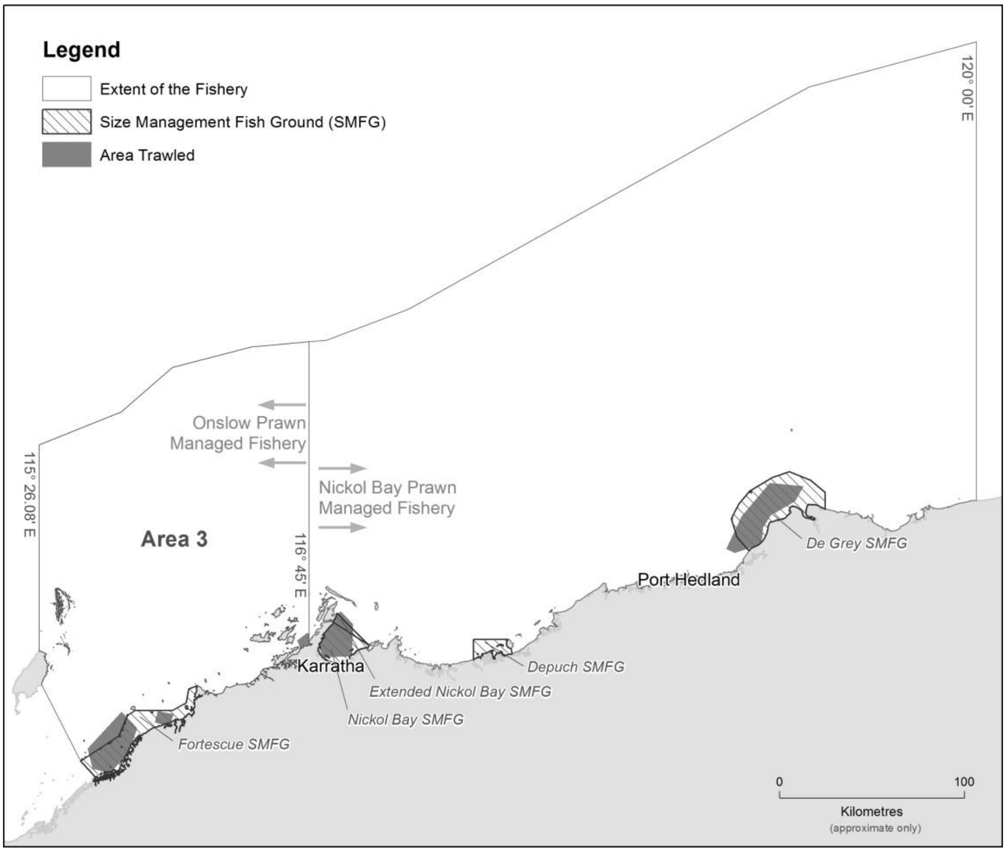
In the BPMF one factor influencing catches is the timing of the season which is set by the mid-season closure for the Northern Prawn Fishery, and, since the permitted fishing area is small, in some years the timing of prawn recruitment and the prawn migration patterns may not result in significant abundances 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.

The marine heatwave event in 2010/11 and continued higher than average water temperatures in northern WA waters may be having a negative effect of abundance of king prawns which could also be contributing to the very low landings of this species in all of these northern fisheries.



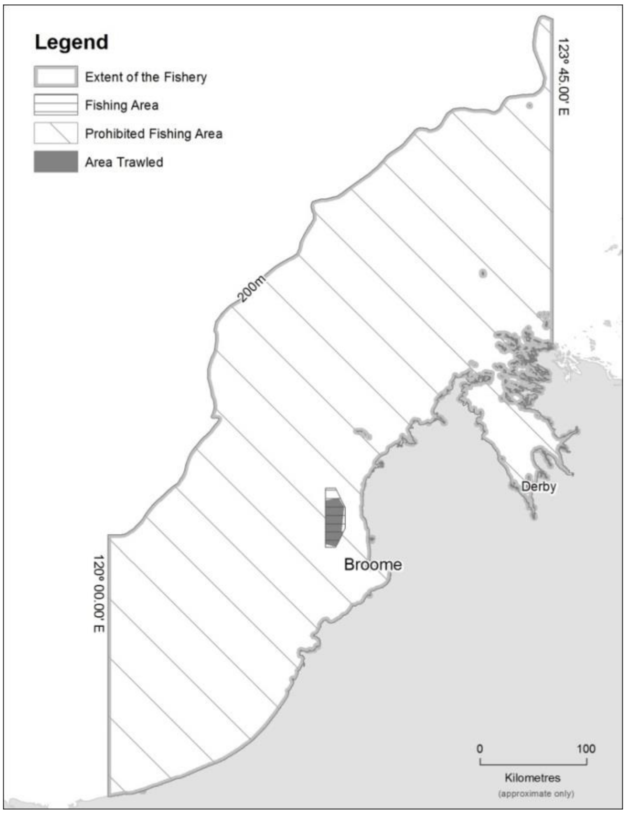
NORTHERN PRAWN FIGURE 1

Boundaries of the Onslow Prawn Managed Fishery indicating trawl closures and size management fish grounds area trawled in 2013.



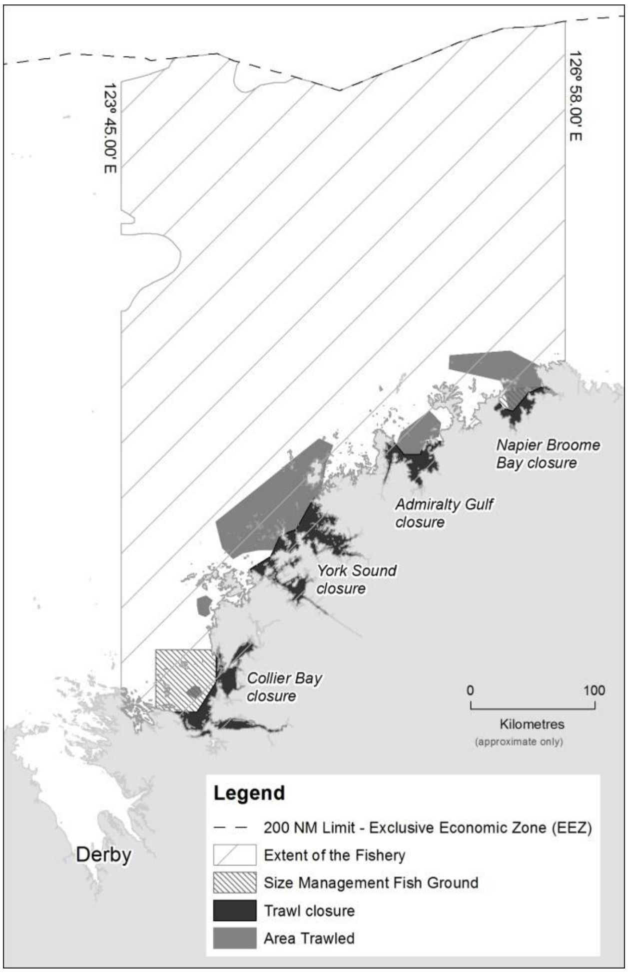
NORTHERN PRAWN FIGURE 2

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2013.



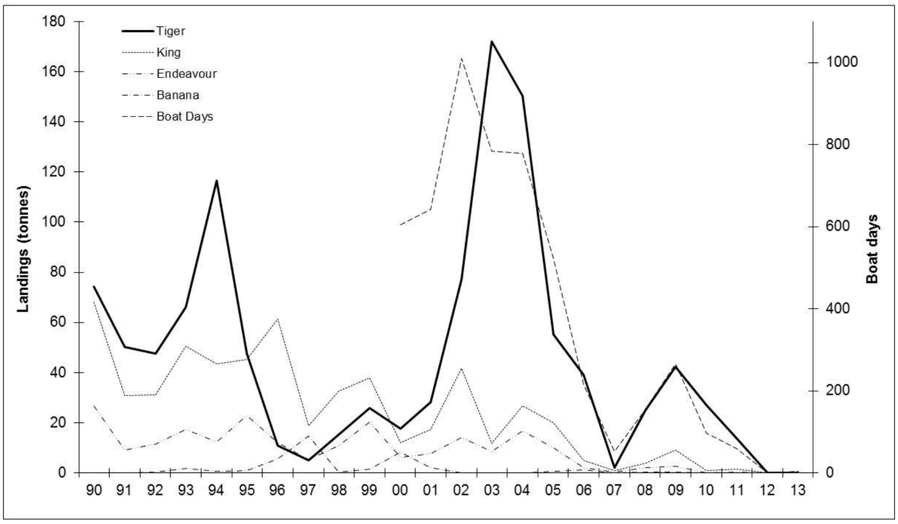
NORTHERN PRAWN FIGURE 3

Boundaries of the Broome Prawn Managed Fishery indicating area trawled in 2013.



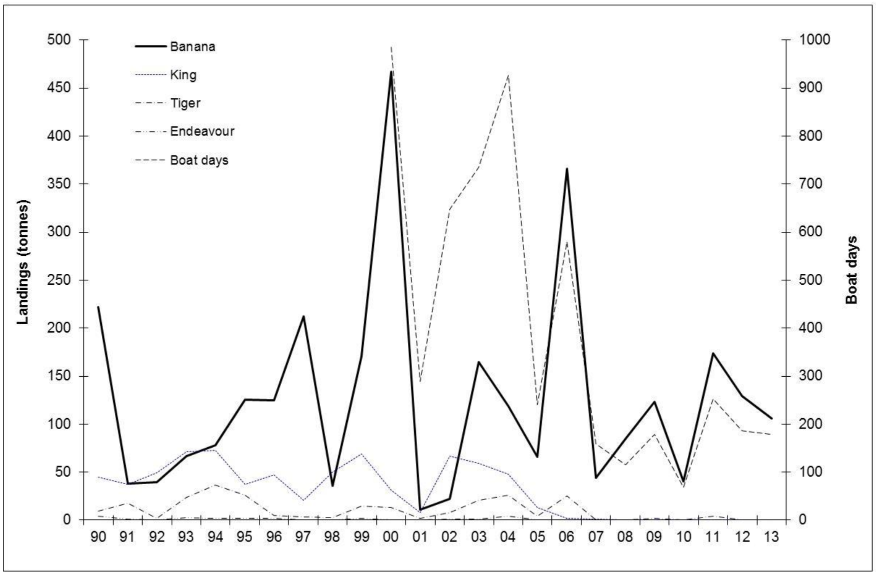
NORTHERN PRAWN FIGURE 4

Areas fished in the Kimberley Prawn Managed Fishery in 2013, Size Management Fish Grounds and the inshore trawl closures.



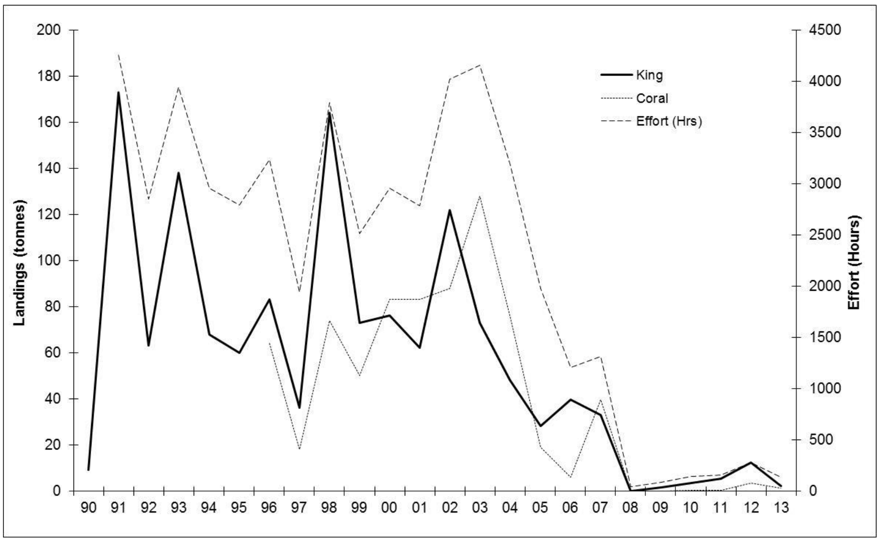
NORTHERN PRAWN FIGURE 5

Annual landings and number of boat days (from 2000) for the Onslow Prawn Managed Fishery, 1990 – 2013.



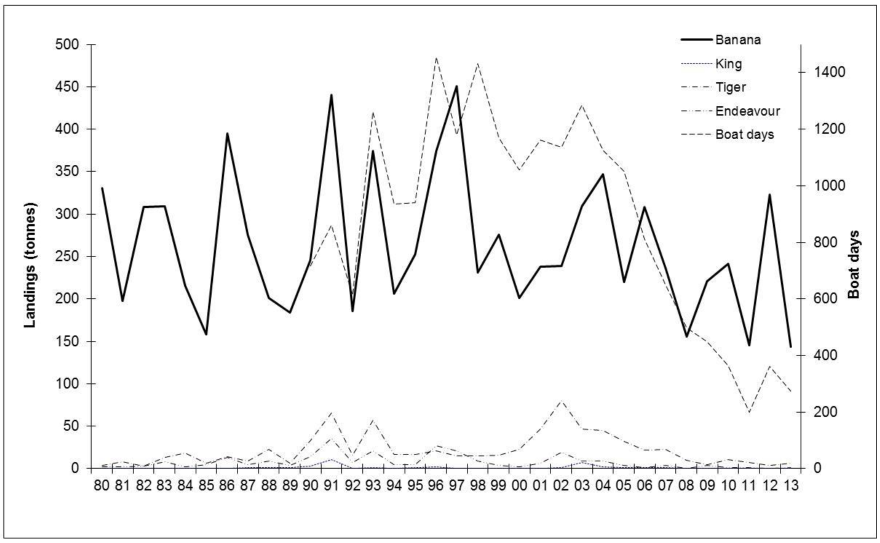
NORTHERN PRAWN FIGURE 6

Annual landings and boat days (from 2000) for the Nickol Bay Prawn Managed Fishery, 1978 – 2013.



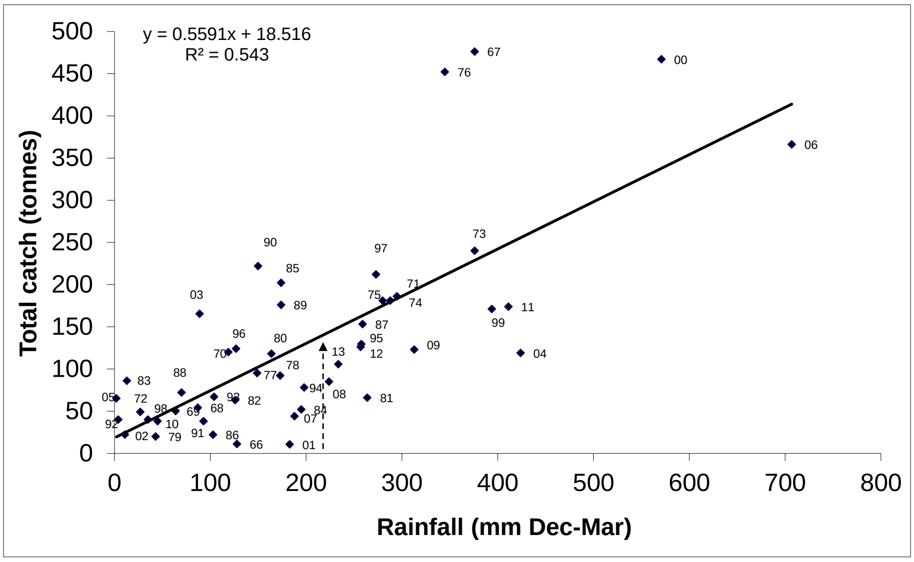
NORTHERN PRAWN FIGURE 7

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1991 – 2013.



NORTHERN PRAWN FIGURE 8

Annual landings and number of boat days (from 1990) for the Kimberley Prawn Managed Fishery, 1980 – 2013.



NORTHERN PRAWN FIGURE 9

Relationship between banana prawn landings in Nickol Bay and rainfall between December and March for 1966 – 2013 with rainfall level for 2014 indicated by the arrow.

North Coast Nearshore and Estuarine Fishery Status Report

S.J. Newman, G. Mitsopoulos, C. Skepper, A. Thomson, R. Marriott and D. Wallis

Main Features

Status		Current Landings	
Stock levels	Acceptable	Total	124.6 t
Fishing Levels	Acceptable	Barramundi	52.1 t
		Threadfin	57.3t
		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 (129ºE) to the top end of Eighty Mile Beach, south of Broome (19ºS). It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi *(Lates calcarifer)* by any means.

The other species taken by the fishery are predominantly king threadfin *(Polydactylus macrochir)* and blue threadfin *(Eleutheronema tetradactylum)*. The main areas of operation for the fishery are the river systems and tidal creek systems of the Cambridge Gulf, the Ria coast of the northern Kimberley, King Sound, Roebuck Bay and the northern end of Eighty Mile Beach to 19ºS (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 21º46’S latitude and east of 114º50’E longitude).

Management arrangements

Commercial

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures and gear restrictions. Access to the KGBF is limited to five licences, following the buyout of the two licences from the Broome coast (Roebuck Bay) in 2013.

There is a closed season in which fishing is prohibited in the KGBF. In the southern KGBF (west of Cunningham Point, 123º08.23´ E longitude) the closure extends from 1 December to 31 January the following year, while in the northern section of the KGBF (east of Cunningham Point) the closure extends from 1 November to 31 January the following year (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 now only three principal fishing areas within the KGBF: Cambridge Gulf (including Ord River), Kimberley coast (six small river systems) and King Sound. Following the buyout of the two licences from the Broome coast (Roebuck Bay), this area is now closed to commercial fishing.

There are commercial fishing area closures around major town sites and recreationally important fishing locations, namely Broome Jetty to Crab Creek, Roebuck Bay, 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 17º27′ 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 ecological suite and risk to sustainability. The bag and size limits are species-specific (e.g. Barramundi) or species group specific (e.g. mullet) to ensure that stock levels are maintained. These bag and size limits have been revised and new simpler rules that apply across most Bioregions were introduced 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 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 stock structure of both threadfin species was defined by Welch *et al*. (2010)[2] and will be considered in future monitoring and assessment programs. The bycatch of elasmobranchs in the KGBF and the previous Pilbara Coast fishing area was examined during 2002 and 2003 (McAuley *et al*. 2005)[3]. 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 2013):

All species	**124.6 tonnes**
Barramundi	**52.1 tonnes**
Threadfin	**57.3 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 2013 was 124.6 t (Kimberley Gillnet Figure 2). The total landings of barramundi from the KGBF were 52.1 t for 2013 (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 3), an increase on the reported catch of 39.7 t in 2012. The 2013 landings of threadfin from the KGBF were 57.3 t (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 4), higher than that reported in 2012 (46.2 t). The composition of the KGBF catch in 2013 is summarised in Kimberley Gillnet Table 2.

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. This estimate 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 2013 were estimated to be approximately 4.1 t of barramundi and approximately 2.2 t of threadfin.

As such, there is an estimated annual harvest of 12.5 t of barramundi (recreational + charter) reported in the North Coast Bioregion. In addition, there is an estimated annual harvest of 9.2 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) is 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. 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 block days. 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 their nets for a few hours while others leave their 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 2013, the total effort across the fishery was 630 block days, an increase on the 2012 effort figure of 511 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.

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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 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.

3 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.

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

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 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 2013 due to an increase in effort levels along the Kimberley Coast and Broome Coast areas. The level of catch of threadfin was higher than that reported in 2012, with the catch increasing in the Kimberley coast area in 2013.

The commercial catch rates for barramundi in the KGBF increased in 2013 (82.7 kg/block day) to the highest level reported since 1990 (Kimberley Gillnet Figure 3). The catch rate for threadfin in 2013 (90.88 kg/block day) across the fishery was much lower than that reported in 2012 (178.1 kg/block day; Kimberley Gillnet Figure 4) and 2011 (184.7 kg/block day).

There is a need to update the stock assessment for barramundi 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.

Listed 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, listed 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 2013, 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 2013:

Level 2 - $1-5 Million

The value of the North Coast Nearshore and Estuarine Fishery was reported using the 6 categories defined in Fletcher *et al*. (2010[1]) 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 2012-2013 financial year.

The KGBF historically principally targeted the high-value species, barramundi and threadfin. With the closure of Roebuck Bay, the future catches from the KGBF will primarily consist of barramundi as the majority of the threadfin catches were derived from Roebuck Bay. The fishery's score value in 2013 was estimated to be 2 (i.e. Risk level – Low; Economic value – $1-5 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 **33-44 tonnes**

Current Fishing (or Effort) Level: **Acceptable**

The target commercial catch range is calculated based on catch information from 1989 – 1999, a period during which the fishery was stable and levels of exploitation were considered to have been sustainable. Note that the target catch range for barramundi has recently been revised to be consistent with the reference points and control rules adopted for other fisheries. The current approach specifies this range as the values within the minimum and maximum catches observed during the reference period. The revised target commercial catch range (33 – 44 t) is similar to that previously used (32 – 45 t). As such, the threshold values for the target commercial catch range have been calculated as being within the range of 33 – 44 t, with a limit reference range of 23-54 t.

For most years, the level of barramundi catch was within the target catch range. The barramundi catch in 2001, 2003 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 barramundi catch in 2013 was 52.1 t, above the target catch range but below the limit range. The increase in catch was due to a marked decrease in fishing effort in the Kimberley Coast and Broome sectors of the fishery. This increased catch was obtained with high catch rates and may suggest increasing stock biomass for barramundi. Furthermore, in 2013, 2 licenses were removed from the Broome sector of the fishery (Roebuck Bay closure). This sector of the fishery is now recreational and indigenous only fishing. This effort removal is likely to produce reduced levels of catch in future years. The current fishing level is therefore considered to be acceptable.

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 and the target catch range for barramundi.

New management initiatives (2014/15)

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 monitored.

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 by regional population growth resulting from gas and mining developments), and specific management arrangements may be needed in the future.

In addition, the introduction of new marine parks (State and Federal) 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 underwent MSC pre-assessment in late 2013. Outcomes are expected in late 2014.

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

KIMBERLEY GILLNET TABLE 1

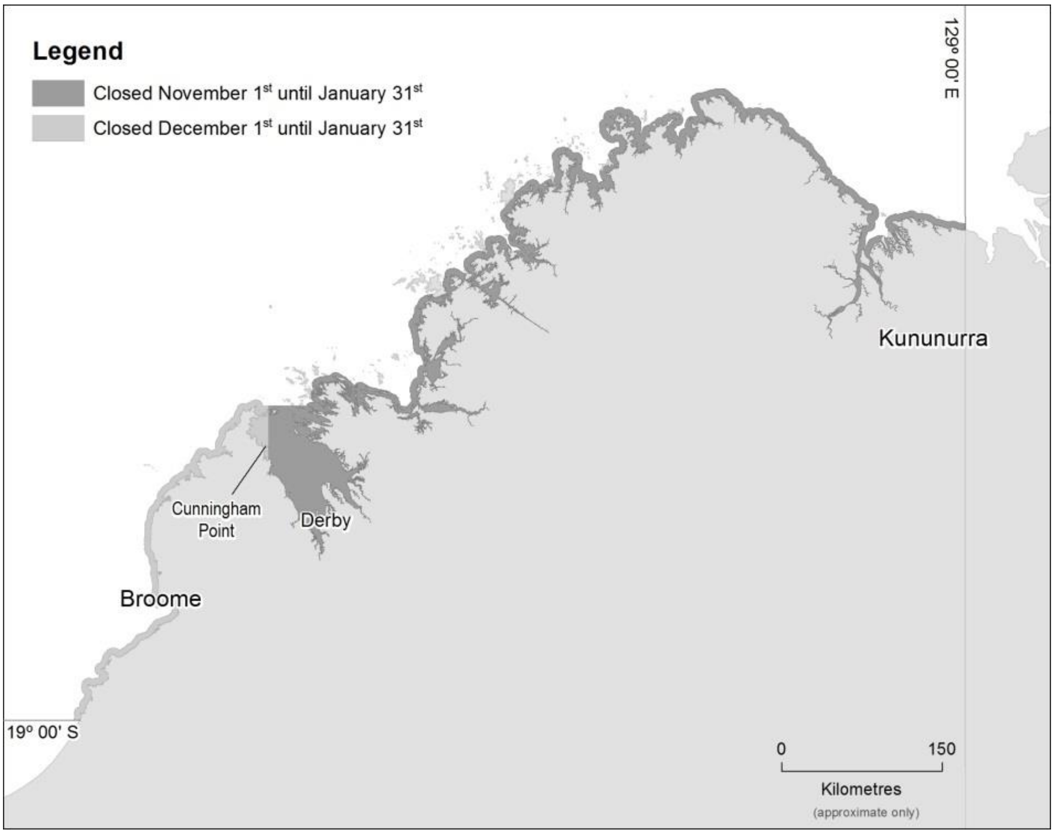
Annual catches of the major target species by the KGBF from 2003-2013.

Species	Kimberley Gillnet Annual Catch (tonnes)										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Barramundi	45.0	53.5	35.6	36.3	27.2	54.8	59.6	57.1	28.5	39.7	52.1
Threadfin	94.1	75.8	70.6	67.7	78.5	101.2	89.9	83.3	74.2	46.2	57.3
Total	148.0	136.1	117.8	109.9	111.4	165.6	167.3	150.9	110.5	91.0	124.6

KIMBERLEY GILLNET TABLE 2

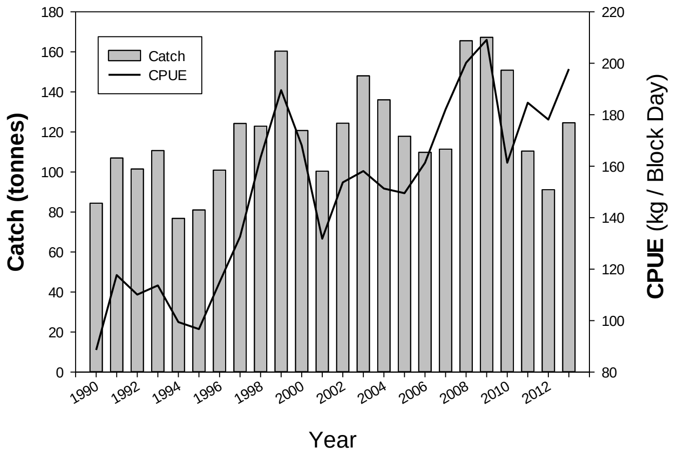
Summary of the reported catch (t) in the KGBF in 2013 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin	57.2	46.0
Barramundi	52.1	41.8
Tripletail	0.8	0.6
Black jewfish	2.1	1.7
Sharks	10.6	8.5
Other fish	1.8	1.4
Total	124.6	100



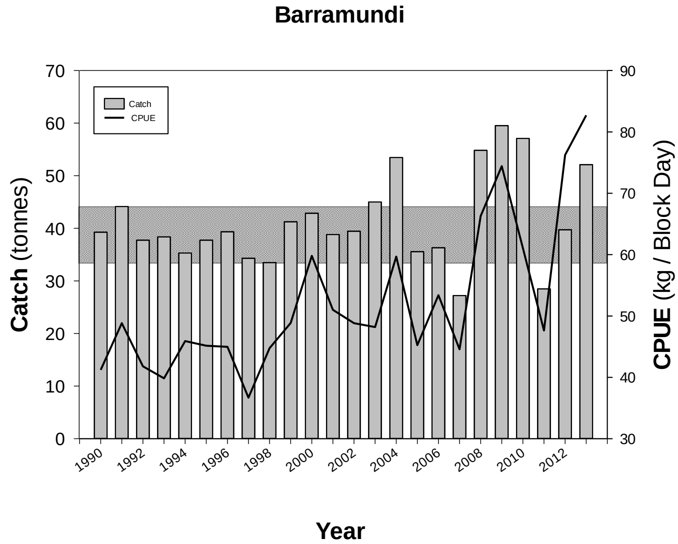
KIMBERLEY GILLNET FIGURE 1

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



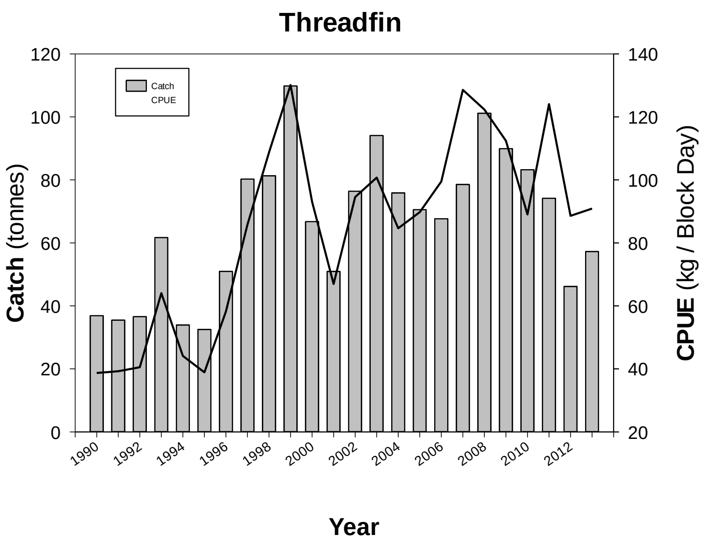
KIMBERLEY GILLNET FIGURE 2

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 2013.



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 2013. The upper and lower bounds of the target commercial catch range for barramundi are shown by the shaded catch area between 33 and 44 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 2013.

North Coast Demersal Fisheries Status Report

S.J. Newman, C. Wakefield, C. Skepper, D. Boddington, N. Blay, R. Jones and D. Wallis

Main Features

Status		Current Landings	
Pilbara:		Total North Coast Demersal landings	2,727 t
Stock level	Adequate	Recreational (top 10 demersal)	77 t (~3% of total)
Fishing Level		Pilbara:	
Trawl Fishery	Acceptable	Total	1,499 t
Trap Fishery	Acceptable	Red emperor	104 t
Line Fishery	Acceptable	Rankin cod	56 t
Kimberley:		Bluespotted emperor	139 t
Stock level	Adequate	Pilbara Fish Trawl Fishery	1,074 t
Fishing Level	Acceptable	Pilbara Fish Trap	339 t
		Pilbara Line	85 t
		Charter	~26.7 t (1.8.% of total)
		Kimberley (NDSF):	
		Total	1,228 t
		Red emperor	131 t
		Goldband snapper	493 t
		Charter	~11.2 t (0.9% 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*), crimson snapper (*Lutjanus erythropterus*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and moses snapper (*Lutjanus russelli*). 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 primary 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

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). The *Northern Demersal Scalefish Managed Fishery Management Plan 2000* was amended in 2013 to formalise the previous voluntary industry agreement which further divides the offshore sector (Area 2) 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 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 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. Currently, the Interim Management Plan has a cessation date of 30 June 2016.

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 Management

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 round, with separate effort allocations (in hours) in each of the Areas, as outlined in the Interim Management Plan. The open areas of the Trawl Fishery are trawled with varying intensity due to differing effort allocation, substrate composition and economic considerations (e.g. distance from 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. There has also been a closure to line fishing for demersal scalefish in Area 3 since 1998.

Comprehensive Ecological Sustainable Development (ESD) assessments were submitted to the Commonwealth Government's Department of the Environment (DotE), 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, listed 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 has been recently re-accredited as an approved Wildlife Trade Operation until May 2017.

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 Zones A, B and C in Area 2 of the Fishery. In 2014, the annual effort capacity was 616 fishing days for Zone A, 985.6 fishing days in Zone B and 1,100 fishing days for Zone C.

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.

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.

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 2013, 8 vessels (trap fishing in zones A and B and one line trip in Zone C) 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 m^3. 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. The number of allowable fishing days declines, if the number of traps (or lines) being fished increases beyond this level. 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).

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 provides a statewide 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 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 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 DotE within the current WTO for the Fishery. The outcomes of the observer program are reported in Fisheries Research Report 244.

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 (scheduled for 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 2013):

Pilbara Fish Trawl	**1,074 tonnes**
Pilbara Fish Trap	**339 tonnes**
Pilbara Line	**85 tonnes**
Kimberley (NDSF)	**1,228 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 2013 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 1,166 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 seven consecutive years, with 1,074 t landed in 2013 (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 lower or similar in 2013 than the previous year due to less effort, i.e. crimson snapper 132 t (182 t in 2012), bluespotted emperor 98 t (151 t in 2012), rosy threadfin bream 76 t (102 t in 2012), brownstripe snapper 66 t (90 t in 2012), goldband snapper 80 t (75 t in 2012), red emperor 54 t (62 t in 2012), saddletail snapper 53 t (52 t in 2012), spangled emperor 11 t (15 t in 2012) and Rankin cod 11 t (16 t in 2012). The total retained byproduct was 9 t (17 t in 2012) 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 438 t per year (North Coast Tables 1 and 2). In 2013, the total catch of 339 t was below the target catch range of 400-500 t, but was associated with reduced effort in the fishery (North Coast Table 2 and 3). The major species taken by the trap fishery in 2013 were goldband snapper 61 t (56 t in 2012), red emperor 49 t (60 t in 2012), Rankin cod 43 t (64 t in 2012), bluespotted emperor 41 t (59 t in 2012), and crimson snapper 32 t (39 t in 2012).

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 2013, the total annual catch for the line fishery was 85 t, which was slightly lower (~5 t) than that taken in 2012 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 2013, the ruby snapper catch was 12 t (26 t in 2012) and the goldband snapper catch was 31 t (9 t in 2012) (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

The NDSF catches over the past six years have all been in excess of 1,000 t, and represent the highest recorded catches since the inception of the fishery in 1998. The total catch of 1,228 t in 2013 is the highest catch recorded during this period, although the Zone B component (913 t) was slightly lower than the peak catch recorded from this sector of the fishery in 2012. The catch in Zone A of the fishery increased significantly to 291 t in 2013, which exceeded the previous highest recorded catch from this sector of 201 t in 2010 (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 2013 is similar to that reported in 2012, with goldband snapper dominating the landed catch. The landed catch of goldband snapper in 2013 (493 t) was similar to that reported in 2012 (487 t). Catch levels of goldband snapper have remained high since the peak catch of 523 t reported in 2010. The last five 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 2013 was 131 t, which is similar to the red emperor catch levels reported over the past three years (2010-2012). The cods/groupers catch in 2013(195 t) was higher than that reported in 2012 (170 t), and represents the highest level of catch reported for this species complex. It continues a trend of increasing catches for the cods/groupers since 2002. Rankin cod dominates the composition of the cod/grouper catch complex. The catch of Rankin cod increased from 52 t in 2012 to 62 t in 2013 (North Coast Table 7). The catches reported above represent those derived from all zones of the NDSF. It is noteworthy that the increased catches of cods/groupers in Zone A have largely driven the overall higher catches of this complex since 2010. The catches from Zone A also consist of a large number of species which are not well represented in the Zone B catch; these include bluespot emperor (*Lethrinus punctulatus*) and crimson snapper (*Lutjanus erythropterus*). In 2010, this mix of Zone A species ('other fish') constituted 149 t (51%) of the overall catch from Zone A.

The catch rate of red emperor in Zone B in 2013 decreased slightly, remaining at a level consistent with those recorded during the period 2009-12. However, recent catch rates are lower than those reported for this species from 2005-08 (North Coast Figure 4). Total landings were also significantly higher during this period. 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 2013 decreased slightly, noting that catch rates in 2012 were 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 2013 catch of red emperor and goldband snapper were within acceptable levels as defined in the Export exemption for this fishery (see 'Fishery Governance' section), with neither species exceeding the threshold level (20% increase in average catch of the previous 4 years). However, the cod/grouper complex did exceed the threshold, with a 25.7% increase in the average catch over the last four years, derived primarily from Zone A.

Recreational catch estimate (season 2013):

Pilbara	**~3%**
Kimberley	**~3%**

North Coast Bioregion

A statewide integrated survey of boat-based recreational fishing in WA was conducted during 2011/12 (Ryan *et al*. 2013[1]). Estimates from this survey are not directly comparable to the survey conducted in 1999/2000 (Williamson *et al*. 2006[2]).

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 2013. 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 2013.

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 was 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 2013 was estimated to be 26.7 t (red emperor – 3.4 t; Rankin cod – 8.4 t; spangled emperor – 2.7 t; goldband snapper – 2.1 t; ruby snapper – 0.4 t). The Pilbara charter vessel catch is estimated to be ca. 1.8% 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.

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, 61p

The reported charter vessel catch of demersal scalefish in the waters of the Kimberley demersal fishery in 2013 was estimated to be 11.2 t (grass emperor – 2.1 t; golden snapper – 3.7 t; goldspotted/blackspotted rockcod – 0.9 t; saddletail snapper – 1.2 t). The Kimberley charter vessel catch is estimated to be ca. 0.9% 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 2012/13 season. The percentage of allocated hours used by the trawl fleet during the 2012/13 season were 91% in Area 1, 100% in Area 2, 96% in Area 4 and 93% in Area 5. Trawling has not been permitted in either Area 3 or Area 6 since 1998 and both trap and line fishing has not been permitted in Area 3 since 1998 (North Coast Figure 1).

In 2013, 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 81% of the units used as calculated from the VMS.

In 2013, line fishers reported operating for 357 days, compared with 395 days in 2012.

Kimberley

The eight fish trap vessels that fished in the NDSF in 2013 reported using between 20 and 36 fish traps per day. A small amount of line fishing was reported in the deeper water area of Zone C. Effort across all zones of the fishery in 2013 was 1,199 days (North Coast Table 8).

The total effort allocated in Zone B in 2013 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 930 SFD's (94%). That is, 6% of effort allocated to Zone B in 2013 was not used. A total of 616 standard fishing days was allocated to Zone A. The number of SFDs recorded using VMS data was 233 (162 SFDs in 2012), indicating that ~62% remained unutilised in Zone A at the end of the season. The effort expended in Zone C in 2013 was 36 SFD's.

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 - most recent in 2008)

Level 5 - Integrated model (Periodic - most recent in 2007)

Kimberley

Level 2 - Catch and Catch rates (Annual)

Level 5 - Integrated Model (Periodic - most recent in 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 mortality[1] on a periodic basis with the last analysis completed using 2008 data. An age-structured model incorporating catch rates, catch history and age structure data is used to assess spawning biomass levels for red emperor and Rankin cod also on a periodic basis (~5 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 spatial (i.e. management areas) 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

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.

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 to 2013 varied, with similar rates between years in Areas 4 and 5 but decreasing rates in Areas 1 and 2 for both species. 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) in recent years (i.e. since 2011) were inconsistent between species and areas, with increasing or stable catch rate trends in trawl Areas 1 and 4 for Rankin cod and Areas 1, 4 and 5 for red emperor, but decreasing trends for in Areas 2 and 5 for Rankin cod and Area 2 for red emperor (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 references levels for red emperor in Areas 1 and 2 in 2007, voluntary effort reductions were taken 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 five years since these effort reductions were introduced and early signs of stock rebuilding are evident from stabilising 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. Since 2008 and following the implementation of effort reductions, the longer lived indicator species (red emperor and Rankin cod) have generally displayed stable or marginal increases in catch rates in most management areas, with the exception of red emperor in Area 2. If these longer-lived species are also recovering, it is expected that increases in catch rates will become evident from approximately 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 2011 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 scheduled for 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.

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 2013, Zone B catch rates for the indicator species were 120 kg/std day for red emperor, 490 kg/std day for goldband snapper and 178 kg/std day for cods/groupers. Catch rates for red emperor in 2013 are consistent with those reported in 2011 and 2012 (119 and 125 kg/std day, respectively), while the catch rate for cods/groupers decreased from 198 kg/std day in 2012. The catch rate for goldband snapper continued a steady decline from a peak catch rate of 544 kg/std day in 2011. There is some evidence of recent fishing practices having an effect on catch rates which may bias estimates calculated using historical methods.

The 2013 catch of cods/groupers from all zones exceeded the average of the previous four years, and also exceeded the ESD trigger point of a 20% increase in catch above the average of the past four years. The 2013 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 recent study by Marriott *et al.* (in press) examined catch rate data for goldband snapper and red emperor. For goldband snapper, standardised catch rates displayed an increasing trend, although the underlying cause could not be determined. As such, the standardised index for goldband snapper should be used with caution. In contrast, the standardised index generated for red emperor is the best available indication of historical trends in abundance for that stock and therefore should be used for future stock assessments. The results of this work will be incorporated in 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 2013. Therefore, there is currently a very low risk to the sustainability of the fishery resources in this zone.

NDSF: The performance measures for this fishery relate to the maintenance of adequate breeding stocks for the key indicator species as indicated by the catch levels. In 2013, the catch of both goldband snapper and red emperor were similar to that reported in 2012, and both were below the performance indicator of a 20% increase in catch above the average catch of the preceding four years. In contrast, the 2013 level of catch of cods/groupers complex was above that landed in 2012, and exceeded the performance indicator of a 20% increase in catch above the average catch 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). 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, were achieved. 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.

Listed 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 levels of mortalities of these ETP megafauna by the PFTF were considered to pose a negligible risk to their sustainability based on 1) these levels are likely to be less than their natural mortality rates (e.g. at least 371 bottlenose dolphins stranded in Western Australia from 1981-2010, 2) they appear abundant in Western Australian waters despite large scale mortalities from historic foreign fishing (e.g. 13,459 cetacean mortalities from Taiwanese fishing from 1981-86), and 3) they have wide distributions and are highly mobile. The outcomes of this observer program were reported in Fisheries Research Report 244, published in 2014.

The reporting of interactions with listed species has improved for the Kimberley and Pilbara trap fisheries. These fisheries regularly capture sea snakes. In 2013, the Pilbara and Kimberley trap fisheries reported 114 and 187 sea snakes, respectively. Sea snakes are returned to the water alive.

Pilbara: The performance measures for the impact of the trawl fishery on listed 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 244) their capture is very rare (~0.005 trawl^{-1} in 2012, FRR 244).

Based on estimates from independent observers, exclusion devices that were made compulsory in fish trawl nets in March 2006 reduced 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 listed 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 2013 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
Eight vessels fished in the 2013 fishing season, at least 24 people (assuming ~3 crew per vessel) 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 2012-13:

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 2012-2013 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 seven seasons. Considering, 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 2014 and 2015; 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 below the target catch range in 2013 due to less effort. The total catch in the Line Fishery was within the acceptable catch range in 2013.

Kimberley

For the 2013 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 2013 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 2013 catch of the cods/groupers complex was above the average of the previous four years, and also exceeded 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 (2014/15)

Pilbara

In 2014, the Department will work with permit holders in the Pilbara Fish Trawl Interim Managed Fishery to adhere to the conditions of the recently (2014) re-accredited Wildlife Trade Operation approval.

Kimberley

In 2013 the industry agreed zoning and effort allocation arrangements of Area 2 of the NDSF was 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 undertook MSC pre-assessment in late 2013. Outcomes are expected in 2014.

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 2013 (catches rounded to the nearest tonne).

Species		Trawl catch		Trap catch		Line catch		Total catch
		tonnes	%	tonnes	%	tonnes	%	tonnes
Bluespotted emperor	*Lethrinus punctulatus*	98	70%	41	29%	-	-	139
Crimson snapper	*Lutjanus erythropterus*	132	79%	32	19%	4	2%	168
Rosy threadfin bream	*Nemipterus furcosus*	76	99%	< 1	< 1%	-	-	76
Brownstripe emperor	*Lutjanus vitta*	66	81%	15	19%	-	-	81
Goldband snapper	*Pristipomoides multidens*	80	47%	61	35%	31	18%	172
Red emperor	*Lutjanus sebae*	54	52%	49	47%	1	1%	104
Saddletail snapper	*Lutjanus malabaricus*	53	73%	15	21%	5	7%	73
Spangled emperor	*Lethrinus nebulosus*	11	28%	16	40%	13	33%	40
Frypan snapper	*Argyrops spinifer*	32	96%	1	3%	< 1	1%	33
Rankin cod	*Epinephelus multinotatus*	11	20%	43	77%	2	4%	56
Ruby snapper	*Etelis carbunculus*	-	-	-	-	12	100%	12
Other demersal scalefish		461	85%	66	12%	17	3%	544
All demersal scalefish		**1,074**	**72%**	**339**	**23%**	**85**	**6%**	**1,499**

NORTH COAST TABLE 2

Summary of reported commercial catches (catches rounded to the nearest tonne) 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.

	Demersal Scalefish				Byproduct*
Year	Line	Trap	Trawl	Total	Trawl
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	1,097	1,656	18
2012	90	416	1,312	1,806	17
2013	**85**	**339**	**1,074**	**1,499**	**9**

* Byproduct in 2013 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)
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	712	10,605
2010	366	472	658	9,723
2011	376	420	544	7,338
2012	395	441	706	10,269
2013	**357**	**357**	**562**	**8,237**

NORTH COAST TABLE 4

Estimates of fishing mortality (F) relative to Exploitation Reference Points (ERPs) calculated for each of the indicator species collected in different management areas of the commercial trawl and trap fisheries in the Pilbara region from 2006 to 2008. ns = not sampled.

Indicator species	Year	Trawl area (Zone 2)				Trap
		1	2	4	5	
Red emperor	2007	$F > F_{limit}$	$F > F_{limit}$	$F_{threshold} > F > F_{target}$	$F_{threshold} > F > F_{target}$	$F_{limit} > F > F_{threshold}$
Rankin cod	2006	$F = F_{target}$	$F < F_{target}$	$F_{threshold} > F > F_{target}$	$F = F_{threshold}$	$F < F_{target}$
Goldband snapper	2008	$F_{threshold} > F > F_{target}$	$F < F_{target}$	$F < F_{target}$	$F_{threshold} > F > F_{target}$	ns
Bluespotted emperor	2008	$F_{threshold} > F > F_{target}$	ns	ns	ns	ns

NORTH COAST TABLE 5

Reported bycatch of listed species by skippers in the Pilbara trawl fishery in 2013.

	Number released Alive	Number deceased*	Total Reported
Bottlenose dolphins	4	22	26
Pipefish	7	13	20
Green sawfish	10	19	29
Narrow sawfish	15	22	37
Seahorses	1	0	1
Sea-snakes	83	34	117
Turtles	1	0	1

*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	2013
Goldband snapper (*Pristipomoides* spp.)	429	331	405	457	485	524	487	487	493
Red emperor (*Lutjanus sebae*)	192	164	179	173	156	142	128	135	131
Saddletail snapper (*Lutjanus malabaricus*)	92	78	99	104	108	126	87	100	116
Spangled emperor (*Lethrinus nebulosus*)	21	27	15	17	23	30	20	25	21
Cod/grouper (Epinephelidae)	110	127	126	149	142	153	155	170	195
Other species	78	62	107	102	132	144	161	191	273
Total demersal scalefish catch	**922**	**789**	**933**	**1002**	**1046**	**1117**	**1037**	**1109**	**1228**

NORTH COAST TABLE 7

Catches of major target and byproduct species or species groups by zone in the NDSF in 2012 and 2013.

Species	NDSF annual catch (tonnes)			
	2012		2013	
	Zone A & C	Zone B	Zone A & C	Zone B
Goldband snapper (*Pristipomoides* spp.)	17.2	470.2	25.6	467.5
Red emperor (*Lutjanus sebae*)	32.8	102.2	43.5	87.1
Saddletail snapper (*Lutjanus malabaricus*)	11.6	88.8	18.8	97
Spangled emperor (*Lethrinus nebulosus*)	1.3	24.0	2.7	17.9
Rankin cod (*Epinephelus multinotatus*)	18.3	33.9	28.4	33.5
Other Cods/groupers (Epinephelidae)	23.1	94.6	42.8	90.6
Other species	70.3	120.3	154	119.1
Total demersal scalefish catch	**175**	**934**	**316**	**913**

NORTH COAST TABLE 8

Total catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF since 2001.

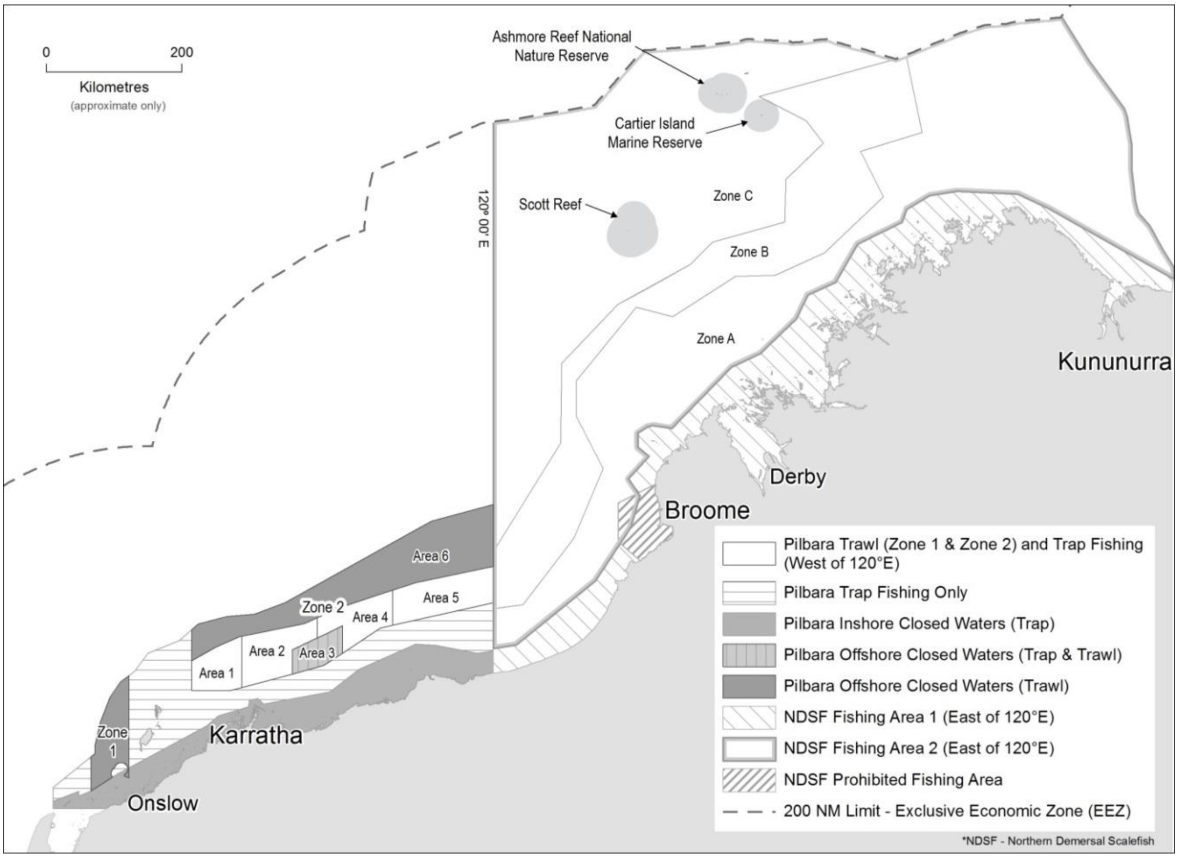
Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	0	0	690	1,300	690
2005	1,760	0	0	922	1,318	922
2006	1,144	0	0	801	1,193	801
2007	1,144*	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	1,109	1,059#	1,109
2013	986*	**<1**	**4**	**1,228**	**1,195#**	**1,228**

(* = TAE is for B Zone only; # = total effort is from all zones; 2013 Estimated Catch: Zone A = 291 t, Zone B = 913 t; 2013 Estimated Effort: Zone A = 233 SFDs, Zone B = 930 SFDs)

NORTH COAST TABLE 9

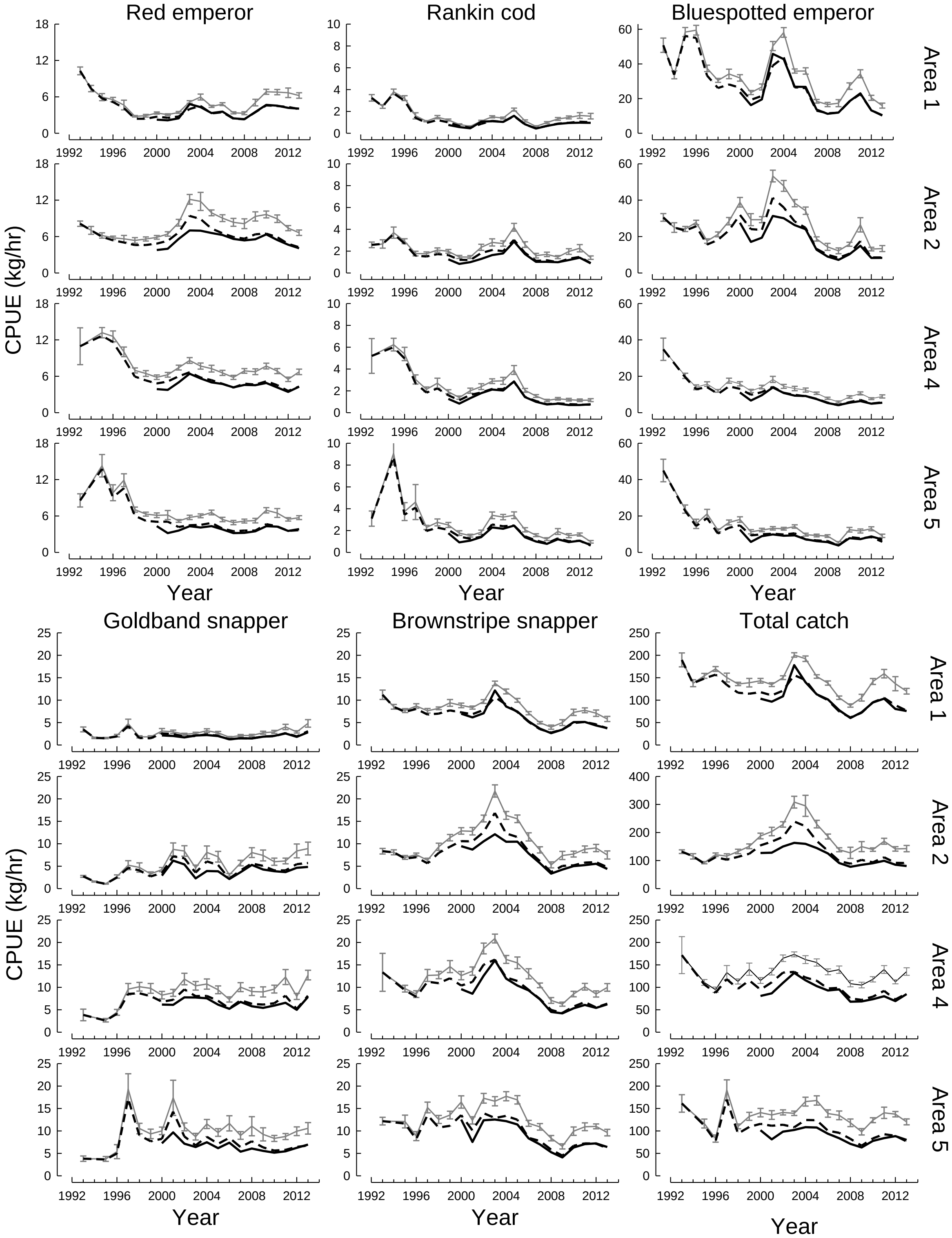
Summary of the commercial catches and the relative contribution (% composition) of each of the major or iconic species taken within the Pilbara and Kimberley sectors of the North Coast Bioregion in 2013.

Species	Pilbara catch		Kimberley (NDSF) catch		Total catch
	tonnes	% total	tonnes	% total	tonnes
Red emperor	104	44	130.7	56	234.7
Saddletail snapper	73	39	115.8	61	188.8
Crimson snapper	168	65	89.0	36	257
Brownstripe snapper	81	91	7.8	9	88.8
Goldband snapper	172	26	493.1	75	665.1
Spangled emperor	40	66	20.6	34	60.6
Bluespotted emperor	139	70	59.1	30	198.1
Rankin cod	56	48	61.8	52	117.8
Frypan snapper	33	> 99	< 0.1	< 1	33
Rosy threadfin bream	76	> 99	< 0.1	< 1	76
Moses snapper	28	69	12.4	31	40.4
Longnose emperor	10	45	12.2	55	22.2
Mozambique bream	-	-	7.9	100	7.9
Grass emperor	0.3	6	5.0	94	5.3
Barcheek coral trout	8	52	7.3	48	15.3
Other demersal scalefish	510.7	71	208.4	29	719.1
Total all demersal scalefish	**1499**	**55**	**1228**	**45**	**2727**



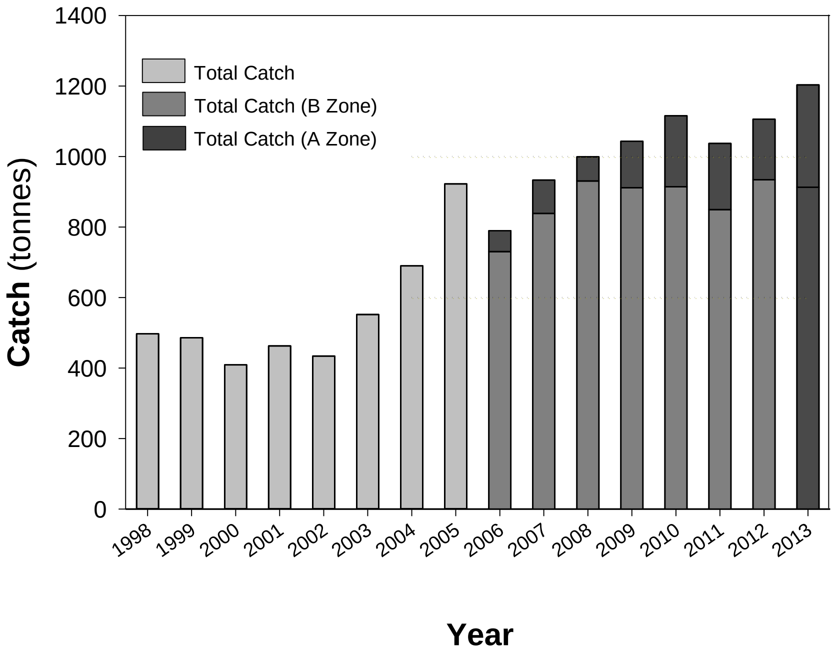
NORTH COAST FIGURE 1

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.



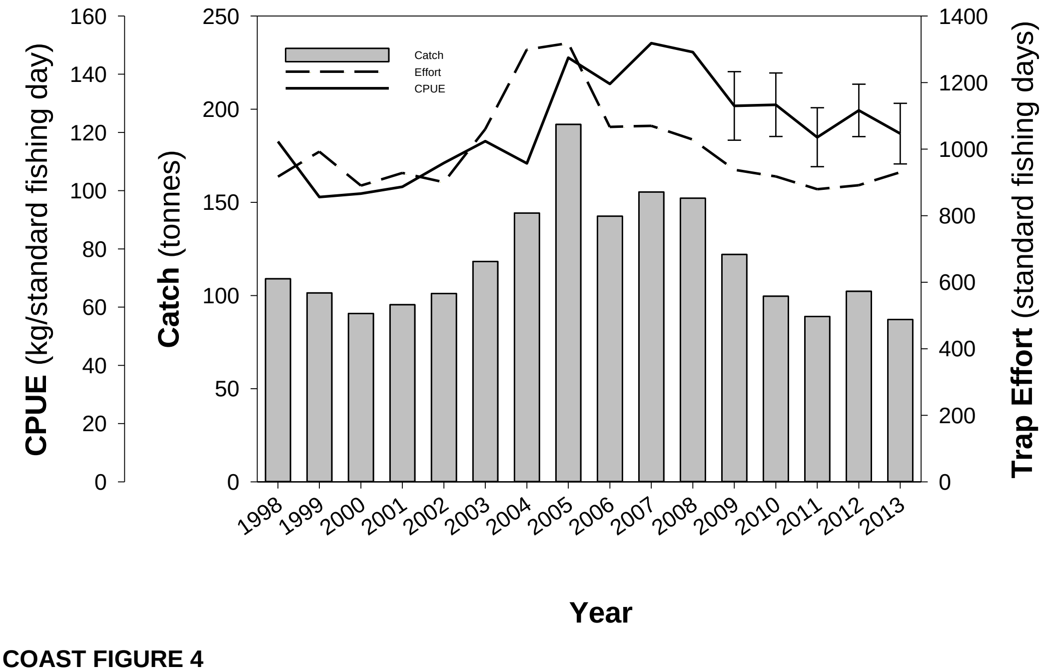
NORTH COAST FIGURE 2

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 1993–2013. The solid grey line is nominal annual catch rate (±1 se) with trawl time as the effort measure, the dashed black line is that catch rate incorporating efficiency increase (trawl time as the effort measure) and the solid black line is annual catch rate using the time spent in each area as the effort measure (derived from VMS, data available since 2000).



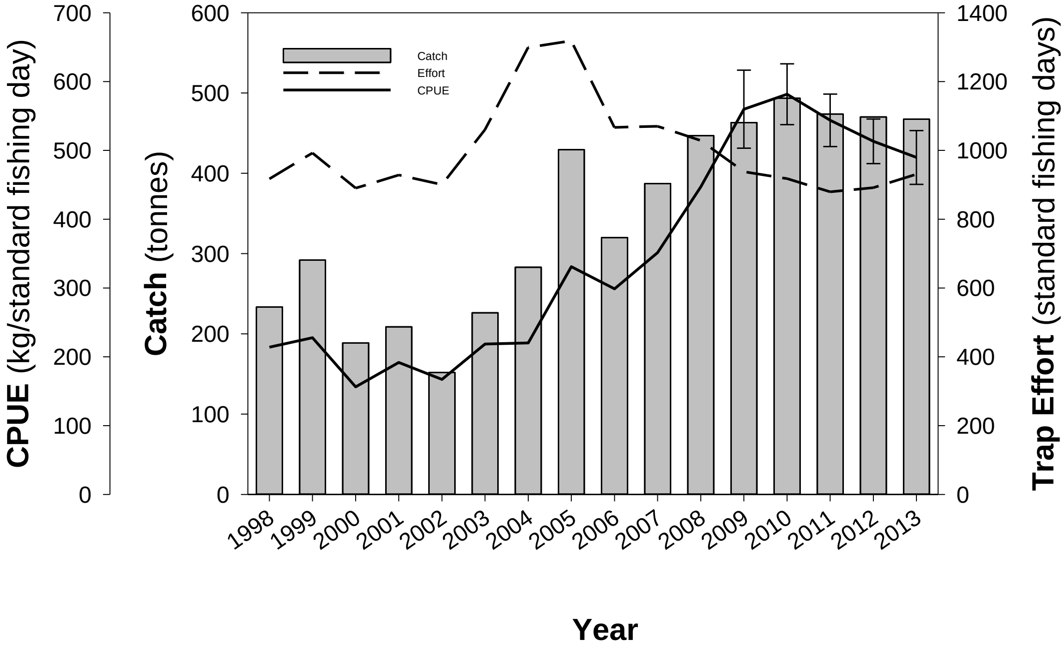
NORTH COAST FIGURE 3

Catch levels of demersal finfish in the NDSF by line and trap from 1998–2013. 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.



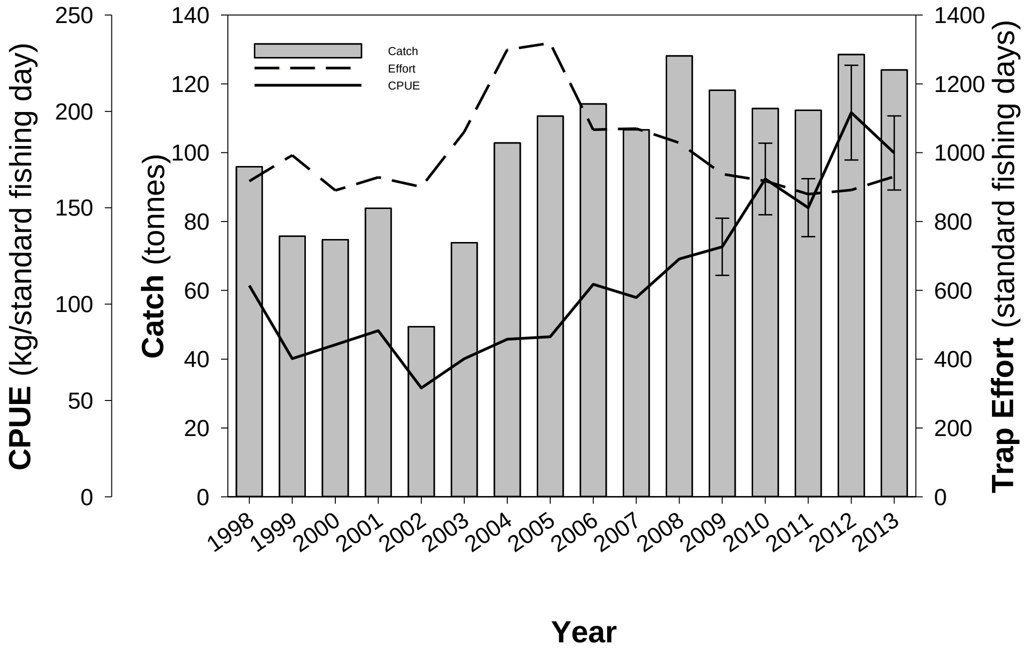
NORTH COAST FIGURE 4

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2013 (2006-2013 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 logbooks (2010-13).



NORTH COAST FIGURE 5

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998–2013 (2006-2013 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 logbooks (2010-13)



NORTH COAST FIGURE 6

Catch, effort and catch per unit of effort of the cod/grouper complex in the NDSF by trap, 1998–2013 (2006-2013 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 logbooks (2010-13).

Mackerel Managed Fishery Report: Statistics Only

B. Molony, S. Newman, E. Lai and N. Blay

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 (121º E to WA/NT border); Area 2 - Pilbara (114º E to 121º E); Area 3 - Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S) (Spanish Mackerel Figure 1).

Recreational

The fishery operates between the West Coast Bioregion and the WA/NT border, with most activity occurring between Perth and Dampier.

Management arrangements

Commercial

The Fishery transitioned from an interim managed fishery to a managed fishery on 1 January 2012. 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 2013 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 50 licences in the Fishery with 15, 15 and 20 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.

A revised statewide combined daily bag limit of three Spanish mackerel and grey mackerel was introduced in 2013 as an outcome of the statewide recreational fishing review. Previously a combined daily bag limit of two in the West Coast and South Coast Bioregions and four in the Gascoyne and North Coast Bioregions applied.

Landings and Effort (Season 2012)

Spanish mackerel	**277.2 tonnes**
Grey mackerel	**11.4 tonnes**
Other mackerel	**0.1 tonnes**

Commercial

A total of 13 boats operated in 2013, with three, four and six vessels operating in the Kimberley, Pilbara and Gascoyne/South Management Areas (Spanish Mackerel Figure 2). A total of 684 fishing days of effort were reported in 2013, with most (more than 44%) of days reported from the Kimberley Area.

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 2013 season estimated at 277.2 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 11.5 tonnes of other species of mackerel were landed in the 2013 season, including 11.4 t of grey mackerel. The catch of grey mackerel in 2013 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. A second Statewide integrated survey of boat-based recreational fishing in WA, conducted during 2013/14 is currently being finalised.

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 2013 of 277.2 t was within the acceptable catch range for the Fishery. The reported catch from the Kimberley Area of 144.5 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 2013 catch of 99.0 t (acceptable catch range 80 – 126 t) the highest catch since 2005. Catches from the Gascoyne/West Coast Area in 2013 were 33.8 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 (Spanish Mackerel Figure 2). The high catch rates for the two main (Northern and Pilbara) fishery areas, both near record levels, indicates a relatively high abundance of Spanish mackerel in these management Areas (Spanish Mackerel Figure 3). Catch rates in the Gascoyne/West Coast have remained stable at relatively high levels since 2007.

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. As catch rates are either continuing to increase or are stable at relatively high levels within each management Area, this suggests that the overall spawning stock is increasing. Additionally, the total catches of Spanish mackerel remain within the target range. Spanish mackerel in Western Australia is not considered to be recruitment overfished, and the level of fishing mortality is unlikely to cause the biological stock to become recruitment overfished.

Grey mackerel catch levels in the Mackerel Managed Fishery from 2000 to 2013 have been relatively low and stable, ranging between 10 and 24 t, with catches only reported from a small area of their range. This level of catch is well below the TAC for grey mackerel. Grey mackerel in Western Australia is not considered to be recruitment overfished, and the level of fishing mortality is unlikely to cause the biological stock to become recruitment overfished.

New management initiatives (2014)

The Mackerel Managed Fishery underwent pre-assessment for Marine Stewardship Certification in early 2014. Outcomes will be available late in 2014.

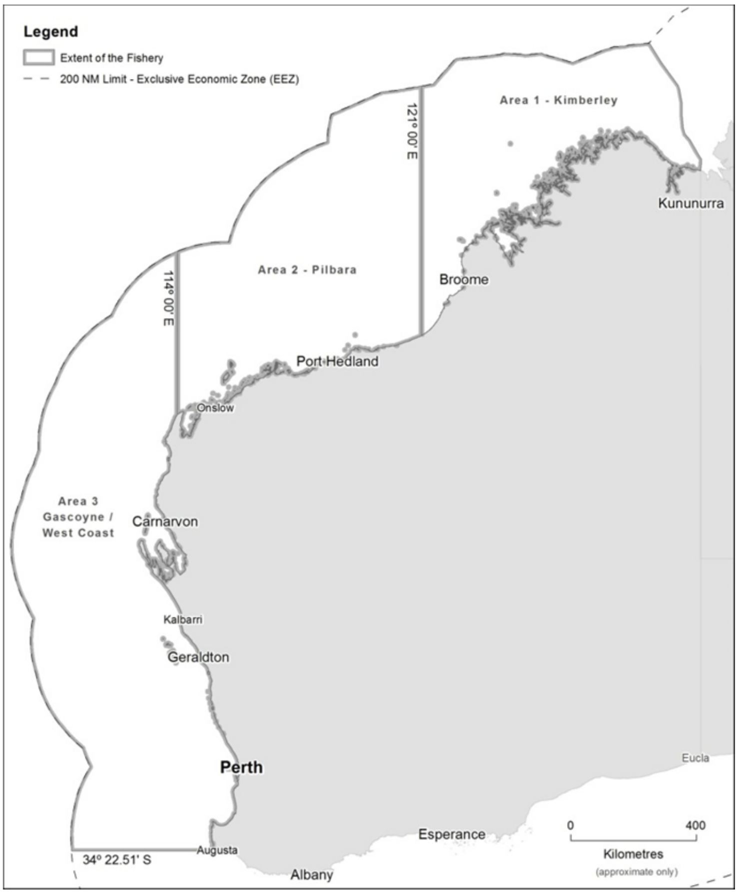
A harvest strategy is currently being developed for the fishery which will assist the monitoring and performance of the fishery.

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

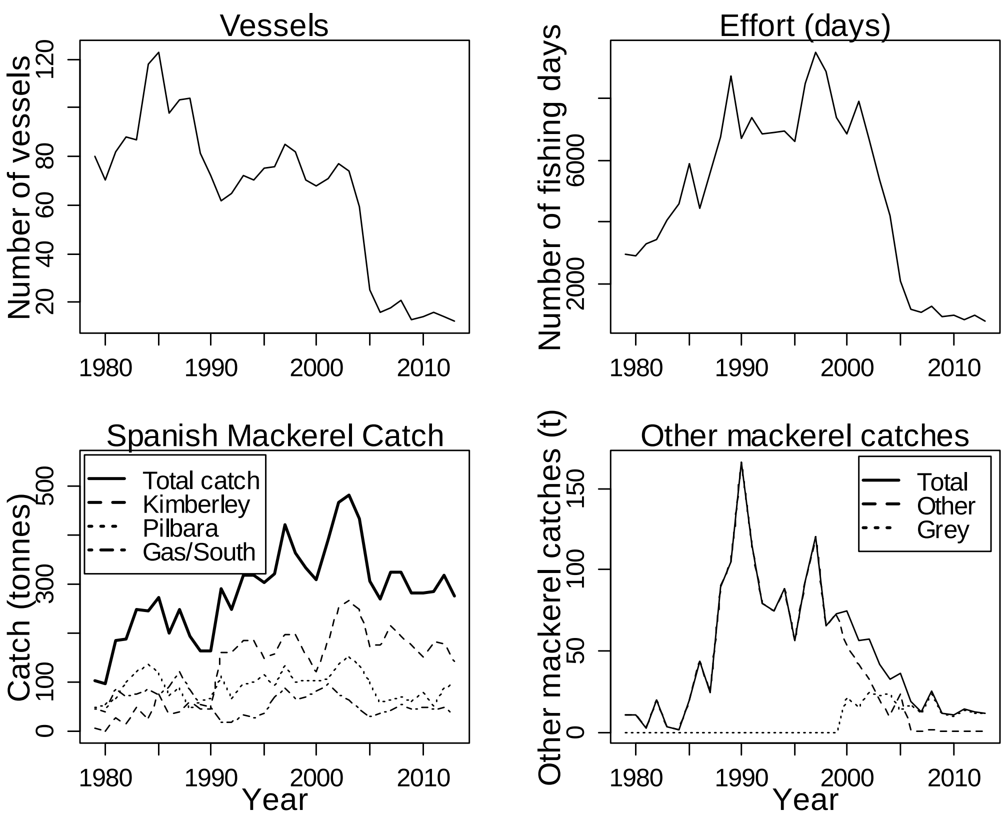
Recreational boat-based catch estimates (in tonnes, t) of Spanish mackerel in Western Australia 2011/12. Estimates are based on an average weight of a Spanish mackerel of 6.9 kg. No Spanish mackerel were reported from the South Coast Bioregion during 2011/12.

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)



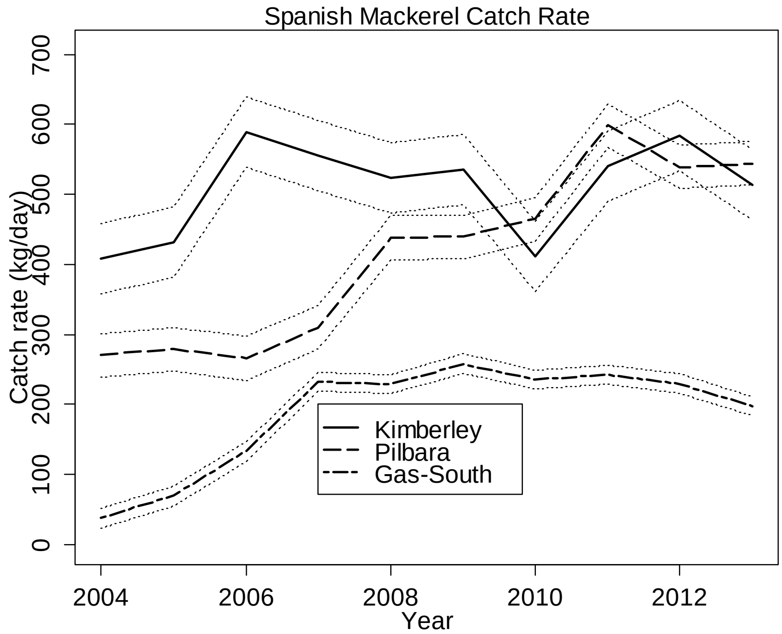
MACKEREL MANAGED FISHERY FIGURE 1

Map of the extent of the Mackerel Managed Fishery.



SPANISH MACKEREL FIGURE 2

Annual number of vessels, effort (days) and catches of Spanish mackerel (by management Area) and other mackerel in Western Australian Mackerel managed Fishery, 1979–2013. Note: quota management was introduced in 2006 and the fishery became fully managed in 2013.



SPANISH MACKEREL FIGURE 3

Nominal annual catch rates of Spanish mackerel (by management Area) in the Western Australian Mackerel managed Fishery, 1979–2013 derived from daily logbooks, 2004–2013. Dotted lines around each line represent +/- 1 standard error of the mean of each series.

Pearl Oyster Managed Fishery Status Report

A. Hart and D. Murphy and R. Jones

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial Pearl Oyster Catch	
Fishing level	Acceptable	Shell numbers (All Zones)	517,653 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 the Pearl Producer's Association (PPA) and licensees on operational issues. Formal license 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 Thouin (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 the seeding of pearls followed by grow-out in pearl oysters 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 & 3 – 457). 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 'culture-sized' (or 100 – 174 mm) wild stock quota unit for Zone 2/3 for the 2013 season was 1,200 shell for oysters, as a result of stock levels returning from record high levels (Pearl Figure 2). In addition, a quota for 'MOP' only (oysters ≥ 175 mm) of 163 shells per unit (TAC = 74,791 MOP oysters) was also granted, resulting in a total TAC of 1,363 shells per unit. The Zone 1 wild stock quota unit remained at 478 shell per unit.

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 - 2014. 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 175 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.

The Pearl Oyster Fishery was re-assessed in 2013 under the *Environment Protection and Biodiversity Conservation Act 1999* and is currently exempt from export controls under the List of Exempt Native Species until December 2018.

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 control 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 2013):

517,653 shell

In 2013, catch was only taken in Zone 2/3 and the number of wild-caught pearl oyster shell was 517,617 comprised of 381,632 culture shells and 135,721 MOP shells (Pearl Figure 2). The TAC for culture shells was 548,400, thus 70% of the TAC was caught. In comparison, 556,000 culture shells were caught in 2012. The reduced catch in 2013 was due to a lower quota and abundance returning to more normal levels with some culture shell not fished for economic reasons. The take of 135,721 shells for MOP, which are large oysters (>175 mm shell length), was similar to 129,000 MOP caught in 2012 and represents the second year of the trial fishery for MOP (Pearl Figure 2).

There has been no fishing in Zone 1 since 2008.

Fishing effort/access level

Total effort was 11,993 dive hours (Pearl Figure 2), a decrease of 31% from the 2012 effort of 17,396 hours (highest effort level since the early 1990s). Of this total effort, 10,780 hours was focused on culture shell fishing, and the remaining 1,213 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 2013 fishing season based on catch and effort statistics, settlement analysis (42,000 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (5,000 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 assessment of the TAC for 2014 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 2013, a standardised SCPUE index was developed and provides the best estimate of annual abundance accounting for environmental and efficiency effects. SCPUE in 2013 was 24 shells per hour which is at the lower end of the target range, but still above the threshold SCPUE (Pearl Figure 3). Raw CPUE was 35 shells per dive hour, a similar level to 2012 (36 shells per dive hour; Pearl Figure 3). This stabilisation of catch rate indicates that stock levels have returned to normal levels after record high levels in 2008 - 2011 as a result of good spat settlement in 2005. The MOP catch rate of 112 shell per hour in 2013 was much higher than the 72 shell per hour in 2012.

Catch rate prediction: Recruitment to the Zone 2/3 fishery, as measured by the standardised catch rate (SCPUE), is predicted by the piggyback spat abundance index at 4 to 6 years prior to the current fishing year. The predicted recruitment is then used to set the quota for forthcoming years according to the harvest control rule (Pearl Figure 4). 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; Pearl Figure 4), but CPUE has now returned to normal levels as a result of spat settlements returning to normal levels.

Using the catch rate prediction system, the culture catch quota for 2014 was reduced to a unit value of 1,100 shells (TAC = 502,700) which is an 8% reduction in the 2013 TAC of 548,400 shell (Pearl Figure 4). A small increase in CPUE is predicted for the following two years, 2015 and 2016. Fishers were also given an MOP quota of 328 shell per unit to further explore the potential of the MOP fishery, resulting in a total quota of 1,428 shells per unit.

Zone 1: The Zone 1 fishery has not been fished since 2008.

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 – 2013.

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 2013. 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.

Listed species interaction: Negligible

There is no interaction between the pearl oyster fishing operation and listed 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 2013 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 2013

Level 5 - > $20 million ($61 million)

A precise estimate of the total industry value is difficult to achieve, owing to the variable time lags that occur between harvesting and sale to offshore buyers, and the costs incurred in marketing before sales take place. Based on information provided by the industry, the value of cultured pearls and by products in 2013 was considered to be approximately $61 million, which is 23% lower than 2012, in which it was $79 million.

Fishery Governance

Target effort range: 14,071 - 20,551 hours

Target SCPUE range (Zone 2/3 fishery):

25 - 90 shells per hour

The target effort range relates to the time required to achieve the TAC (culture shell only) in all zones of the pearl oyster fishery. 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.

Historically, the target effort range has been the main governance / performance measure, however recent changes in the fishery such as the cessation of fishing in Zone 1 and Zone 3 for economic reasons, and new management initiatives such as the MSC assessment process has resulted in the development of new, more relevant indices for management. In 2013, a target SCPUE range was developed based on the 11 year time period 2003 – 2013 considered to reflect the typical variation in abundance of the stock under natural environmental conditions. This replaces the old target effort range, which has been provided for comparison.

Zone 2/3 of the pearl oyster fishery achieved its catch with 10,778 dive hours of effort, which was just below the lower limit of the old target range.

Zone 2/3 of the pearl oyster fishery achieved its catch at an SCPUE of 25 shells per hour, which was within the target range of SCPUE.

Zone 1 of the pearl oyster fishery was not fished in 2013.

Current effort level: Acceptable

Overall fishery effort level is acceptable.

New management initiatives (2014)

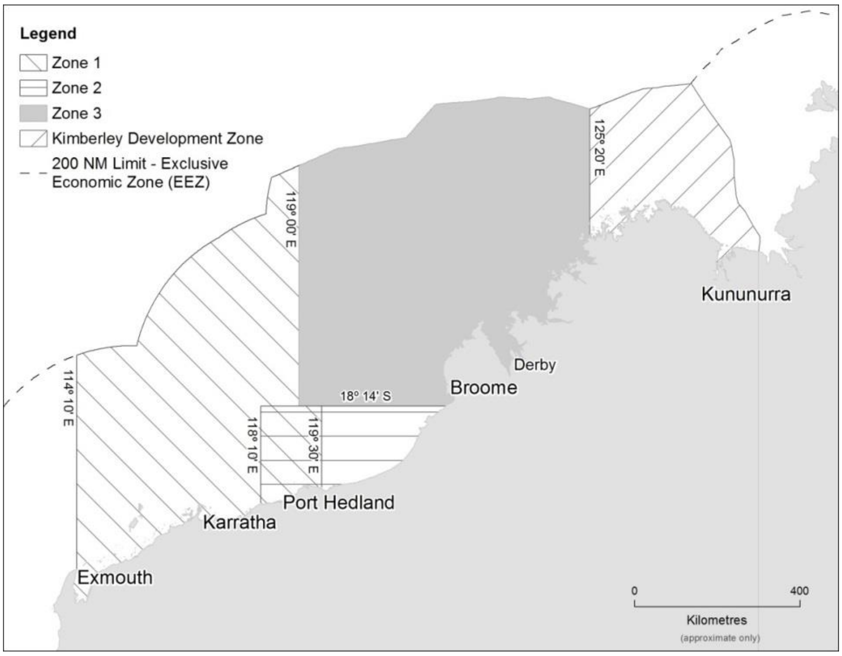
The Department has approved the continuation of a trial for industry to take smaller shell legally, 100 - 119 mm until the end of 2016. The request to take smaller shell was put forward by industry to evaluate the economics for their business model. The Department advised that there were no sustainability issues under a fixed TAC.

The Pearl Oyster Fishery underwent MSC pre-assessment in 2014.

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 2014. 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.

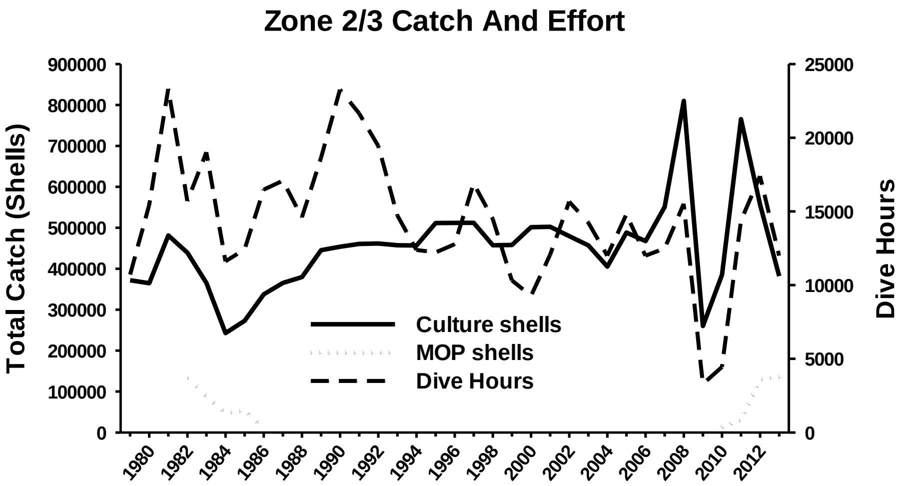
External Factors

The pearl oyster stocks underpinning the fishery in Zone 2/3 continue to provide a sufficient level of production to support this major Western Australian industry, however preliminary research points to environmental factors being an external driver of the 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 2014 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.



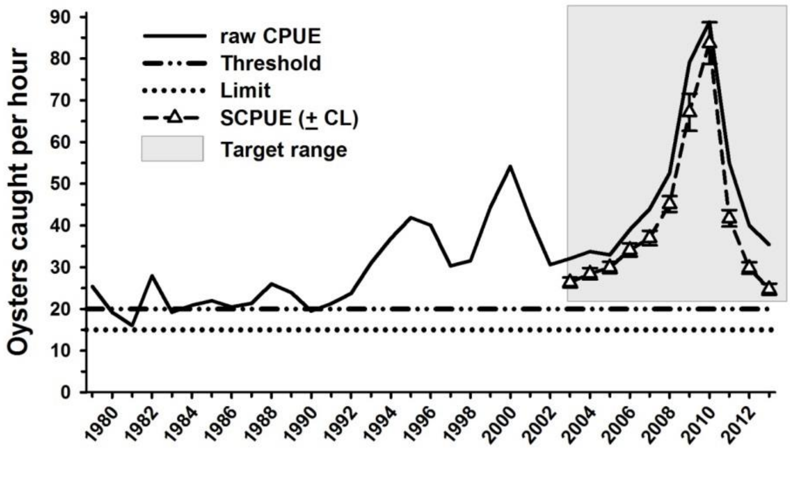
PEARL FIGURE 1

Distribution of pearl oyster stocks and fishing zones in Western Australia.



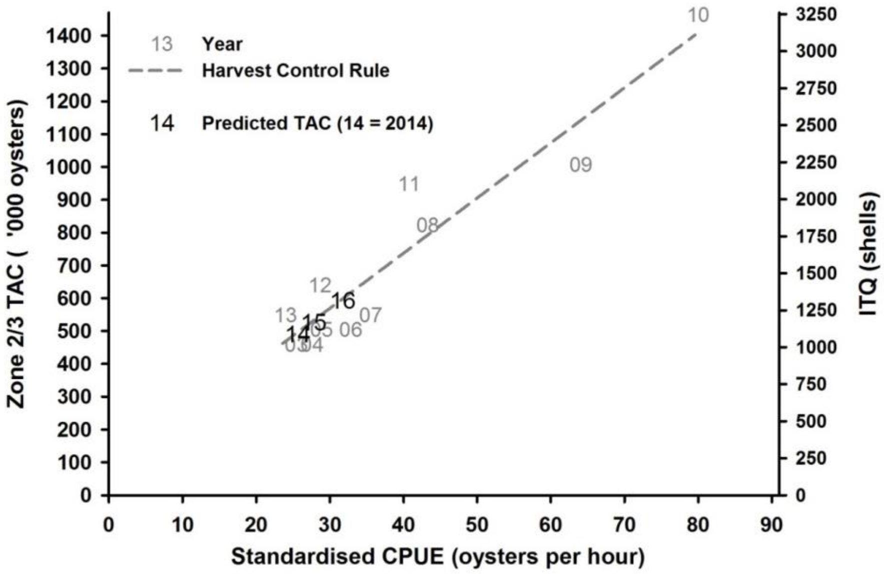
PEARL FIGURE 2

Pearl shell catch and effort – Broome area (Zone 2/3)



PEARL FIGURE 3

Standardized and raw Pearl shell catch per unit effort (CPUE) in the Zone 2/3 fishery with threshold and limit reference points and target range indicated.



PEARL FIGURE 4

Harvest control rule for the Zone 2/3 pearl oyster fishery. The current rule takes the form TAC (Total Allowable Catch) = 16.8 * SCPUE + 66.5 (r^2 = 0.89). The harvest rule is updated with each annual assessment and prediction of future SCPUE

Beche-de-mer Fishery Status Report

A. Hart, D. Murphy and K. Green

Main Features

Status		Current Landings	
Stock level	Acceptable	*Holothuria scabra* – Sandfish	0 t
Fishing level	Acceptable		

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 Management 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 2013

0 tonnes (live weight)

Landings

No fishing for *beche-de-mer* occurred in 2013. Industry has advised they are adopting a rotational fishing strategy for both the traditional sandfish *Holothuria scabra* fishery and recently discovered deepwater redfish *A. echinites* fishery. Fishing activity within the Western Australian fisheries is in a resting phase. Current trends of catch and effort within the fisheries are shown in Figure 1.

This is the third year in the last 7 years that *Actinopyga echinites* has not been caught and represents an effort reduction on this new target species. This is the first year since 1995 that *Holothuria scabra* have not been caught.

Fishing effort/access level

None of 6 licensed vessels fished for *beche-de-mer* in 2013, therefore nil hours fished.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Level 2 - Catch rate

Breeding stock levels: Adequate

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 2013, there was no fishing for this species so the performance measures could not be evaluated.

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 2013, 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.

Listed species interaction: Negligible

There are currently no known interactions with listed 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

Generally a vessel employs 4 to 6 crew with one of those a master, a deckhand and remaining divers. 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 2013:

Level 1 - < $ nil

Fishery Governance

Sandfish catch range: 20 – 100 tonnes

Redfish catch range: 40 – 150 tonnes

New management initiatives (2014)

A review of the developing Beche-de-mer fishery is planned for 2014/15.

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.

External Factors

The remoteness of the currently fished stock and the large tidal ranges where it occurs are natural barriers to uncontrolled expansion of fishing of *beche-de-mer*. Marine park planning 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.

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
2013	0	0	0	0	0	0	0

BECHE-DE-MER TABLE 2

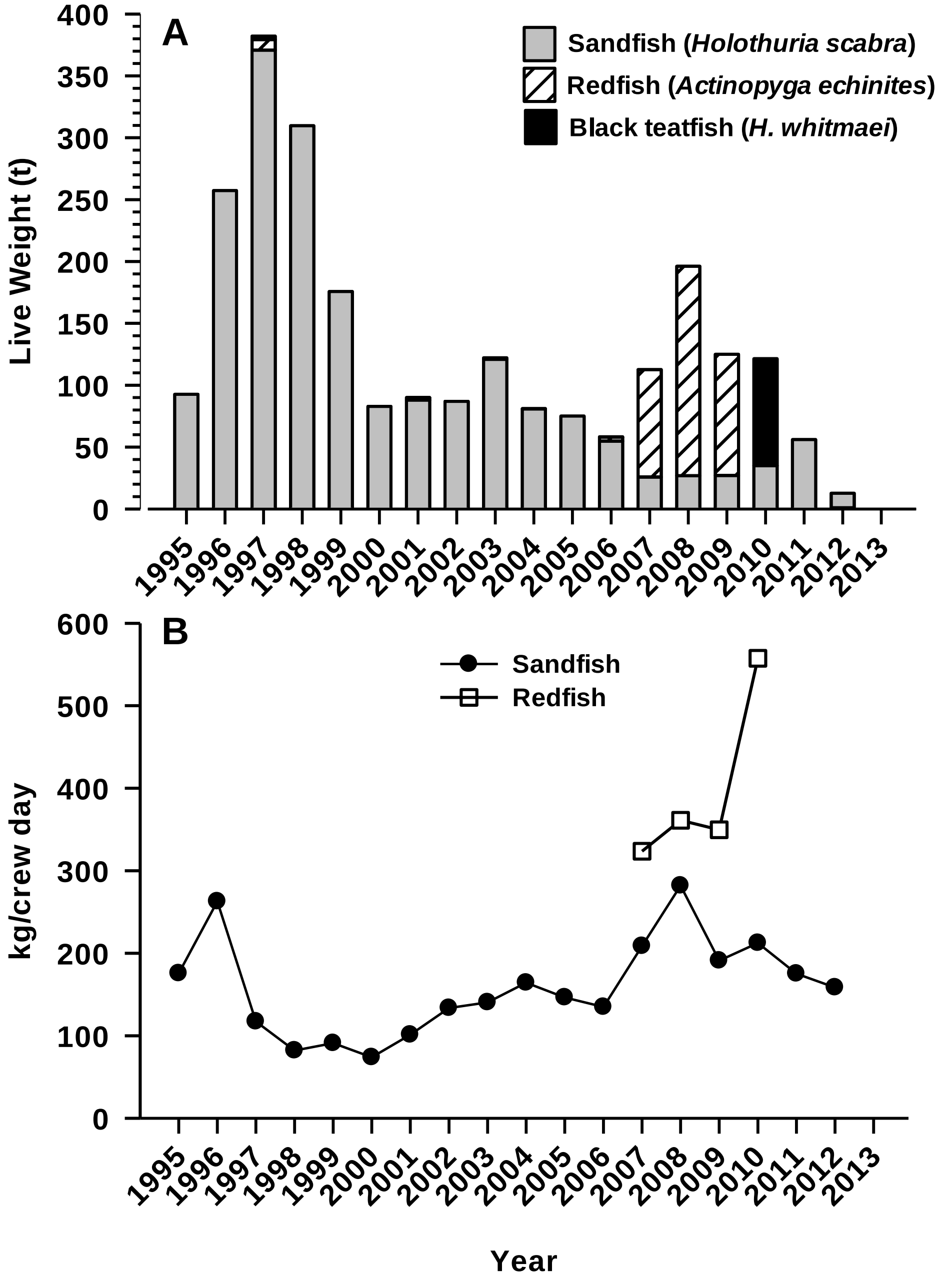
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

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, C. Marsh, R. Evans, N. Blay and D. Wallis

Main Features

Status		Current Landings	
Stock level		Blue swimmer crab	
Blue swimmer crab	Acceptable	Commercial	5.8 t
Mud crab	Unknown	Recreational (boat-based) (Mar 11- Feb 12)	3.4 t
Fishing Level		Mud crab	
Blue swimmer crab	Acceptable	Commercial	7.9 t
Mud crab	Acceptable	Recreational (boat-based) (Mar 11- Feb 12)	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 Port Hedland in the north.

Blue swimmer crabs are targeted using a variety of fishing gear but most commercial crab fishers in WA now use purpose-designed crab traps. Operators in the Pilbara Developmental 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 Developmental Crab Fishery was established in 2001 via the Developmental 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, 1994[5], Robertson, 1996[6]).

The Kimberley Developing Mud Crab fishery is currently a small developing fishery that 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 Kimberley Developing Mud Crab Fishery has been granted via 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

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 (Forskal)(Decapoda: Portunidae) in Eastern Cape estuaries, South Africa. South African Journal of Zoology. 31:4. 177-185.

determine the most appropriate gear for the high tidal conditions. However, prior to using the trap, the design of mud crab traps 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 and 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 Kimberley 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 dorys 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 spatial, 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 Developmental Crab Fishery should ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

The management arrangements for the Pilbara Developmental Crab Fishery are set by conditions on the exemption and are aimed at ensuring the stock and environment are protected. A maximum of 400 crab traps are permitted in the fishery.

Management controls for the Onslow and Nickol Bay Prawn Managed Fisheries are based on limited entry, seasonal and spatial closures, moon 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 head-rope length of 20 fathoms (36.6 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 (drop nets, scoop nets only).

Mud Crab

Since 2006, access to the Kimberley 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 bycatch 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 Developmental 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 (90-120mm CW for green and 86-96mm CW for brown). This was later revised to 131-138mm CW for green mud crabs after reclassification of the *Scylla* genus (Knuckey, 1999)[1]. 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.

1 Knuckey, I.A. (1999). Mud crab (*Scylla serrata*) population dynamics in the Northern Territory, Australia and their relationship to the commercial fishery. PhD Thesis. Northern Territory University, Darwin.

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 research logbooks. Relevant research information is sourced from 2 recent FRDC funded projects involving NT Fisheries investigating escape gap sizes of traps (Grubert & Lee., 2012)[2] and environmental correlations with mud crab catches in the Northern Territory (Meynecke *et al*., 2010)[3]. 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)[4].

Retained Species

Commercial landings (season 2012/13):

Blue swimmer crabs	**5.8 tonnes**
Mud crabs	**7.9 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 2012/13 was 5.8 t, a 53% decrease on the 2011/12 catch of 12 t (North Coast Crab Figure 4). The majority of the recorded catch was taken by the trap fishery, with trawlers retaining 0.3 t of crab catch during 2012/13.This Pilbara catch accounted for 2% of the state commercial blue swimmer crab catch of 277 t for 2012/13 (West Coast Blue Swimmer Crab Figure 1). The crab trap catch continues a declining trend and is the lowest in over 10 years primarily due to a decline in effort with one of the 2 exemptions not being renewed in 2008 and the remaining exemption holder exploring other employment opportunities in recent years.

Mud Crab

The total trap catch of mud crabs for the Kimberley Developing Mud Crab Fishery during 2013 was 7.9 t which represented 100% of the total catch of mud crab in Western Australia (North Coast Crab Figure 5). Logbooks submitted during 2013 reported that 22% or 1,4 t were brown mud crab and 78% or 4.8t were green mud crab. With the remaining 1.7 t not reported as either species or not identified due to neglecting to report catch in daily research logbooks. This catch level is significantly higher than the 3.7 t reported in 2012 (catch has been updated from figure in last year's report) due to an increase in effort, with three commercial operators fishing and 2 Aboriginal Corporations fishing in the May to November 2013 period. Catch in 2013 was higher than the 5 year (2008 – 2012) mean of 3.1 t and may be attributed to the absence of cyclonic and flooding weather events and difficulty in retaining crew and securing local markets commonly reported in previous years.

2 Grubert, M.A, and Lee, H.-S. 2012. Improving gear selectivity in Australian mud crab fisheries, Northern Territory Department of Resources, Fishery Report.

3 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.

4 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. 183p.

Recreational catch:

Blue Swimmer Crab
(boat-based) (Mar 11- Feb 12) 3.4 tonnes

A statewide survey of boat-based recreational fishing was conducted between 1st March 2011 and 29th February 2012 and was a collaboration between the Department of Fisheries, Edith Cowan University and RecfishWest. Approximately 3,000 fishers from the "Recreational Fishing from Boat" licence database participated in a 12 month phone-diary survey in conjunction with boat ramp surveys of boat-based fishers. Catch data were recorded in numbers of crabs, and have been converted to weight for this report using a mean statewide estimate of 229 g/crab (based on 382 crabs weighed during the boat ramp surveys). The survey provided a statewide boat-based recreational estimate of retained blue swimmer crabs for the 12-month period of 97 t (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
The Department of Fisheries survey of boat recreational fishing conducted over 2011/12 reported that 9387 green and brown mud crabs were retained during this period (Ryan *et al.*, 2013). 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. The current survey has run from May 2013 to April 2014 with data analysis yet to be completed.

Fishing effort/access level

Blue Swimmer Crab
Crab trap fishers along the Pilbara coast reported 8100 traplifts during 2012/13, which is the lowest in over 10 years and a 42% decrease on the 13,880 traplifts reported for 2011/12.

Mud Crab
Mud crab fishers along the Kimberley coast reported 9190 traplifts during 2013, a 46% increase on the 4250 traplifts reported for 2012 (North Coast Crab Figure 5). This 2013 level of effort is significantly higher than the 5 year average of 4302 traplifts (2008-2012). This higher level of effort is due to 3 commercial fishers and 2 aboriginal corporations fishing compared with 4250 traplifts reported in 2012. The absence of adverse environmental events such as cyclones and flooding cited in previous years could account for this increase in number of operators and overall effort within the Kimberley mud crab fishery for 2013.

Stock Assessment

Assessment complete:

Blue Swimmer Crab	**Pilbara - Yes**
Mud Crab	**Kimberley - Yes**

Assessment level and method:

Blue Swimmer Crab	**Level 2 - Catch rate**
Mud Crab	**Level 2 - Catch rate**

Breeding stock levels:

Blue Swimmer Crab	**Pilbara - Adequate**
Mud Crab	**Kimberley- Adequate**

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 (127 mm carapace width for recreational fishers; 135 mm carapace width for commercial fishers) for crab fisheries in the North Coast Bioregion is set well above the size at first maturity of the resident stocks (based on size at maturity of crabs in Shark Bay - 97 mm CW males and 92.4 mm CW females, de Lestang *et al.*, 2003[3]). 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. However, while warm temperatures during the winter have been shown to positively influence the recruitment in Shark Bay, warm summer temperatures have been shown to have a negative effect.

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 Developmental 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.

1 Ryan KL, Wise BS, Hall NG, Pollock KH, Sulin EH, Gaughan DJ (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. 168pp.

2 Williamson, P. C., Sumner, N. R., 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, WA. 61 pp.

3 de Lestang, S., Hall, N. G. and Potter. I. C. 2003. Reproductive biology of the blue swimmer crab, *Portunus pelagicus* (Decapoda: Portunidae) in five water bodies on the west coast of Australia. *Fish. Bull.* 101:745–757.

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 Developmental Crab Fishery recorded a mean catch rate for 2012/13 of 0.7 kg/trap lift – a 22% decrease on the catch rate of 0.9 kg/traplift reported during the previous year (North Coast Crab Figure 4).

Mud Crab
Between 1994 and 2005, trap catch and effort for mud crabs in the Kimberley remained low, ranging between 68 kg and 2.9 t 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 9.3 t 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 (~ 5 t 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 (2009 – 2013) has fluctuated between 0.5 and 1.0 kg/traplift, with a catch rate of 1.0 kg/traplift reported in 2013. 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 Camp Inlet, King Sound, York Sound and Cambridge Gulf in 2013.

The minimum legal size at first capture is 150 mm carapace width (CW) for green mud crab (*Scylla serrata*) and 120 mm CW for brown mud crab (*Scylla olivacea*). This is set well above the size at first maturity of 90-120mm CW for green and 86-96mm CW for brown mud crab fisheries in the North Coast Bioregion (Knuckey, 1999) [1].

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.

Listed species interaction — Negligible

Blue Swimmer Crab
The crab trap longline system used in the targeted crab fisheries has little possibility of interacting with listed species. The fishery is conducted in a manner that avoids mortality, 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 listed 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 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.

1 Knuckey, I.A. (1999). Mud crab (*Scylla serrata*) population dynamics in the Northern Territory, Australia and their relationship to the commercial fishery. PhD Thesis. Northern Territory University, Darwin.

Social Effects

Blue Swimmer Crab

During 2012/13, 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.

Due to an absence of adverse weather including seasonal flooding and cyclone activity reported in previous years, there was a higher than normal fishing level with 3 commercial operators and 2 Aboriginal Corporations in the 2013 fishing season.

Economic Effects

Estimated annual value (to fishers)

Level 1 - < $1 million

Blue Swimmer Crab

The commercial blue swimmer crab catch in the North Coast Bioregion for 2012/13 was valued at approximately $53,300 - a 53% decrease on the $112,300 generated in 2011/12. Price data was generated by collecting monthly returns recording prices paid to fishers by fish processors, a weighted average price is then calculated for the financial year from the monthly data collected. Average prices for trap caught blue swimmer crabs in the North coast fisheries for the year were around $9.23/kg. The crab catch from the Pilbara region was sold through local and interstate markets

The economic value of the total commercial blue swimmer crab catch for the State of Western Australia for the 2012/13 financial year was estimated to be $2.6 million – a 1% increase on the estimated $2.5 million generated in 2011/12.

Mud Crab

Mud crab landings from the Kimberley mud crab fishery during 2013 were worth approximately $174,572 a 54% increase on the $95,394 generated in 2012. As the Kimberley 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 Kimberley for 2013 was around $22/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.

Price data was generated by collecting monthly returns recording prices paid to fishers by fish processors, a weighted average price is then calculated for the financial year from the monthly data collected.

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 - Acceptable**

Mud Crab **Acceptable**

Blue Swimmer Crab

While the Pilbara Developmental Crab 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 local environmental influences such as tide and wind, has allowed commercial fishers to improve fishing practices with effort decreasing in recent years. Fishing effort in this region is limited by very hot weather experienced during the summer months, which generally restricts fishing effort to between April and November.

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 Kimberley. 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 (2014/15)

Blue Swimmer Crab

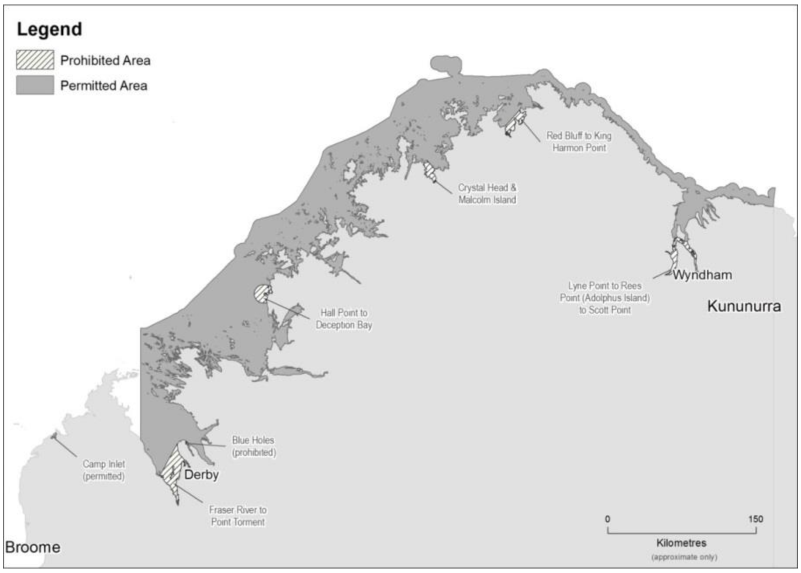
The Department is currently progressing formal management arrangements of the Pilbara Crab DNF through the development of a (Interim) Management Plan for the fishery. This is scheduled to be completed in early 2015.

Mud Crab

The Department proposes to bring the Kimberley Developing Mud Crab Fishery under formal management arrangements in the near future.

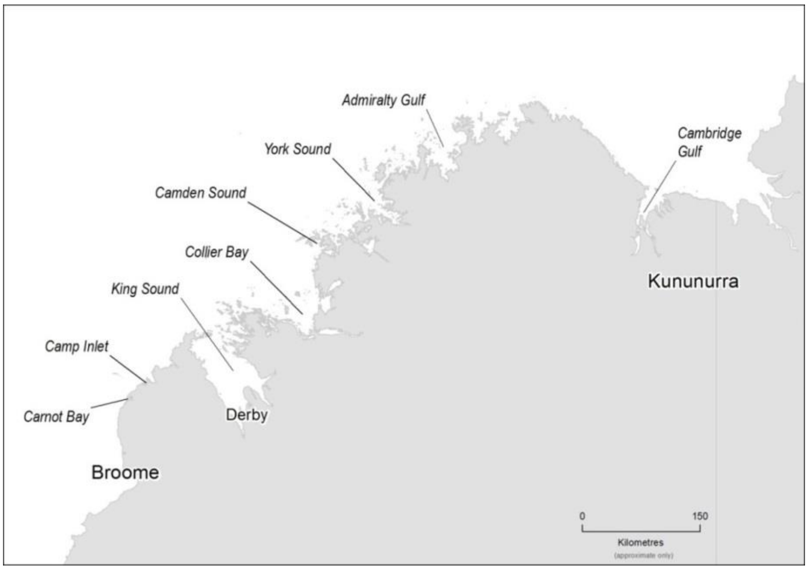
External Factors

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.



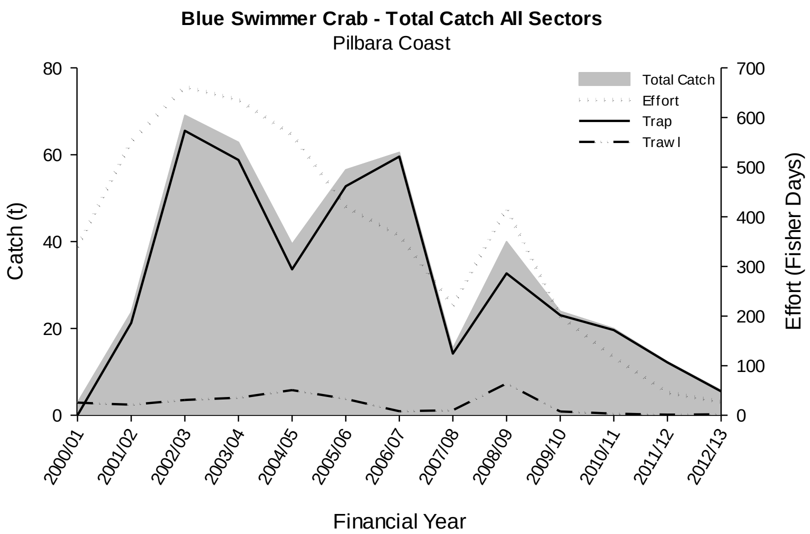
NORTH COAST CRAB FIGURE 1

Areas fished for mud crab along the Kimberley coast of Western Australia.



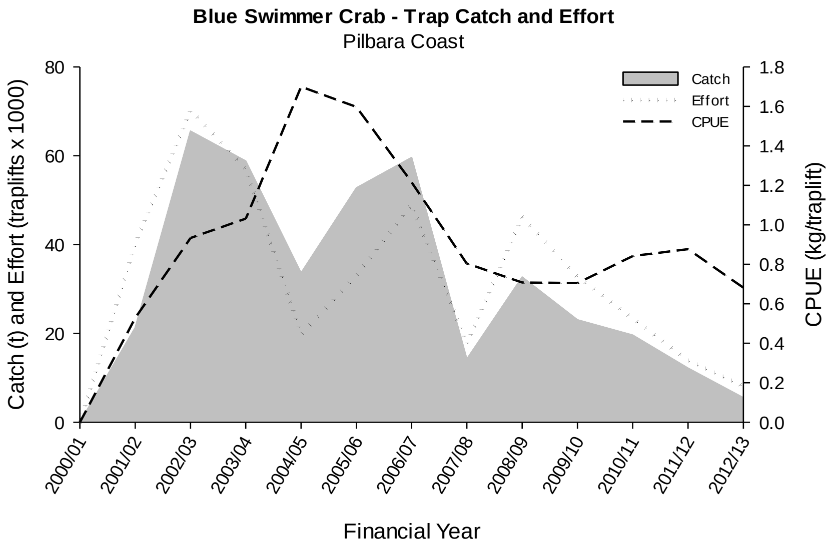
NORTH COAST CRAB FIGURE 2

Key areas fished by exemption holders operating in the Kimberley Developing Mud Crab Fishery in Western Australia.



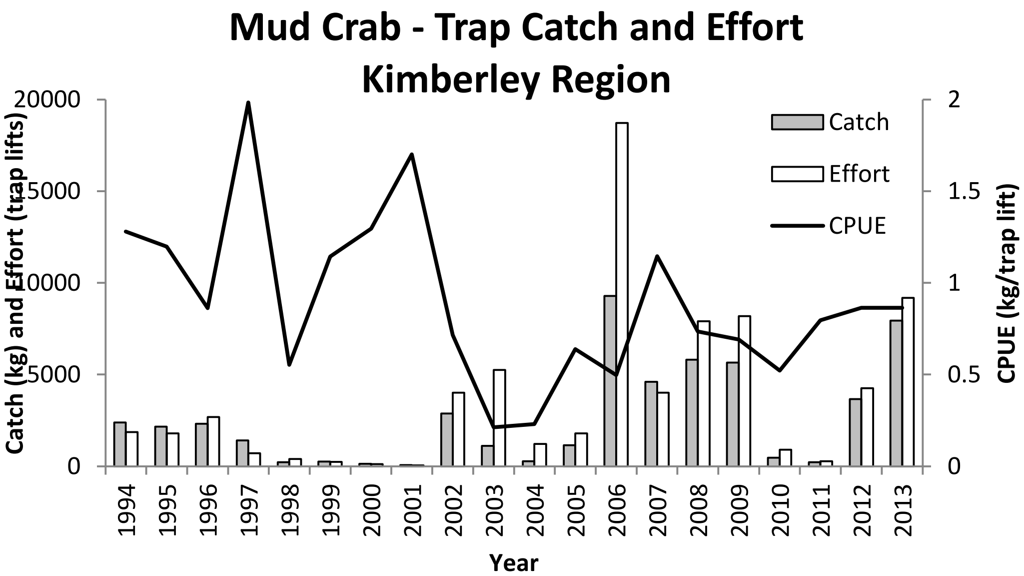
NORTH COAST CRAB FIGURE 3

Total 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 and effort in fisher days.



NORTH COAST CRAB FIGURE 4

Commercial trap catch history for the Pilbara Developmental Blue Swimmer Crab (*Portunus armatus*) fishery since 2000/01. Data represents the total trap crab catch, effort (traplifts x 1000) and catch per unit effort (CPUE) (kg/traplift).



NORTH COAST CRAB FIGURE 5

Annual catch, effort and catch rate (CPUE) for mud crab in the Kimberley Region since 1994 when permissive conditions of fishing boat licenses were issued. The Kimberley 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 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 company developing a project culturing marine microalgae for the production of bio-fuels, omega-3 lipid and protein biomass previously established a demonstration facility near Karratha. The company is currently assessing alternative sites for the project.

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 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, 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 has now received environmental approval, through the Minister for Environment issuing an implementation statement. The Minister for Fisheries is now going through the process to formally declare the zone.

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 thirteen permanent Fisheries and Marine Officers and one Community Education officer. An additional two officer Recreational Mobile Patrol 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 placed on developing materials that focus on local issues and their dissemination through regional brochure stockists and local publications.

Activities during 2012/13

During 2012/13, the North Coast Bioregion’s FMOs delivered a total of 7,751 officer hours of active compliance patrol time (North Coast Compliance Table 1). FMOs also achieved 19,215 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 2012/13. This resulted in 10 infringement warnings, 11 infringement notices being issued and 43 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 171 infringement warnings were issued, 152 infringement notices and 27 matters resulted in prosecution action.

Initiatives in 2013/14

The Department will continue 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.

The Northern Region Mobile Patrol, comprising of two FMOs 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 bio-security checks 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 2012/13 financial year.

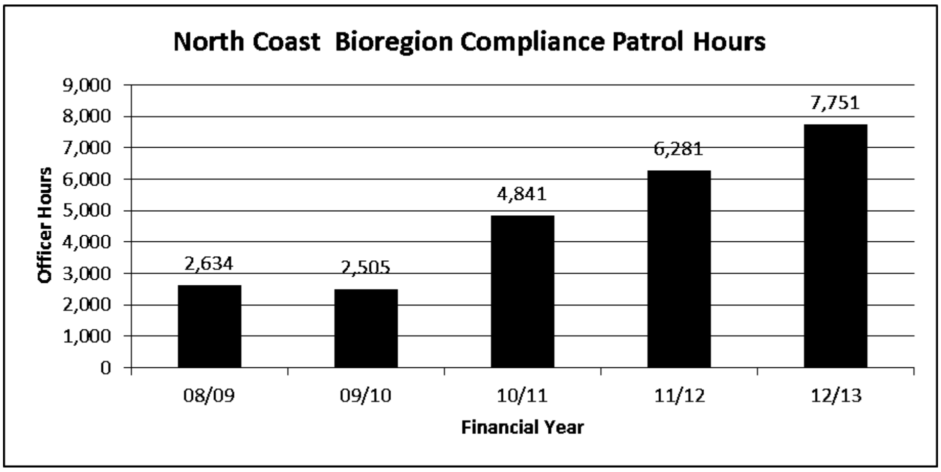
PATROL HOURS DELIVERED TO THE BIOREGION	7,751 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	244
Infringement warnings	10
Infringement notices	11
Prosecutions	43
Fishwatch reports***	2
VMS (Vessel Days)****	7,598
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	17,584
Infringement warnings	171
Infringement notices	152
Prosecutions	27
Fishwatch reports	39
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	1,387
Fishwatch reports	1

* Pearling contacts are included in these totals.

** 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 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 and PV Walcott while they were operating in the Bioregion.

*** 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 FIGURE 1*

"On Patrol" Officer Hours showing the level of compliance patrol activity delivered to the North Coast Bioregion over the previous 5 years. The 12/13 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. and any services delivered by the Department's large Patrol Vessels: *PV Walcott, PV Houtman* and *PV Hamelin*).

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.

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 is undertaking a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay.

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;

Listed 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 2) 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

The areas and proportions of the South Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which meet the IUCN criteria for classification as marine protected areas.

IUCN category or equivalent	State Waters only ($17,116\ km^2$)				All Waters ($534,016\ km^2$ (including State waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km^2	%	km^2	%	km^2	%	km^2	%
I	0	0	0	0	0	0	0	0
II	1	< 1	0	0	1	< 1	0	0
III	0	0	0	0	0	0	0	0
IV	2,400	14	15	< 1	2,400	< 1	15	< 1
V	0	0	0	0	0	0	0	0
VI	14,700	86	0	0	531,600	99	0	0

SOUTH COAST ECOSYSTEM MANAGEMENT TABLE 2
RISK LEVELS FOR EACH ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Moderate values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, 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.

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.

Fish species	Aquatic zone	Risk	Status and Current Activities
Crustaceans	Shelf	MODERATE	The catch levels of lobsters and crabs remains at relatively low but consistent levels.
Molluscs	Nearshore	MODERATE	The stocks of abalone are maintained at appropriate levels
	Shelf	NEGLIGIBLE	The stocks of scallops varies annually and fishing only occurs when stocks are abundant

Listed species

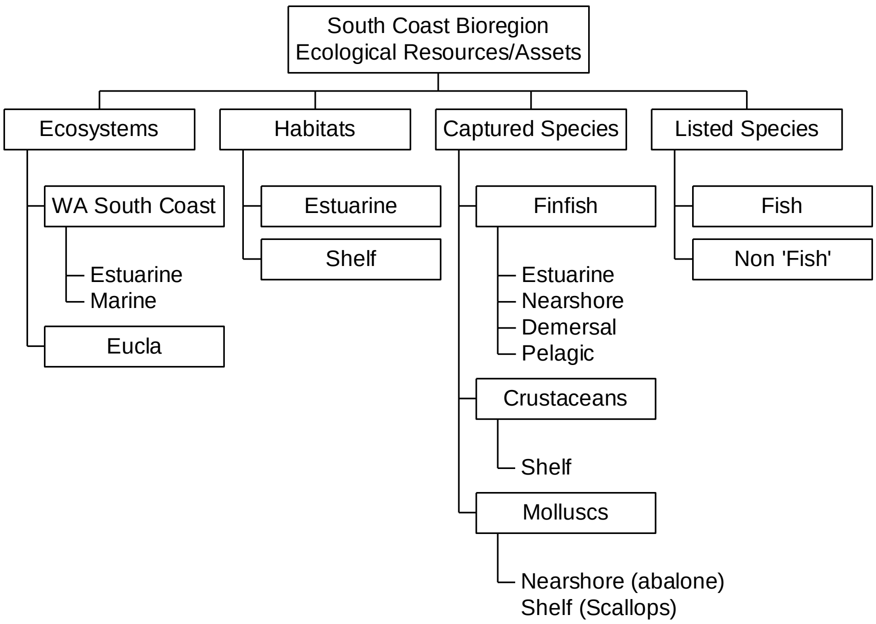
Listed fish species	Species	Risk	Status and Current Activities
Listed non 'Fish' species	Non fish (birds)	MODERATE	The capture of shearwaters in purse seine operations has been addressed by a code of conduct
	Mammals	MODERATE	The potential for the capture of sealions and seals by all fishing operations in this region, but especially gillnets has been the subject of a number of recent studies.
Listed 'Fish' Species	Fish	NEGLIGIBLE	There are few risks to the listed 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 Codium fragile fragile 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.

Introduced Pests Status Report

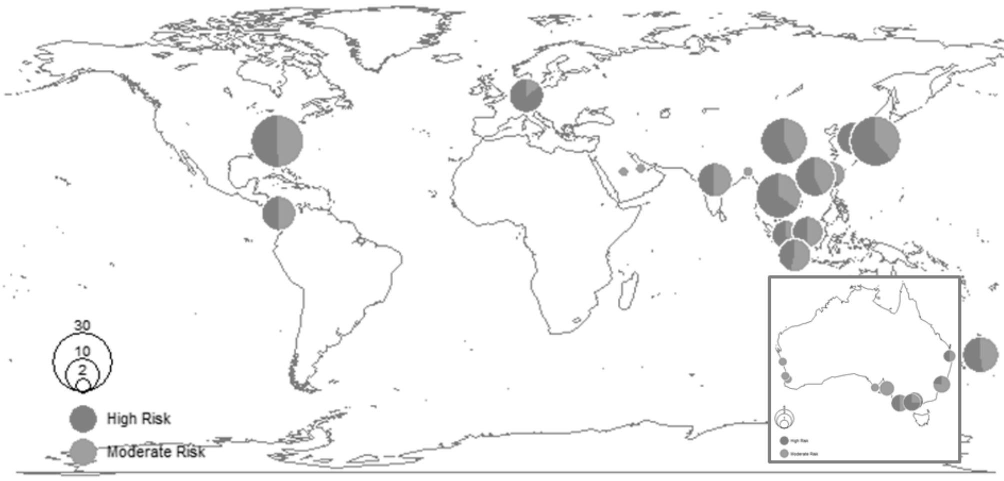
Regional Monitoring and Research Update

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. There are two key vectors for marine pest translocation: ballast water and hull fouling. The Marine Biosecurity Research and Monitoring group continue to implement a series of biosecurity related projects in the South Coast Bioregion with three aims. The first is to examine the likelihood of inoculation, infection and establishment of compatible marine pests in the North Coast Bioregion from commercial vessel movements (see Bridgwood & McDonald 2014[1]). The second aim is for early detection of the presence of introduced marine pests (IMPs) using a suite of tools. The third is to undertake a control program targeting the marine pest *Codium fragile* ssp *fragile*, a green alga present in Albany Port's waters.

From a biosecurity perspective the introduction of a marine pest to any region is based on multiple factors that can be grouped into two themes; the likelihood of inoculation and the likelihood of infection and establishment. Inoculation likelihood assumes that the greater the number of vessel visits from a source with introduced marine pests (IMP) the greater the risk of IMPs being brought into the recipient port i.e. a positive linear relationship. Based on available commercial vessel data from 2011, there were 302 commercial visits to the South Coast Bioregion and the greatest inoculation risk was from international vessel movements. The infection and establishment likelihood takes into account the sources of IMPs (based on a vessels last port of call (LPOC)), the frequency of visits from those sources and the compatibility between the IMPs salinity and temperature tolerances and South Coast Bioregion. There was a 95% compatibility rating of potential inbound IMPs with the environment of the South Coast Bioregion from 19 international LPOC (Introduced Pests Figure 1). When the cumulative effect of the number of vessel visits from a LPOC and number of IMPs present at that LPOC is considered, the greatest infection and establishment risk to the South Coast Bioregion was from China, followed closely by Japan (Introduced Pests Figure 2).

The Marine Biosecurity Research and Monitoring group, with financial and in-kind assistance from the Esperance Ports Sea and Land Authority and the Department of Transport is running an Early Warning System program using in-situ sampling arrays to aid in the early detection of marine pests. Early detection of IMPs is vital if any attempt at eradication or other management strategies is to be successful. Through this surveillance the only species detected to date is the colonial ascidian *Didemnum perlucidum*.

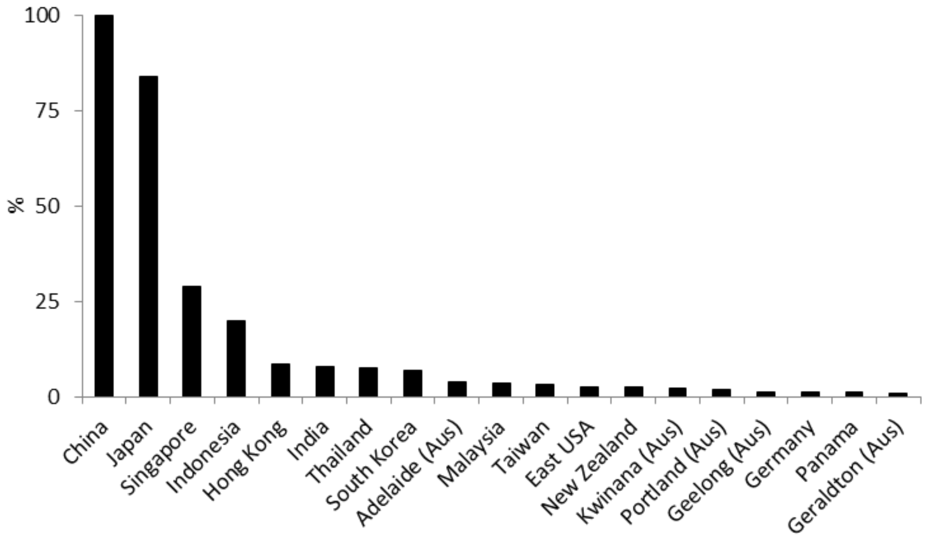
In early 2014 the Marine Biosecurity Research and Monitoring group undertook the first stage of a control program to manage the population of *C. fragile* ssp. *fragile* in Albany Port's waters. Stage one consisted of divers removing by hand any detected specimens of the algae. The second stage, planned for late 2014 will involve a diving-based survey of the controlled area to determine if the alga persists and if so in what density. Further control strategies will depend on the outcome of that repeat survey.



INTRODUCED PESTS FIGURE 1

The last port of call locations of compatible IMPs for the South Coast Bioregion

1 Bridgwood, S and McDonald, J. 2014. A likelihood analysis of the introduction of marine pests to Western Australian ports via commercial vessels. Fisheries Research Report No. 259. Department of Fisheries, Western Australia. 212pp.



INTRODUCED PESTS FIGURE 2

Ranking of the infection and establishment risk posed to the South Coast Bioregion by international and domestic last ports of call. Each last port of call value is expressed as a relative percentage of the largest last port of call value (i.e. China 100%).

FISHERIES
South Coast Crustacean Fisheries Status Report

J. How and R. Oliver

Main Features			
Status		Current Landings	
Stock level	Adequate	Southern Rock Lobster	46 t
Fishing Level	Acceptable	Deep sea crabs	23 t

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 areas, and the South Coast deep-sea crab fishery (South Coast Crustacean Figure 1).

The fisheries are multi-species and take southern rock lobster (*Jasus edwardsii*) and western rock lobster (*Panulirus cygnus*) as well as deep-sea crab species including giant crab (*Pseudocarcinus gigas*), crystal crab (*Chaceon albus*) and champagne crab (*Hypothalassia acerba*).

Southern rock lobster comprises 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 lobster is 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).

Governing legislation/fishing authority

Commercial

Windy Harbour-Augusta Rock Lobster Managed Fishery Management Plan 1987

Esperance Rock Lobster Managed Fishery Management Plan 1987

Southern Rock Lobster Regulation Licence

Fishing Boat Licence Condition 105

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation).

Recreational

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

Consultation process

The Department is responsible for the statutory management plan consultation and undertakes consultation directly with licensees on operational issues and processes. 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.

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 fishing season for rock lobster across all four 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 specified 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 2012/13 there were two Windy Harbour/Augusta Rock Lobster Managed Fishery Licences; eight licences in the ERLF (five vessels reported catch); 28 licences in the Southern Rock Lobster Pot Regulation Fishery (17 vessels reported catch) and 23 holders of Fishing Boat Licence Condition 105 (ten vessels reported catch).

Recreational

Recreational fishers generally only target rock lobster. 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 Rock Lobster Recreational Fishing Licence.

Research summary

A recent pre-assessment of the fishery for Marine Stewardship Certification has been the focus of the research for this fishery. It has resulted in the development of standardised catch rates to evaluate the stock status and a proposed harvest strategy and control rules framework, based on the catch rates.

Retained Species

Commercial landings (season 2012/13):

Southern rock lobster	**47 tonnes**
Deep sea crabs	**23 tonnes**
Western rock lobster	**not reported**

due to confidentiality policy (too few operators)

In 2012/13, the south coast catch of southern rock lobster 46.5 t was below the target catch range and slightly lower than last year's catch of 51.2 t (South Coast Crustacean Figure 2a). However, this target catch range is currently being reviewed as a part of the overall review of the management for this fishery. The catch records are based on monthly statutory (catch and effort) returns.

The deep-sea crab catch was similar to year's catch of 22 t, comprising of 4.0 tonne of champagne, 13.7 t of giant, and 5.0 t of crystal crab.

Recreational
Southern rock lobsters <5 tonnes

Estimates from mail surveys sent to a randomly selected sample of Rock Lobster Recreational Fishing 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 Rock Lobster Recreational Fishing Licence holders that catch southern rock lobster is 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.

Fishing effort/access level

The effort figures are based on monthly statutory catch and effort (CAES) returns. There was a total of 267,035 potlifts recorded for all fishing in the south coast crustacean fisheries, with almost half (114,925) potlifts occurring in the Albany area. The remainder of the effort was spread between Esperance (60,760 potlifts), Windy Harbour / Augusta (47,648 potlifts) and the Bight (43,702 potlifts) areas.

As effort from CAES does not specify the effort level for particular species, sub-setting of the data is required to determine the effort levels relating to specific catches. Therefore, fishers are assumed to be targeting a particular species if that species represents >90% of the catch in a CAES record. The associated effort for that trip and species is then ascribed 'targeted' effort. Targeted effort for southern rock lobster in south coast crustacean fisheries has declined by 7% this season to 117,228 potlifts, after progressively increasing for each of the last four seasons (South Coast Crustacean Figure 2b).

Stock Assessment

Assessment complete **Yes**

Assessment level and method:

Level 2 - Catch rate

Breeding stock levels **Adequate**

As part of a recent MSC pre-assessment process, a harvest strategy is being developed for a number of species captured in the 'south coast crustacean fisheries'. A standardised catch rate assessment was undertaken and notional target, threshold and limit reference points were developed for the southern rock lobster. Similar measures were also established for the deep sea crabs (crystal, giant and champagne crabs) which are secondary target species for many of the south coast crustacean fishers. The assessments of these secondary target crab species are still being developed and will be presented in future assessments.

The standardised catch rate for southern rock lobsters moved from being near its threshold level in 2011/12 to within the target region in 2012/13 (South Coast Crustacean Figure 2c). In 2012/13 the standardised catch rate for southern rock lobsters was 0.31 kg/potlift, representing a 9% increase from the previous season

The proposed performance measures for the fishery were established as part of the MSC pre-assessment and were:

a) the standardised catch rate of southern rock lobsters is acceptable (above the proposed 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 their potential to 'ghost fish' if lost is negligible.

Listed species interaction **Negligible**

The pots and ropes used in crab longlines have limited capacity to interact with listed species in this fishing area. In the 2012/13 season there was a report of a leatherback turtle which was entangled in fishing gear in the Windy Harbour / Augusta fishery.

Ecosystem Effects

Food chain effects **Negligible**

The effects of the removal of lobster and deep sea crabs has been assessed for the West Coast Deep Sea Crustacean Fishery and Western Rock Lobster Managed Fishery on the state's west coast. Both of these fisheries have been assessed as having negligible food chain effects by the removal of crabs and lobsters respectively. Therefore, at current catch levels, it is unlikely that removal of lobster and crabs on the south coast are likely to result in food chain effects.

Habitat effects **Low**

Potting is considered to have a low impact on the 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 the South Australian / West Australian border and Augusta, generating some additional economic activity and benefits.

Economic Effects

Estimated annual value (to fishers) for 2012/13

Level 2 - $1 - 5 million ($3.6 million)

The beach value of the fishery was about $3.6 million in 2012/13 with the majority of the catch sold live to Asian markets both locally and internationally.

Fishery Governance

Target commercial catch range:

Southern rock lobsters **50 – 80 tonnes**

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

In 2012/13, the south coast catch of 46.5 t was below the target catch range (South Coast Crustacean Figure 2a). This coincided with a reduction in the targeted effort for southern rock lobster, and as such the catch and fishing effort is considered acceptable. However, this target catch and associated effort range is currently being reviewed as a part of the overall review of the management for this fishery.

New management initiatives (2014/15)

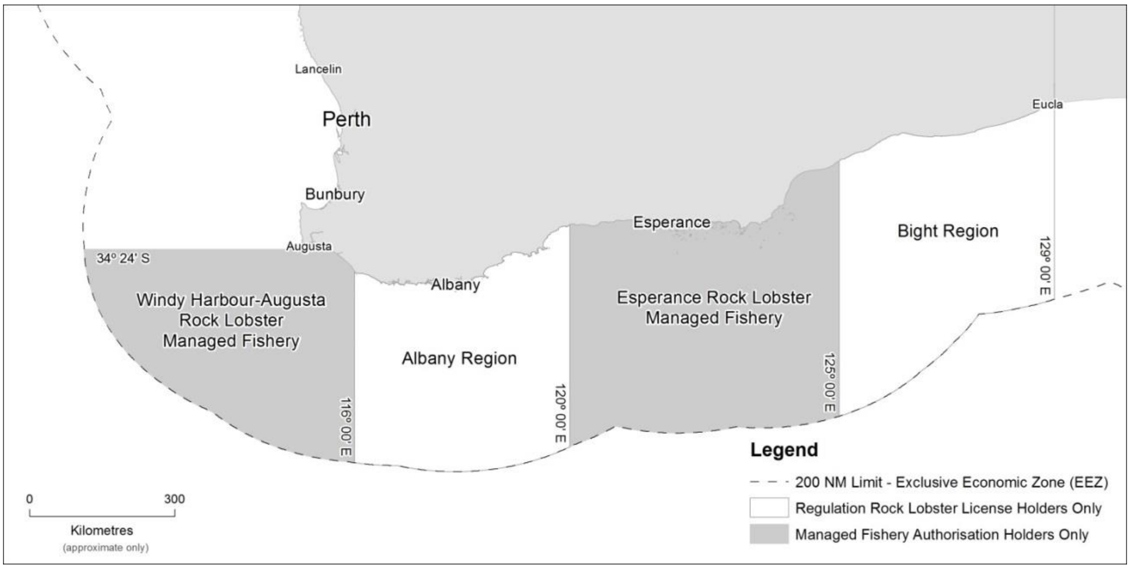
In January 2009 the Department released Fisheries Management Paper 232 entitled, 'The South Coast Crustacean Fishery: A Discussion Paper'. This public discussion paper provided a review of the management arrangements and history of the four south coast crustacean fisheries, as well as making a number 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 were approved by the Minister for Fisheries and will form the basis for entry into each zone within the new South Coast Crustacean Fishery. A new management plan is currently being drafted for the South

Coast Crustacean Fishery to incorporate these management arrangements and is expected to be implemented during 2014/15, superseding the two management plans, regulation licence and licence condition which currently regulate the four fisheries.

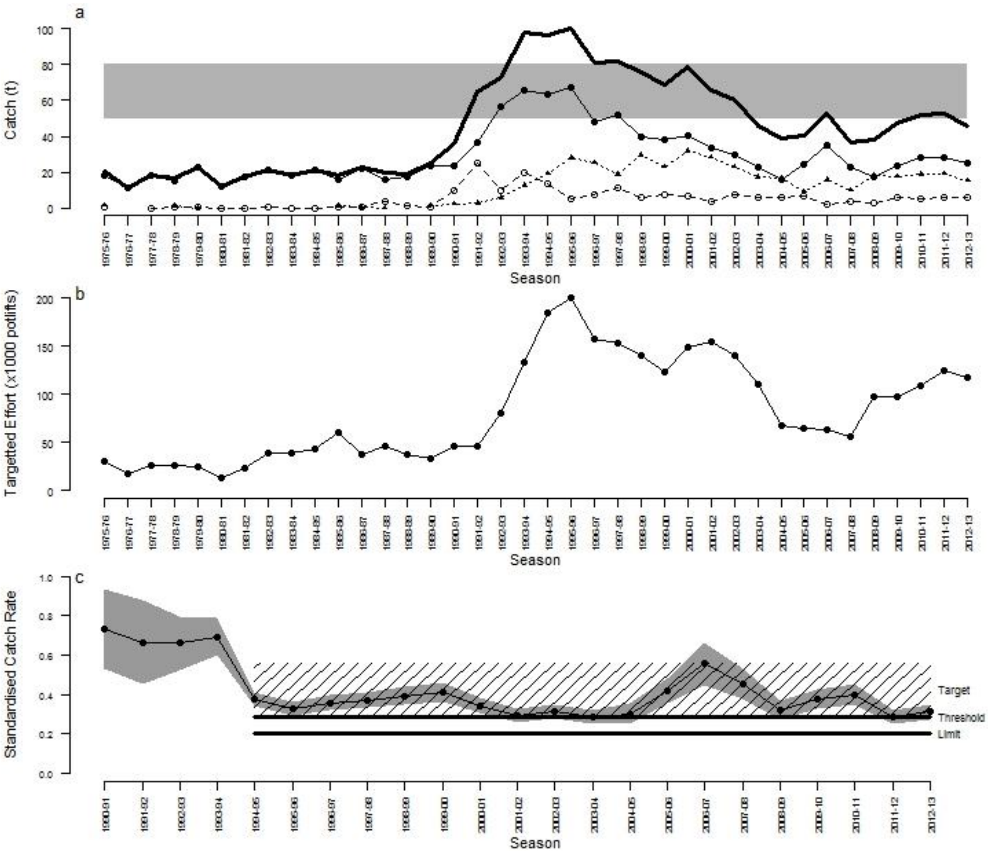
External Factors

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



SOUTH COAST CRUSTACEAN FIGURE 1

Management boundaries in the South Coast crustacean fisheries.



SOUTH COAST CRUSTACEAN FIGURE 2

Southern rock lobster seasonal a) catch for Esperance (line with solid circles), Albany (dashed line and open circles), Bight (solid triangles and dotted line) and all three zones combined (bold line) b) targeted effort for all fisheries and c) standardised catch rate for all fisheries with indicative target region (hashed area), threshold and limit reference points.

Greenlip/Brownlip Abalone Fishery Status Report

A. Hart, F. Fabris and J. O'Malley

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial	
Fishing level	Acceptable	Total	202 t
		Greenlip	166 t
		Brownlip	36 t
		Recreational	3-4% of total catch

Fishery Description

The Western Australian greenlip and brownlip abalone fishery is a dive fishery that operates in the shallow coastal waters off the south-west and south coasts of Western Australia. The fishery targets 2 large species of abalone: greenlip abalone (*Haliotis laevigata*), and brownlip abalone (*H. conicopora*), both of which can grow to approximately 200 mm shell length.

Abalone divers operate from small 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 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

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 Individually Transferable Quotas (ITQs).

The overall TACC for 2013 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 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 145 mm, 150 mm and 153 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 an Abalone Recreational Fishing Licence. Licences are not restricted in number, but the recreational fishing season is limited to 7.5 months – from 1 October to 15 May.

The combined daily bag limit for greenlip and brownlip abalone is five per fisher, and the household possession limit (the maximum number that may be stored at a person's permanent place of residence) is 20.

General

A comprehensive ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issues identified through this process were the breeding stock levels of greenlip and brownlip abalone. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Current research is focused on stock assessment using catch and effort statistics, meat weight indices, and length-frequency sampling. Commercial abalone divers are required to provide daily catch information on the weight and number of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. The divers also supply a random selection of abalone shells from each fishing day, and these are measured and used to estimate fishing mortality.

An annual standardized catch per unit effort (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 fishery-independent survey data collected from 220 sites across the fishery, and mark-recapture analysis of growth and mortality in brownlip abalone.

The telephone diary surveys have previously estimated the statewide catch of greenlip and brownlip abalone. 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 brownlip abalone continued in 2013/14, under the externally funded FRDC project titled "*Demographic Performance of Brownlip Abalone: Exploration of Wild and Cultured Harvest Potential*". Results from this project will inform industry and management about the development of harvest control rules and sustainable catch levels for this species.

Retained Species

Commercial landings (season 2013): 202 tonnes

In 2013 the greenlip/brownlip catch was 202 tonnes whole weight (Greenlip Brownlip Abalone Table 1), which was similar to the 2012 catch. The Area 1 (Nullarbor fishery) exploratory quota remained at 1.2 t and has not been fished since 2010.

The greenlip catch of 166.3 t whole weight from a total quota of 173.4 t, was similar to the preceding three years catch of greenlip. The brownlip catch of 36 t whole weight for the 2013 season was similar to the preceding two years catch and represents 98% of the quota of 36.2 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 2013.

Fishing effort/access level

Commercial

Total fishing effort on the main stocks in 2013 was 1,558 days. This was 8% higher than 2012 (1,438 days).

Recreational

For the 2013 season, 15,949 Abalone Recreational Fishing Licences were issued allowing abalone fishing. This is similar to the number of licences that have been obtained since the "umbrella" Recreational Fishing 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 2013 fishing season, based on commercial catch and effort statistics, biological growth studies, and fishery-independent surveys.

Standardised catch per unit effort (SCPUE): As a result of a recent review[1], the SCPUE for the greenlip fishery is now used as the principal indicator of the abundance of legal-sized abalone and the basis for the control-rule framework. Raw CPUE data (kg whole wt per diver per day) is also presented for comparative purposes.

In 2013, the SCPUE for the combined greenlip stocks was 29 kg whole weight per hour. This was a decrease from the 2012 and 2011 values of 31 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. No analysis of F was available for 2013 due to lack of data, hence trends in previous years are examined.

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 153 mm shell length for the faster-growing portions of the fishing grounds, 150 mm for the average growing portions and 140 mm for the slower growing portions of the fishing grounds.

In 2013, the average sizes of greenlip and brownlip caught were 178 g and 238 g respectively which are both well above the minimum breeding sizes of 140 g for greenlip and 160 g for brownlip.

For brownlip, the assessment showed that the TACC was being caught at a lower average meat weight i.e. declined from 282 g in 2006 to 238 g in 2013. The TACC was therefore reduced to 36.2 t in 2012 and 2013 (Greenlip Brownlip Abalone Table 1) and the brownlip average meat weight has stabilised.

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.

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.

In 2013, the average sizes of greenlip and brownlip caught were 178 g and 238 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 (1,558 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 a combination of lowered abundance and changes in operational developments in the fishery including the use of 2 divers per day on some vessels and new divers with lower catching efficiency. A 10% TACC reduction has been implemented in the Area 3 fishery as a result of the lowered abundance.

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.

Listed species interaction: **Negligible**

The only listed 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 community members that appreciate abalone as a delicacy. There were

15,949 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 2013:

Level 3 - $5 - 10 million ($7.8 million)

The estimated average price received by commercial fishers was $105/kg meat weight ($39/kg whole weight) for greenlip and $87/kg meat weight ($35/kg whole weight) for brownlip abalone, resulting in a fishery valued at $7.8 million, similar to $8.0 million in 2012.

Greenlip prices in 2013 were similar to prices in 2012 ($107/kg) and are still considerably lower compared to 10 years ago e.g. $126/kg meat weight in 2003, due to the high value of the Australian dollar.

Fishery Governance

Target effort range: **907 – 1,339 days**

Current effort level: **Not 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 (201 t in 2013) 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 2013 was 1,558 days (main stocks), which is above the governance range. The range was exceeded due to lowered abundance in the Area 3 fishery, 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). TACC reductions in Area 3 have been implemented for the 2014 season, however a review of the target effort range will also be undertaken.

New management initiatives (2014/15)

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 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 decreases 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 effort[1] by quota period since 2001.

Quota period	Greenlip TAC kg whole weight	Greenlip caught kg whole weight (all stocks)	Brownlip TAC kg whole weight	Brownlip caught kg whole weight[3]	Combined catch kg whole weight	Diver days (main stocks only)[2]	Greenlip Raw CPUE kg whole (meat)[3] wt per diver day)	Greenlip standardised CPUE (kg whole weight) per diver hour
2001	194,691	187,459	33,075	31,091	218,550	1,002	165 (62)	35
2002	194,691	166,828	33,075	27,458	194,286	1,027	134 (50)	32
2003	202,521	180,730	37,453	33,449	214,179	1,144[2]	136 (51)	32
2004	190,520	170,385	35,000	34,196	204,581	1,154[2]	129 (48)	32
2005	171,755	169,285	38,500	38,745	208,030	1,252	131 (49)	28
2006	171,755	168,752	39,750	37,265	206,017	1,161	133 (50)	28
2007	171,755	166,647	39,750	38,660	205,307	1,139	137 (51)	30
2008	163,220	157,224	41,900	39,515	196,739	1,144	135 (51)	30
2009	171,221	160,156	41,900	39,050	199,206	1,205	133 (50)	29
2010	171,221	165,558	41,900	39,006	204,564	1,196	138 (52)	34
2011	173,355	165,927	39,950	36,274	202,201	1,224	136 (51)	31
2012	173,355	167,562	36,150	34,187	201,749	1,438	116 (44)	31
2013	173,355	166,315	36,150	35,616	201,931	1,558	107 (40)	29

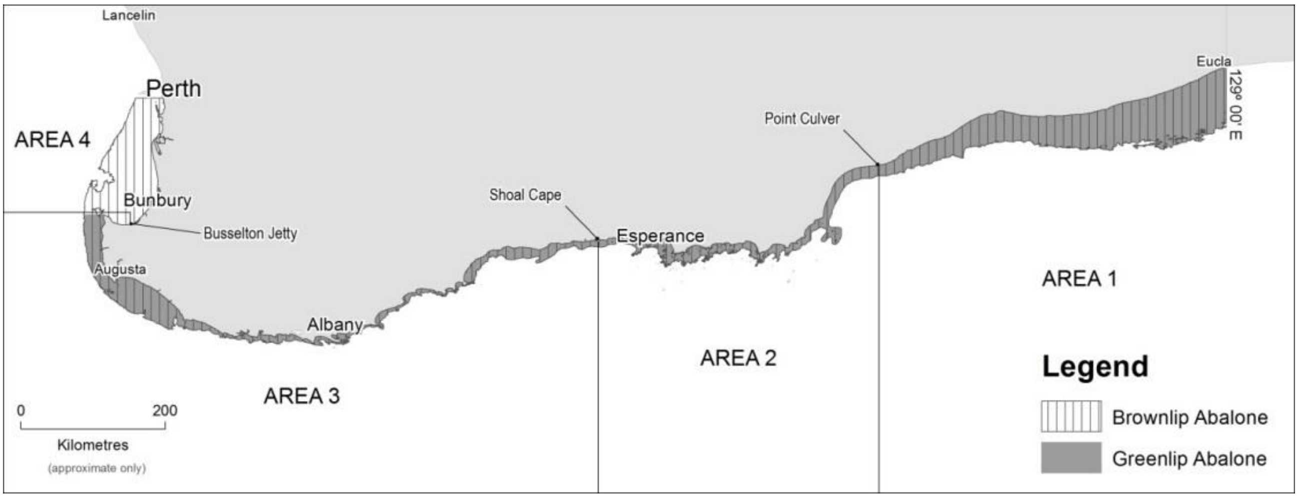
1. Data source: quota returns.
2. Effort (diver days): main stocks are separated from stunted stocks,
3. The conversion factor for meat weight to whole weight for Greenlip is 2.667 and Brownlip is 2.5.

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.

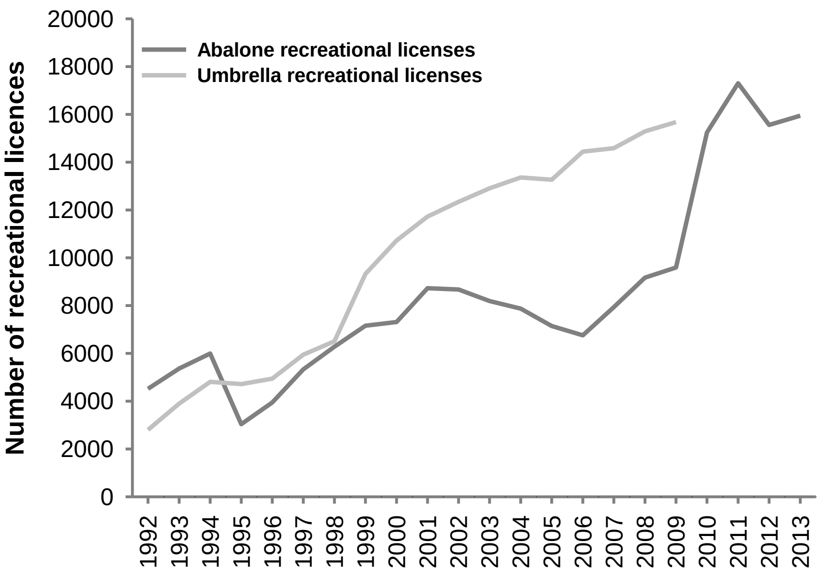
Location	Year	Effort	Greenlip		Brownlip	
			Catch Rate	Catch (tonnes)	Catch Rate	Catch (tonnes)
West Coast	2004	10,100 (6,500 – 13,600)	0.6	4 (2–6)	0.4	3 (1–5)
	2006	8,000 (4,700 – 11,300)	0.3	2 (0–3)	0.4	3 (0–5)
	2007	6,300 (3,800 – 8,800)	0.7	3 (0–6)	0.1	<1 (0–1)
South Coast[1]	2004	2,700 (1,700 – 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).



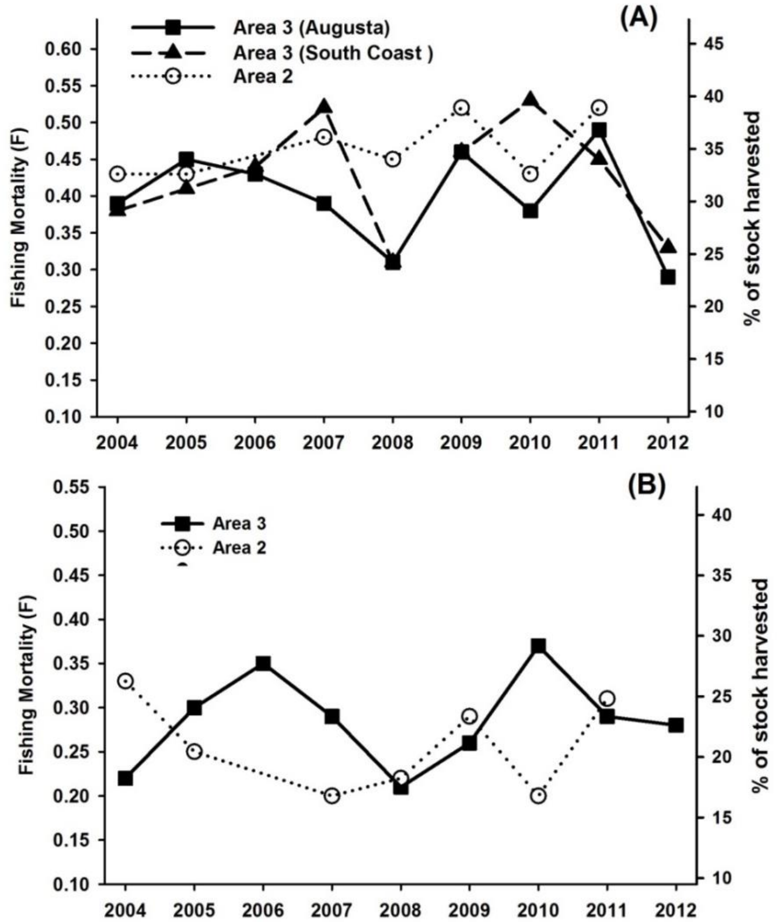
GREENLIP/BROWNLIP ABALONE FIGURE 1

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. Quinn and T. Nicholas

Main Features

Status		Current Landings (2013)	
Stock levels:		Commercial total	595 t (finfish only)
Australian herring	Inadequate	South Coast Salmon Fishery	139 t (salmon only)
Western Australian salmon	Adequate	South Coast herring trap net fishery	228 t (herring only)
Black bream (Stokes Inlet)	Adequate	South Coast Estuarine Fishery	211 t (finfish only)
Black bream (Beaufort Inlet)	Adequate	Other commercial	17 t (finfish only)
Black bream (Wilson Inlet)	Adequate	Recreational total	(not available for current year)
Black bream (Oyster Harbour)	Adequate	Most recent survey 2000/01	368 t (key species only)
Black bream (Walpole-Nornalup Inlet)	Not assessed	Recreational estuarine	
Cobbler (Wilson Inlet)	Adequate	Most recent survey 2002/03	50 t (key species only)
Cobbler (Oyster Harbour)	Adequate	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 (Australian herring only), beach seines, haul nets and gillnets. 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, gillnets 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 gillnet and haul net. The main target species are cobbler (*Cnidoglanis macrocephalus*), black bream (*Acanthopagrus butcheri*), sea mullet and Australian herring.

Recreational

Most finfish caught recreationally in South Coast Bioregion estuaries and nearshore waters are taken by line fishing. Shore and boat-based fishing are both popular. The most commonly captured recreational species include Australian herring, various species of whiting (Family: 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 129º east longitude, including Princess Royal Harbour and Oyster Harbour, and all the rivers, streams and all the tributaries that flow into those estuaries.' The areas that are open to commercial fishing are (from west-to-east) Broke Inlet, Irwin Inlet, Wilson Inlet, Princess Royal Harbour, Oyster Harbour, Waychinicup Inlet, Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Culham Inlet, Jerdacuttup Lakes, Oldfield Inlet and Stokes Inlet.

Recreational

Recreational line fishing is permitted in most areas within estuaries and nearshore waters of the South Coast Bioregion. Some spatial closures exist, including closures around dive wrecks.

A limited number of areas within 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 2011[1]). 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. Recent monitoring of the age structure of fishery landings has been undertaken 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.* 2013[1]). 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 (2013):

384 tonnes in nearshore waters

211 tonnes in estuarine waters

Commercial landings by fishery (2013):

South Coast Salmon	**139 tonnes (salmon only)**
Herring trap net	**228 tonnes (herring only)**
South Coast Estuarine	**211 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), gillnets, 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 2013, the total commercial catch of finfish by estuarine and beach-based fisheries in the South Coast Bioregion was 595 t and included at least 37 species. The majority of the catch consisted of Australian herring (42% by weight) caught primarily by the trap net fishery, western Australian salmon (23%) caught by the South Coast Salmon Managed Fishery, cobbler (11%) and black bream (7%) caught by the South Coast Estuarine Managed Fishery.

In 2013, the nearshore finfish catch was comprised predominantly of Australian herring (61% by weight) and western Australian salmon (36%). The estuarine finfish catch was comprised mainly of cobbler (31%), black bream (19%), sea mullet (15%) and Australian herring (9%).

Since 2000, 95% of landings by the South Coast Estuarine Managed Fishery have been finfish. The non-finfish component is dominated by blue swimmer crabs (*Portunus armatus*), which ranged from 1 t in 2006 to 39 t in 2001. In 2013, 32 t of blue swimmer crabs was reported by this fishery. Almost all blue swimmer crabs were taken by gillnets.

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, a total catch of 122 t was reported, which is the lowest since the commencement of commercial fishing in the 1940s. In 2013, the total catch was 232 t. The declining trend 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 an historical low of 75 t in 2012. In 2013, the South Coast catch was 139 t. In the West Coast Bioregion, landings of salmon have ranged from 0 to 1,364 t per year since the commencement of the fishery (South Coast Nearshore and Estuarine Figure 1). In 2013, the West Coast catch was 93 t.

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.

Commercial fishery landings of western Australian salmon in SA have also declined, following a similar trend to WA landings. From 1983/84 to 2002/3, total SA landings were relatively stable at around 400-600 t per year. In the mid 2000s, landings declined sharply, and have subsequently been <200 t per year[2]. A historically low total catch of 74 t was

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. (2013). The South Australian Marine Scalefish Fishery Status Report - Analysis of Fishery Statistics for 2012/13. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000565-8. SARDI Research Report Series No. 747. 44 pp.

recorded in 2012/13. The decline in SA landings is partly due to a reduction in targeted effort but may also partly reflect a decline in the supply of recruits to SA from the spawning area in WA.

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 2013, 67 t of cobbler was caught in the South Coast Estuarine Managed Fishery. The majority (84%) 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 2013, 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 (33% of landings), Stokes Inlet (29%), Oyster Harbour (13%) and Wilson Inlet (10%). Minor black bream landings were reported in 7 other estuaries.

In 2013, a total of 41 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 2013, 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 4 t and 5 t, respectively, in 2013. 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 (2013): NA

Key species

Nearshore + estuarine catch (most recent estimate 2000/01): 368 tonnes

Estuarine catch only (most recent estimate 2002/03): 50 tonnes

Boat-based nearshore + estuarine catch (most recent estimate 2011/12): 37 tonnes

Recreational catch levels of finfish in nearshore and estuarine waters of the South Coast Bioregion were not estimated in 2013. The most recent nearshore estimates are from the National Recreational and Indigenous Fishing Survey conducted in 2000/01 (Henry and Lyle 2003[1]). The most recent estuarine estimates are from a creel survey in 2002/03 (Smallwood and Sumner 2007)[2]. 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

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 No. 159. Department of Fisheries, Western Australia. 56pp.

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 bream, with an estimated recreational catch of 15 t during the survey period.

A statewide survey of boat-based recreational fishing was undertaken in 2011/12 (South Coast Nearshore and Estuarine Table 2). 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.* 2011[1]).

Recreational catch share

The recreational catch share of total finfish landings in nearshore and estuarine waters of the South Coast Bioregion cannot be determined for the current year 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 2013, the fishery reported a total of 3859 fishing days and an average of 18.2 boats fished per month.

In 2013, 42% of effort (method days) occurred in Wilson Inlet, 24% in Oyster Harbour, 19% in Princess Royal Harbour, 5% in Irwin Inlet, 5% in Beaufort Inlet, 2% in Broke Inlet and 2% in Stokes Inlet. The remaining effort (1%) occurred in Dempster Inlet, Culham Inlet, Oldfield River and Jerdacuttup Lakes. Two estuaries (Gordon Inlet and Waychinicup Inlet) were not fished during 2013.

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 2013, only 3 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 2013, western Australian salmon landings were reported by 7 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). 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). Total effort during the survey period was estimated at 254,171 fisher hours or 86,482 fisher days. This total included boat-based (202,658 hours), shore-based (47,816 hours) and house boat (3,698 hours) fishing. Recreational netting and charter boat effort was not quantified in this survey, but was considered to have

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.

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 herring[1] 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. In 2013, the catch was 139 t. 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 2013, a relatively low catch (93 t) 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 2013 level was not exceptional. However, very low catches have occurred in the past 4 consecutive years (2010-2013), 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.* 2011[2]). 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 Wilson Inlet and to a lesser extent in the estuaries around Albany (Oyster Harbour, Princess Royal Harbour).

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.

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 2012/13. 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). There was a slight increase in catch rate in 2012/13, although the level still 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 may be used to regularly 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.

Listed species interaction: Negligible

It is compulsory for commercial fishers to report all interactions with 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 declining and is relatively low compared to historic levels. Recreational fishing effort directed towards Australian herring is relatively high.

Habitat effects: Negligible

The operation of gillnets 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 2013, there were approximately 31 commercial fishers involved in the South Coast Salmon Fishery and approximately 13 commercial fishers involved in the South Coast herring trap net fishery. In 2013, the South Coast Estuarine Managed Fishery employed an average of 23 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 2003, Barharthah 2006[1]). 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 2012/13:

South Coast Estuarine Fishery

(Level 2: $1 to 5 million (finfish only)

South Coast Salmon + Herring trap net fisheries

Level 1: <$1 million

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**

1 Barhathah, T. (2006). Department of Fisheries community survey 2005. Fisheries Occasional Paper No. 33. Department of Fisheries, Perth.

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 2013 South Coast Estuarine Managed Fishery total catch of finfish (211 t) was within 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 2013. This fishery has reported a steady increase in landings of blue swimmer crabs, from 1 t in 2006 to 14 t in 2012 and 32 t in 2013. 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 2013 South Coast catch of Australian herring (251 t) was well below the target range. The catch has now been below the target range for 11 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 2013 (232 t) was below the target range. The catch has now been below the target range for 7 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. A higher level assessment (e.g. level 3 – age based) of salmon is being considered in order to increase certainty about stock status.

Recreational

Current Fishing (or Effort) Level:	**Not available**
Target catch range:	**Not developed**

New management initiatives (2014/15)

An application to the Commonwealth Department of the Environment has been submitted to maintain export accreditation for the western Australian salmon fisheries (South Coast Salmon Managed Fishery and South West Coast Salmon Managed Fishery), effectively declaring the fisheries exempt from Part 13 and 13A of the EPBC Act for a period of 5 years. The current exemption expires on 15 November 2014.

South Coast nearshore and estuarine fisheries underwent MSC pre-assessment in 2014. Outcomes are expected 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.* 2008[1]). 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 and 2013 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

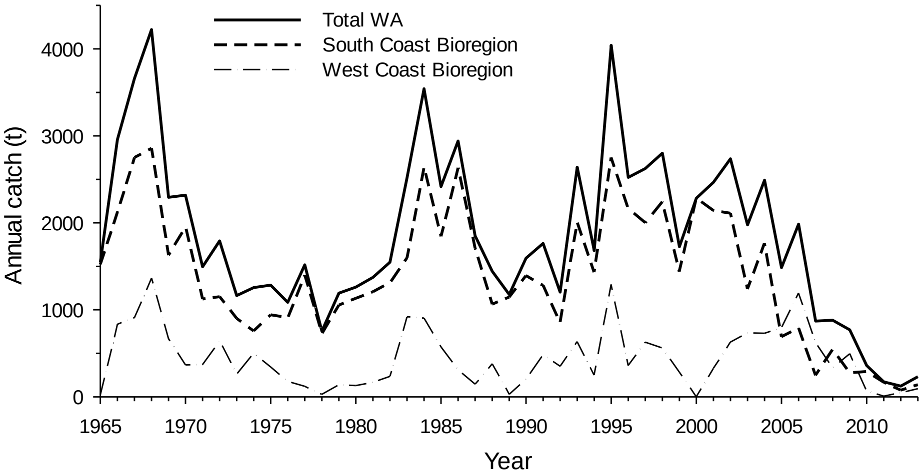
Total annual catches of finfish (excluding sharks and rays) from the estuarine and beach-based nearshore commercial fisheries in the South Coast Bioregion, 2009 to 2013.

Species	Scientific name	Catch (tonnes)				
		2009	2010	2011	2012	2013
Western Australian salmon	*Arripis truttaceus*	275.8	291.4	165.2	75.0	139.4
Australian herring	*Arripis georgianus*	180.7	182.7	110.7	134.4	250.6
Cobbler	*Cnidoglanis macrocephalus*	86.6	69.8	65.5	53.1	67.2
Black bream	*Acanthopagrus butcheri*	50.0	65.5	43.9	42.7	41.2
Sea mullet	*Mugil cephalus*	26.3	32.3	29.8	30.7	33.7
Southern garfish	*Hyporamphus melanochir*	7.6	13.7	11.1	5.4	13.4
King George whiting	*Sillaginodes punctata*	6.8	7.0	8.0	9.9	11.5
Leatherjackets	Monocanthidae	6.2	7.3	7.5	10.9	7.0
Tarwhine	*Rhabdosargus sarba*	2.7	2.8	6.7	3.9	4.6
Flatheads	Platycephalidae	5.2	3.0	4.4	3.2	4.5
Yelloweye mullet	*Aldrichetta forsteri*	3.4	2.6	3.9	4.9	3.4
Snook	*Sphyraena novaehollandiae*	2.4	1.3	1.7	1.7	1.9
Pink snapper	*Pagrus auratus*	1.9	0.9	1.3	2.1	0.6
Trevally	Carangidae	2.9	2.1	2.0	1.5	2.9
Flounder	Pleuronectidae	0.2	1.5	1.3	0.8	5.9
Trumpeters/Grunters	Teraponidae	1.7	0.3	1.6	0.3	0.3
Yellowtail scad	*Trachurus novazelandiae*	0.2	0.6	0.8	2.2	0.1
Tailor	*Pomatomus saltatrix*	0.1	0.4	0.4	0.3	1.8
Mulloway	*Agyrosomus japonicus*	0.3	0.4	0.7	1.0	0.5
Scaly mackerel	*Sardinella lemuru*	0.9	0.4	0.3	0.3	0.9
Whiting species	*Sillago* spp.	0.3	0.4	0.6	1.4	0.7
Other finfish	*Teleostei*	3.3	3.3	3.5	3.7	3.3
TOTAL		665.7	689.6	470.8	389.5	595.3

SOUTH COAST NEARSHORE AND ESTUARINE TABLE 2

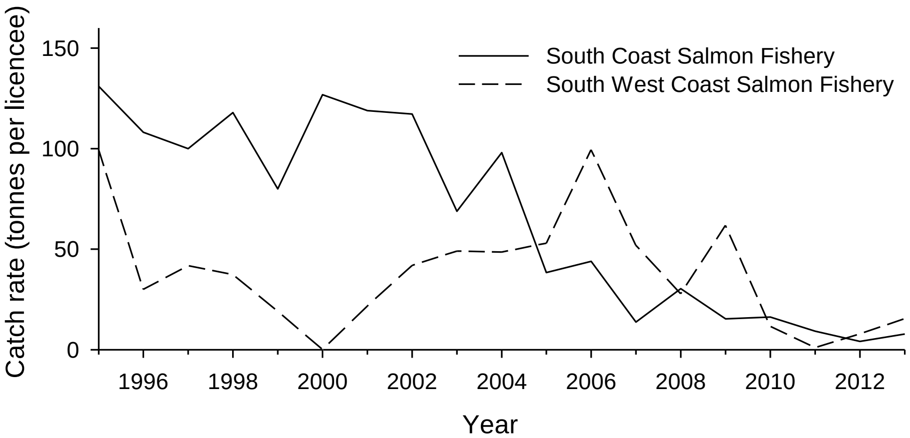
Estimated annual catch of key nearshore and estuarine finfish species in the South Coast Bioregion by boat-based recreational fishers in 2011/12 (Ryan *et al.* 2013).

Species		Catch (tonnes)
King George whiting	*Sillaginodes punctata*	12
Black bream	*Acanthopagrus butcheri*	7
Western Australian salmon	*Arripis truttaceus*	7
Silver trevally	*Pseudocaranx dentex*	5
Australian herring	*Arripis georgianus*	4
Southern school whiting	*Sillago bassensis*	2
TOTAL		37



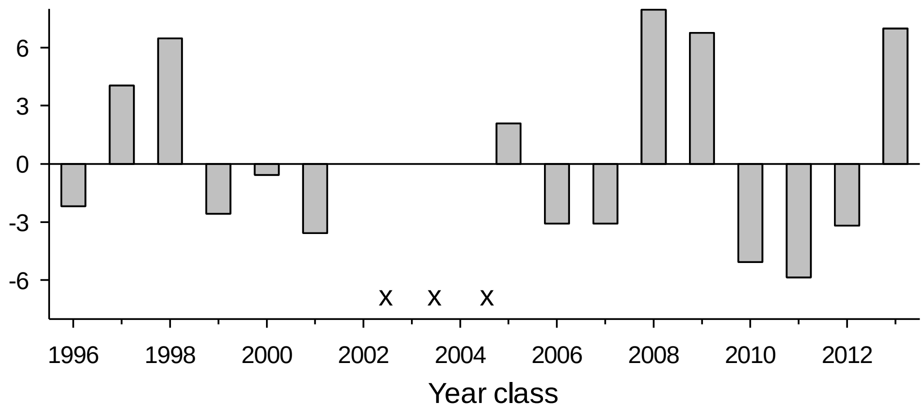
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 1

Total annual commercial catches of western Australian salmon in the South Coast and West Coast Bioregions, 1965 – 2013.



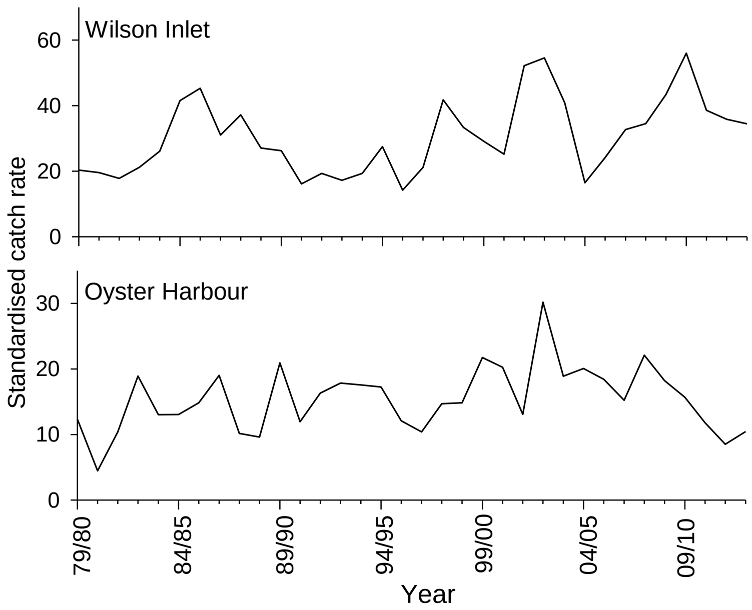
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 2

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 – 2013.



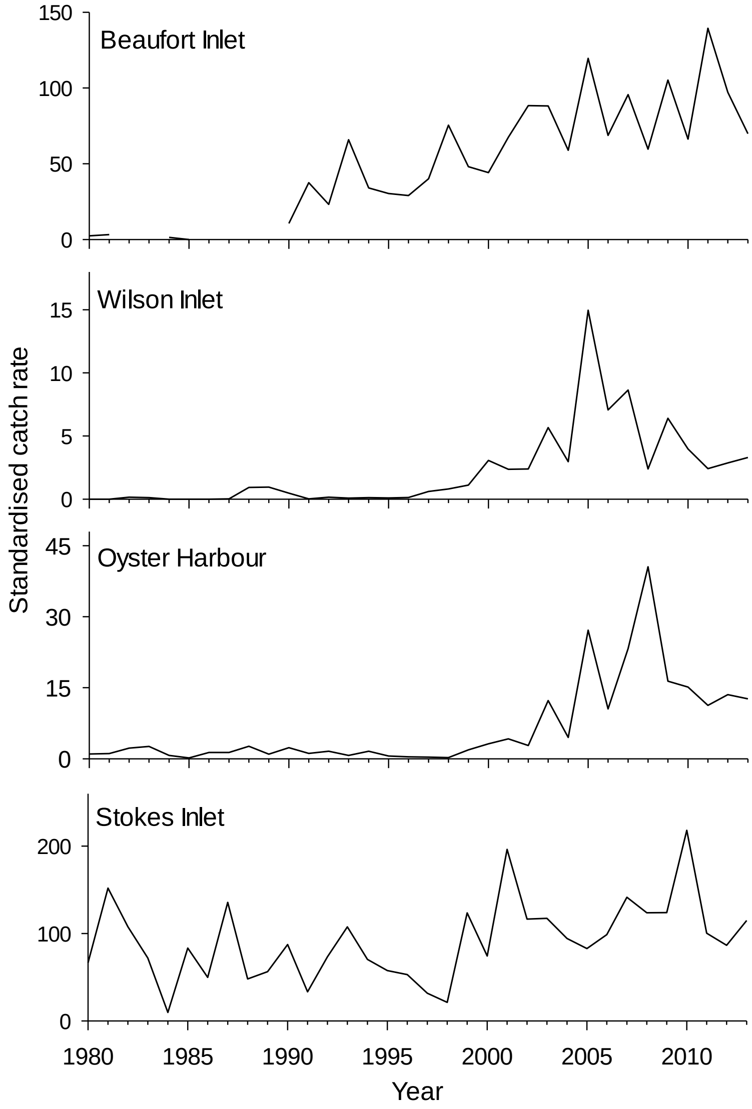
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 3

Annual fishery-independent relative recruitment index for western Australian salmon in the South Coast Bioregion, 1996 – 2013. 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 – 2012/13.



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 – 2013.

South Coast Purse Seine Fishery Report: Statistics Only

B. Molony, E. Lai, M. Holtz and S. Walters

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 Limited Entry Fishery Notice 1994* also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*), scaly mackerel (*Sardinalla lemuru*), sandy sprat (*Hyperlophus vittatus*) blue sprat (*Spratelloides robustus*) and maray (*Etrumeus teres*).

Boundaries

The 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 120ºE. The large Esperance Zone (Zone 4) extends from 120ºE to the WA/SA border. An additional zone (Zone 5) exists between Cape Leeuwin and Point D'Entrecasteaux but has not been significantly fished to date. The Zones are broken down into finer spatial scale blocks for reporting of catch and effort in the statutory 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 statutory return submissions.

Management arrangements

The SCPSF is primarily managed through output controls in the form of Individually Transferable Quota (ITQ) units. The quota season for the SCPSF runs from 1 July to 30 June the following year. 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 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 2012/13

Bremer Bay and Esperance: Cannot report as less than three vessels fished in 2012/13

Albany 1,128 tonnes

Effort in the SCPSF was much lower than in recent years with a total of 845 days of fishing (2009/10: 1,450 days; 2010/11: 1,290 days, 2011/12: 1,359 days). Effort levels decreased in all zones.

The 2012/13 pilchard catch in the South Coast Purse Seine fishery (1,408 tonnes) was the lowest since 2003 and ended the trend of slowly increasing catches since the late 1990s (South Coast Purse Seine Figure 2). Although catches in 2012/13 were much lower than previous years, the low effort levels do not suggest a decline in biomass as nominal daily catch rate has shown an increasing trend since reopening (South Coast Purse Seine Figure 2). Most of the commercial catches were reported from the Albany Zones (1,128 t). Less than 6 t of other pelagic species were also landed, dominated by yellowtail scad.

Overall effort and catches remain below those recorded during the late 1980s and 1990s. Catch rates are now greater than the pre-virus levels.

Fishery Governance

Target commercial catch range: Acceptable

For the 2012/13 season, the total pilchard catch (1,408 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 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 (2014/15)

Since 2006/07, the SCPSF listed species bycatch mitigation program has undertaken a range of measures to monitor and mitigate shearwater bycatch during the peak interaction period between 1 March and 30 April. These bycatch mitigation measures are reviewed annually and are continually being refined and improved.

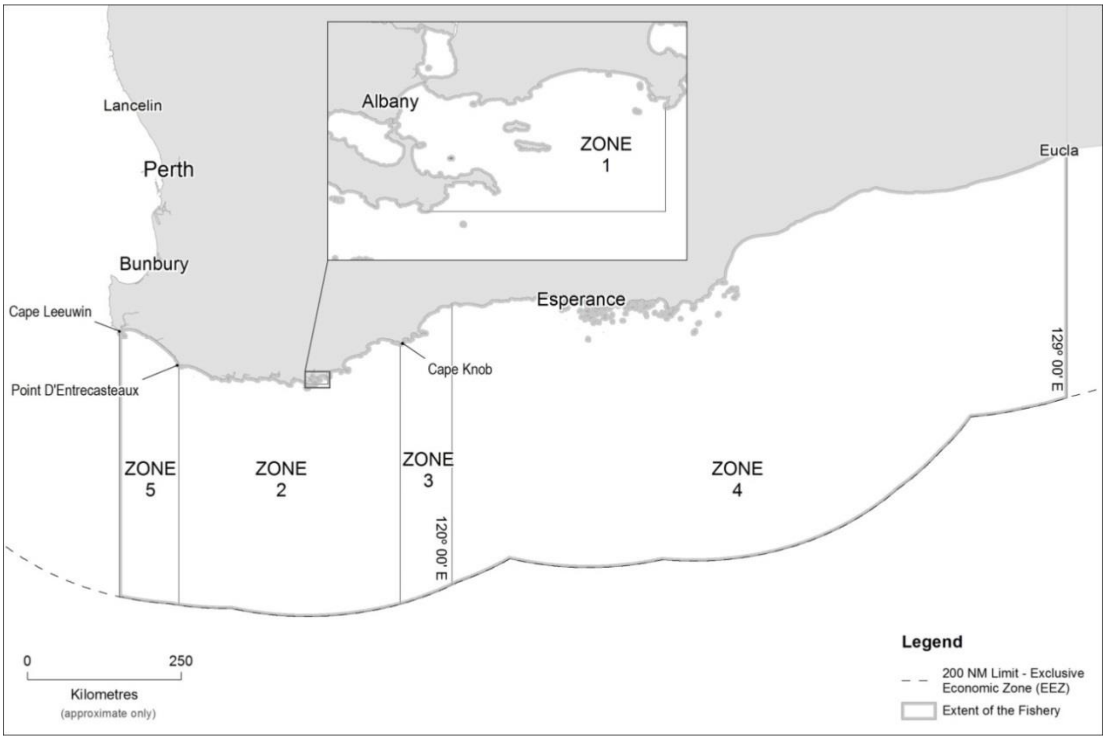
There are no significant legislative management changes planned for this fishery.

In 2014, the fishery underwent pre-assessment for Marine Stewardship Certification. Outcomes of the pre-assessment are expected in late 2014.

SOUTH COAST PURSE SEINE FISHERY TABLE 1

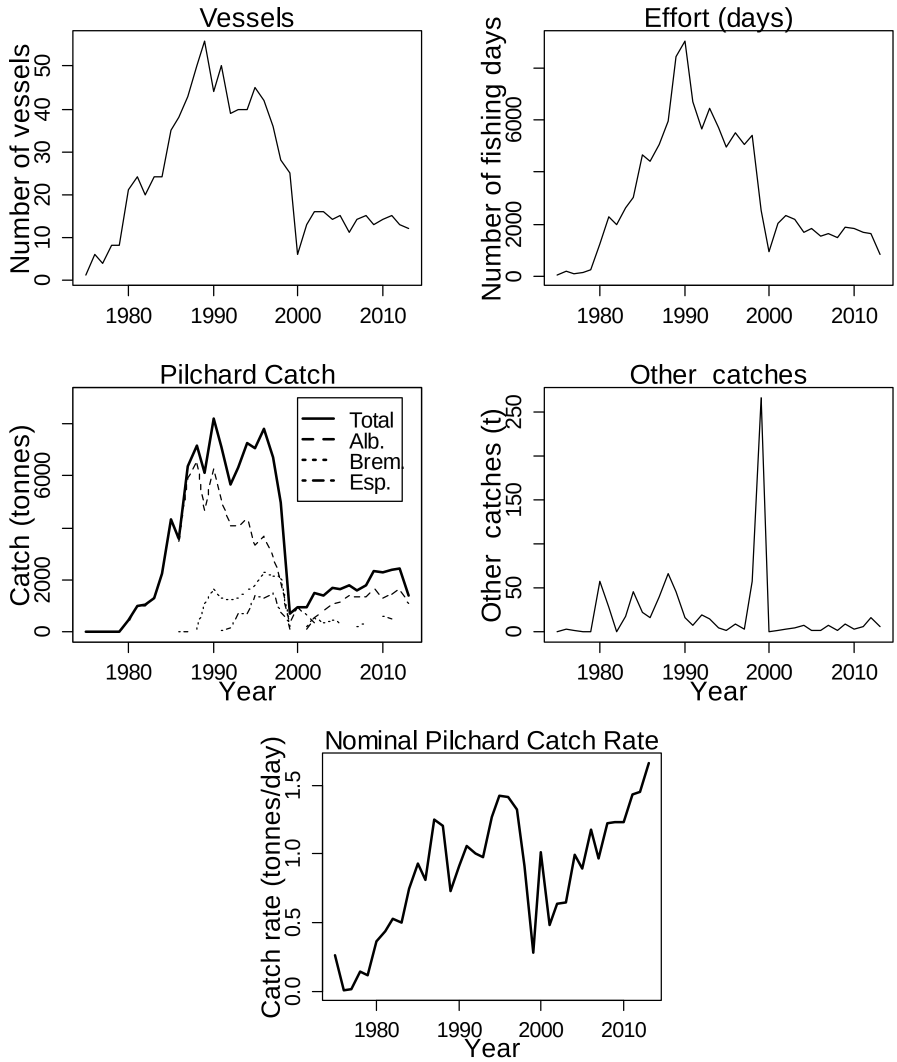
2012/13 pilchard catches and TACs in tonnes (t) for each of the major Management Zones. * Three or less vessels operated in each of these zones in 2012/13and cannot be reported.

Management Zone	TAC (t)	2012/13catch (t)	2012/13 catch as per cent of TAC
Albany (Zones 1 and 2)	2,683	1,128	42.0%
Bremer Bay (Zone 3)	1,500	*	-
Esperance (Zone 4)	1,500	*	-
Total for Fishery	5,683	1,408	24.8%



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

Number of vessels, total effort (days), annual catches of pilchards *(Sardinops)* by main zone, catches of other species and nominal pilchard catch rate in the South Coast Purse Seine Fishery, 1975 –2013. For pilchard catches, Alb. = Albany (Zones 1 and 2), Brem. = Bremer Bay (Zone 3), Esp. = Esperance (Zone 4). Catch data for years when less than three vessels fished in any zone in any one year are not shown due to confidentiality restrictions. However, the total pilchard catches for the SCPSF include catches reported from all Zones of the fishery for all years.

Temperate Demersal Gillnet and Demersal Longline Fisheries Status Report

M. Braccini, R. McAuley & J.O'Malley

Main Features

Status		Current Landings (2012/13)	
Stock level		Demersal Gillnet and Demersal Longline Fishery	
Gummy shark	Adequate	Total sharks and rays	938 t
Dusky shark	Recovering	Total scalefish	134 t
Sandbar shark	Recovering	Indicator species	
Whiskery shark	Adequate	Gummy shark	378 t
Fishing Level		Dusky shark	204 t
JASDGDLF Zone 1	Acceptable	Sandbar shark	49 t
JASDGDLF Zone 2	Acceptable	Whiskery shark	119 t
WCDGDLF	Acceptable	Sharks and rays by other commercial fisheries	3 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 (JASDGDLF) and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF).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 the catch for both fisheries. 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 Statewide 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 JASDGDLF 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 WCDGDLF 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 JASDGDLF (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 WCDGDLF (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 were permitted to use 27 m of gillnet or 9 longline hooks for 288 hours in the WCDGDLF, 264 hours or 380 hours in Zone 2 of the JASDGDLF. However in 2014 the unit value in the WCDGDLF in respect of hooks was reduced to 1 hook x 1 hour in response to a dramatic increase in demersal longline effort and catch of demersal scalefish. In addition to these effort controls all boats operating in the TDGDLF 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 species (ETPs). These include:

- the Statewide 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 WCDGDLF and the waters of the South Coast west of 118° E (in the JASDGDLF) to assist in the recovery of the over-exploited whiskery shark stock.

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 WCDGDLF, 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 WCDGDLF entitlements.

The TDGDLF 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* (EPBC Act). 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 reaccredited for the purposes of Part 13 of the EPBC Act which provides protection for operators who may interact with ETPs. 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 TDGDLF catch and the fisheries are being closely monitored to ensure the combined catch of demersal scalefish taken from the commercial sector does not exceed the target (see West Coast Demersal Scalefish Fishery Status Report).

Research summary

Major FRDC-funded studies of the shark fishery on the south and west coasts of Western Australia, undertaken over the period 1993–2004, have provided a detailed basis for monitoring and assessing the fisheries. The extensive biological and fishery information gained from these studies have been reported in three FRDC final reports, numerous international journal publications and have been used to develop stock assessment models for the fisheries' key target stocks to determine their likely responses to current levels of exploitation and to test alternative harvest regimes. A 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 statutory 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 Commonwealth's 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 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 Australian 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 2012/13)[1]:

All sharks (and rays):	**938 tonnes**
Indicator shark species:	**750 tonnes**
Gummy:	**378 tonnes**
Dusky[2]:	**204 tonnes**
Whiskery:	**119 tonnes**
Sandbar:	**49 tonnes**

Other finfish (i.e. non shark) catch: In addition to their primary catch of sharks, the JASDGDLF and WCDGDLF land a variety of scalefish species, which totalled 134 t in 2012/13 (Demersal Gillnet and Longline Figure 3). This catch included 37 t of demersal scalefish species taken in the West Coast Bioregion and 70 t of demersal scalefish taken in the South Coast Bioregion and a total of 26 t of non-demersal scalefish species (Demersal Gillnet and Longline Table 1). For details of other fisheries' demersal scalefish catches in those Bioregions, see West Demersal Scalefish Resource Status Report and South Coast Demersal Scalefish Resource 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 (3 t in 2012/13).

1 All reported weights are live weight

2 Dusky shark catches include catches of bronze whaler (*Carcharhinus brachyurus*), which cannot be accurately separated in catch returns data prior to 2006/07.

Recreational catch 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 TDGLF. 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.* 2013[3]). 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, a total of 2,664 individuals were retained. The most commonly retained species were also hound sharks (38%), followed by whalers (31%), other sharks (16%), wobbegongs (10%) and hammerheads (5%). 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 JASDGDLF (24 in Zone 1 and 33 in Zone 2) and 20 WCDGDLF permits, which can be used collectively in conjunction with a fishing boat licence. Only 5 Zone 1, 13 Zone 2 and 4 WCDGDLF vessels reported active fishing returns during 2012/13, similar to the levels of participation in the fisheries over the last five 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 $gn.hr^{-1}$), the hourly component of effort reported in monthly fishing returns prior to 2006/07 is known to be a poor indication of the time nets actually spent fishing (i.e. 'soak time'). With the transition from monthly to hourly effort entitlement units and the introduction of a daily catch and effort logbooks in 2006/07, actual soak times have been more accurately reported over the last seven years. Thus, the hourly components of fishing effort reported in monthly and daily fishing returns are not directly comparable. To allow for historical comparison and assessment of effort and CPUE trends in the fisheries, the entire time series of effort data have been recalculated in comparable units of kilometre

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.

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 JASDGDLF, 20 hours day^{-1} in Zone 2 and 24 hours day^{-1} in the WCDGDLF. Thus, specified fishing effort limits for each management zone of the fishery are:

JASDGDLF Zones 1 and 3:	84,075 km gn.hr $^{-1}$ (3,503 km gn.d^{-1})
JASDGDLF Zone 2:	144,102 km gn.hr $^{-1}$ (7,205 km gn.d^{-1})
WCDGDLF[1]:	67,692 km gn.hr^{-1} (2,832 km gn.d^{-1})

Expended effort in 2012/13 was 62,868 km gn.hr (3,494 km gn.d^{-1}) in Zone 1; 97,057 km gn.hr (5,368 km gn.d^{-1}) in Zone 2 and 10,034 km gn.hr (438 km gn.d^{-1}) in the WCDGDLF (Demersal Gillnet and Longline Table 1). The effort decline in the WCDGDLF is consistent with the gradual declining trend observed in recent years explained by the combination of reduction of fishing units due to the VFAS, area closures and new effort management regimes. When measured in km gn.hr^{-1}, 57% of the fisheries' effort capacity was utilised in 2012/13 (75% in Zone 1, 67% in Zone 2 and 15% in the WCDGDLF). When measured in km gn.d^{-1}, 69% of the fisheries' effort capacity was utilised in 2012/13 (100% in Zone 1, 75% in Zone 2 and 15% in the WCDGDLF). 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**

(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**

The current status of the whiskery and gummy shark stocks is adequate. The current effort levels and consequent CPUE and catch levels are all acceptable. The dusky and sandbar shark stocks are currently recovering. The current effort levels and consequent CPUE and catch levels are all acceptable, permitting recovery of the stock. It is highly likely that the four stocks are above the point where recruitment would be impaired.

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 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 integrated stock assessment model that incorporates contemporary catch, effort, size and movement information that is due to be developed over the next three years.

1 The WCDGDLF limit is adjusted to 64% of the 2001/02 effort level to account for the reduction in entitlement units arising from the 2008 Voluntary Fishery Adjustment Scheme.

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 overall increasing trend in the effective CPUE over the past eight 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 2006[1], 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. The decline in effective CPUE over the last two years will be considered in more detail during development of the new stock assessment models.

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.

Whiskery shark: Previous age structured modelling of the whiskery shark stock (based on hourly CPUE data) concluded that total biomass was depleted to less than 40% of 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 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 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. 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.* 2012[1]).

Listed species interaction: Negligible-Low

Historical on-board observer programs have shown that ETP species interactions were very low throughout the fishery. The Demersal Gillnet and Longline Table 2 details individual interactions between the fishery and all ETP species since recording began in fishery returns in 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) to Koolan Island, or within 3 nautical miles of the Abrolhos Islands baselines, where populations of turtles and Australian 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 57 and 74 crew were employed in the JASDGDLF and between 14 and 15 were employed in the WCDGDLF during 2012/13. 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 2012/13:

JASDGDLF: Level 2 - $1 - 5 million

WCDGDLF: Level 1 - <$1 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 $20/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	
JASDGDLF Zone 1	**Acceptable**
JASDGDLF Zone 2	**Acceptable**
WCDGDLF	**Acceptable**

The total catch for 2012/13 was within target range, similar to previous years and considered acceptable given effort levels.

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 listed 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 20004/05, except for 2006/07 when they were 5 tonnes below the minimum limit. The dusky shark catch in 2012/13 was 204 t which is within the target range of 200–300 t. Catch rates in 2012/13 were similar to previous years. It is worth noting that the fishery has not utilised its full entitlement during 2012/13 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 catches 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 are determined.

Sandbar shark catches exceeded their maximum acceptable level until effort declined dramatically in the WCDGDLF 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, 34 t in 2011/12, and 49 t in 2012/13. The historically low catch of sandbar sharks is likely to reflect the low level of fishing effort and other fleet dynamics in the WCDGDLF. 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 (2014/15)

The review of the whiskery shark 'pupping' closure for the 2013/2014 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 were expected to recruit to the fisheries around 2012/13, with the long-term 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 2014/15 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 form the TDGDLF to assist in evaluating management options to ensure interactions with Australian sea lions are maintained with acceptable levels.

On 1 June 2014 *West Coast Demersal Gillnet and Demersal Longline (Interim) Management Plan 1997* was amended to significantly reduce the value of a demersal longline unit in the West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery in response to a dramatic increase in demersal longline effort and catch of demersal scalefish. The value of a demersal longline unit was reduced from 288 hours at nine hooks to one hour at one hook.

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 ETPs without fear of prosecution. The accreditation carries a condition associated with addressing interactions between the fishery and Australian sea lions. The Department has convened an Australian sea lion Working Group (the Working Group) that consists of Departmental staff from both management and research, as well as industry, the conservation sector and the Department of Parks and Wildlife (formerly the Department of Environment and Conservation).

The Working Group are developing strategies to address the EPBC Act's Part 13 accreditation condition and specifically are identifying management measures that will 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.

The TDGDLF underwent MSC pre-assessment in 2014. Outcomes are expected in late 2014.

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 JASDGDLF (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 2012/13 catch (t live wt.) by the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Data are given by management zone and also by Bioregion (italicised). Indicator species and catches are highlighted in bold.

Name	Species or taxon	JASDGLF		WCDGDLF	Bioregion		Total
		Zone 1	Zone 2		South Coast	West Coast	
Sharks and rays							
Gummy	***Mustelus antarcticus***	**27.6**	**349.4**	**0.7**	**358.5**	**19.1**	**377.7**
Dusky whaler	***Carcharhinus obscurus***	**120.6**	**78.5**	**5.0**	**97.1**	**107.0**	**204.1**
Whiskery	***Furgaleus macki***	**27.2**	**90.5**	**1.4**	**102.3**	**16.8**	**119.1**
Sandbar	***Carcharhinus plumbeus***	**21.4**	**5.9**	**21.3**	**13.4**	**35.2**	**48.6**
Hammerheads	F. Sphyrnidae	21.6	37.5	0.8	42.9	17.0	59.9
Spinner (long nose grey)	*Carcharhinus brevipinna*	50.0	9.5	8.0	16.5	51.1	67.6
Wobbegongs	F. Orectolobidae	17.8	7.7	2.1	13.6	14.0	27.6
Rays	Batoidea	3.6	5.9	2.3	6.2	5.6	11.8
Common saw shark	*Pristiophorus cirratus*	1.2	6.6		6.6	1.2	7.8
Other elasmobranchs		4.8	6.2	2.4	7.0	6.4	13.5
Total elasmobranchs		**295.8**	**597.6**	**44.1**	**664.1**	**273.4**	**937.5**
Scalefish							
Queen Snapper	*Nemadactylus valenciennesi*	10.5	22.0	<0.1	28.0	4.6	32.6
Blue Groper	***Achoerodus gouldii***	**18.6**	**14.8**	**0.2**	**21.6**	**12.0**	**33.6**
Dhufish	***Glaucosoma hebraicum***	**8.6**	**0.5**	**1.8**	**2.1**	**8.8**	**10.9**
Pink snapper	***Pagrus auratus***	**9.7**	**5.5**	**2.8**	**9.0**	**8.9**	**17.9**
Boarfishes	F. Pentacerotidae	1.3	5.3		5.5	1.1	6.6
Samsonfish	*Seriola hippos*	6.8	2.3	0.9	3.1	6.9	10.0
Redfishes	***Centroberyx* spp.**	**0.2**	**3.3**	**<0.1**	**3.5**	**0.1**	**3.6**
Mulloway	*Argyrosomus hololepidotus*	2.3	2.3	0.5	2.3	2.8	5.2

Name	Species or taxon	JASDGLF Zone 1	JASDGLF Zone 2	WCDGDLF	Bioregion South Coast	Bioregion West Coast	Total
Sweetlips	F. Haemulidae			0.6		0.6	0.6
Baldchin groper	***Choerodon rubescens***			**0.6**		**0.6**	**0.6**
Other scalefish		7.8	1.8	2.5	4.5	7.5	12.1
Total scalefish		65.9	57.8	9.9	79.7	53.9	133.6
'Demersal scalefish suite' component		49.0	51.7	6.6	70.0	37.2	107.2
Fishing effort (km gn d)		3,494 (100)[1]	5,368 (75)[1]	438 (15)[2]			9,300 (69)[2]
Fishing effort (1000 km gn hr)		63 (75)[3]	97 (67)[3]	10 (15)[3]			170 (57)[3]

1 Percentage of respective 2001/02 levels

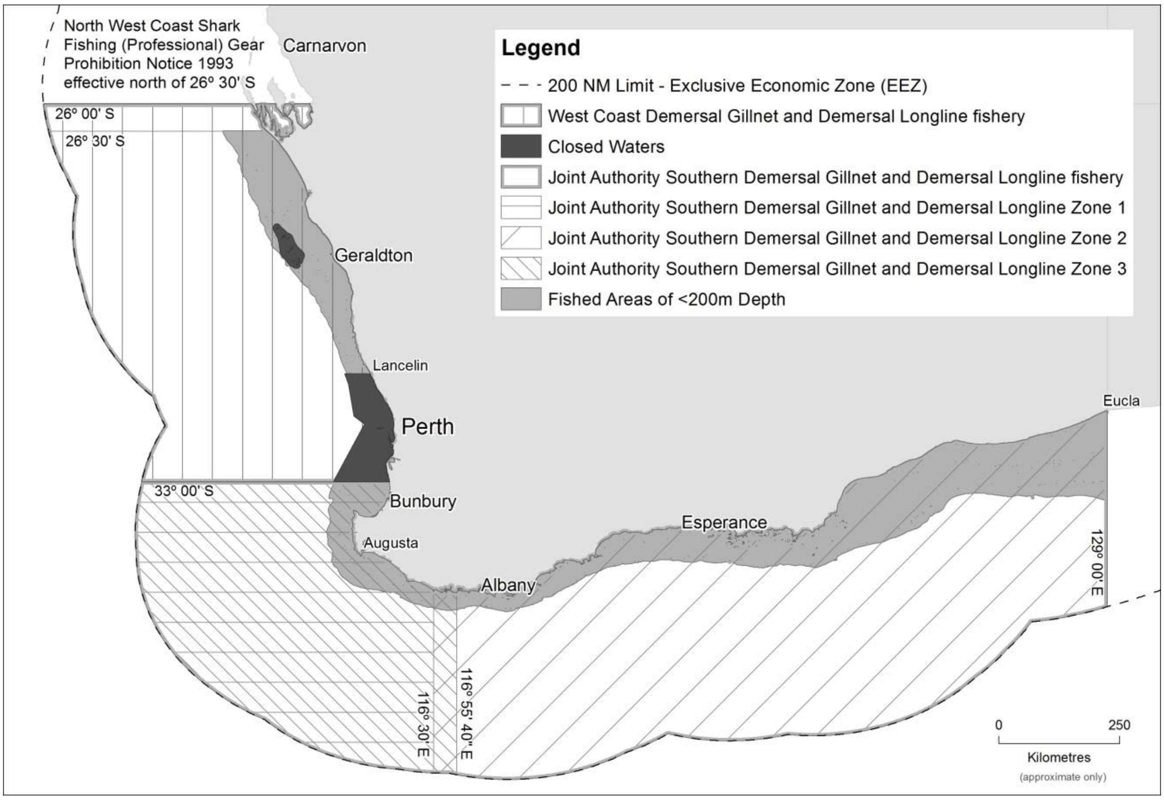
2 Percentage of VFAS adjusted 2001/02 levels

3 Values in parentheses are percentages of each management zone's maximum hourly effort capacity

DEMERSAL GILLNET AND LONGLINE TABLE 2

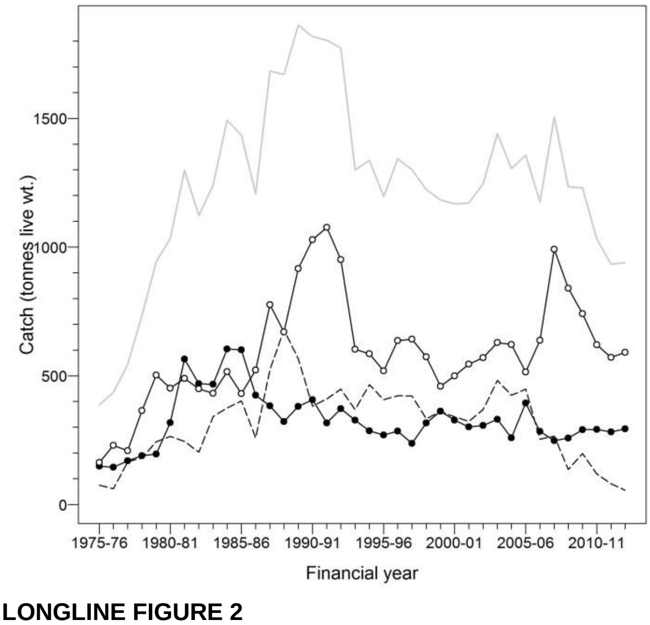
Recorded interactions with Endangered, Threatened, Protected (ETP) species.

ETP SPECIES	2006/07		2007/08		2008/09		2009/10		2010/11		2011/12		2012/13	
Alive(A)/Dead(D)	A	D	A	D	A	D	A	D	A	D	A	D	A	D
Dolphins		6	1		1	2		2		3				
Manta Rays	2								2				1	
Muttonbird, General								7	4					
Sawfish, General			1						1					
Sea Birds	1	3		2	2	1								
Sea Lions						2						3		1
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	68	19
Shearwater, Fleshfooted								2						
Snake, Sea				2										
Turtle, General	4	3	5		2	2	2	1	1		3		3	
Whales					1									
White Shark	10	3	10	3	14	2	2	1	3	5	19	3	17	1



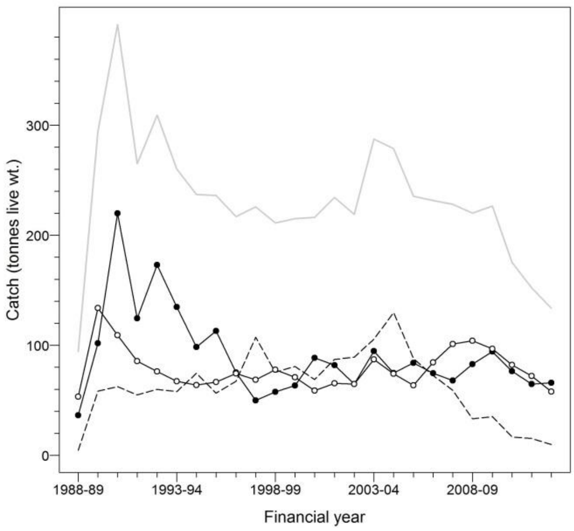
DEMERSAL GILLNET AND LONGLINE FIGURE 1

Management boundaries of the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Black shading represents fished areas of less than 200m depth.



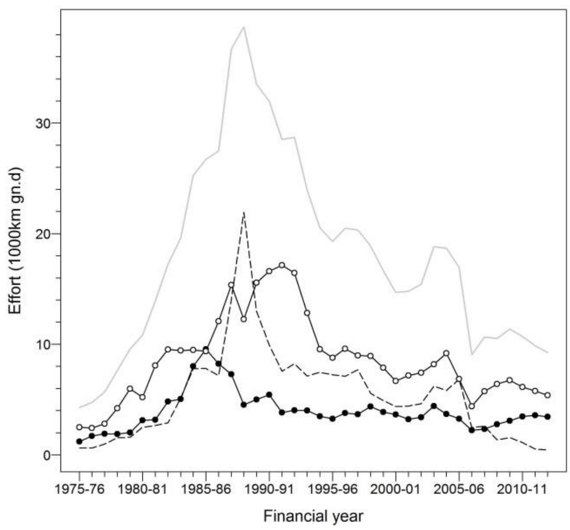
DEMERSAL GILLNET AND LONGLINE FIGURE 2

Total elasmobranch catches. Black circles = JASDGDLF Zone 1; white circles = JASDGDLF Zone 2; dashed black line = WCDGDLF; plain grey line = total from the three management zones.



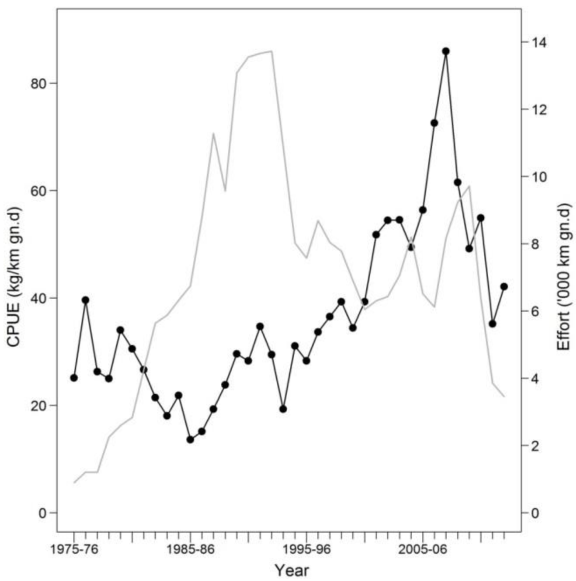
DEMERSAL GILLNET AND LONGLINE FIGURE 3

Total scalefish catch. Black circles = JASDGDLF Zone 1; white circles = JASDGDLF Zone 2; dashed black line = WCDGDLF; plain grey line = total from the three management zones. Catches prior to 1988/89 cannot be distinguished from other fisheries' gillnet and longline catches and are omitted.



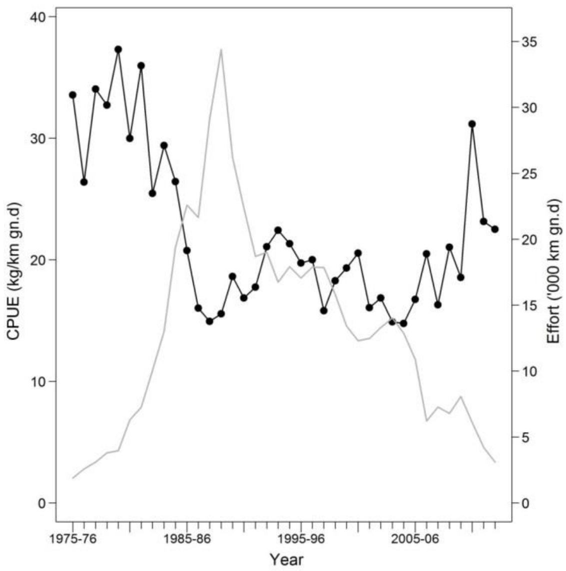
DEMERSAL GILLNET AND LONGLINE FIGURE 4

Standardised demersal gillnet and demersal longline effort. Black circles = JASDGDLF Zone 1; white circles = JASDGDLF Zone 2; dashed black line = WCDGDLF; plain grey line = total from the three management zones.



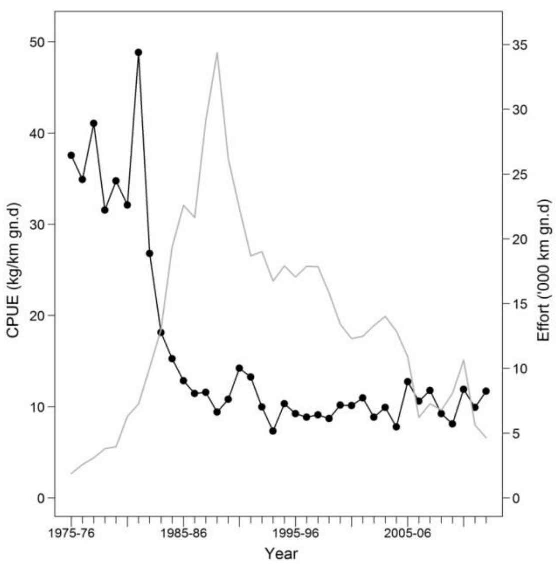
DEMERSAL GILLNET AND LONGLINE FIGURE 5

Gummy shark effective effort (grey line) and CPUE (black circles).



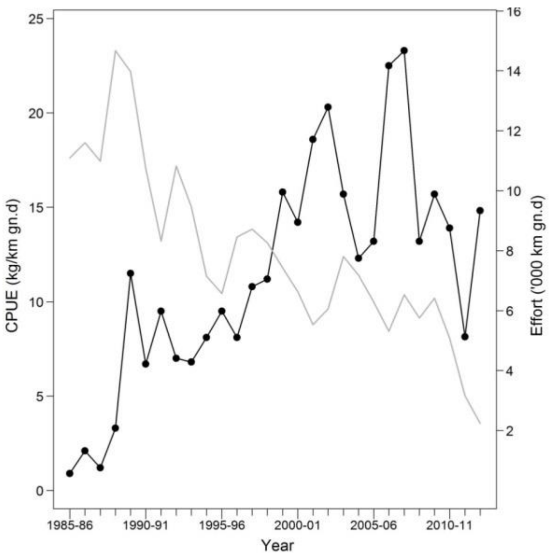
DEMERSAL GILLNET AND LONGLINE FIGURE 6

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 S. Walters

Fishery Description

Commercial

Operators in this fishery target demersal scalefish species such as pink snapper, Bight redfish, blue morwong (queen snapper) and hapuku, and the pelagic Samson fish 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 the catch reported here also includes minor quantities of demersal scalefish taken in nearshore waters by haul nets and set nets whilst targeting nearshore species (e.g. herring, whiting, mullet), and by fish trapping whilst targeting leatherjackets.

The take of scalefish by trawl methods, salmon by line and beach netting, estuarine netting and pilchards by purse seine in the South Coast Bioregion are separately managed fisheries and their catches are not included here. 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 and reported separately (see Temperate Demersal Gillnet and Longline Fisheries Status Report).

Recreational

Recreational fishers, mostly using line based methods from boats, also take these species.

Boundaries

This wetline fishery operates in the South Coast Bioregion's (SCB) oceanic waters from near Black Point at 115° 30' E to the WA/SA border at 129° E (South Coast Demersal Scalefish Resource 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 2013):

61.3 tonnes demersal scalefish

53.1 tonnes non-demersal scalefish

Commercial

Catch estimates (South Coast Demersal Scalefish Resource Table 1) are monitored through the Department's statutory Catch and Effort Statistics (CAES) return 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 SCB. These indicator species are used to monitor the status of the resource and represent the large majority of the catches in this suite by the commercial fishery. Hapuku, blue-eye trevalla and eightbar grouper have been identified as indicator species for the offshore demersal suite.

Two new catch statistics are included in this chapter for the first time as they are unreported elsewhere: Samson fish, one of the indicator species for the SCB pelagic suite; and the catch of leatherjackets unconnected to the South Coast Estuarine Managed Fishery and taken mostly by trap. The high leatherjacket catch in 2011 was due to a concerted attempt to develop that fishery at the time.

The catch of 61.3 t of demersal scalefish during 2013 is much lower than any year since at least 2000, which had ranged from 104 to 147 tonne (South Coast Demersal Scalefish Resource Figure 2). Pink snapper, Bight redfish, blue morwong and hapuku catches were at their lowest since 2000. This may be due to reduced fishing effort, although the reason is currently not well understood. In addition, 53.5 t of non-demersal scalefish catch was reported in 2013, including Samson fish (13.1 t), leatherjackets species (9.0 t) and an unusually high catch of bonito (21.7 t).

Recreational

A survey of boat based recreational fishing for the 12 months to 29 February 2012 estimated the SCB catch (tonnes ±standard error) of some demersal indicator species: Bight redfish 11.8 (±1.7), blue morwong 12.0 (±1.8), snapper 9.4 (±2.3). The recreational catch of Samson fish was estimated to be 670 fish kept and 568 fish released.

Fishery Governance

Target commercial catch range: Not available

Current Fishing (or Effort) Level: Not available

A formal catch range has not been developed for this fishery, but will be considered following the completion of a Western Australian Natural Resource Management (WANRM) Office funded research project in 2015, described under New Management Initiatives (below).

New management initiatives (2014/15)

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 SCB and consequential resource sharing issues.

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 (pink snapper, Bight redfish, blue morwong and western blue groper), and to elucidate the stock structure of Bight redfish. A research report will be finalised in 2015 which will inform the development of more formal fishery management arrangements.

The Department commenced a review of wetline fishing (including ‘open access’ commercial line, net and fish trap fishing) on the South Coast in late 2013. Through this review, the Department intends to implement more formal management arrangements for these open access fisheries to address stakeholder concerns and provide an improved framework for the sustainable management of commercial line, net and trap fisheries into the future.

This fishery underwent pre-assessment for Marine Stewardship Certification in mid 2014. Outcomes will be available late in 2014.

External Factors

Bight redfish are an important component of the catch of the Great Australia Bight Trawl Sector (GABTS), part of a Commonwealth managed fishery operating across southern Australia as far west as Cape Leeuwin. Off the Western Australia coast (i.e. west of 129 º E) it operates outside State fishery shelf waters (depth less than 200 metres), except for east of 125º E (approximately 250 km east of Esperance) where shelf waters are fished. A preliminary estimate of 297 t was taken in the 2012-13 fishing season, including 37 t from all waters (shelf and slope) off the West Australian coastline. 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 Australian Fisheries Management Authority that manages the GABTS.

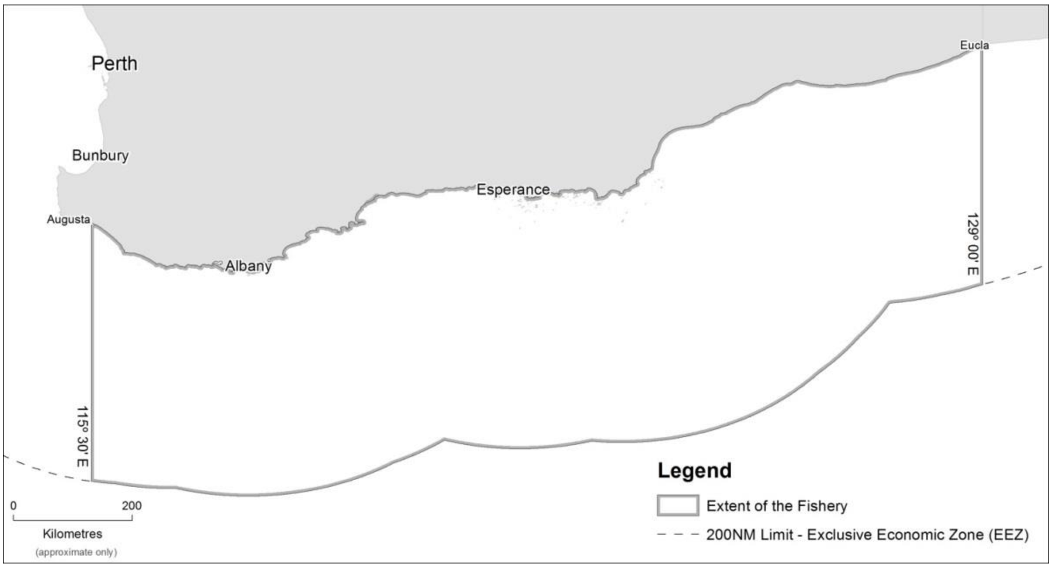
SOUTH COAST DEMERSAL SCALEFISH RESOURCE TABLE 1

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, 2009–2013.

Species	2009	2010	2011	2012	2013
Bight Redfish*	33.5	31.2	36.4	45.6	21.3
Blue groper	1.4	0.7	1.4	0.4	0.9
Blue Morwong	8.1	5.0	5.2	4.4	4.0
Pink Snapper	44.9	40.7	30.2	27.2	17.4
Hapuku	18.5	12.8	16.8	14.5	7.4
Blue-eye trevalla	2.4	2.2	3.4	3.1	0.6
Eightbar grouper	0.8	0.6	1.6	3.4	1.5
Other demersal scalefish	16.7	14.8	11.8	10.1	8.3
Total demersal scalefish	126.4	108.0	106.8	108.8	61.3
Samson fish (pelagic)	16.2	15.4	19.4	13.3	13.1
Leatherjackets	4.5	4.9	39.1	6.2	9.0
Total other non-demersal scalefish**	8.4	4.6	11.5	9.3	31.4
Total Scalefish	155.5	133.0	176.8	137.6	114.8

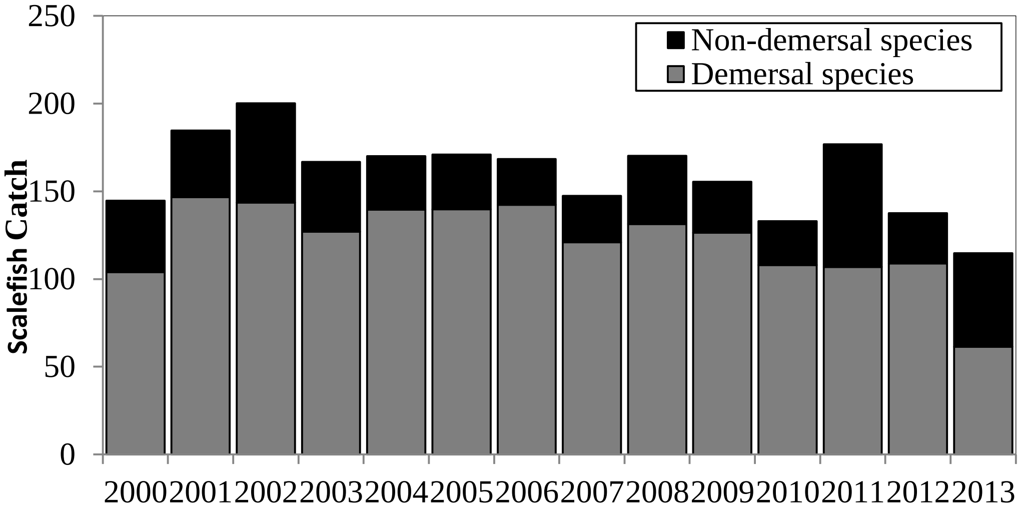
* Estimates of Bight redfish catches include fishes reported as ‘Bight redfish’, ‘yelloweye redfish’ and ‘redfish’, confirmed by recent catch sampling to be almost exclusively Bight redfish.

** Non demersal scalefish includes fishes from the pelagic and nearshore suites excluding samson fish and leatherjackets.



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—2013.

AQUACULTURE

Regional Research and Development Overview

Greenlip abalone (*Haliotis laevigata*) 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 Management and Environmental Monitoring Plan (MEMP), which includes provisions for biosecurity. Independent audits are undertaken to ensure compliance with the Biosecurity Plan.

An offshore abalone farm near Augusta has achieved encouraging results for abalone being cultured using purpose-built concrete grow-out structures located on the sea bed.

Following the successful outcome of trials undertaken at two sites under an Exemption issued by the Department of Fisheries, the operator has submitted an application for a variation to its current aquaculture licence to add two new sites; and an application for a new aquaculture lease for the two new areas. The Department is in the final stages of assessing the applications.

The abalone aquaculture industry sector is now operating and being managed according to the July 2013 *Abalone Aquaculture in Western Australia Policy*. A key purpose of the Abalone Aquaculture Policy, which places a high level of emphasis on biosecurity, 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 District Offices 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 conducted on land, at-sea, at commercial fish processors establishments, aquaculture sites and wholesale/retail outlets. Vessels, catches, fishing gear, marine safety equipment are inspected and commercial and recreational licences are checked.

There are two part-time South Coast Marine Education Officers who deliver the Education program for the South Coast.

Activities during 2012/2013

Compliance

Due to the variety of commercial and recreational fisheries, expanse of coastline and the variable and seasonal weather conditions, FMOs employ a risk management driven approach to prioritise and plan compliance activities.

Overall, FMOs delivered a total of 3,665 hours ‘on-patrol’ officer hours to the bioregion, similar to that in 2011/12 (South Coast Compliance Figure 1).

Commercial Fisheries

FMOs made contact with a total of 392 commercial fishers in the field, across the south coast. Offences detected included licensing issues, quota management and breaches of individual fisheries management arrangements (South Coast Compliance Table 1.).

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.

During the year, 12 infringement warnings and 10 infringement notices were issued with a further 10 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. FMOs contacted a total of 9680 recreational fishers. During 2012/13, there were 123 infringement warnings and 55 infringement notices issued and 7 prosecution actions were taken against recreational fishers (South Coast Compliance Table 1).

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 Officers. Activities included the delivery of school programs and excursions to primary and secondary students across the region in structured sessions. 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. These included agricultural shows and science expos. Where possible, education initiatives were delivered in collaboration with other environmental education providers. Partnerships included Recfishwest, 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 2013/2014

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.

There will be a 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 will continue to be driven with FMOs attending several investigation and management courses.

Peak fishing periods including higher influx of holiday makers and fishers will become a focus of both high-profile presence of FMOs, and of community education activities. The Mobile Recreational Fishing vehicle will be rostered to conduct patrols in the Bioregion and increase the high profile presence with roster start-times 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 Parks and Wildlife, and the 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 recreational fishers for commercial purposes will concentrate on 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 at schools and school excursions focused on sustainability and key departmental initiatives, as well as providing 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

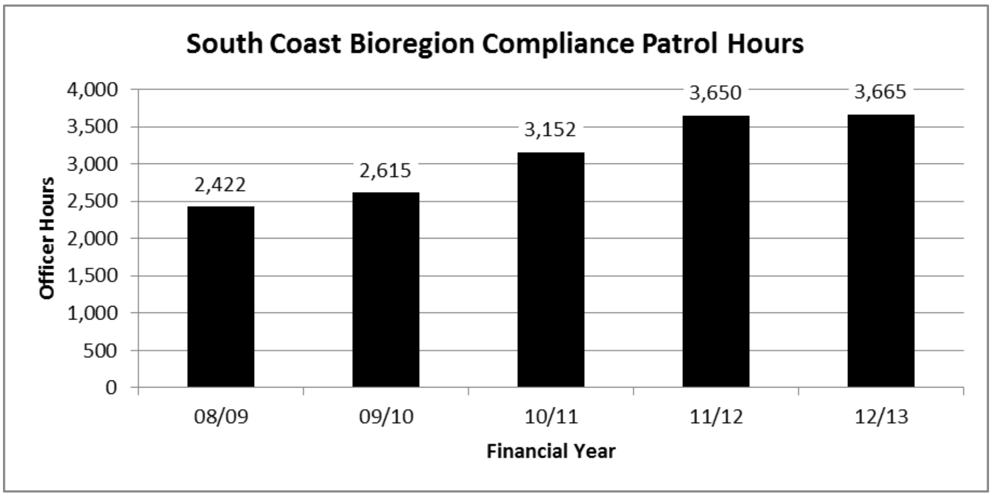
Summary of compliance and educative contacts and detected offences within the South Coast Bioregion during the 2012/13 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	3,665 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	392
Infringement warnings	12
Infringement notices	10
Prosecutions	10
Fishwatch reports**	6
VMS (Vessel Days)***	2,996
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	9,680
Infringement warnings	123
Infringement notices	55
Prosecutions	7
Fishwatch reports	26
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	1,082
Fishwatch reports	0

*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 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 2012/13 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

Listed 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

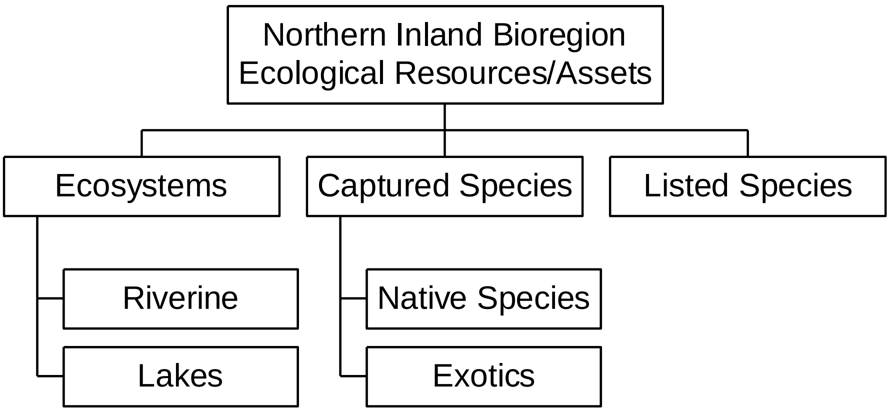
Ecosystem	Risk	Status and Current Activities
Ecosystems	LOW (non fishing)	Minimal threats and these would be due to non-fishing activities

Captured fish species

Fish species	Risk	Status and Current Activities
Finfish Native	LOW	The stocks of freshwater fish are not under any material threat

Listed species

Listed fish species	Species	Risk	Status and Current Activities
Listed 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, G. Mitsopoulos, C. Skepper, A. Thomson and D. Wallis

Fishery Description

Commercial

The only commercial freshwater fishery in Western Australia is in Lake Argyle in the north-eastern. 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 listed 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 2013): 78 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 1). 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 2013 catch of 78 t is the lowest reported catch since 2011.

Nominal effort is this gillnet fishery is currently assessed using block days fished. Effort for silver cobbler is calculated as the effort associated with any catch of silver cobbler in each block of the LASCF. The effort used in the fishery is currently being reviewed. The net lengths reported by some fishers have been inconsistent. Fishing practices vary across the vessels used in the fishery and are not uniform. Furthermore, reporting practices are inconsistent across time. As such, block day is the only reliable effort measure available.

During 2013, three vessels were active in the fishery, and generated a total effort of 459 block days. This level of effort is higher than that reported from 2009 – 2012 (a range of 255 – 426 block days), and is similar to that reported in 2008. There is considerable latent effort available in the LASCF.

The overall catch in 2013 (78 t) was lower than 2012 (118 t) despite greater effort being expended across fewer vessels. The fishery requires further monitoring.

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 2013 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: 93-180 tonnes

The target commercial catch range is calculated based on catch information from 1990 – 1998, a period during which the fishery was stable and levels of exploitation were considered to have been sustainable. The target catch range for silver cobbler has recently been revised to be consistent with the reference points and control rules adopted for other fisheries. This catch range previously represented a confidence interval calculated using time series analyses (statistical control charting) of annual catch for the fishery. In contrast, the current approach specifies this range as the values within the minimum and maximum catches observed during the reference period. The revised target catch range (93 – 180 t) is similar to that previously used (90 – 155 t).

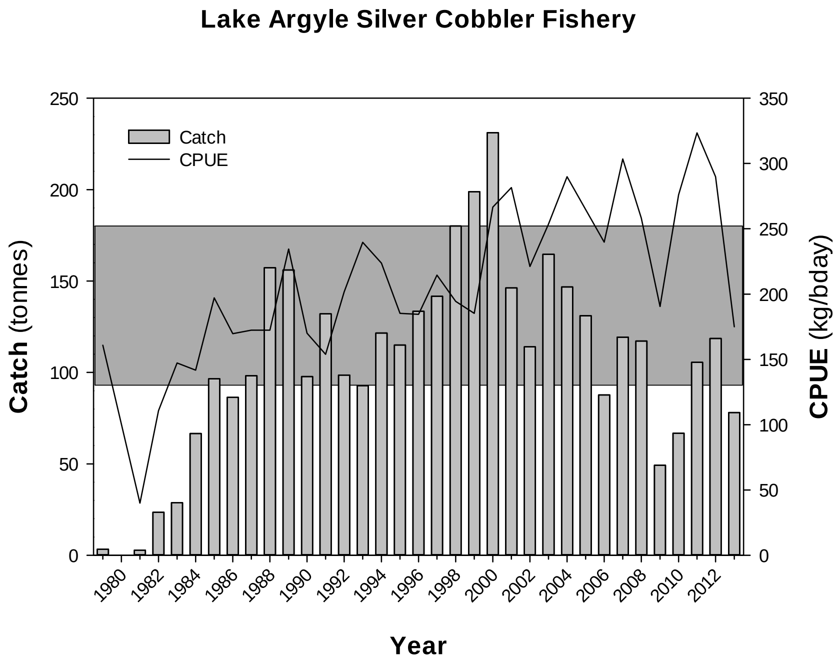
Current Fishing (or Effort) Level Acceptable

The level of catch in the fishery in 2013 is below the acceptable catch range. This level of catch is considered acceptable as the effort in the fishery is still low and the catch rate is within the historical range. The lower levels of catch in the fishery in 2009, 2010 and 2013 are likely to have allowed the stock to increase in size.

New management initiatives (2014/15)

The next management review for the Fishery is scheduled for 2016/2017.

The LASCF underwent MSC pre-assessment in late 2013. Outcomes are expected in late 2014.



LAKE ARGYLE SILVER COBBLER FIGURE 1

The annual catch and catch per unit effort (CPUE, kg/block day) for silver cobbler in the Lake Argyle Silver Cobbler Fishery over the period from 1979 to 2013. The upper and lower bounds of the target commercial catch range are shown by the shaded catch area between 93 and 180 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 was delayed while the relevant group reviews its options.

A licence to produce barramundi has been issued, but is currently inactive; the licence holder has made substantial progress in its efforts to secure tenure over a land based lease to support its proposed aquaculture activities.

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;
- listed 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. Both the Fitzroy River and the Ord River are identified as major breeding areas for barramundi.

Officers pay particular attention to catch of any protected sawfish species, disused recreational fishing gear and localised impacts of fishers.

Activities during 2012/13

During 2012/13, Fisheries and Marine Officers (FMOs) recorded 1,529 hours of active compliance patrol time in the Northern Inland bioregion (Northern Inland Compliance Patrol Hours Figure 1).

Across the Northern Inland bioregion, personal contact was made with 4,095 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, listed 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 2013/14

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 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.

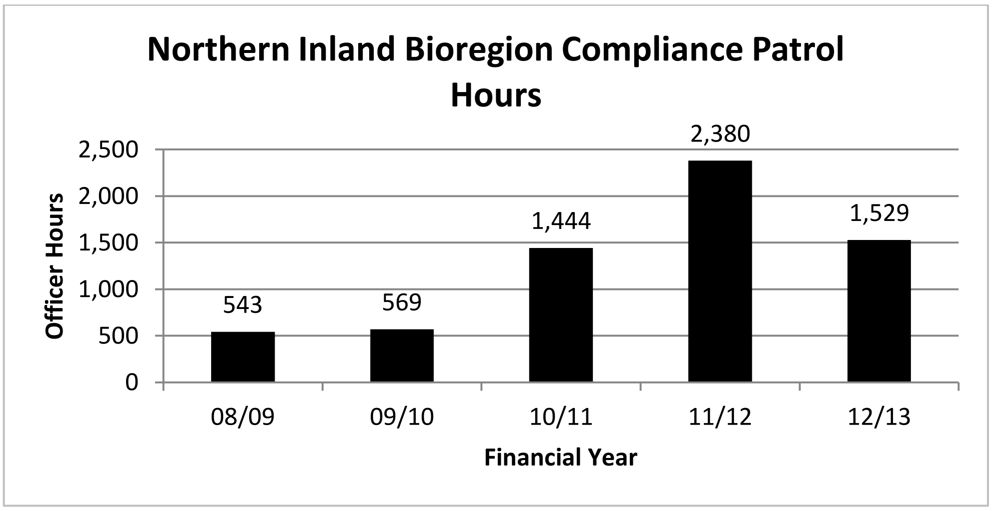
NORTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Northern Inland bioregion during the 2012/13 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	1,529 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY[1]	
Field contacts by Fisheries & Marine Officers	11
Infringement warnings	3
Infringement notices	5
Prosecutions	6
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	3,322
Infringement warnings	3
Infringement notices	8
Prosecutions	3
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY	
Field contacts by Fisheries & Marine Officers	762
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 **Fishwatch calls relating to the Northern Inland bioregion are not recorded as the service provider reporting mechanism only details calls referred to district offices. Calls relating to the Northern Inland bioregion will be included in both the North Coast and Gascoyne Coast Bioregion totals.



NORTHERN INLAND COMPLIANCE FIGURE 1

This figure gives the "On Patrol" officer hours showing the level of compliance patrol activity delivered to the Northern Inland Bioregion over the previous five years. The 2012/13 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

Listed 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
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.

Captured fish species

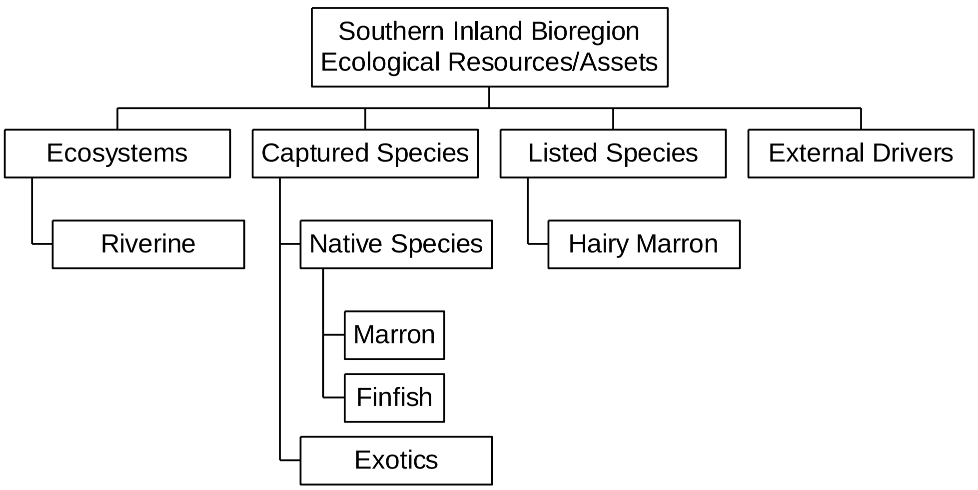
Fish species	Risk	Status and Current Activities
Finfish Native (not listed)	HIGH (non-fishing)	The abundance and distribution of most native fish have been severely impacted due to reduced rainfall and land management practices. This has led to widespread fragmentation of native fish populations (i.e. 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	HIGH (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.

Listed species

Listed fish species	Species	Risk	Status and Current Activities
Listed 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 above)

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, F. Trinnie, K. Ryan, B. Rome

Fishery Description

The South-West recreational freshwater fishery is primarily an angling fishery for rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and redfin perch (*Perca fluviatilis*). In addition, anglers take the native freshwater cobbler (*Tandanus bostocki*). Rainbow and brown trout are the subject of an annual controlled stocking program by the Department of Fisheries, while the non-native species 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 licence authorises anglers to fish for freshwater finfish species in all inland waters of Western Australia south of 29^{o} latitude (Greenough) and above the tidal influence including all lakes, dams, rivers and their tributaries.

Management arrangements

Access to this fishery is controlled by licences, 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*), brown trout (*Salmo trutta*), freshwater cobbler (*Tandanus bostocki).* Rainbow and brown trout have a minimum legal size limit of 300 mm, but no minimum legal size limit applies to freshwater cobbler. No bag limit or size limit applies to redfin perch (*Perca fluviatilis*) and anglers are encouraged not to return any redfin to the water as this feral species negatively affects the marron fishery and predates actively on trout fry.

The trout stocking program administered by the Department of Fisheries in consultation with Recfishwest focuses on public waters where trout have been stocked or been present since the 1930s. The Departments trout stocking processes are conducted in accordance with the Department’s Five-Year Management Strategy for the Recreational Trout Fishery- Fisheries Management Paper 250. This strategy, developed by the Department in collaboration with Recfishwest and the Recreational Fisheries Stakeholder Sub-Committee (RFFSS), ensures that an appropriate level of management is provided for the translocation of trout into rivers and dams of the South West of Western Australia. All trout stocked into public waters are produced at the Department of Fisheries, Pemberton Freshwater Research Centre (PFRC).

There were no significant change to the management arrangements between 2013 and 2014.

Landings and Effort

Commercial catch estimate (season 2013/14)

Not applicable

Recreational catch estimate (season 2013/14)

58,203 retained fish

At the end of the 2014 season, a phone recall survey was undertaken of 397 metro and 398 country respondents (7.7% of licence holders in that season). Extrapolation of the survey results estimated that approximately half of all licence holders actively fished (Freshwater Angling Table 1). Therefore, there is a large proportion of people that purchase a license but don’t actually use it.

The estimated total effort for 2014 was 34,021 days (with standard error ±2,368), which was an increase from 23,646 in 2013 (Freshwater Angling Table 1, Freshwater Angling Figure 1a).The estimated total number of licensed fishers was 10,370 in 2014, which was an increase from 9,718 in 2013 (Freshwater Angling Table 1). The estimated total number of licensed fishers that participated in freshwater angling was 5,357 in 2014; an increase from 4,787 in 2013 (Freshwater Angling Table 1). The average number of days fished per fisher was 6.35 days in 2014, which was higher than the 4.94 in 2013. Harvey Dam continued to receive the highest fishing pressure (45% of all effort) (Freshwater Angling Table 2). The highest proportion of fishing in rivers was undertaken in the Warren River (Freshwater Angling Table 2). Fishing effort in the main rivers in Freshwater Angling Table 3 was generally lower than previous years, whilst the effort in “other rivers” has increased. The cause of the increase fishing effort is unknown, but it demonstrates that fishers are prepared to visit new areas in search of fish.

The estimated total recreational catch from south-west freshwater angling across all species for 2014 was 103,017 (by number) (fig 2b) of which 58,203 were kept and 44,814 were released. This was an increase from 2013, where the estimated total recreational catch was 61,075 (by number) (Freshwater Angling Table 3).

The estimated catch per unit effort (CPUE) for all species combined in 2014 (3.03 (number of fish per fisher day)) was higher than the CPUE estimated for 2013 (2.58) (fig 1a). In 2014, the CPUE for fish kept (1.71 fish per fisher day) was higher than the CPUE for fish released (1.32), which was similar to 2013 where the CPUE for fish kept (1.98) was higher than the CPUE for fish released (0.61). For information on individual species, refer to fig 2). Catches of all species are relatively stable.

Of particular interest is the large number of trout that are released by fishers each year. From the available data, it is not possible to accurately determine if the fish released because they are undersized, or if catch and release forms a large part of the fishery.

FRESHWATER ANGLING TABLE 1

Summary of survey respondent effort and total effort extrapolated to all licence holders for seasons (2012 to 2014).

Season	Stratum	Licences	Total effort			
			Total fishers	Mean days	Total effort days	Std error (Total effort)
2012	Ctry	3591	1742	6.24	10868	
2012	Metro	4950	2426	4.01	9726	
		8541	4167	4.94	20594	1979
2013	Ctry	4004	1902	7.35	13979	
2013	Metro	5714	2886	3.35	9667	
		9718	4787	4.94	23646	2302
2014	Ctry	4631	2350	7.40	17393	
2014	Metro	5739	3007	5.53	16628	
		10370	5357	6.35	34021	2368

FRESHWATER ANGLING TABLE 2

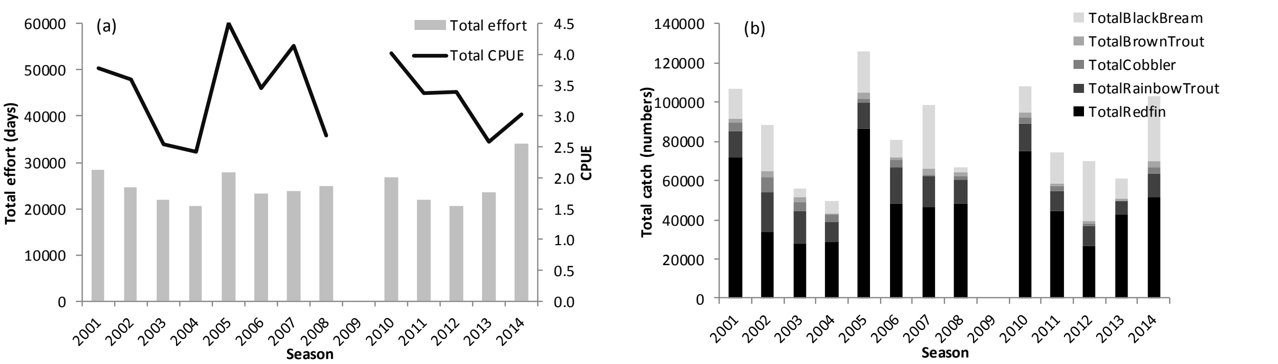
Summary of proportion of effort (days) for individual dams and rivers for seasons (2012 to 2014).

Waterbody	Watercourse	Proportion of effort % Season		
		2012	2013	2014
Dams	Big Brook	6	4	4
	Drakes Brook	2	4	4
	Harvey	50	49	45
	Logue Brook	12	17	15
	Waroona	14	13	14
	Wellington	9	6	16
	Other	7	6	3
	Total	100	100	100
Rivers	Blackwood	19	18	14
	Collie	12	19	14
	Donnelly	6	10	8
	Hutt	0.4	0	0
	Margaret	0.1	1	2
	Murray	15	11	11
	Preston	3	1	4
	Warren	24	19	17
	Other	20	21	30
	Total	100	100	100

FRESHWATER ANGLING TABLE 3

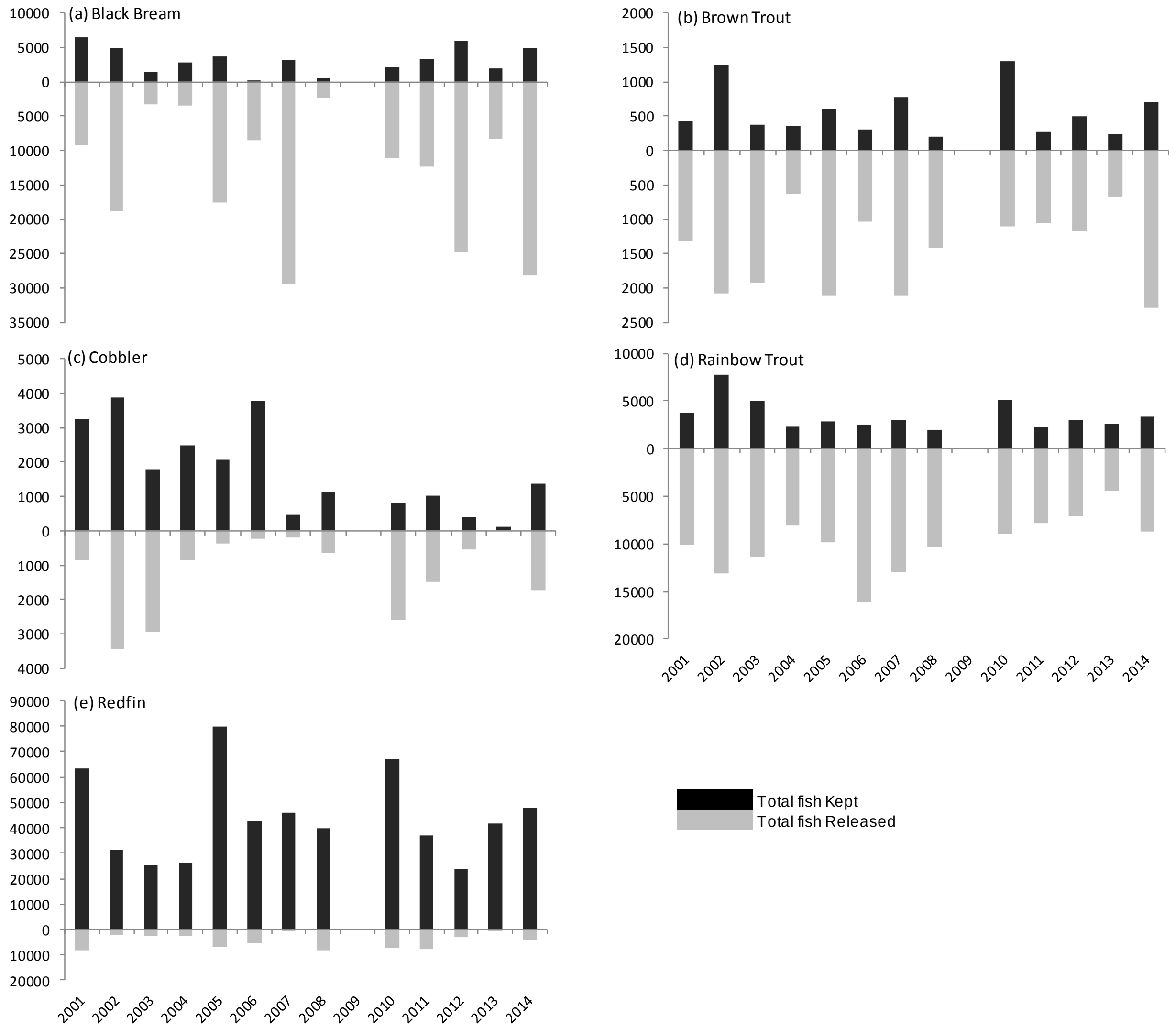
Summary of survey estimates for the main freshwater species targeted for seasons (2012 to 2014). Release rate = (Released /Total)

Season	Species	Total (numbers)			Release rate %
		Kept	Released	Total	
2012	Black Bream	5955	24607	30561	81
	Brown Trout	501	1169	1670	70
	Cobbler	394	556	949	59
	Rainbow Trout	2958	7026	9984	70
	Redfin	23913	3014	26926	11
	Total	33720	36371	70092	52
2013	Black Bream	1987	8338	10325	81
	Brown Trout	237	669	906	74
	Cobbler	114	0	114	0
	Rainbow Trout	2578	4396	6974	63
	Redfin	41841	915	42756	2
	Total	46757	14318	61075	23
2014	Black Bream	4948	28131	33079	85
	Brown Trout	708	2282	2990	76
	Cobbler	1381	1718	3099	55
	Rainbow Trout	3389	8761	12151	72
	Redfin	47776	3922	51698	8
	Total	58203	44814	103017	59



FRESHWATER ANGLING FIGURE 1

Estimated total effort, CPUE (a) and total number of fish caught (b) for 2001 to 2014 seasons.



FRESHWATER ANGLING FIGURE 2

Total kept and released numbers by species Black Bream (a) Brown trout (b) Cobbler (c) Rainbow trout (d) and redfin (e) for 2001 to 2014 seasons.

Licensed Recreational Marron Fishery Report

R. Duffy, F. Trinnie, K. Ryan.

Main Features

Status		Current Landings	
Stock level	Acceptable	Commercial	nil
Fishing level	Acceptable	Recreational catch estimate	
		2013	50, 330 marron
		2014	71,268 marron

Fishery Description

Marron are endemic to Western Australia and are the third largest freshwater 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 Marron Recreational Fishing Licence. For the 2013 season, licensed fishers were permitted to fish for marron from midday 8th January to midday 5th February 2013. Three types of legal gear exist; scoop nets, drop nets and snares. In most waters there is a minimum size of 80 mm carapace length and a daily bag limit of 8 marron per day. The possession limit was decreased from 20 marron to 16 marron in 2012. 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.

There were no significant change to the management arrangements between 2013 and 2014.

Research summary

Detailed research on the marron stocks in south-west rivers and dams has been undertaken since the 1970s, including Logbook Surveys from 1971 to 2008 and an annual phone recall survey from 1990 to 1999. These surveys have been documented elsewhere.

An annual phone recall survey has been undertaken to quantify the marron recreational catch and effort in public waterways (dams and rivers) since 2000. This survey utilises the Marron Recreational Fishing Licence (and the Umbrella Fishing Licence from 2000 to 2011) as a sampling frame to contact fishers.

In conjunction with the annual phone survey, annual monitoring through fishery-independent surveys provides data on relative abundance and average size of marron in three dams and eight rivers.

Retained Species

Recreational catch estimate (season 2013)

50,330 marron

Recreational catch estimate (season 2014)

71,268 marron

At the end of the 2013 season (8 January 2013 to 5 February 2013), a phone survey was undertaken to sample 200 metro and 200 country respondents (3.7% of licence holders in that season). At the end of the 2014 season (8 January 2014 to 5 February 2014) a total of 414 licence holders from metro and 344 from country areas were included in the survey (6.7% of licence holders in that season).

The estimated recreational marron catch for 2013 was 50,330 (by number, with standard error ±5,376) (Recreational Marron Table 1, Recreational Marron Figure 1) with an estimated 35,982 taken in rivers and 14,350 in dams (Recreational Marron Table 2). The estimated marron catch for 2014 was 71,268 (by number, ±7,234) (Recreational Marron Table 1, Recreational Marron Figure 1) with an estimated 49,653 taken in rivers and 19,638 in dams (Recreational Marron Table 2).

The catch per unit effort (CPUE) in 2013 (2.85 (number per fisher day) was lower than the CPUE observed in 2014 (3.90) (Recreational Marron Figure 1). In 2013, the CPUE observed in rivers (2.87 number per fisher day) was almost the same in dams (2.80). Similarly, in 2014 the CPUE in rivers (3.99) was higher than in dams (3.57) (fig 1).

Total effort was estimated at 17,641 days in 2013 and 18,267 in 2014 (Recreational Marron Table 1). Total number of licensed fishers was 10,728 in 2013 and 11,392 in 2014 (Recreational Marron Table 1). The total number of active fishers was estimated at 6,060 in 2013 and 6,232 in 2014. The average number of fishing days per fisher was 2.91 days in 2013 and 2.93 in 2014 (Recreational Marron Table 1).

The proportion of total effort in 2013 was 12,544 days (71%) in rivers compared to 5,134 days (29%) in dams (Recreational Marron Table 3). Similarly, the proportion of total effort in 2014 was 12,438 days (69%) in rivers compared to 5,504 days (31%) in dams (Recreational Marron Table 3). This division of effort between dams and rivers is consistent over time and demonstrates the importance of rivers to the marron fishing experience (Recreational Marron Table 6). The proportion of effort in Wellington Dam and Harvey Dam has increased from 58% in 2012 to 88% in 2014 (Recreational Marron Table 4). Although these levels are within the historical range future research should attempt to identify the cause of this pattern (Recreational Marron Figure 2a). Effort in rivers is spread over a greater number of sites with the Warren, Blackwood and Collie Rivers accounting for 40 to 50% of the effort rivers receive (Recreational

Marron Table 5). However, unspecified systems still account for a substantial portion of all river fishing effort (approximately 30%) (Recreational Marron Figure 2b, Recreational Marron Table 4).

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 Recreational Marron Figure 2).

The annual fishery-independent survey provides vital data for monitoring trends in stocks, evaluating the performance of changes in management on stocks and will allow for recommendations to be made for adjustments to the management of the fishery when necessary.

Relative abundance and size of marron varies greatly among the surveyed rivers and dams (Recreational Marron Figure 3). Size of animals in most locations has stayed relatively stable. However, the mean size in Moore River has shown a steady decrease since a peak in 2009 and recorded the lowest mean size since initiation of the stock assessment survey in 2006 (Recreational Marron Figure 3). The mean size of animals in Drakesbrook Weir was the largest recorded for any dam or river since the initiation of this survey.

Marron abundances in Waroona Dam were lower than previous years, however, Wellington Dam showed an increase, as too did Drakesbrook Weir. River CPUE was stable, with some rivers showing an increase in CPUE. Donnelly River is the only river to show a substantial decline. CPUE in this river has always been highly variable, therefore this year's low catch is not alarming, but will continue to be monitored closely.

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.

Investigations into enhancing stock estimation methods are currently being undertaken. The work consists of a comparison of population estimation methods (tagging vs capture data). At the conclusion of this research, the results will be used to enhance estimates obtained from the annual fishery independent stock assessment.

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.

Listed 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 recreational marron catch cannot 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. 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 28 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 2014 was 18,267 fishing days with a 28 day season.

New management initiatives (2014/15)

For 2014 the marron season started at midday on 08 January and ran for a 28 day period until midday 05 February. Fisheries managers and scientists 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.

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.

RECREATIONAL MARRON TABLE 1

Summary of survey estimates for each regional stratum from previous (2012) and current seasons (2013 and 2014).Participants, number of fishers actively using licence; Partrate, participation rate (participants/sample); Totalfishers (licences x partrate); Total effort (totalfishers x daysmean); Catchrate (totmarron/dayssum); Totalcatch (catchrate x totaleffort).

Season	Stratum	totalfishers	daysmean	catchrate	totaleffort	stderr	totalcatch	stderr
2012	Ctry	3964	3.11	4.87	12329		60042	
2012	Metro	1698	2.71	3.93	4603		18088	
	Total	5663	2.99	4.61	16931	1371	78130	10014
2013	Ctry	4285	3.16	2.86	13542		38730	
2013	Metro	1774	2.31	2.83	4099		11600	
	Total	6060	2.91	2.85	17641	1487	50330	5376
2014	Ctry	4249	3.24	4.17	13766		57405	
2014	Metro	1983	2.27	3.08	4501		13863	
	Total	6232	2.93	3.90	18267	1254	71268	7234

RECREATIONAL MARRON TABLE 2

Summary of survey estimates by stratum and waterbody type for the previous season (2012) and current seasons (2013 and 2014). Participants, number of fishers actively using licence; Participation rate, participation rate (participants/sample); Totalfishers (licences x participation rate); Total effort (total fishers x days mean); Catchrate (total marron/days sum); Totalcatch (catch rate x total effort).

Season	Stratum	Waterbody	Licences	Total population				
				totalfishers	daysmean	catchrate	totaleffort	totalcatch
2012	Ctry	Dam	6446	999	3.19	3.89	3187	12398
2012	Metro	Dam	3466	433	2.44	1.18	1057	1247
	Total		9912	1432	2.96	3.22	4244	13646
2012	Ctry	River	6446	3320	2.74	5.23	9096	47572
2012	Metro	River	3466	1421	2.50	4.75	3553	16875
	Total		9912	4741	2.67	5.10	12649	64447
2013	Ctry	Dam	6912	1486	2.66	2.97	3953	11740
2013	Metro	Dam	3816	649	1.82	2.21	1181	2609
	Total		10728	2135	2.40	2.80	5134	14350
2013	Ctry	River	6912	3214	2.99	2.81	9610	27004
2013	Metro	River	3816	1183	2.48	3.06	2934	8977
	Total		10728	4397	2.85	2.87	12544	35982
2014	Ctry	Dam	7308	1296	2.93	4.03	3797	15302
2014	Metro	Dam	4084	829	2.06	2.54	1707	4336
	Total		11392	2125	2.59	3.57	5504	19638
2014	Ctry	River	7308	3335	2.9	4.19	9672	40528
2014	Metro	River	4084	1263	2.19	3.3	2765	9125
	Total		11392	4598	2.71	3.99	12438	49653

RECREATIONAL MARRON TABLE 3

Proportion of total effort between river and dams from 2000 to 2014.

Season	Effort (proportion)	
	Rivers	Dams
2000	0.70	0.30
2001	0.74	0.26
2002	0.69	0.31
2003	0.78	0.22
2004	0.86	0.14
2005	0.75	0.25
2006	0.72	0.27
2007	0.65	0.38
2008	0.69	0.31
2010	0.58	0.43
2011	0.75	0.25
2012	0.75	0.25
2013	0.71	0.29
2014	0.69	0.31

RECREATIONAL MARRON TABLE 4

Total fishers and total effort for each individual dam for previous (2012) and current seasons (2013 and 2014).

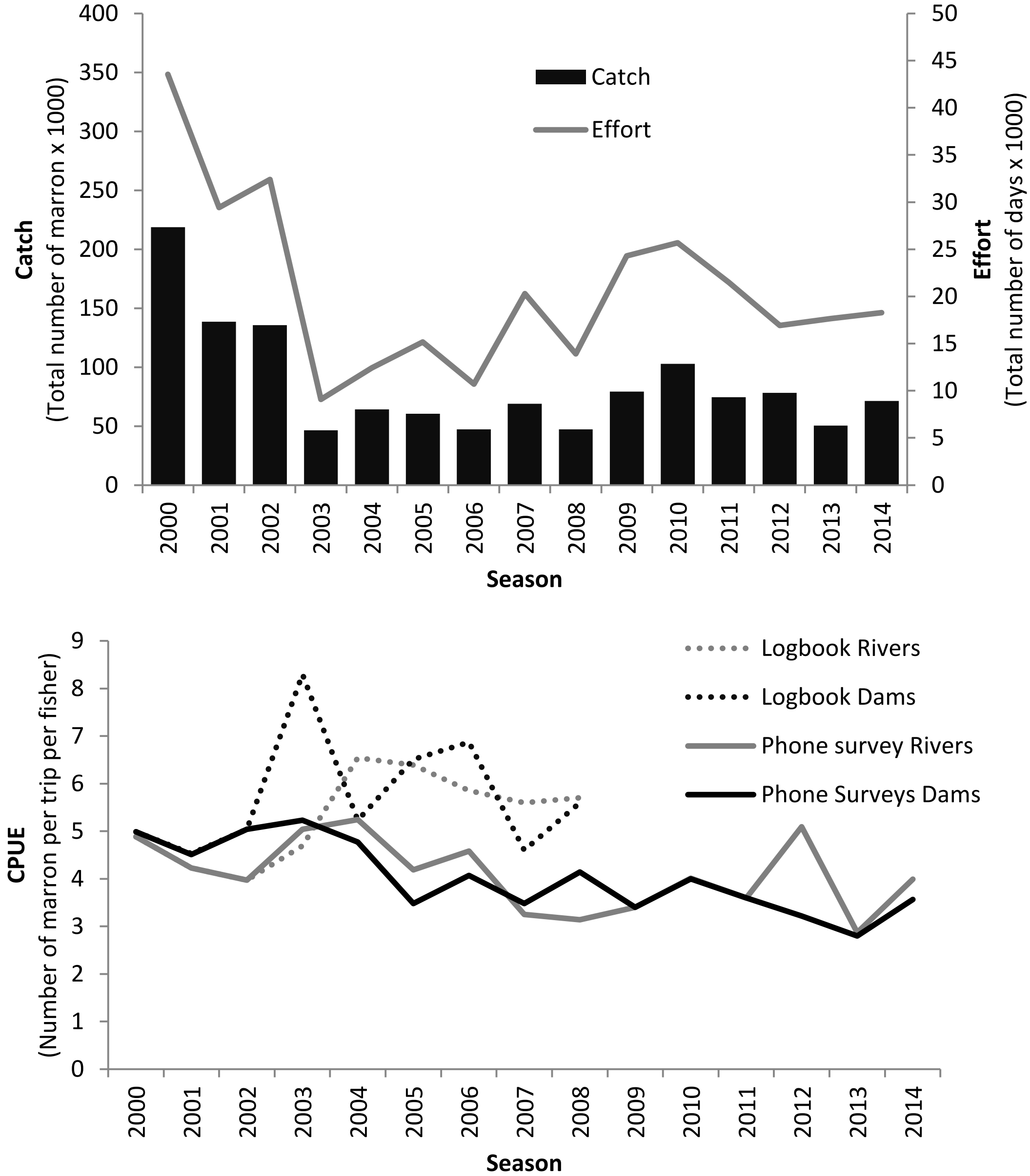
Season	Watercourse	Total population totalfishers	totaleffort	% effort
2012	BigBrook	99	233	5
	DrakesBrook	64	322	8
	Harvey	610	1587	37
	LogueBrook	151	389	9
	Waroona	99	116	3
	Wellington	347	888	21
	Other	325	713	17
	Total		4248	100
2013	BigBrook	19	19	0.4
	DrakesBrook	0	0	0
	Harvey	1108	2944	57
	LogueBrook	107	230	4
	Waroona	92	92	2
	Wellington	529	1006	20
	Other	417	853	17
	Total		5144	100
2014	BigBrook	72	133	2.4
	DrakesBrook	30	39	1
	Harvey	1089	2920	53
	LogueBrook	151	171	3
	Waroona	149	250	5
	Wellington	673	1914	35
	Other	82	82	1
	Total		5508	100

RECREATIONAL MARRON TABLE 5

Total fishers and total effort for each individual river for previous (2012) and current seasons (2013 and 2014).

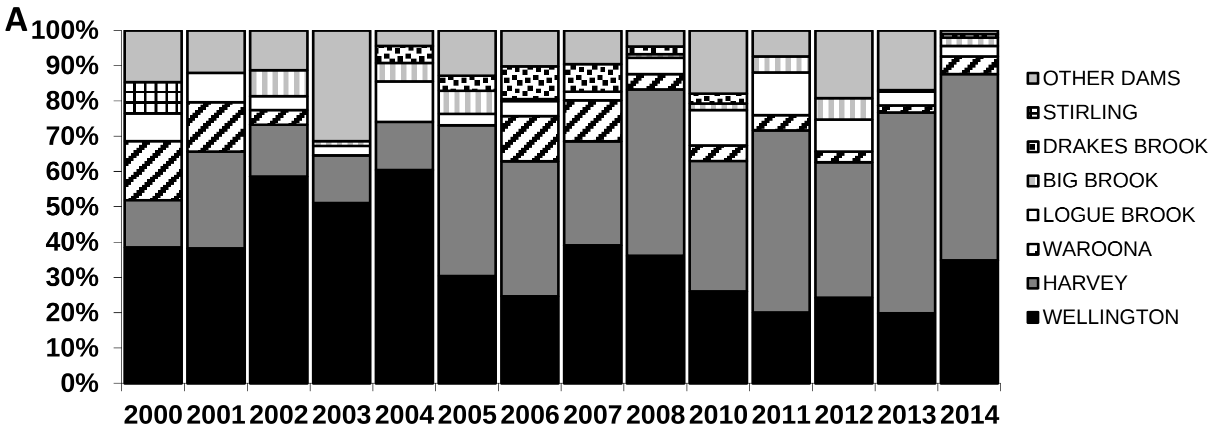
Season	Watercourse	Total population totalfishers	totaleffort	% effort
2012	Blackwood	944	2455	19
	Collie	525	1228	10
	Deep	307	844	7
	Donnelly	114	163	1
	Hutt	32	64	1
	Margaret	146	293	2
	Murray	265	826	7
	Preston	340	1242	10
	Warren	637	1718	14
	Other	1787	3806	30
	Total		12638	100

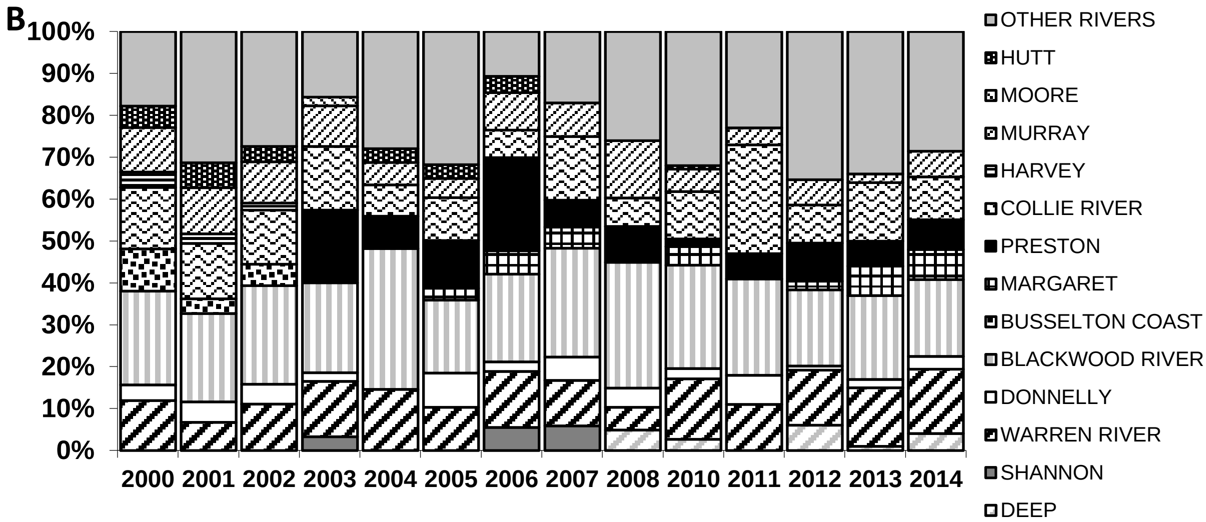
Season	Watercourse	Total population totalfishers	totaleffort	% effort
2013	Blackwood	1036	2544	20
	Collie	751	1695	14
	Deep	54	73	1
	Donnelly	104	207	2
	Hutt	35	35	0.3
	Margaret	246	928	7
	Murray	161	288	2
	Preston	246	764	6
	Warren	609	1709	14
	Other	1418	4309	34
	Total		12550	100
2014	Blackwood	962	2289	18
	Collie	568	1260	10
	Deep	222	508	4
	Donnelly	208	392	3
	Hutt	82	82	0.7
	Margaret	283	923	7
	Murray	344	777	6
	Preston	435	881	7
	Warren	753	1849	15
	Other	1404	3492	28
	Total		12454	100



RECREATIONAL MARRON FIGURE 1

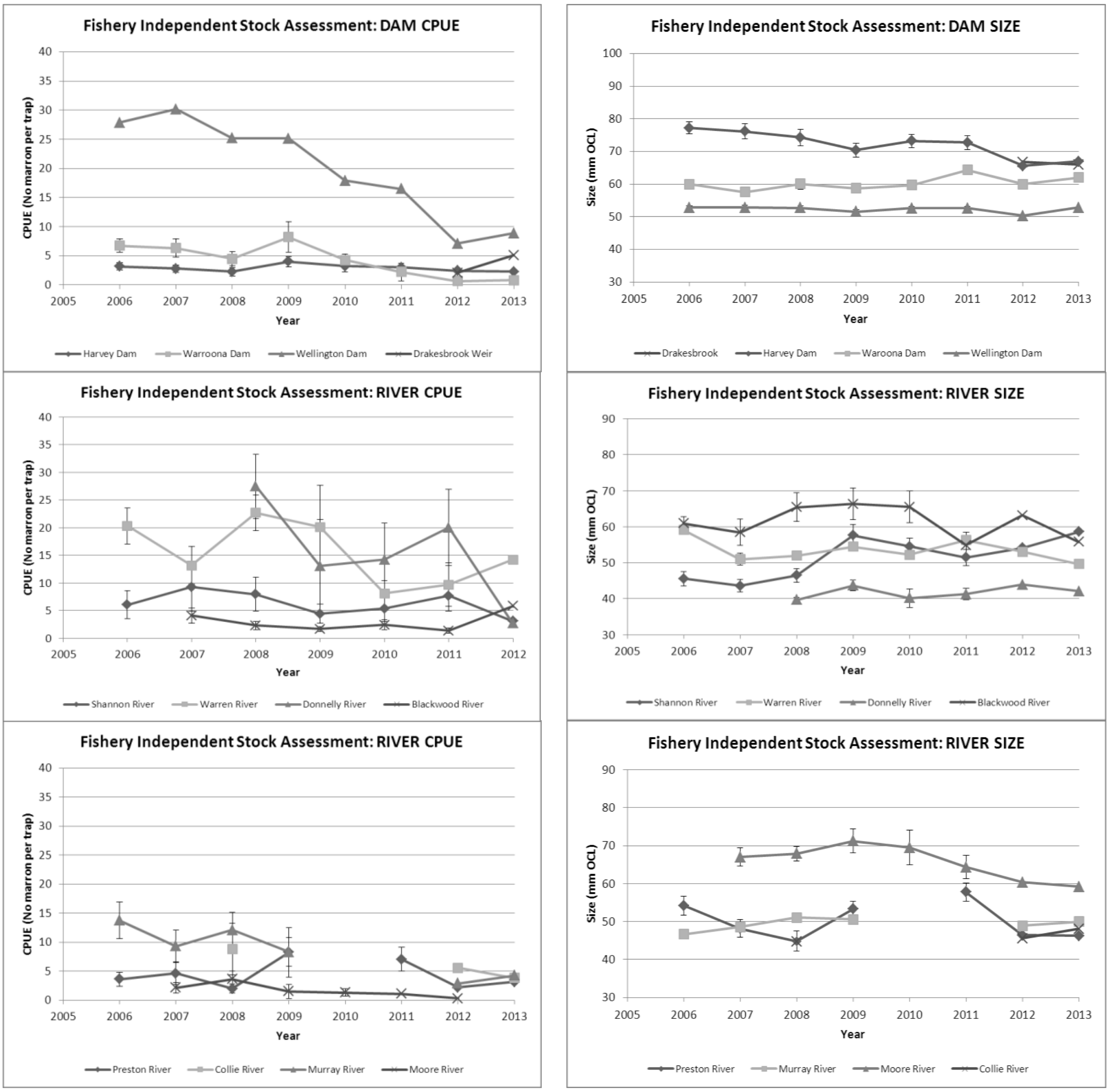
The estimates of total marron catch in numbers and effort in days from phone surveys (a) and the catch per unit effort by logbook surveys and phone surveys (b) from 2000 to 2014.





RECREATIONAL MARRON FIGURE 2

The distribution of marron effort among individual dams (a) and individual rivers (b) of the recreational marron fishery from 2000 to 2014.



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 stocking. 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). 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 marron season additional resources are provided to ensure compliance. Strategic rostering practices ensure that available staff from neighbouring districts contribute to operational needs in providing a high profile and professional presence. This presence provides education, licence inspections, size and bag limit inspections and patrols of waterways to ensure no illegal gear is being used to take marron.

FMOs frequently engage in 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 FMOs to assist with the compliance of illegal fishing on Water Corporation dams. Some Department of Parks and Wildlife officers have also been authorized as honorary FMOs and play an important role in marron compliance throughout the South West.

The other main education focus for this fishery is checking bag limits, that fishers hold a current freshwater recreational fishing licence and 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 FMOs 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 2012/13

During 2012/13 FMOs delivered 2,486 ‘on-patrol’ officer hours during to the Southern Inland bioregion, an increase of about 300 hours on the previous year(Southern Inland Compliance Figure 1).

Officers conducted patrols throughout the bioregion in vehicles, dinghies and canoes, making 4,076 field contacts with recreational fishers and 58 contacts with commercial operators (Southern Inland Compliance Table 1).

There were four infringement warnings and four infringement notices issued with a further 39 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 2013 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 Southern Inland Compliance Table 1) are also a focus in the Southern Inland bioregion for FMOs. Activities mainly involve inspection of aquaculture facilities, oversight of broodstock collection to ensure compliance with exemption conditions, and inspection of proposed aquaculture sites to ensure that the harvesting does not affect the wild stocks in WA waters. FMOs continue to work closely with police to investigate theft from farm dams.

Initiatives for 2013/14

Compliance operations will again target ‘out of season’ marron fishing with both covert and overt patrols. A high-profile professional presence is again planned for the marron season.

FMOs 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.

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.

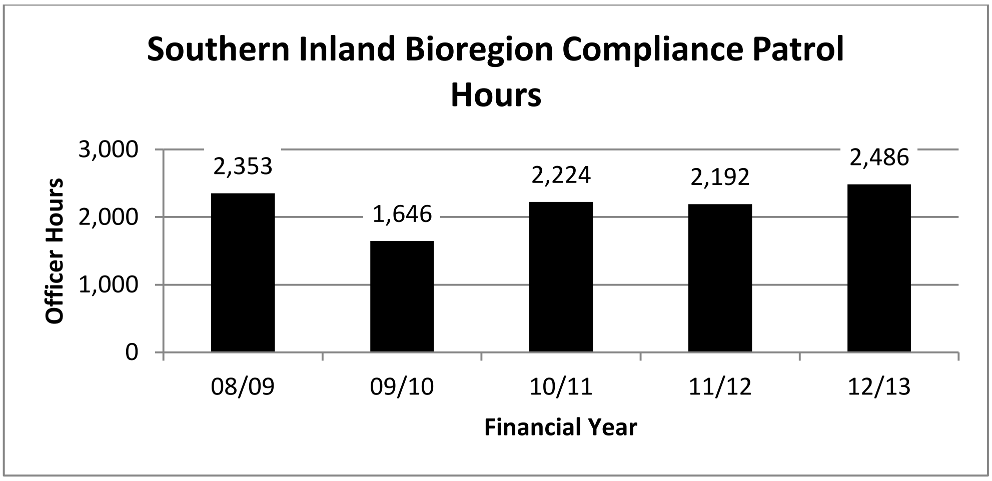
SOUTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Southern Inland bioregion during the 2012/13 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,486 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	58
Infringement warnings	2
Infringement notices	0
Prosecutions	2
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	4,076
Infringement warnings	4
Infringement notices	4
Prosecutions	39
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	1,082
Fishwatch Reports**	Not recorded

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing-related contacts with the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine protected areas), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category.

**Fishwatch calls relating to the Southern Inland bioregion are not recorded as the service provider reporting mechanism only details calls referred to district offices. Calls relating to the Southern Inland bioregion will be included in both the South Coast and West Coast Bioregion totals.



SOUTHERN INLAND COMPLIANCE FIGURE 1

In this figure, "On Patrol" Officer Hours shows the level of compliance patrol activity delivered to the Southern Inland Bioregion over the previous five years. The 2012/13 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 Statewide 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 (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.

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 developed 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.

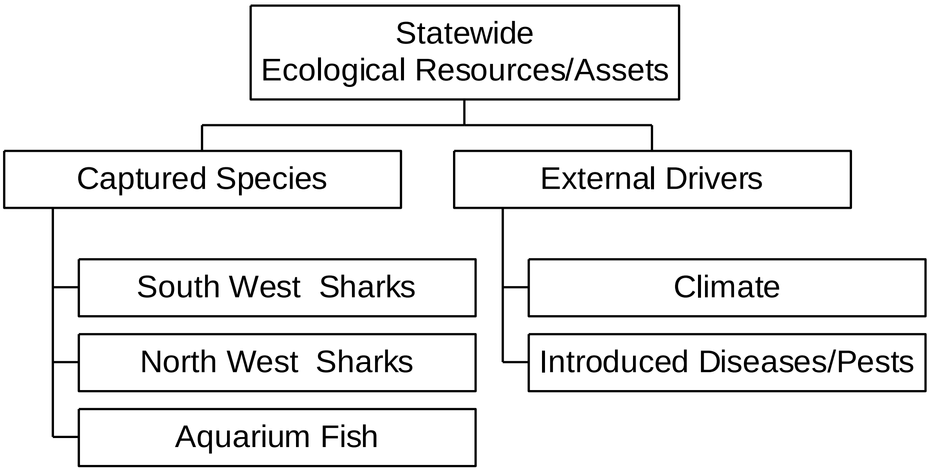
STATEWIDE ECOSYSTEM MANAGEMENT TABLE 1 - RISK LEVELS FOR EACH ASSET.
Low and Medium values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required.

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Sharks	South and lower west	MODERATE	The stock levels of most sharks in these regions are now either at acceptable levels or are deemed to be recovery at acceptable rates following management intervention.
	Mid West – North	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 950 species of marine aquarium fish under the *Marine Aquarium Fish Management Plan 1995* (this includes sharks and rays (Chondrichthyes), syngnathids, moral eels, and higher taxonomic groups at the Order, Family or Genus level in cases where the species cannot be specifically identified and also includes unquantified aquarium species). However, the number of marine aquarium fish species targeted and/or landed by the fishery varies from year to year (e.g. in the period from 2005 to 2013 the number of marine aquarium fish species landed ranged from 183 to 288; 223 marine aquarium fish species were recorded in 2013). Operators in the MAF are also permitted to take coral, live rock, algae, seagrass and invertebrates under the *Prohibition on Fishing (Coral, 'Live Rock' and Algae) Order 2007* and by way of Ministerial Exemption. In 2013, a total of over 383 species or species groups were reported in the landed catch of the MAF. The reported catch includes groups that were reported at the level of 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 listed 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 km^2. 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; however, only six licences are permitted to take all hard corals and most soft corals (all 12 licences are permitted to take coral like anemone groups such as corallimorphs and zoanthids in the Class Anthozoa). In 2013, 10 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 non-finfish 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 19,302 fish (excluding syngnathids) were landed in 2013. 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 2013 were lower than those reported in 2012 (22,780), 2011 (19,776) and in 2010 (25,708), but were higher than that reported in 2009 (18,575). Although all catches in these years are somewhat similar.

The main fish (excluding syngnathids) species landed in 2013 were damselfish of the *Chromis* genus and the scribbled angelfish (*Chaetodontoplus duboulayi*) (Marine Aquarium Fish Table 2). Likewise, the main coral species landed in 2013 were the coral like anemones of the *Corallimorphus* genus (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 2013 (1,635) are slightly higher in comparison and are similar to the catch levels reported in 2012 (1,232), 2011 (1,138) and 2008 (1,218).

In 2013, 10 licences reported some level of activity (effort). Effort in the fishery has decreased from 981 fishing days (2007) to 494 fishing days in 2013, 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 2013, of the 5 land hermit crab exemption holders, 4 collectors reported some level of activity.

Given that the specimens are collected for a live market, licences are restricted in terms of the quantities that they can safely handle and transport (for example, by boat to shore, by vehicle to the holding facility and then on to the retailer) without impacting on the quality of the product. The size of the holding facility and access to regular freight and infrastructure services (such as airports, particularly in the remote northern locations of Western Australia) restricts the levels of effort that can be expended in the fishery at any given time.

There was one reported listed species interaction for the fishery in 2013.This interaction was with a turtle and it was released alive.

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 2013, the catch of syngnathids from all species and areas was 1,635 below the target commercial catch range level of 2,000 individuals per year. The catch level of syngnathids has increased from those reported in 2012 (1,232), 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 (2014/15)

The Marine Aquarium Fish Fishery is currently under review with changes to the management arrangements expected to be introduced in early 2015. Among the changes under consideration is to consolidate existing legislative instruments for the fishery into a new Management Plan that will provide for the take of finfish, invertebrates, hard and soft coral, live rock, algae and seagrass.

In December 2012 an application for reassessment of the MAF as ecologically sustainable under the provisions of the EPBC Act 1999 was submitted to the Department of the Environment (DotE), the then Department of Sustainability, Environment, Water, Population and Communities. This application was successful and Wildlife Trade Operation (WTO) approval was granted till December 2013. In November 2013 a subsequent application was submitted to DotE for further WTO approval, this application was successful and WTO approval was granted till October 2016.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Managed Fishery and associated endorsements in 2013.

Common Name	Quantity (numbers)	Weight (kg)	Volume (litres)
Fish	19,302		
Syngnathidae (not included in Fish)	1,635		
Hermit crabs (land hermit crabs only - *Coenobita variabilis*)[1]	88,443		
Invertebrates (not including Hermit crabs or Corals)	49,643		
Hard coral		3,773.826	
Soft coral[2]		6,099.20	
Living rock		14,013.50	
Sponges	3,632		
Algae/Seagrasses			218
Live Feed (mainly shrimps/prawns)			1

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 5,389 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 (excluding Syngnathids) species landed from the Marine Aquarium Managed Fishery for 2013, with catch for the previous six years. Note the species reported in this table vary from year to year.

Species	Common Name	Year 2008	2009	2010	2011	2012	2013
Chromis spp.	*Chromis* damselfish	0	2849	2650	2320	400	2039
Chaetodontoplus duboulayi	Scribbled Angelfish	590	492	1333	2275	2527	1938
Chelmon marginalis	Margined Coralfish	542	682	1266	1506	1048	1429
Chromis atripectoralis	Black-axil *Chromis*	3065	50	1350	1550	1010	1200
Istiblennius meleagris	Spotted Blenny	1730	2846	1040	2081	1468	1075
Chromis cinerascens	Green *Chromis*	873	790	2998	1941	2203	1052
Plotosus lineatus	Striped Catfish	4	416	607	1142	0	900
Gobiidae	Gobies	445	447	580	979	967	749
Valenciennea puellaris	Orange-dashed Goby	100	26	440	1559	1250	562
Apogonidae/Dinolestidae Undifferentiated	Cardinalfishes	3451	1766	94	54	0	500
Salarias fasciatus	Banded Blenny	102	51	45	2	0	472
Trachinops brauni	Blue-lined Hulafish	150	300	992	2019	531	455
Siganidae	Rabbitfishes	7	25	183	125	543	383
Blenniidae	Blennies	400	38	75	82	128	282
Amphiprion clarkii	Clark's Anemonefish	846	573	935	452	326	280

MARINE AQUARIUM FISH TABLE 3

Summary of the reported catch of the main coral species landed from the Marine Aquarium Managed Fishery for 2013, with catch for the previous six years.

Species	Common Name	Year 2008	2009	2010	2011	2012	2013
Corallimorphus	*Corallimorphus* anemones	0	0	0	45	72.5	1869
Zoanthidae Undifferentiated	Zoanthid anemones	238.5	2184	1606	799	527.5	1712
Corallimorpharia Undifferentiated	Coral-like anemones	1377.6	1899	2233	2932	3725	1009
Lobophyllia	*Lobophyllia* brain coral	261.2	462.8	430.2	438.5	293.2	555.9
Zoanthidea Undifferentiated	Anemones & Corals	180	56	105	35	736.6	404
Zoanthus	*Zoanthus* colony polyps	811.5	744	669	558	513	395
Euphyllia ancora	Anchor coral	370.5	414.8	605.6	599.7	491.8	344.8
Duncanopsammia axifuga	Duncan coral	439.2	548	877.4	407.3	456.4	326.5
Sarcophyton	Toadstool coral	300.9	166.2	174.1	203.4	118.8	314.6
Euphyllia paraancora	Branching hammer coral	0	0	0	0	29	269
Euphyllia glabrescens	Torch coral	198.7	149.8	374.1	402	504.6	246.6
Alcyonacea	Soft coral & Sea fans - undifferentiated	13.6	6	0.4	0.6	10.8	243
Goniopora	Goniopora	265	102.5	68.4	156.1	145.1	235.9
Trachyphyllia geoffroyi	*Trachyphyllia* brain coral	396.9	503.5	640.4	470.9	266.3	230
Scleractinia Undifferentiated	Hard corals	18.6	16	4	16.4	18.15	222.4
Acanthastrea	*Acanthastrea* large polyp stony corals	122.8	100.3	72.4	102.2	129.5	174.5
Turbinaria	*Turbinaria* cup corals	204.6	165.3	271.3	169	94.2	149.1
Favia	*Favia* brain corals	296.1	481	267.1	243.8	140.6	136.4
Echinophyllia	*Echinophyllia* chalice corals	162.5	511	293	222.4	197.3	109.3
Acropora	*Acropora* corals	336.6	333.3	193.5	285.6	186.2	98.4
Symphyllia	Symphyllia	23.4	169.4	289.8	225.6	189.9	74.8
Dendronephthya	Flower soft coral	113.6	106.4	29.9	43.3	41.3	72
Plerogyra sinuosa	Green bubble coral	10.8	0	22	380	30	60
Moseleya latistellata	Giant star coral	110	188.6	294.1	79.3	11.4	57.3
Fungia	*Fungia* disc coral	77	139.6	67	105.2	57.8	56.5

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	8,896 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 over 200 (218) different Specimen Shell species were collected in 2013, 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 current exemption method being employed by the fishery is using a remote controlled underwater vehicle at depths between 60 and 300 m and a new exemption method using baited habitat structures at depths is being trialled 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, 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 18 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 method by month and year.

A new specific Specimen Shell logbook was formally introduced in August 2013 (which built on the logbook being trialled in the fishery) to aid the reporting of the number sighted and number taken alive and/or dead of the 8 mollusc species identified as potentially ‘vulnerable’ and the reporting of the finer spatial scale, 10 x 10 nautical mile (nm) grid blocks.

This data is used as the basis to provide research advice for fisheries management.

Retained Species

Commercial landings (season 2013): 8,896 shells

Recreational catch estimate (season 2013): Unknown

Commercial Landings

In 2013, the total number of specimen shells collected was 8,896 distributed over a wide range of species. This is based on 100% of submitted catch returns. In the past 5 years, more than 487 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, 14% in 2012 and 19% in 2013. 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, about 11 of these are regularly active. Effort has decreased from 1,057 fishing days in 2009 to 745 fishing days in 2013. Over the past 5 years, there was an average of around 873 days fished, with 901 days fished in 2010, 932 days fished in 2011 and 729 days fished in 2012.

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 2013 season the catch rate was approximately 12 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 in 2013. The measure of the number of shells sighted is reported correctly in about 98 % 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 98 % in 2013. It is anticipated that current sightings are an under estimate of the available populations.

This improvement in reporting of the vulnerable (indicator) species, in terms of species identification and the number sighted and number taken alive and/or dead can be contributed to the new return form.

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 2013 season has seen ll licensees report the smaller spatial resolution grid blocks rather than reporting the 60 x 60 nm blocks. This was the same for the 2011 and 2012 season.

For convenience for fishers, 10 x 10 nm block generic maps were added to the front of the new Specimen Shell logbooks (which built on the logbook being trialled in the fishery) and therefore has helped the fishers with the requirement of reporting the smaller spatial resolution grid blocks.

All species collected in Western Australia, including the 8 indicator 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 2013, the catch level of approximately 8,896 shells is just under the range set , i.e. 10,000 – 25,000 shells and the catch rate of 12 shells/day is within the range set ,i.e. 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.

Listed species interaction: Negligible

The fishery reported no interactions with listed species during 2013. Reports of interactions with listed species are required to be recorded on monthly catch and effort returns.

Ecosystem Effects

Food chain effects: Negligible

Habitat effects: Negligible

Social Effects

In 2013 there were 32 authorisation holders in this fishery with around 11 licences recording consistent activity, the number of people employed regularly in the fishery (licensees plus crew/ dive buddies) is likely to be around 19 . There were also around 8 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 2013:

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 (2014/15)

The Specimen Shell Managed Fishery is currently under review with changes to the management arrangements expected to be introduced in 2015. Among the changes under consideration is to consolidate existing management arrangements for the fishery into a new Management Plan that will provide for additional permitted methods of collection in the Fishery such as remotely operated underwater vehicles.

APPENDICES

APPENDIX 1
Fisheries Research Division staff publications 2013/14

Scientific Papers

Bentley, B.C., Harvey, E.S., Newman, S.J., Welch, D.J., Smith, A.K. and Kennington, W.J. (2013). Characterization of 13 polymorphic microsatellite loci for the dogtooth tuna *Gymnosarda unicolor*. *Conservation Genetics Resources* 5 (3): 693-695.

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APPENDIX 2
Table of catches from fishers' statutory monthly returns for 2012/13

This table contains the landed[1] and estimated live weight[2] of species recorded in the compulsory catch and fishing effort returns provided by commercial fishers each month. These data include the catch taken as by-product as well as the targeted catch.

These catch data may differ slightly from some of the catch estimates presented for specific fisheries as the latter may include additional data from other sources, such as research log books and processors. The figures may also differ slightly from previously reported figures, as additional data may have been received by the Department of Fisheries. The table represents the latest year for which a complete set of data is available.

While scientific names have been included wherever possible, it should be noted that many fish recorded under a common name cannot be identified as belonging to a particular single species and therefore must be reported as being part of a commercial grouping of several species. For example, the common name '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				
Carcharhinidae				
	Bronze Whaler	*Carcharhinus brachyurus*	30	48
	Dusky Whaler	*Carcharhinus obscurus*	92	147
	Sandbar Shark	*Carcharhinus plumbeus*	29	47
	Spinner Shark	*Carcharhinus brevipinna*	44	69
	Tiger Shark	*Galeocerdo cuvier*	3	4
Lamnidae				
	Shortfin Mako	*Isurus oxyrinchus*	2	3
Orectolobidae				
	Wobbegong Shark	Orectolobidae	18	28
Pristiophoridae				
	Common Sawshark	*Pristiphorus cirratus*	3	8
Rajidae				
	Skates	Rajidae	6	14
Sphyrnidae				
	Hammerhead Shark	Sphyrnidae	39	62
Triakidae				
	Gummy Shark	*Mustelus antarcticus*	253	403
	Pencil Shark	*Hypogaleus hyugaensis*	< 500 kg	1
	Whiskery Shark	*Furgaleus macki*	73	109

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)				
Triakidae (Continued)				
	Shark, Other	*Chondrichthyes*	6	10
	Shovelnose/Fiddler Rays	Rhinobatidae / Rhynchobatidae	< 500 kg	1
Ariidae				
	Catfishes	Ariidae	11	11
	Silver Cobbler	*Neoarius midgleyi*	70	100
Berycidae				
	Bight Redfish	*Centroberyx gerrardi*	38	39
	Redfish	*Centroberyx* spp.	12	12
	Yelloweye Redfish	*Centroberyx australis*	11	11
Clupeidae				
	Australian Sardine (Pilchard)	*Sardinops sagax*	2221	2221
	Perth Herring	*Nematalosa vlaminghi*	1	1
	Sandy Sprat (Whitebait)	*Hyperlophus vittatus*	13	13
Hemiramphidae				
	Southern Garfish	*Hyporhamphus melanochir*	9	9
Platycephalidae				
	Flatheads	Platycephalidae	5	5
Plotosidae				
	Cobbler	*Cnidoglanis macrocephalus*	39	55
Haemulidae				
	Barcheek Coral Trout	*Plectropomus maculatus*	16	16
	Common Coral Trout	*Plectropomus leopardus*	2	2
Latidae				
	Barramundi	*Lates calcarifer*	28	46
Polyprionidae				
	Bass Groper	*Polyprion americanus*	1	1
	Hapuku	*Polyprion oxygeneios*	22	22
Serranidae				
	Birdwire Rockcod	*Epinephelus merra*	2	2
	Blackspotted Rockcod	*Epinephelus malabaricus*	26	26
	Breaksea Cod	*Epinephelides armatus*	6	6

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)				
Serranidae (Continued)				
	Chinaman Rockcod	*Epinephelus rivulatus*	2	2
	Duskytail Grouper	*Epinephelus bleekeri*	6	6
	Eightbar Grouper	*Hyporthodus octofasciatus*	21	21
	Flowery Rockcod	*Epinephelus fuscoguttatus*	48	48
	Goldspotted Rockcod	*Epinephelus coioides*	49	49
	Rankin Cod	*Epinephelus multinotatus*	145	145
	Tomato Rockcod	*Cephalopholis sonnerati*	1	1
	Cods	*Epinephelus/Cephalopholis*	77	77
Glaucosomatidae				
	Northern Pearl Perch	*Glaucosoma buergeri*	26	26
	West Australian Dhufish	*Glaucosoma hebraicum*	80	81
Priacanthidae	Bigeyes	Priacanthidae	26	26
Terapontidae	Trumpeters	Terapontidae	3	3
Sillaginidae	King George Whiting	*Sillaginodes punctatus*	13	13
	Yellowfin Whiting	*Sillago schomburgkii*	62	62
	Whitings	Sillaginidae	107	107
Pomatomidae				
	Tailor	*Pomatomus saltatrix*	29	29
Rachycentridae				
	Cobia	*Rachycentron canadum*	14	14
Carangidae				
	Amberjack	*Seriola dumerili*	10	10
	Black Pomfret	*Parastromateus niger*	2	2
	Golden Trevally	*Gnathanodon speciosus*	4	4
	Samson Fish	*Seriola hippos*	37	40
	Silver Trevally	*Pseudocaranx* spp.	7	7
	Trevallies	Carangidae	142	142
	Yellowtail Kingfish	*Seriola lalandi*	1	1
	Yellowtail Scad	*Trachurus novaezelandiae*	19	19
Arripidae				
	Australian Herring	*Arripis georgianus*	288	288

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)				
Arripidae (Continued)				
	Western Australian Salmon	*Arripis truttaceus*	236	236
Lutjanidae				
	Brownstripe Snapper	*Lutjanus vitta*	87	87
	Chinaman Fish	*Symphorus nematophorus*	12	12
	Crimson Snapper	*Lutjanus erythropterus*	255	255
	Darktail Snapper	*Lutjanus lemniscatus*	20	20
	Five Line Snapper	*Lutjanus quinquelineatus*	4	4
	Flagfish / Spanish Flag	*Lutjanus vitta / quinquelineatus / carponotatus / lutjan*	23	23
	Goldband Snapper	*Pristipomoides multidens*	729	730
	Jobfish	*Pristipomoides* spp.	1	1
	Mangrove Jack	*Lutjanus argentimaculatus*	14	14
	Moses Snapper	*Lutjanus russelli*	44	44
	Red Emperor	*Lutjanus sebae*	266	266
	Rosy Snapper	*Pristipomoides filamentosus*	6	6
	Ruby Snapper	*Etelis carbunculus*	22	23
	Saddletail Snapper	*Lutjanus malabaricus*	180	180
	Sharptooth Snapper	*Pristipomoides typus*	3	3
	Tropical Snappers	Lutjanidae	2	2
Nemipteridae				
	Monocle Bream	*Scolopsis* spp.	11	11
	Threadfin Breams	Nemipteridae	101	101
Haemulidae				
	Javelin Fish	*Pomadasys* spp.	18	18
	Painted Sweetlips	*Diagramma labiosum*	20	20
	Sand Snapper	Haemulidae	50	50
Lethrinidae				
	Bluespotted Emperor	*Lethrinus punctulatus*	236	236
	Drab Emperor	*Lethrinus ravus*	5	5
	Grass Emperor	*Lethrinus laticaudis*	6	6
	Longnose Emperor	*Lethrinus olivaceus*	23	23
	Mozambique Seabream	*Wattsia mossambica*	5	5

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)				
Lethrinidae (Continued)				
	Redspot Emperor	*Lethrinus lentjan*	24	24
	Redthroat Emperor	*Lethrinus miniatus*	46	46
	Robinson'S Seabream	*Gymnocranius grandoculis*	41	41
	Spangled Emperor	*Lethrinus nebulosus*	70	70
	Emperors	Lethrinidae	2	2
Sparidae				
	Black Bream	*Acanthopagrus butcheri*	44	44
	Frypan Bream	*Argyrops spinifer*	35	35
	Snapper (Pink Snapper)	*Pagrus auratus*	475	478
	Tarwhine	*Rhabdosargus sarba*	4	4
	Western Yellowfin Bream	*Acanthopagrus latus*	8	8
	Yellowback Bream	*Dentex tumifrons*	1	1
Sciaenidae				
	Black Jewfish	*Protonibea diacanthus*	2	2
	Mulloway	*Argyrosomus japonicus*	13	14
Mullidae				
	Red Mullet	Mullidae	36	36
Clupeidae				
	Scaly Mackerel	*Sardinella lemuru*	364	364
Kyphosidae				
	Sweep	*Scorpis aequipinnis*	1	1
Pentacerotidae				
	Boarfish	Pentacerotidae	6	7
Oplegnathidae				
	Knifejaw	*Oplegnathus woodwardi*	1	1
Cheilodactylidae				
	Blue Morwong	*Nemadactylus valenciennesi*	35	38
	Morwong	Cheilodactylidae	1	1
Mugilidae				
	Mullets	Mugilidae	6	6

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)				
Mugilidae (Continued)				
	Sea Mullet	*Mugil cephalus*	154	154
	Yellow-Eye Mullet	*Aldrichetta forsteri*	26	26
Sphyraenidae				
	Pikes	Sphyraenidae	4	4
	Snook	*Sphyraena novaehollandiae*	2	2
Polynemidae				
	King Threadfin	*Polydactulus macrochir*	38	44
	Threadfin	Polynemidae	2	2
Labridae				
	Baldchin Groper	*Choerodon rubescens*	16	16
	Blue Groper	*Achoerodus gouldii*	29	35
	Bluespotted Tuskfish	*Choerodon cauteroma*	2	2
	Pigfish	*Bodianus* spp.	1	1
	Tuskfishes	*Choerodon* spp.	6	6
	Wrasses	Labridae	1	1
Scaridae				
	Parrotfishes	Scaridae	5	5
Acanthuridae/Zanclidae				
	Surgeonfishes	Acanthuridae/Zanclidae	2	2
Scombridae				
	Bonito	*Sarda australis*	22	22
	Grey Mackerel	*Scomberomorus semifasciatus*	16	16
	Spanish Mackerel (Narrow-barred)	*Scomberomorus commerson*	226	309
	Longtail Tuna	*Thunnus tonggol*	1	1
	Yellowfin Tuna	*Thunnus albacares*	1	1
	Mackerel, Other		< 500 kg	< 500 kg
	Tuna, Other		2	2
Centrolophidae				
	Blue-Eye Trevalla	*Hyperoglyphe antarctica*	3	3
Bothidae				
	Flounder	Bothidae	2	3

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)				
Monacanthidae				
	Leather Jacket	Monacanthidae	14	21
	Fish, other		96	99
TOTAL FISH			8615	9156
CRABS				
	Crystal Crab	*Chaceon albus*	141	141
	Champagne Crab	*Hypothalassia acerba*	4	4
	Giant Crab	*Pseudocarcinus gigas*	15	15
	Blue swimmer Crab	*Portunus armatus*	274	277
	Mud Crab	*Scylla* spp.	4	4
TOTAL CRABS			438	441
PRAWNS				
	Banana Prawn	*Penaeus merguiensis*	324	324
	Brown Tiger Prawn	*Penaeus esculentus*	631	631
	Coral Prawn	*Metapenaeopsis* spp.	137	137
	Endeavour Prawn	*Metapenaeus endeavouri*	62	62
	Western King Prawn	*Penaeus latisulcatus*	1165	1165
	Prawns, Other	Penaeidae	1	1
TOTAL PRAWNS			2320	2320
LOBSTERS				
	Southern Rock Lobster	*Jasus edwardsii*	46	46
	Western Rock Lobster	*Panulirus cygnus*	6020	6020
	Bugs/ Slipper lobster	Scyllaridae	4	4
TOTAL LOBSTERS			6070	6070
MOLLUSCS				
	Squid	*Sepioteuthis* spp./*Loligo* spp.	37	37
	Octopus	Octopodidae	196	250

Family Name	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
MOLLUSCS (Continued)				
	Cuttlefish	Sepiidae	32	32
	Saucer scallop	*Amusium balloti*	58	292
	Brownlip Abalone	*Haliotis conicopora*	15	37
	Greenlip Abalone	*Haliotis laevigata*	57	152
	Roe's Abalone	*Haliotis roei*	70	70
TOTAL MOLLUSCS			465	870
OTHER INVERTEBRATES			4	13
GRAND TOTAL			17912	18870

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 2012/13

K. Nobes

Main Features
There were 453 licensed aquaculture producers
The farm gate value of aquaculture production in WA (excluding marine algae and pearl oysters) was just over $16.78 million
The most valuable industry sector was barramundi ($12.5 million), followed by marron ($1.50 million), mussels ($1.02 million) and yabbies ($0.42 million)
The industry sector with the most participants was marron with 175 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 2012/13. 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. 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 May 2014.

The Industry in 2012/13

A total of 453 aquaculture licence holders were required to submit quarterly returns for one or more quarters in the 2012/13 financial year. Of the 453 licences, 214 i.e. 47 per cent recorded production on their returns. Marron had the largest number of producers with 175 licences recording production (Aquaculture Production Table 1).

Estimated aquaculture production decreased from 1661 tonnes produced in 2011/12 to 1566 tonnes in 2012/13 (excludes algae, pearl oysters, and ornamental species) (Aquaculture Production Table 2).

The estimated value of Western Australian aquaculture (excluding algae and pearl oysters) increased from $16.2 million to $16.8 million in 2012/13 (Table 3). Finfish aquaculture made up 76 per cent of the total value for 2012/13.

AQUACULTURE PRODUCTION TABLE 1

Growout production for the Western Australian aquaculture industry in 2012/13

Common name	Productive licences	Quantity	Units*	Average price/ kg or individual	Value
Barramundi	6	1190	tonnes	$10.51	$12,510,017
Marron	175	52	tonnes	$29.06	$1,501,284
Mussels	8	243	tonnes	$4.19	$1,017,041
Yabbies	7	19	tonnes	$21.49	$415,461
Silver perch	10	13	tonnes	$19.72	$254,561
Koi carp	5	25210	No.	$5.76	$145,094
Rainbow trout	6	4	tonnes	$14.97	$63,956
Ornamental fish	6	19683	No.	n/a	$60,705
Goldfish	4	12975	No.	$2.84	$36,793
Ornamental crustaceans	5	1287	No.	n/a	$8,138
Other species with <5 producers**	<5	45	tonnes	n/a	$770,734
Algae	<5	**			**
Total (not including algae or pearls)					$16,783,784

* 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 Seven Production Years (2006/07-2012/13)

AQUACULTURE PRODUCTION TABLE 2

Estimated quantity of growout production of aquaculture species/categories in Western Australia over the past seven financial years.

Common name	Units	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Barramundi	tonnes	43.2	365.9	455.2	433	862.5	1 126.6	1 190.4
Mussels	tonnes	621.9	481.2	433.5	506.5	364.9	349.8	242.6
Marron	tonnes	58.1	51.1	52.8	53.9	51.1	50.5	51.7
Yabbies	tonnes	87.9	60.8	44.1	46.7	19.7	18.8	19.3
Silver perch	tonnes	26.5	16.9	28.5	27.2	18	14.1	12.9
Rainbow trout	tonnes	11.7	13.3	11.7	7.5	11	4.2	4.3
Ornamental fish & crustaceans	No.	61 492	55 047	50 598	46 425	21 167	24 908	20 970
Koi carp	No.	30 124	35 620	34 270	44 787	39 944	21 366	25 210
Goldfish	No.	35 836	33 918	36 199	15 785	11 448	8 624	12 975
Other species with < 5 producers	tonnes	65.2	97.2	94.9	94.2	75	97.4	44.7

AQUACULTURE PRODUCTION TABLE 3

Estimated farm gate value ($) of growout aquaculture species/categories in Western Australia over the past seven financial years.

Common name/ Category	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Barramundi	$ 467 280	$3 870 071	$4 793 106	$4 512 123	$8 391 579	$11 135 223	$12,510,017
Marron	$1 387 449	$1 298 672	$1 434 494	$1 445 252	$1 418 951	$1 443 954	$1,501,284
Mussels	$1 811 298	$1 531 849	$1 618 594	$1 870 531	$1 357 009	$1 367 470	$1,017,041
Yabbies	$1 381 248	$1 059 532	$ 810 608	$ 760 595	$389 920	$376 830	$415,461
Silver perch	$ 317 275	$ 245 157	$ 405 506	$ 435 624	$310 977	$253 669	$254,561
Koi carp	$ 137 195	$ 160 597	$ 168 279	$ 184 708	$173 928	$113 751	$145,094
Rainbow trout	$ 105 391	$ 135 007	$ 140 422	$ 101 681	$133 257	$61 012	$63,956
Ornamental fish & crustaceans	$ 294 308	$ 237 408	$ 276 986	$ 230 856	$108 023	$57 715	$68,843
Goldfish	$ 65 536	$ 80 732	$ 73 992	$ 52 139	$32 771	$25 759	$36,793
Other	$ 883 044	$1 554 289	$1 715 130	$1 018 211	$1 024 396	$1 337 601	$770,734
Total (not including algae & pearls)	$6 850 022	$10 173 312	$11 437 116	$10 611 720	$13 304 811	$16 173 311	$16,783,784

APPENDIX 3

Research Division - Other Activities

Activities of the Pemberton Freshwater Research Centre and the Aquaculture & Native Fish Breeding Laboratory 2013/14

C. Lawrence, T. Church and R. Duffy

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 Thomson's Flat feature 25 earthen ponds, ranging in size from 150m^2 breeding ponds to 1000m^2 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 2013/14 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 2013/14 the PFRC produced 694,000 fry. These consisted of 680,000 rainbow trout fry and 14,000 brown trout fry, representing an increase in production of 3.2% and a decrease of 26% respectively, compared with 2012/13. The majority of production (67%) consisting of 454,000 rainbow trout fry and 12,000 brown trout fry was stocked into public waterways to support recreational fishing. A further 190,000 rainbow trout (28%) 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 12% increase in sales from PFRC in 2013/14 to 190,000 up from 168,000 in 2012/13.

50,000 sterile triploid rainbow trout were produced at PFRC in 2013/14 which were supplied to licenced aquaculture producers and fishing associations. The remaining 38,000 diploid trout produced (5%) were retained for future brood stock for PFRC, yearling stocking, and research.

In the winter-spring months of 2013 and May-June 2014 27,600 (29,450 in 2012/13) rainbow yearlings and 1,000 brown yearlings as well as 2,600 rainbow and 200 brown trout ex brood stock, were released to public waters for recreational fishing and control of stunted redfin perch populations.

Trout research for recreational fishing and aquaculture

In late 2006 the Department commenced a review of trout production at PFRC to consider two key factors: brown trout embryo survival and rainbow trout brood stock selection strategies. In 2007 the Department commenced research to evaluate hatchery production techniques for producing sterile triploid trout and 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 and climate change.

Investigations by the Department into brown trout sperm motility showed that some trout were not producing motile sperm. This resulted in modifications to hatchery protocols to include assessment of sperm quality prior to egg fertilisation. In 2009/10 sperm motility assessment using basic visual evaluation of sperm quality resulted in a 500% improvement in brown trout egg fertilisation rates. However, visual assessment of sperm motility is labour intensive. Consequently sperm motility assessment was postponed until the purchase of computing equipment and software. Computer Assisted Sperm Analysis software (CASA) was purchased by the Department in late 2010. This software enabled research staff to efficiently analyse and quantify trout sperm fitness during the 2013 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. The laboratory work was completed in 2013 and is currently undergoing analysis.

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.

Establishment of a second repository for temperature tolerant trout lines

Given the value of the temperature tolerant rainbow trout line, a second repository was established at the UWA owned and Departmental run, Shenton Park, Aquaculture and Native Fish Breeding Laboratory. Fish were successfully held at the facility over summer despite air temperatures in excess of 40°C and water temperatures of approximately 28°C. The ability to successfully establish this line through the heat of summer will reduce the risk of loss of trout with the highest known temperature tolerance of any stock worldwide.

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, and 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's 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.

Endangered/Threatened/Protected 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. 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 minnow (*G. occidentalis*) and pygmy perch (*Nannopera vittata*). 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.

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 was 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. Collection of these stocks has commenced.

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.

Trout predation of feral species

A trial to investigate trout predation of the feral mosquito fish (*Gambusia*) was undertaken at the Aquaculture & Native Fish Breeding Laboratory. This research investigated the relationship between size of trout and rates of consumption. Analysis is ongoing, however early results suggest that presence of trout in water bodies will have a significant impact on reducing mosquito fish numbers.

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).

The department has successfully spawned, and is in the process of rearing, offspring from genetically pure hairy marron. The offspring will form the basis of a captive population that will be used to establish secure populations in the wild and supplement the existing populations.

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 of 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 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 future.

Summary

In 2013/14 the Freshwater section of the Department has returned to normal. 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. Core activities for recreational and aquaculture stakeholders, including trout production and monitoring of recreational marron fishery were delivered. In addition, advanced research into mosquito fish control, establishment of unique genetic lines of native species, investigation of breeding techniques and role of native fish in mosquito control have been investigated.

Activities of the Fish Health Unit during 2013/14

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, 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 2013/14 were as follows:

The fish health laboratory received a total of 160 diagnostic cases during 2013/14.

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 four 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 from 8 to 6 in this reporting period. This is partly because a hatchery in Darwin is supplying more spat to Western Australia than in previous years.

There were 11 cases of notifiable diseases reported in 2013/14. Eight notifications related to records of Megalocytivirus in ornamental fish in quarantine facilities at the border following importation from overseas. The notifiable bacterium *Edwardsiella ictaluri* was isolated from *Helostoma temminki* (Kissing gourami) in quarantine at the border. The endemic disease epizootic ulcerative syndrome (EUS) was diagnosed in black bream from the Swan and Canning Rivers on two occasions in late 2013. The spring of 2013 was wetter and warmer than usual and EUS outbreaks appeared to be more severe and prolonged than usual.

In collaboration with staff from the Department of Water, 5 reports of ‘fish kills’ throughout the State were investigated. Most ‘fish kills’ were due to poor water quality resulting from low water levels in autumn or natural events compounded by man-made water flow disturbances. In May 2014 the Indian Ocean Territories were re-visited for updated fish kill training under agreement with the federal government. Fish kill training was provided by members of the Fish Health Unit for personnel who may need to respond to fish kill incidents. In 2013/14 training occurred within the metropolitan area and in several regional centres.

A project funded by the FRDC aimed at investigating the cause of disease in pearl oysters (*Pinctada maxima)* was commenced. The project is in 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 continued. This project aims to identify emerging pathogens of potential significance to both wild fisheries and any potential developing prawn aquaculture industry.

A range of national committees including: the national Subcommittee for Aquatic Animal Health; 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.

Members of the group also attended and presented at the FRDC Second Australasian Scientific Conference on Aquatic Animal Health in Cairns, Australia in 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 2013/14

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 2013/14. 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 are developing a marine pest incursion response plan for HMAS Stirling on behalf of the Garden Island, Defence Services Group.

Early warning system

The Early Warning System uses arrays to examine early stage settlement of marine organisms. By examining these arrays at 3 monthly intervals it provides a reliable mechanism for the early detection of any 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, Esperance 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, 6 and 12 month intervals after the initial surveillance operation, bringing the total number of trap hours to more than 20 000. To date no further specimens of *C. japonica* have been detected by either the Department or the general public.

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 Esperance to Broome. It has also been confirmed that this species is present as a common component of hull fouling on 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. *Didemnum perlucidum* displays all the characteristics typical of a pest species: high growth rate, early maturity and extremely high fecundity. Furthermore this species may spread asexually, both through lateral expansion at the edges of the colony as well as through pieces breaking off and establishing elsewhere.

Previously this pest species has been confined to artificial structures such as jetty pylons and vessels. Recent surveillance by the Marine Biosecurity Research and Monitoring group has detected this species colonising the seagrass *Halophila ovalis* in the Swan River and the seagrass *Posidonia* in Albany. 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.

Established species control program

In 2008 the invasive algae *Codium fragile* ssp *fragile* was detected in Albany, Western Australia. This species is regarded as one of the most invasive algae species in the world. The algae goes by many names such as dead man's fingers and the oyster thief for its reported impact on commercial oyster farms. The species is prolific once established and readily spreads throughout its new location. In 2014 the Marine Biosecurity Research and Monitoring Group undertook a delimiting survey of this species in and around the vicinity of the Albany tug pen where it had been reported. The algae was confined to an area approximately 4m wide by 80 m long and was extremely patchy in its distribution. Divers proceeded throughout this range and removed all visible plants as part of an ongoing control program. The team will return in summer to determine if there is any regrowth and to target any 'missed' plants. It is hoped that with sufficient attention we may be able to remove this species from WA waters.

Research programs

Likelihood analysis

The Marine Biosecurity Research and Monitoring Group have completed their analysis of vessels entering WA ports. This research examined 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 marine pest status of international and domestic ports and environmental matching between the last port of call and the WA port(s) visited. This research provides an 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 has commenced 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 invasive marine pests (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 a pylons to kill fouling which are currently being written up for publication. The use of wrapping has also been successfully implemented by the Biosecurity Compliance group.

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 evaluated by the group to determine its efficacy in detecting these crab types and the results have been published in the international journal Management of Biological Invasions. This methodology is now included in our marine pest monitoring and has been suggested to be included as part of the Australian National System program.

Crab traps and crab behaviour

Following on from the *Charybdis japonica* incursion and trapping program a research project examining the behaviours of crabs towards different traps was developed. This study is ongoing and examines crab behaviour towards different trap types and the presence of other crabs in the traps. Outcomes from this study will help direct future crab trapping programs.

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. The team will resurvey the island in late 2014.

Marine pest research

The Marine Biosecurity Research and Monitoring Group have completed their analysis of vessels entering Christmas Island. This research examined the types and number of commercial vessels that visit the Island from domestic and international last port of calls, duration of the vessels stay, duration of the voyage, the marine pest status of international and domestic ports and environmental matching between the last port of call and Christmas Island. This research provides an analysis of the likelihood of a potential marine pest introduction to Christmas Island based on the above data that will inform management and policy.

Activities of the Freshwater Biosecurity Research Program 2013

Prepared by: C. Bird, A. Harris & R. Duffy

Background

A 2010 NRM funded project which surveyed 114, of 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 2013 there were 16 finfish and 2 crustacean, non-native, freshwater species recorded in Western Australia (WA) (Freshwater Biosecurity Table 1). Most of these species successfully reproduce and are therefore considered established pests. Golden Perch and Silver Perch are the only two introduced species in WA that are yet to have known self-sustaining populations; this does not necessarily imply they are unable to breed in WA.

Among vertebrates, freshwater fishes are one of the most commonly introduced species. Ornamental fish in particular account for a majority of the recent fish introductions to Western Australian freshwater ecosystems. Over the past 20-30 years there has been a steady increase in the number of exotic freshwater ornamental fish species that have become established in Australian waterways. All introduced freshwater species found in WA may have an adverse effect on the survival of native species via competition for resources, predation as well as habitat modification.

Management Arrangements

The Department of Fisheries oversees the management of risks associated with the translocation of live fish into and within the State. The most common activities that require the translocation of live fish include commercial aquaculture, the live seafood/restaurant trade, non-commercial aquaculture (including the stocking of farm dams) and the aquarium trade. The approvals process involves a risk assessment for those species that are not on the Department's White Lists. If the risk assessment determines that the translocation of that species is of an acceptable level of risk to the State, Translocation Approval is granted and with a set of conditions that must be followed. Applications are refused when the risk is assessed as being too high.

The prohibited release of translocated species into Western Australian waterways is typically human assisted. Aquarium release of unwanted fish, is a common pathway for these species to be introduced into waterbodies and catchments, as is the deliberate release for recreational angling purposes. Managing the release of species in this manner is difficult.

Community Engagement

In an attempt to reduce the introduction of unwanted species in Western Australian waterways the Department has put a strong focus on community education and engagement in 2013. The 'don't dump that fish' program was launched in October 2013. The campaign saw 'don't dump that fish' posters, brochures and fish bag stickers distributed to 138 participating aquarium retailers around the State and at 6 community events. The program also received wide media coverage, featuring in 25 media outlets (12 online websites/forums, 2 radio reports, 1 television report and 10 newsletter and magazine publications). As a result, the wider community are becoming more aware and educated on the impacts of releasing unwanted aquarium fish, snails and plants into open waterways, toilets, drains or the ocean.

The Department attended 20 community events around the State distributing materials and engaging with a wide range of stakeholders to raise awareness, educate and inform them about freshwater biosecurity issues.

Additionally, 2013 saw the launch of WA PestWatch, a free application to improve aquatic biosecurity. WA PestWatch can be used on a smart phone, tablet device or accessed via the web and helps members of the public report sightings of potential pests while they are out enjoying the State's oceans and waterways. This app widens our much needed surveillance of newly introduced pests in WA to include the entire community, using a method that is easy to use, fast, includes photos for identification, has accurate GPS data, and automatic mapping of the report.

The Department has increased freshwater compliance activities to prevent new introductions and continued regulations which prevent a large number of high risk ornamental fish species that arrive without translocation permits from gaining entry into Western Australia.

Staff from the Research Division, in addition to staff from all other Divisions across the Department, have formal training in incident management so that there is a preparedness for response to potential biosecurity incidents and emergencies. In tandem with the incident management training, the Department has refined its risk assessment processes and incident management protocols.

Sampling methodology

The majority of sampling in the Perth area in 2013 was undertaken using fyke nets – a trap net that has a wing attached to the bank, which leads to a series of hoops and funnels. 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 for sampling by other methods such as seine netting, electrofishing, gillnets and opera house traps due to habitat type, by-catch and staff safety. However, on occasions, sampling methods included the use of electrofishing, opera house traps, fish box traps or gillnets where appropriate. The fyke nets used by the Department are fitted with a float ring to provide access to the surface for any air-breathing animals captured.

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 introduced freshwater species where required. The survey work in 2013, a continuation from the 2012 monitoring, was concentrated in the Perth-metro region (Swan/Canning coastal plain). This area has been identified as high risk due to previous pest fish 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-metro region, 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 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 introduced fish, creeks, rivers and drains connected to these lakes were also sampled.

During the 2013 survey a total of 176 sampling occasions were conducted, of which 26 were repeat samplings at 15 locations (Freshwater Biosecurity Table 2). In early 2013, a single Murray Cod, *Maccullochella peelii* was captured in Harmony Lake, Atwell. Murray Cod were stocked into many public and private waters outside its natural range, and into a number of localities in south-western Australia in the late 1800s; e.g. the Swan-Avon River and Lake Grassmere (now known as Lake Powell, Albany). Since that time, however, any established populations of Murray Cod are believed to have disappeared. A follow up sampling event at Harmony Lake failed to catch any more Murray Cod, however at least two more sampling occasions are planned to ensure no additional Murray Cod remain. A large predatory species such as this could decimate WA native fish populations.

Survey work conducted in late 2013 revealed the Freshwater Eel-tailed Catfish *Tandanus tandanus* to be present at a second location in the Perth-metro region – Ollie Worrell Reserve Lake, High Wycombe (the first population of the introduced Catfish, detected during the 2010 NRM survey, being found in Marmion Reserve Lake, Myaree). Three individual Catfish, all approximately 40cm, were removed from Ollie Worrell Reserve Lake upon detection. Further sampling will occur in 2014 at Ollie Worrell Reserve Lake, the adjacent wetland area of Munday swamp and the drainage channel joining the two waterbodies to confirm eradication. During the wet season species from Ollie Worrell may move into Munday swamp via the drainage channel. The connectivity of Ollie Worrell to Munday swamp is of particular concern, as once in Munday swamp, species would be able to follow creek and drain linkages directly into the Swan River.

Freshwater Biosecurity Research staff continued with control measures in 2013 for the population of Catfish in Marmion Reserve Lake. Following the population assessment of the Catfish in 2012, several fish-down efforts were conducted in 2013, which removed over 1,800 Catfish from the lake. Continued efforts are aimed at verifying eradication of Catfish from Marmion Reserve Lake in 2014.

Impact on non-target species

The use of fyke nets for sampling can unintentionally capture non-target species, the most prevalent being Oblong Turtles, *Chelodina oblonga*. Of the 176 sites sampled in 2013, Oblong Turtles were captured at 109 of these. A total of 574 fyke nets were used and captured 1692 turtles, all of which were returned alive to the water. Water birds were also captured in shallow waterbodies where the entrance to fyke nets was not completely submerged under water. A total of 23 water birds were captured at nine sites, all of which were released unharmed. Sampling for fish using fyke nets, is a safe method for eliminating death of non-target animals.

Pest Reporting and Response

In addition to the survey work conducted throughout the Perth-metro region (Swan/Canning coastal plain) in 2013, the Freshwater Biosecurity Research Unit also responded to a number of pest species reports. Pest species were reported to the Department via Fishwatch, WA Pestwatch, the Freshwater Fish Distribution website and direct contact with the Department of Fisheries WA. The responses to these reports were prioritised according to risk and previous known distributions of the reported species. From the reports received in 2013, nine were addressed with sampling events. The remaining reports were deemed to be of low risk or reports of species already known to be present in the system.

Of the reports attended, two were from locations outside the Perth-metro region; Wellington Dam (near Collie) and Harding River Dam (Roebourne). Three reports over eight months were received of Koi Carp *Cyprinus carpio* being sighted in Wellington Dam. While Koi Carp are known to be wide spread throughout Perth and the rest of Western Australia, this was considered a high priority due to the Western Australian Government's consideration to make Wellington Dam a Freshwater Recreational Fishing Hub. No Koi Carp were captured during the Department's survey. Wellington Dam is such a large system (approximate full surface area of 1,600 hectares) and the estimated low density of Koi Carp made capture during a one-off sampling occasion difficult. Reports of Koi Carp in Wellington Dam will continue to be scrutinised and follow up sampling undertaken if deemed necessary.

In mid-2013, a report stated that Redclaw crayfish *Cherax quadricarinatus* were in Harding River Dam (Lake Poongkaliyarra). Follow up sampling performed at Harding River Dam confirmed the species was indeed Redclaw. Other than the 130 Redclaw specimens captured, no other species were collected. Data from previous sampling occasions of both the Harding River Dam and surrounding waters of the Harding River suggests that many species reside in the Harding River Dam catchment area. However, data on species captured in the Harding River Dam catchment has not been published for several years, and so it is uncertain which species are present in this area today. Further sampling of the Harding River Dam catchment area would allow for a more comprehensive understanding of the risks posed by this discovery.

New Discoveries

Three of the nine reports attended to in the Perth-metro region were of particular importance to the Freshwater Biosecurity Research Unit.

A report received mid-2013 resulted in the discovery of a population of Southern Platyfish *Xiphophorus maculatus* and a snail (*Planorbella sp*) in two connected waterbodies located at Bodkin Park, Waterford. Neither species has previously been record in Western Australia. Southern Platyfish are considered a highly resilient species with the potential to become a pest, and therefore extremely difficult if not impossible to eradicate once established. The species identity of the snail (genus *Planorbella*) could not be confirmed with certainty. Positive matches were made with two species *P. tenue* and *P. trivolvis*. Sequencing of further specimens identified and vouchered by experts in Museum collections could be conducted to provide further certainty to the species level identification. Due to the nature of this case, poisoning is not an option although the Department will implement a control program using other methods in early 2014.

The discovery of a crustacean species, not previously found in the state was also the result of a public report. Several thousand Indistinct River Shrimp *Cardina indistincta* (B1), an Eastern states species, were captured in May 2013. Specimens were collected while electro-fishing a creek line along Severin Walk, near Cleaver Terrace Belmont. A broader sampling program revealed established populations of the Indistinct River Shrimp at a further two locations in Perth (Bennett Brook, Beechboro and Centenary Park, Belmont). At each location where Indistinct River Shrimp were present, the native Glass Shrimp *Palaemonetes australis* was absent. The Indistinct River Shrimp's ability to exploit habitat very similar to that of the Glass Shrimp, paired with the overlap in each shrimp's life history characteristics is likely to result in strong competition between the two species.

Sampling undertaken at Bells Rapids during late 2013, in response to a feral report of Pearl Cichlids *Geophagus brasiliensis*, confirmed the presence of the South American species. The Pearl Cichlid has been known from Perth waterways since 2006. The new location reveals that in only eight years this highly successful, invasive species has spread over approximately 20km of the Swan River.

Native fish abundance

Native fish abundance recorded from the 2013 sampling displayed a similar trend observed during the 2012 survey. Of the 176 waterbodies sampled, native species were found to be present in only 42 sites (24%). Far less waterbodies were found to contain *only* native freshwater species (2%); other sites contained introduced and native species or only introduced species. Such low frequency and abundance of natives may be due to; reduced water levels from reduced rainfall and/ or increased groundwater extraction, poor water quality (i.e. acidification, eutrophication, salinization, sedimentation as well as pollution by industrial, residential and agricultural waste), destruction of riparian vegetation, channelisation of streams in irrigation areas, and finally introduced feral fish which compete with and consume native fish. It is suggested urgent action is necessary to protect the few 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 where native species are currently absent, but suitable conditions for survival exist. This would require considerable quantities of fish, given the high number of lakes involved in the Perth-metro region alone (up to 560). The breeding stock for the stocking program would need to be sourced from the remnant lake stocks to ensure stocked fish possess genetic traits suitable for survival in the highly modified lakes within the metro region.

No restocking was undertaken during 2013.

FRESHWATER BIOSECURITY TABLE 1

Freshwater species introduced to Western Australia, recorded during the Freshwater Biosecurity Survey (2010-2013)

Common Name	*Scientific Name*	Origin
Finfish		
Brown Trout	*Salmo trutta*	Europe
Carp (Koi)	*Cyprinus carpio*	Eurasia
Convict Cichlid	*Amatitiania nigrofasciata*	Central America
Freshwater Eel-tailed Catfish	*Tandanus tandanus*	Eastern Australia
Gambusia/ Mosquito Fish	*Gambusia holbrooki*	Sth America
Golden Perch	*Macqaria ambigua*	Eastern Australia
Goldfish	*Carassius auratus*	Eurasia
Guppy	*Poecilia reticulata*	Sth America
Murray Cod	*Maccullochella peelii*	Eastern Australia
Pearl Cichlid	*Geophagus brasiliensis*	Sth America
Rainbow Trout	*Oncorhynchus mykiss*	Europe
Redfin Perch	*Perca fluviatilis*	Europe
Rosy Barb	*Puntius conchonius*	SE Asia
Silver Perch	*Bidyanus bidyanus*	Eastern Australia
Southern Platyfish	*Xiphophorus maculatus*	North and Central America
Spangled Perch	*Leiopotherapon unicolor*	Gascoyne
Speckled Mosquito Fish	*Phalloceros caudimaculatus*	Sth America
Swordtail	*Xiphophorus helleri*	Sth America
Tilapia	*Oreochromis mossambicus*	Africa
Crustaceans		
Redclaw Crayfish	*Cherax quadricarinatus*	Eastern Australia
Yabby	*Cherax destructor albidus*	Eastern Australia
Indistinct River Shrimp	*Caridina indistincta (B1)*	Eastern Australia
Molluscs		
Snail sp.	*Planorbella sp*	Unknown

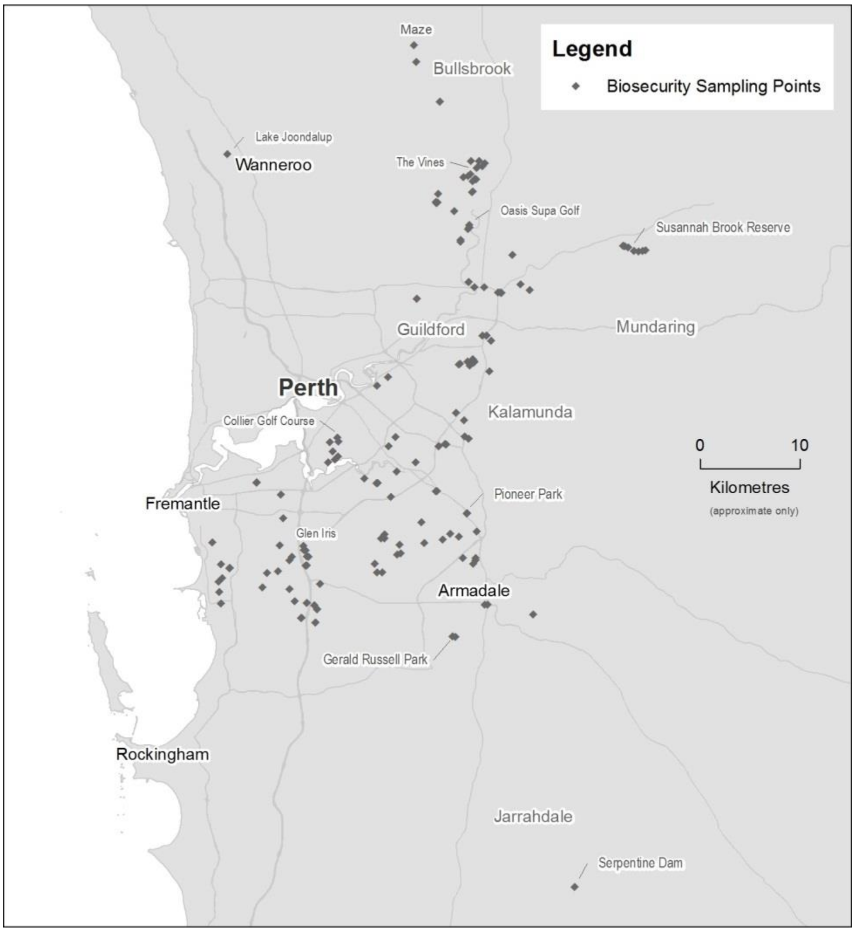
FRESHWATER BIOSECURITY TABLE 2

Freshwater Biosecurity Sampling Results from the Perth-metro Region

Year of Sampling	2013		2012	
	Total	%	Total	%
Finfish				
Number of locations visited	176	-	140	-
Number of locations by visit dry or too shallow	8	5	9	6
Number of locations sampled	164	93	124	95
Number of locations containing finfish	134	76	119	96
Number of locations containing estuarine fish	33	19	42	34
Number of locations containing native freshwater finfish	17	10	8	6
Number of locations containing only native freshwater finfish	0	-	3	2
Number of locations containing feral freshwater fish	126	72	99	80
Number of locations containing only feral freshwater finfish	49	29	71	57
Number of new introduced finfish species detected	2	1	1	<1
Number of new locations introduced freshwater finfish detected in	1	<1	0	-
Number of new locations introduced freshwater finfish detected in	1	<1	8	6
Number of new locations introduced freshwater finfish detected in	3	2	NA	NA

Crustaceans				
Number of locations containing crustaceans	85	48	66	53
Number of locations containing native crustaceans	63	36	51	41
Number of locations containing only native crustaceans	3	2	29	23
Number of locations containing feral crustaceans	45	26	37	30
Number of locations containing only feral crustaceans	4	2	14	24
Number of new introduced crustacean species detected	1	<1	NA	NA

NA not applicable for this year of sampling



FRESHWATER BIOSECURITY FIGURE 1

2013 Freshwater Biosecurity Sampling Locations in Perth-metro region.

Indian Ocean Territories Fishery Status Report

S.J. Newman, L. Bellchambers, C. Skepper, S. Evans and D. Wallis

Main Features			
Status		Current Landings	
Stock level	Some species at risk	Total	Not assessed
Fishing Level	Not Assessed	Main Commercial Fishery	Not reportable

Fishery Description

Commercial

In November 2002, the territorial seas (out to 12 nautical miles) of the Cocos (Keeling) Islands and Christmas Island were declared as ‘excepted waters’ from the *Fisheries Management Act 1991*. Management responsibilities were transferred from the Australian Fisheries Management Authority to the Commonwealth Government, and the Department of Fisheries of the Government of Western Australia has now taken on management responsibilities for the marine territorial waters of the Indian Ocean Territories on behalf of the Commonwealth Department of Infrastructure and Regional Development. 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 Infrastructure and Regional Development, the Department Fisheries, WA 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 the Department of Infrastructure and Regional Development 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, demersal fishing activities are also undertaken targeting deepwater demersal fish, mainly the deepwater snappers.

The Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) primarily targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*).

Recreational

Large amounts of recreational fishing are undertaken around the Cocos (Keeling) Islands and Christmas Island targeting both finfish and invertebrate species. The Cocos (Keeling) Islands consist of a diverse range of fishable habitats that include a sheltered lagoon, fringing reefs and offshore 'blue water' environments that support a range of demersal and pelagic fish species, as well as various crustaceans (e.g. lobsters, crabs) and molluscs (e.g. gong gong, clams), 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 pelagic fish species and a limited range of demersal fish species and some invertebrates (e.g. lobster, clams).

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, which all operated during 2013. The CILF also has output controls in the form of catch limits on both demersal and pelagic species to be harvested.

The commercial Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) is managed through input controls in the form of a limited entry fishery (there is only 1 licence in the fishery) and gear restrictions. The fishery also has a number of output controls in the form of limits on the species permitted to be harvested, limits on the total number of individuals of all species combined that can be harvested in a year and limits of the number of individuals within a Family that can be harvested within a year. 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. 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 finfish group has also been working on collating all historical research data on fish assemblages at the IOTs. A report is in preparation. The marine ecology and monitoring section has focussed on invertebrate and ecosystem research at the Cocos (Keeling) Islands. Invertebrate research has focussed on assessments of the abundance and biology of the key recreational invertebrate species of gong gong (*Lambis lambis*) and giant clams (*Tridacna* spp.). Previous surveys have also examined the abundance and distribution of bêche-de-mer (Holothurians). Ecosystem research has focussed on maintaining a long term reef-monitoring program at Cocos (Keeling) Islands to help detect changes to the benthic reef and lagoon environments and associated targeted recreational fish species using stereo diver operated videos (DOVs) and baited remote underwater videos (BRUVs).

Retained Species

Commercial landings (season 2013) 6.7 tonnes

Pelagic species dominate the catch of the CILF, comprising 91% (6.1 t) of the total reported catch. Wahoo (*Acanthocybium solandri*) is the main target species of the CILF, comprising 70% (4.7 t) of the total reported catch. 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.) and these species comprised 9% (0.6 t) of the total reported catch in 2013. The commercial catch for Christmas Island usually consists of catch data from only 2 vessels and the exact catch data in many years 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 8 years.

There is no commercial line fishery at the Cocos (Keeling) Islands.

The CKIMAFF targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*). As there is only one license in the CKIMAFF the catch data is not reportable due to confidentiality provisions.

Recreational catch estimate (season 2013)

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 increasing steadily over the past five years, with 252 fishing days reported in 2013. 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:

Holuthurians: In 2006 a large-scale assessment of the holothurian communities inhabiting the lagoon and outer reef at the Cocos (Keeling) Islands was undertaken to determine the status of key holothurian species and enable recommendations to be made regarding the feasibility of a commercial holothurian fishery being developed in the region. Analysis of abundance and distribution data found that the holothurian community is strongly influenced by habitat and although some species are wide-ranging and found in relatively high densities, they tend to be of low economic value. In contrast, species of moderate to high value were recorded at densities too low to support commercial fisheries and typically had very restricted distributions. The holothurian community found at the Cocos (Keeling) Islands is near to pristine, due to a lack of historical fishing pressure. Holothurian stocks are very sensitive to fishing pressure and have been heavily overexploited in other areas of the Indian and Pacific Oceans.

Gong Gong: The common spider conch or gong gong (*Lambis lambis*) is a heavily recreationally-targeted gastropod inhabiting shallow waters of the lagoon. This species is vulnerable to over-fishing as it is highly accessible and presumably shares biological traits with other exploited conch species, including slow growth and late maturity. Monitoring data collected between 2007 and 2014 indicates 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, WA. 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 and lagoon communities at Cocos (Keeling) Islands.

The implementation and ongoing monitoring of these initiatives will enable the Department of Fisheries, WA to assess the health of the invertebrate stocks and reef and lagoon ecosystems at the Cocos (Keeling) Islands to 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 assist in reducing the sustainability risks identified.

Aquarium Fish:

The CKIMAFF targets *Centropyge joculator* and to a lesser extent *Centropyge flavissima. Centropyge joculator* is endemic to the Cocos and Christmas Islands and inhabits fringing reefs from 15 to 70 m.

Little is known about the biology of *C. joculator* 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 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.

Listed species interaction: Negligible

The line fishing methods used in CILF are not known to catch any listed species. However, there is some potential for low levels of seabird bycatch at Christmas Island.

No listed 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 4 people were employed in the CILF around Christmas Island during 2013. 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 2013.

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 2013:

Not assessed

The value of the CILF is not known. The value of the CKIMAFF is also unknown, although *C. joculator* commands a high price on the international market (reported in excess of AUS $700.00 each).

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.

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 (2014)

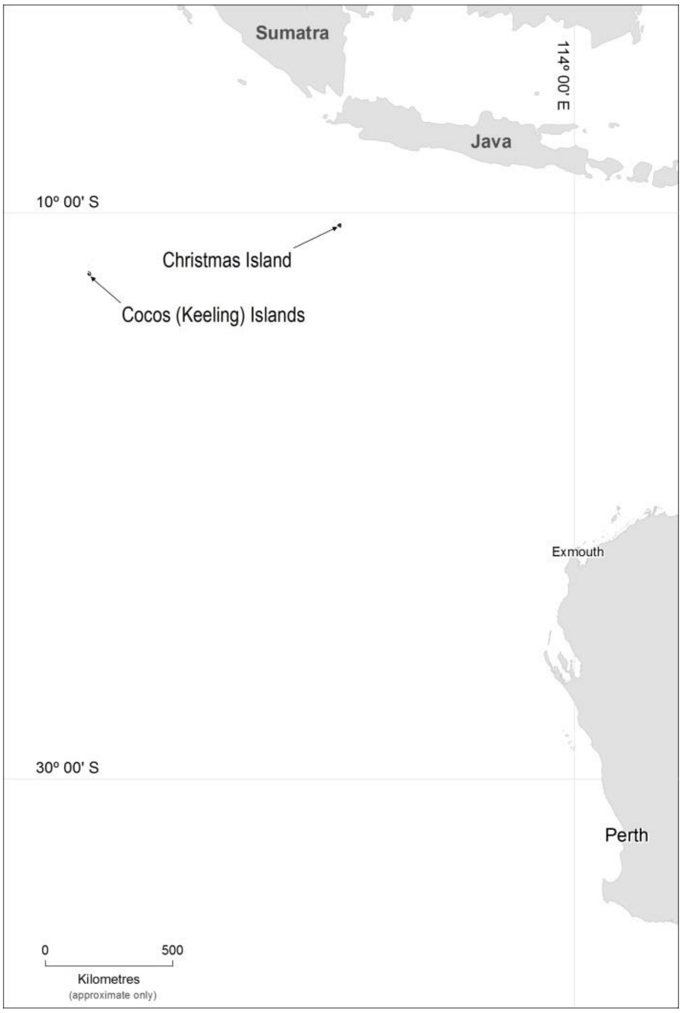
New island-specific recreational fisheries management arrangements for the Indian Ocean Territories are currently being progressed to legislation.

The effective implementation of any future recreational fisheries management legislation at the Indian Ocean Territories will require ongoing community education and compliance programs.

External Factors

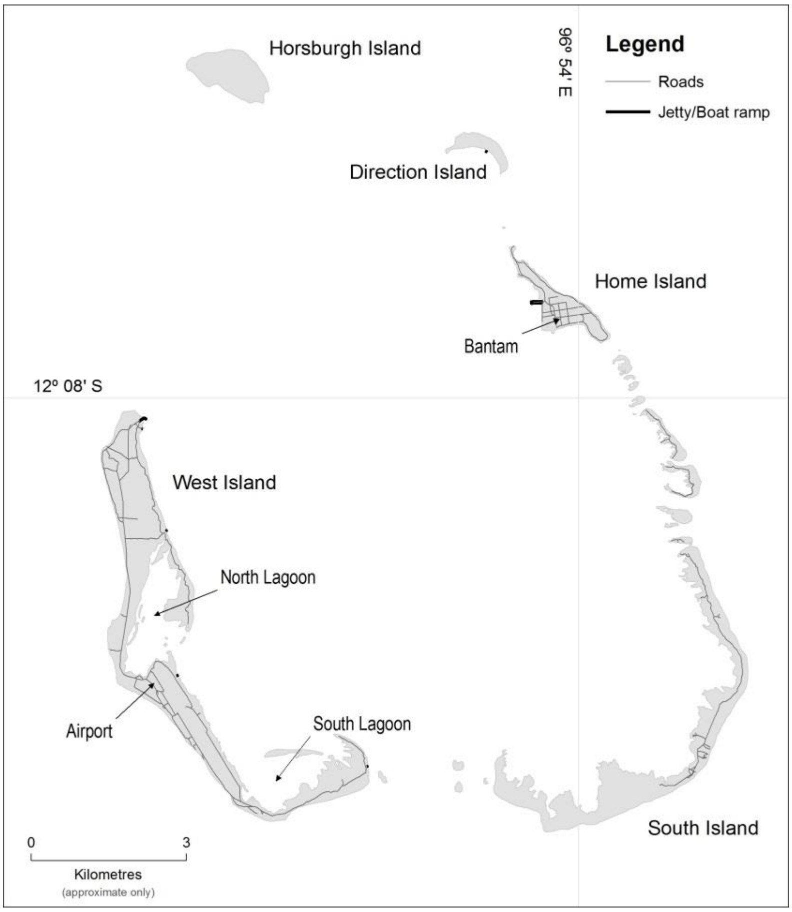
The demersal fish and invertebrate populations of Cocos (Keeling) Islands and Christmas Island are likely to consist of small, isolated populations that are expected to experience highly variable recruitment due to environmental fluctuations.

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. Assessment of the impacts of the MV Tycoon grounding on fish assemblages and reef habitats has not been finalised.



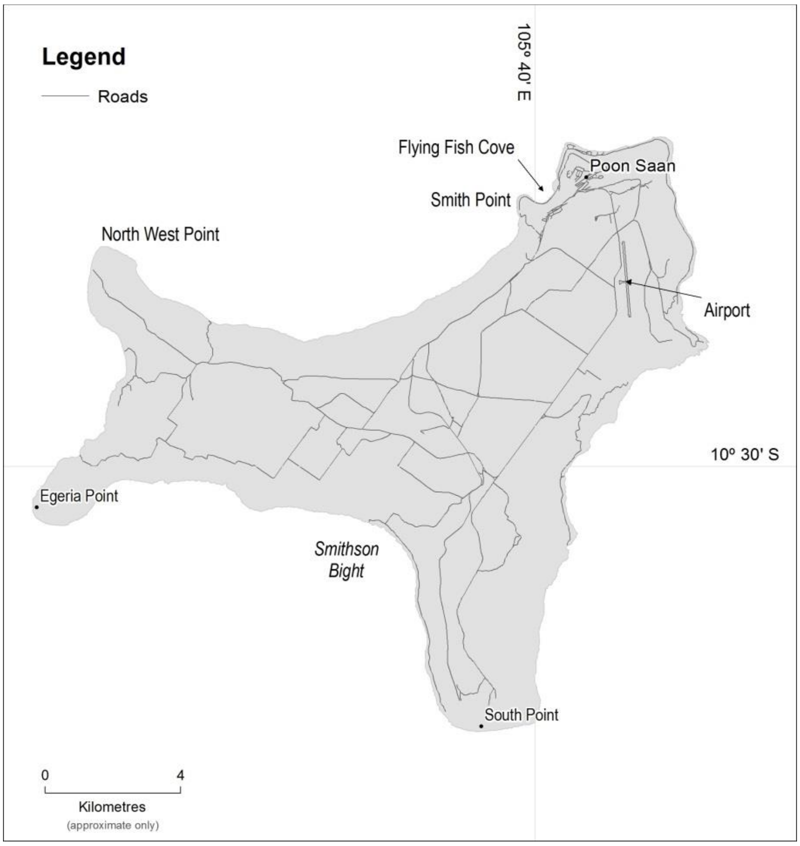
INDIAN OCEAN TERRITORIES FIGURE 1

Location of the Cocos (Keeling) Islands and Christmas Island comprising the Indian Ocean Territories within the Indian Ocean and illustrating their proximity to the Western Australian coast.



INDIAN OCEAN TERRITORIES FIGURE 2

Location of the major Islands and landmarks within the Cocos (Keeling) Islands in the Indian Ocean.



INDIAN OCEAN TERRITORIES FIGURE 3

Location of the key landmarks around Christmas Island in the Indian Ocean.

Finfish Ageing Laboratory

J. Norriss

The Finfish Ageing Laboratory (FAL) at the WA Fisheries and Marine Laboratory continues to produce age data for assessing stocks of indicator 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 the status of 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 suites across the four marine Bioregions, ranked in terms of their risk to sustainability. The RAF is subject to periodic review.

In 2013 the FAL processed and aged 18,098 fish (see Finfish Ageing Laboratory Table 1), the highest annual total on record. The priority species were barramundi, red emperor and goldband snapper from the North Coast Bioregion, (pink) snapper from the Gascoyne Bioregion, Australian herring, West Australian dhufish, (pink) snapper, redthroat emperor and Bight redfish from the West Coast Bioregion, and cobbler, (pink) snapper and Bight redfish from the South Coast Bioregion.

The number of fish aged in 2013 was significantly higher than the ~11,500 fish aged in 2012. This was due to more species that could be aged using whole rather than sectioned otoliths (e.g. Australian herring and cobbler) and additional staff.

The FAL is working with fisheries agencies around Australia, under the auspices of the Australian Society for Fish Biology's committee for the National Framework for Routine Fish Ageing, to develop best practice protocols (guidelines) for the production of quality-assured fish age data for stock assessments of Australian fisheries. Outcomes will be documented as national best practice standards, guidelines, or protocols that can be developed on an agency and species-specific basis. The document is planned to be completed in 2015.

Meanwhile, a guide to methods used to age key finfish species from the West Coast and South Coast Bioregions is currently being developed by the Department of Fisheries, with a combined North Coast and Gascoyne Coast Bioregions guide to follow. There will be a chapter devoted to each key species, authored by scientists experienced in interpreting their otoliths and routinely generating age estimates. The Australian herring chapter will be the first to be developed and will serve as a template for other chapters.

FINFISH AGEING LABORATORY TABLE 1.

The number of fish processed and aged by the Finfish Ageing Laboratory in 2013, by Bioregion, species, ecological suite and whether it is and indicator species for that suite.

North Coast Bioregion	Number processed	Ecological suite	Indicator species
Barramundi *Lates calcarifer*	473	Estuarine	Yes
Rusty jobfish *Aphareus rutilans*	63	Inshore demersal	No
Goldband jobfish *Pristpomodides multidens*	739	Inshore demersal	Yes
Red emperor *Lutjanus sebae*	598	Inshore demersal	Yes
Total	1,873		

Gascoyne Bioregion	Number processed	Ecological suite	Indicator species
Pink snapper *Chysophrys auratus*	1,081	Inshore demersal	Yes
Spangled Emperor *Lethrinus nebulosus*	232	Inshore demersal	Yes
Total	1,313		

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

West Coast Bioregion	Number processed	Ecological suite	Indicator species
Black bream *Acanthopagrus butcheri*	2	Estuarine	yes
Australian herring *Arripis georgianus*	2,164	Nearshore	Yes
Southern garfish *Hyporhamphus melanochir*	1,284	Nearshore	No
West Australian Dhufish *Glaucosoma hebraicum*	1,527	Inshore demersal	Yes
Pink Snapper *Pagrus auratus*	2,293	Inshore demersal	Yes
Redthroat emperor *Lethrinus miniatus*	2,005	Inshore demersal	Yes
Bight Redfish *Centroberyx gerrardi*	1,821	Inshore demersal	Yes
Total	11,096		

South Coast Bioregion	Number processed	Ecological suite	Indicator species
Cobbler *Cnidoglanis macrocephalus*	960	Estuarine	Yes
Pink Snapper *Pagrus auratus*	825	Offshore demersal	Yes
Bight Redfish *Centroberyx gerrardi*	1,779	Offshore demersal	Yes
Total	3,564		

Statewide	Number processed	Ecological suite	Indicator species
Eightbar Grouper *Hyporthodus octofasciatus*	21	Not assessed	Yes
Bass Groper *Polyprion americanus*	13	Not assessed	Yes
Hapuku *Polyprion oxygenios*	75	Inshore demersal	Yes
Blue Eye Trevalla *Hyperoglyphe antarctica*	35	Not assessed	Yes
Ruby snapper *Etelis carbunculus*	72	Offshore demersal	Yes
Etelis marshi	35	Not assessed	No
Knifejaw *Oplegnathus woodwardi*	1	Inshore demersal	No
Total	252		

GRAND TOTAL	18,098		

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 2012/13 season or the calendar year 2013 for fisheries data but up to June 2014 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 2012/13 or 2013	Comment
Fishery: Abalone *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* August 2004 *Current accreditation:* August 2009 *Expiry date:* September 2014	Greenlip/brownlip abalone Areas 2/3 (spawning stock)	Effort range 907–1,339 diver days; minimum meat weight 140 g greenlip, 160 g brownlip	Acceptable	
	Roe's abalone Area 1 (spawning stock)	Effort range 14–43 diver days; total catch 9.9 t	Acceptable	Exploratory quota. No fishing in 2012/2013.
	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	
Fishery: Abrolhos Islands and Mid West Trawl *Approval type:* Accredited Export Exempt Fishery *Initial accreditation*: March 2005 *Current accreditation:* March 2013 *Expiry date*: 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

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2012/13 or 2013	Comment
Fishery: Beche-de-mer *Approval type:* Wildlife Trade Operation Exemption *Initial accreditation:* December 2004 *Current accreditation:* August 2011 *Expiry date*: August 2015	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.
Fishery: Broome Prawn *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* August 2004 *Current accreditation:* August 2010 *Expiry date:* August 2015	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any one year	Acceptable	Very low level of effort this year.
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–90 t (7-year catch range)	Acceptable	Low level of exploitation
Fishery: Exmouth Gulf Prawn *Approval Type:* Accredited Export Exempt Fishery *Initial accreditation:* March 2003 *Current accreditation:* February 2013 *Expiry date*: February 2018	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.
	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 2012/13 or 2013	Comment
Fishery: Gascoyne Demersal Scalefish Managed Fishery *Approval type:* Wildlife Trade Operation Exemption *Initial accreditation:* June 2004 *Current accreditation:* August 2010 *Expiry date*: September 2015	Pink snapper (spawning stock)	Catch rate not to fall below 500 kg/standard June–July boat day	Acceptable	The performance measure needs to be reviewed following significant reductions in quota and the move (in 2008) to higher resolution catch & effort reporting (daily/trip logbooks).
Fishery: Kimberley Prawn *Approval Type:* Accredited Export Exempt Fishery *Initial accreditation:* November 2004 *Current accreditation:* August 2010 *Expiry date*: August 2015	Banana prawn (spawning stock)	Total catch within acceptable range of 200–450 t	Acceptable	
	Brown tiger prawn (spawning stock)	Total catch within acceptable range of 15–60 t	Acceptable	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.
Fishery: Mackerel *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* November 2004 *Current accreditation:* November 2009 *Expiry date*: November 2014	Spanish mackerel (spawning stock)	Total catch within acceptable range of 246-410 t: acceptable regional catch ranges: Kimberley 110–205 t: Pilbara 80–126 t: Gascoyne/West Coast 56–79 t	Acceptable	
Fishery: Marine Aquarium Managed Fishery *Approval type:* Wildlife Trade Operation Exemption *Initial accreditation:* October 2005 *Current accreditation:* December 2013 *Expiry date*: October 2016	Seahorses of hippocampus species/coral/giant clam	No export of Hippocampus spp. but managed to limit of 2000 for domestic purposes	Acceptable	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2012/13 or 2013	Comment
Fishery: Northern Demersal Scalefish *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* November 2004 *Current accreditation:* June 2010 *Expiry date*: June 2015	Red emperor and goldband snapper (spawning stock)	Spawning biomass > 40% of virgin spawning biomass with lower limit of 30%; total annual catches should not increase > 20% above average catches of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years	Acceptable	
	Cods/groupers (spawning stock)	Total annual catch should not increase >20% above average catch of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years.	Acceptable	
Fishery: Onslow and Nickol Bay Prawn *Approval Type:* Accredited Export Exempt Fishery *Initial accreditation:* November 2004 *Current accreditation:* August 2010 *Expiry date*: August 2015	Banana prawns (spawning stock)	Nickol Bay: total catch in high rainfall years within acceptable range of 40–220 t: in low rainfall years within acceptable range of 0–40 t.	Acceptable	
		Onslow: total catch within acceptable range of 2–90 t	Acceptable	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 Iin 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: Pearl Oyster *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* September 2003 *Current accreditation:* December 2013 *Expiry date*: December 2018	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 some years of high catch rates due to high recruitment.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2012/13 or 2013	Comment
Fishery: Pilbara Trawl *Approval type:* Wildlife Trade Operation Exemption *Initial accreditation:* November 2004 *Current accreditation:* May 2014 *Expiry date*: May 2017	Long-lived target species (spawning stock) – includes Rankin cod, red emperor, scarlet perch, goldband snapper, red snapper, spangled emperor	Spawning biomass of Rankin cod and red emperor should remain above minimum limit of 40% of virgin spawning biomass; annual trawl catch should not increase > 20% above average catch of previous 4 years; no decrease in annual trawl catch rates in > 2 consecutive years	Acceptable	
	Short-lived target species (spawning stock)	Median spawning biomass of blue-spot emperor should be > 40% of the 1993 spawning biomass in Area 1; annual catch of each short-lived target species should not increase > 20% above the average annual catch of the previous 4 years; annual catch rate of each short-lived target species should not decrease in two consecutive years	Acceptable	
	Bycatch of listed 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 listed 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 listed 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;
	Bycatch of listed 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

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2012/13 or 2013	Comment
	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	
Fishery: Salmon *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* November 2004 *Current accreditation:* November 2009 *Expiry date*: November 2014	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.
Fishery: Shark Bay Crab Interim Managed Fishery *Approval type:* Wildlife Trade Operation Exemption *Initial accreditation:* November 2004 *Current accreditation:* October 2011 *Expiry date*: September 2016	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: Shark Bay Prawn *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* February 2003 *Current accreditation:* January 2013 *Expiry date*: 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 lin 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.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2012/13 or 2013	Comment
	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.
Fishery: Shark Bay Scallop *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* February 2003 *Current accreditation:* January 2013 *Expiry date*: 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.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2012/13 or 2013	Comment
Fishery: South Coast Crustacean *Approval type:* Wildlife Trade Operation Exemption *Initial accreditation:* September 2004 *Current accreditation:* November 2011 *Expiry date*: Mid-2015	Southern rock lobster (spawning stock)	Catch to remain between 50 to 80 tonnes	Acceptable	New management arrangements for south coast crustacean fisheries should be finalised in 2015.
Fishery: Specimen Shell *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* 25 May 2005 *Current accreditation:* December 2013 *Expiry date*: 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
Fishery: Temperate Demersal Gillnet and Demersal Longline (Shark) Fisheries *Approval type:* Accredited Export Exempt Fishery *Initial accreditation:* February 2006 *Current accreditation:* March 2012 *Expiry date*: August 2015	Dusky and sandbar sharks	Continue to review and report outcomes of actions taken to rebuild stocks	On-going	Recovery of dusky sharks is clearly evident and sandbar sharks is now likely. New stock assessments due in mid 2015
	Dusky and sandbar sharks	Continue to develop strategies to ensure recovery of stocks within biologically appropriate timeframes	Underway	Draft strategies developed as part of the MSC pre-assessment processes
	Australian sea lions	Continue monitoring fishing effort around Australian sea lion colonies and investigate and implement management measures that will limit the overlap of gillnet fishing and Australian sea lion foraging areas to support recovery of the species. These management measures could include independent validation of interaction rates	Underway and ongoing	An ASL working Group is exploring the potential of (electronic) observer programs within the fishery. The Working Group is also undertaking activities to monitor spatio-temporal levels of gillnet effort and to develop an annual risk assessment. The Department Is also supporting further research on ASL foraging ranges being undertaken within an Australian Marine Mammal Centre research project.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2012/13 or 2013	Comment
Fishery: West Coast Rock Lobster *Approval Type:* Wildlife Trade Operation Exemption *Initial accreditation:* August 2002 *Current accreditation:* May 2013 *Expiry date*: 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%	Un-acceptable	
	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 18 confirmed whale entanglements in WRL gear during the 2013 humpback whale migration season. Mitigation measures have been implemented to reduce whale entanglements.
Fishery: West Coast Deep Sea Crustacean Managed Fishery *Approval type:* Wildlife Trade Operation Exemption *Initial accreditation:* March 2004 *Current accreditation:* May 2013 *Expiry date*: May 2018	Champagne and Giant crab (spawning stock)	Unitisation of the fishery has permitted a maximum of 14t of Champagne crab and 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	

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
	PhD co-supervision, Murdoch University, supervises Daniel Yeoh – "Ecology and movement patterns of the fish fauna in the Walpole-Nornalup Marine Park".
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 (*Mustelus schmitti*) 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 "
Samantha Bridgwood	Technical Advisor for IMarEST Biofouling Expert Management Group
Dave Fairclough	Adjunct Senior Lecturer (May 2014-April 2017). School of Veterinary and Life Sciences, Murdoch University.
	Adjunct Senior Lecturer (March 2014-December 2015). Department of Environment and Agriculture, Faculty of Science and Engineering. Curtin University.
Rick Fletcher	Member and Acting Chair, NSW Marine Estate Expert Knowledge Panel
Norman Hall	Emeritus Professor, Murdoch University
	Scientific member of Northern Prawn Resource Assessment Group (NPRAG)
	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 *Acanthopagrus butcheri* in south-western Australia. PhD, Murdoch University
	Supervision, Eloïse Ashworth - Influence of environmental variables on the growth and reproductive biology of Black Bream, *Acanthopagrus butcheri*
	Supervision, Daniel Yeoh – Gillnet selectivity of Black Bream *Acanthopagrus butcheri*, Honours, Murdoch University
Alastair Harry	Adjunct Research Associate, School of Earth & Environmental Sciences, James Cook University
Alex Hesp	Adjunct Senior Lecturer, Murdoch University
	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 *Acanthopagrus butcheri* 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 (*Galaxias occidentalis*) 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.

Staff Member	Position
Justin McDonald	Adjunct Senior Lecturer, Faculty of Natural and Agricultural Sciences - Oceans Institute, University of Western Australia
	PhD co- supervision, University of Western Australia, supervises Tiffany Simpson - ' Factors influencing the establishment of invasive marine species'.
	Technical Advisor and committee member IMarEST Biofouling Expert Management Group
	California State Lands Commission - Biofouling Technical Advisory Group member
	Ministry for Primary Industries New Zealand - Biofouling Technical Advisory Group member
	Member of Technical Advisory Panel (TAP) for the Swan River Trust
	Member CSIRO Biosecurity Flagship Advisory Committee
	Associate Editor Management of Biological Invasions – International Journal
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
	Adjunct Professor – Department of Environment and Agriculture, Faculty of Science and Engineering, Curtin University
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'
Michael Snow	Masters Co-supervision, Edith Cowan University, supervises Lia Smith. eDNA: analysis for fresh water fish biodiversity in Western Australia,.
	Honours Co-supervision, University of Western Australia, supervises Katrina West Microsatellite Analysis of Population Genetic Structure in *C. cainii* and *C. tenuimanus* from the south-west of Western Australia.
Michael Travers	Adjunct Research Scientist, Australian Institute of Marine Science
	Honours Co-supervision, University of Western Australia, supervises Elisabeth Myers. Day-night differences in temperate reef fish assemblages.
Corey Wakefield	Adjunct Senior Lecturer, Marine Ecology Group, School of Plant Biology, University of Western Australia
	Honorary Research Fellow, Victoria University of Wellington, New Zealand
	Adjunct Senior Lecturer, Curtin University of Technology
	Masters co-supervision, Curtin University of Technology, supervises Claire Wellington – 'Description and comparison of demersal fish ecology of the continental slope of Western Australia'.
	Masters co-supervision, 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 Polyprionidae from Australia and New Zealand'.
Brent Wise	Adjunct Associate Professor, School of engineering, Faculty of Health, Engineering and Science, Edith Cowan University

GLOSSARY OF ACRONYMS

AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AIMWTMF	Abrolhos Islands and Mid West Trawl Managed Fishery
ASL	Australian Sea Lion
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
DFAC	Developing Fisheries Assessment Committee
DOTE	Department of the Environment (Commonwealth Government) (formerly Department of Sustainability, Environment, Water, Population and Communities)
DPAW	Department of Parks and Wildlife (formerly Department of Environment and Conservation)
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
JANSF	Joint Authority Northern Shark Fishery

JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
KGBF	Kimberley Gillnet and Barramundi Managed Fishery
KPMF	Kimberley Prawn Managed Fishery
LASCF	Lake Argyle Silver Cobbler Fishery
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
PFRC	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
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

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