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

Status reports of the fisheries and aquatic resources of Western Australia **2014/15**

State of the fisheries



Fish for the future



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

Status reports of the fisheries and aquatic resources of Western Australia **2014/15**

State of the fisheries

Edited by W.J. Fletcher and K. Santoro

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

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OVERVIEW FROM THE DIRECTOR

GENERAL

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia (SRFAR)* provide the public with an annual update on the state of the fish stocks and other aquatic resources of Western Australia (WA) managed by the Department of Fisheries (Department). These reports outline the most recent assessments of the cumulative risk status for each of the aquatic resources (assets) within WA's six Bioregions using an Ecosystem Based Fisheries Management (EBFM) approach. This world leading approach details all the fisheries and fishing-related activities within each of the Bioregions which 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 2013-14 or 2014 seasons, the Departmental activities undertaken during 2014/15 plus any outcomes from 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 WA 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 WA's aquatic environment.

WA is one of the only fisheries jurisdictions in the world to fully implement such a comprehensive and practical EBFM framework. This 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 these current status reports is that the comprehensive systems of management for fishing and aquaculture activities in WA do not present an unacceptable risk to the marine, estuarine and freshwater ecosystems underpinning them. The overwhelming majority of aquatic ecological resources in WA continue to be at acceptable levels of risk except where they are being affected by adverse environmental conditions or non-fishing related impacts.

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 issue identified in last year's report for the stock of Australian herring has resulted in a rebuilding strategy being implemented which included additional management actions for both the commercial and recreational sectors. A further four fisheries in the Gascoyne and the West Coast Bioregion were assessed as having inadequate breeding stocks but as a result of the negative impacts of environmental perturbations, not fishing. The high mortality of adults and extremely poor recruitment levels observed for scallops in Shark Bay and the Abrolhos Islands region initiated during the marine heatwave of 2011 has continued with limited recovery so these fisheries

remained closed during 2014. The stock of crabs in Cockburn Sound is again showing signs of environmental impacts on its growth and recruitment, as is the case for the West Coast Beach Bait Fishery and the management arrangements for these will be examined further this year.

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 WA 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 identified as posing some risk now has targeted research programs to reduce their interactions (e.g. whale entanglements).

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 which 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 pre-assessed against the Marine Stewardship Council (MSC) certification criteria. This is acknowledged worldwide as the gold standard for fishery certification schemes and the government has recently decided on the affiliated Aquaculture Stewardship Council (ASC) to be the system to enable third party certification of WA's aquaculture industries. WA's rock lobster fishery was the first in the world to gain certification back in 2000. Some additional fisheries have now progressed through the full MSC process and also gained certification (Exmouth Gulf and Shark Bay trawl). A number of other fisheries are currently undergoing this process including the first ever MSC assessment of a combined commercial and recreational fishery for Peel Harvey blue swimmer crabs. This exciting MSC initiative is designed to help public confidence that WA's fisheries and resources are being sustainably managed.

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
DIRECTOR GENERAL

October 2015

EDITOR'S INTRODUCTION

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014/15* uses the Ecosystem Based Fisheries Management (EBFM) framework which is now the basis for management of Western Australia's aquatic resources (Fletcher, *et al.*, 2010¹, 2012²). This is 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 IMCRA³ 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.

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 (resources) 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 also 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.

While the *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014/15* provides the general public, interested fishers and other stakeholders with a ready

reference source, it also meets the reporting requirements of the Department, including the need to annually report on the 'state of fisheries managed under' the FRMA⁴ to the Western Australian Parliament and to the Commonwealth Government, on the performance of fisheries that are relevant under their EPBC Act. In addition, with the government initiative to have all WA commercial fisheries undergo 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 reports⁵.

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

October 2015

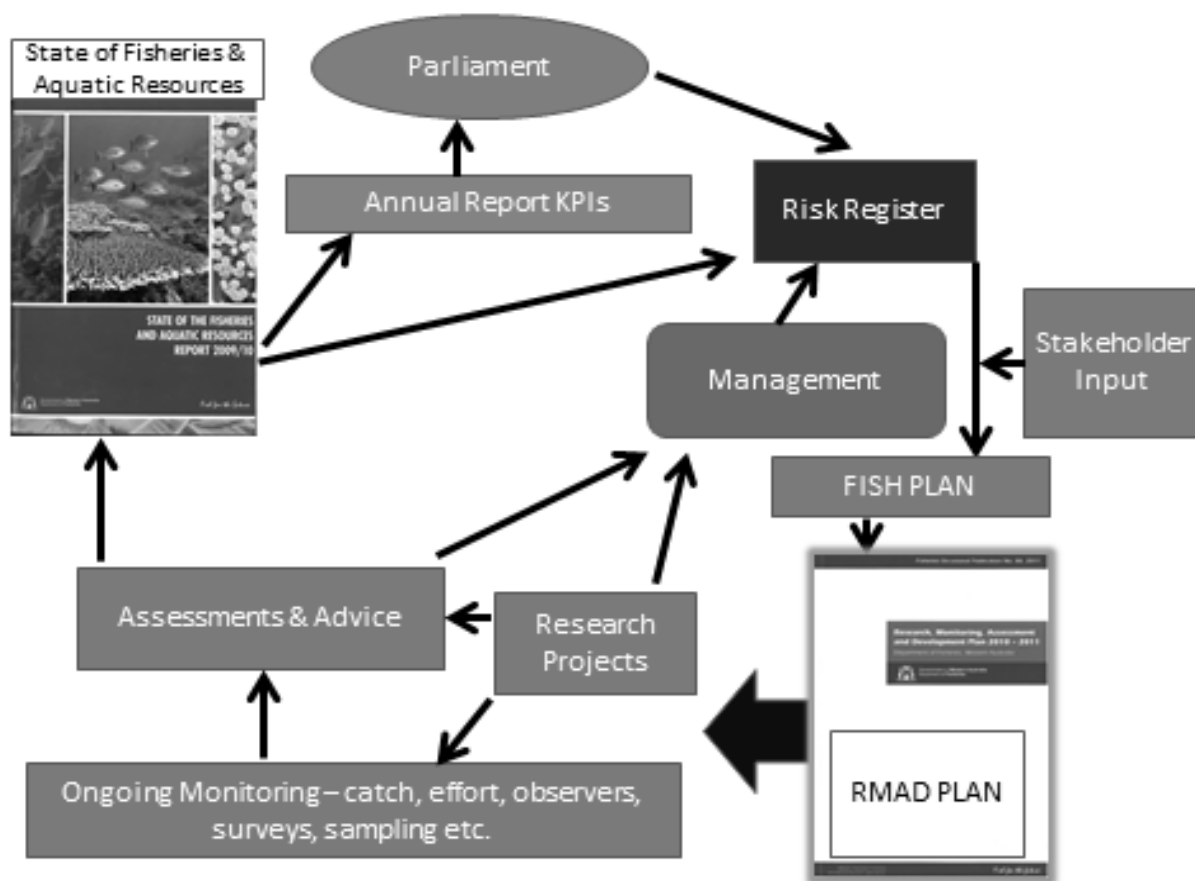
1 W.J. Fletcher, J. Shaw, S.J. Metcalf & D.J. Gaughan (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34 (2010) 1226-1238

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.

5 Flood et al. (2014) Status of Key Australian Fish Stocks. Fisheries Research & Development Corporation, Canberra



EDITOR'S FIGURE 1

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

HOW TO USE THIS VOLUME

To obtain full benefit from the information provided in this edition of the *Status Reports of Fisheries and Aquatic Resources of Western Australia*, the following outlines the various terms and headings used in the text, the fishery status overview table (which also appears in the Department of Fisheries *Annual Report 2014/15* to Parliament) and 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 Ecosystem Based Fisheries Management (EBFM) framework (Fletcher *et al.* 2010, 2012)² and the Resource Assessment Framework (DoF, 2011)³. The terminology used in reports has now been updated to be consistent with the MSC criteria, and where possible, that used within the Status of Key Australian Fish Stocks reports⁴.

In addition to the explanations provided below, acronyms are expanded at their first occurrence in a section of the text. It also needs to be noted that references are only presented as footnotes once within each report.

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).

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. FRDC project 2000/145, 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., Metcalf, S.J., Shaw, J. 2012. Using a regional level, risk-based framework to cost effectively implement Ecosystem Based Fisheries Management (EBFM). In: Kruse et al. (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

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

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

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

The high level set of ecological resources/assets that are to be managed under the FRMA for each bioregion have been identified (see Introduction Figure 1). The ecological resources/assets in each Bioregion include the ecosystems and their constituent habitats, captured species and listed species. A step-wise, risk-based approach is used to integrate the individual issues identified and information gathered into a form that can be used by the Department. Implementing EBFM 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, which includes 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 assessment processes, as detailed in Fletcher (2015)⁶. 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,

6 Fletcher, W.J. (2015). Review and refinement of an existing qualitative risk assessment method for application within an ecosystem-based management framework. *ICES Journal of Marine Research* 72:1043-1056

2009¹), 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.

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) remote Camera Surveys. The most recent (second) survey was undertaken from 1 May 2013 to 30 April 2014.

Estimates of the recreational catch and effort range at statewide and bioregional levels from the second survey presented in Ryan *et al.* (2015²) provide the data for the catch and effort by the recreational sector throughout this report.

The statewide survey of boat-based recreational fishing will be repeated every second year and the next (third) series of surveys were begun 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 has now been completed (DoF, 2015³). Each harvest strategy establishes the clear and specifically articulated reference 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 not only covers target species abundance, it incorporates social and economic considerations including sectoral allocations plus 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

1 ISO (2009) Risk Management -Principles and guidelines.

2 Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

3 DoF (2015) Harvest strategy policy and operational guidelines for the aquatic resources of Western Australia. Department of Fisheries, Western Australia Fisheries Management Paper No. 271, 44pp

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. marine heatwave) 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), or in combination with some external event 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 Methodologies: Weight of Evidence, Risk-based Approach)

Each of the stock assessment reports now clearly identifies what type of assessment method(s) have been used to determine the status of stocks. The specific methods used for monitoring and assessment vary among resources and indicator species which is affected by many factors including the level of ecological risk, the biology and the population dynamics of the relevant species; the type, size and value of the fishery exploiting the species; data availability and historical level of monitoring. The methods therefore vary from the relatively simple analysis of catch levels and catch rates, through to more sophisticated analyses that involve sampling of the catch (fishing mortality), direct surveys up to highly complex age and/or size structured simulation models. These are categorised into five levels

Level 1	Catch data and biological/fishing vulnerability
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 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 plus outputs from integrated simulation, stock assessment model.

While there are five different categories of quantitative analysis methodologies, all stock assessments undertaken by the Department now take a Weight of Evidence, Risk-based approach (Fletcher, 2015). This requires specifically considering each available line of evidence both individually and collectively to generate the most appropriate overall assessment conclusion. The lines of evidence include the outputs that are generated from each available quantitative method, plus any qualitative lines of evidence such as biological and fishery information that describe the productivity and vulnerability of the species/stock and information from fishers, stakeholders and other sources. The strength of the WoE risk-based approach is that it explicitly shows which lines of evidence are consistent or inconsistent with a specific consequence level and therefore where there are uncertainties which assist in determining the overall risk level (see also Fletcher, 2015).

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).

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, as outlined in the harvest strategy policy (DoF 2015)¹ 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 take into account natural variations in recruitment to the fished stock, which can be expected under a fishing-effort-based management plan to determine when a review and/or intervention is required.

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. Australian salmon), 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 (i.e. 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, climate change) 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

The individual fishery and aquaculture production figures relate to the latest full year or season for which data are available. Therefore, the statistics in this volume generally refer either to the financial year 2013/14 or the calendar year 2014, whichever is more appropriate.

Similarly, the statistics on compliance and educational activities are also for 2013/14, following the analysis of data submitted by Fisheries and Marine Officers.

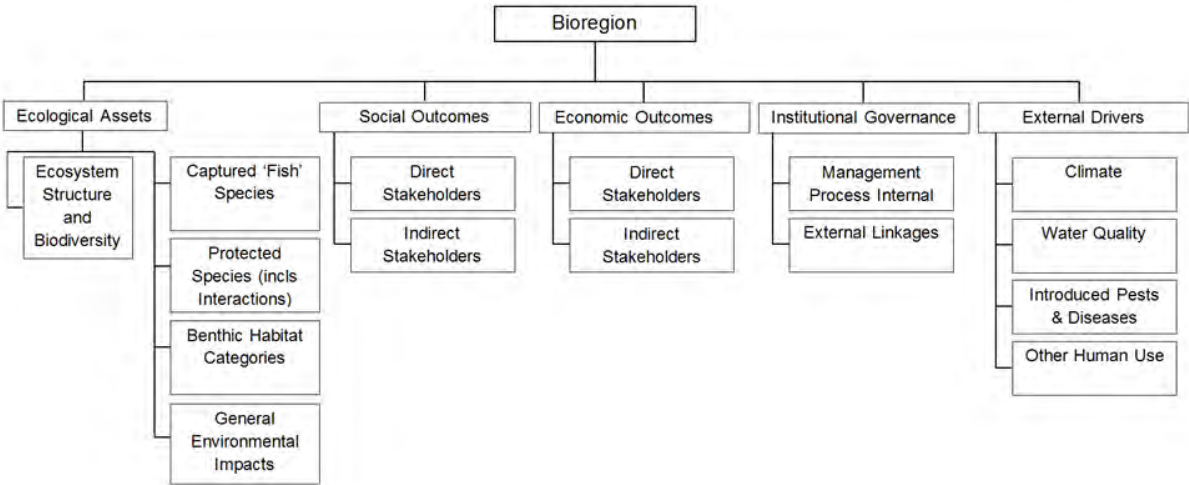
In contrast, the sections on departmental activities in the areas of fishery management, new compliance activities and research summaries are for the current year, and may include information up to June 2015.

Performance measures

Many of the State's significant fisheries have now undergone assessment and achieved environmental certification for more than a decade under the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Consequently, this document reports against specific performance measures required to meet any EPBC Act requirements. 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.

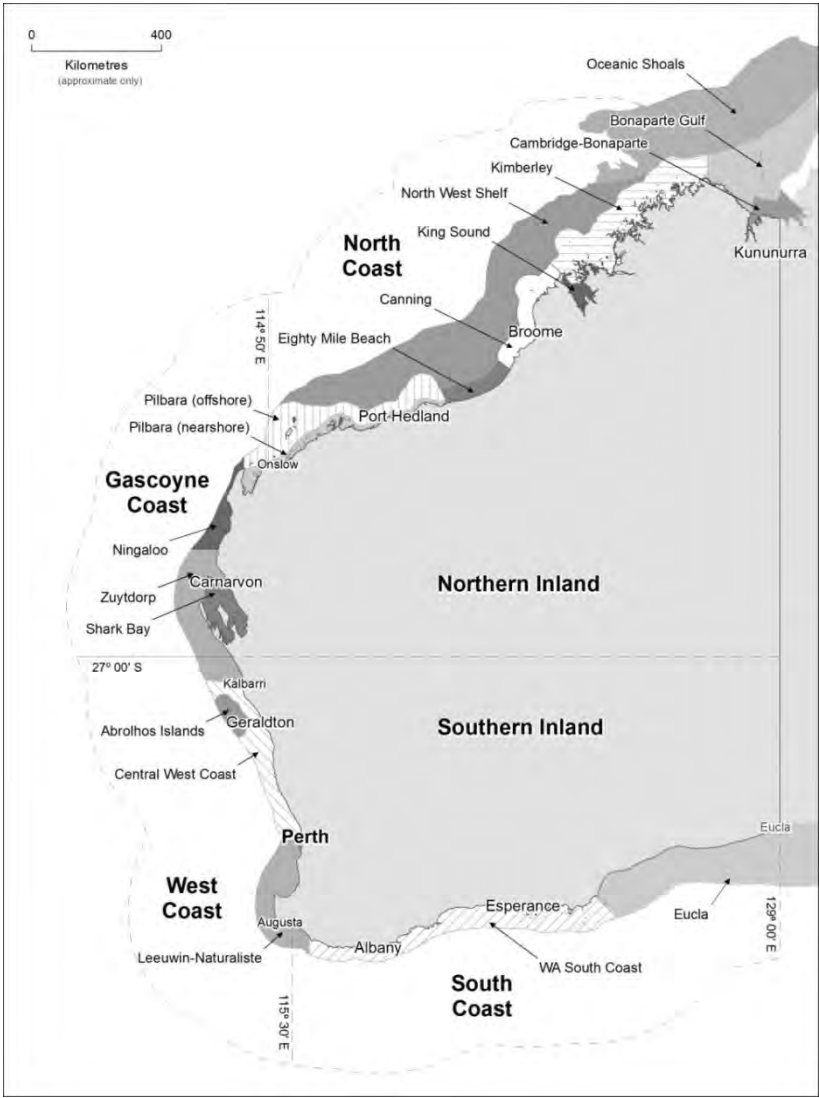
As fisheries move through the full MSC process some will gain conditions to maintain certification. The status of these conditions will therefore begin to be reported as this process progresses.

¹ Harvest Strategy Policy and Operational Guidelines for the Aquatic Resources of Western Australia (2015) *Fisheries management Paper No. 271*. Department of Fisheries, Western Australia. 44 pp.



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.

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 2014/15.

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

Annual stock assessments of the fisheries that are subject to management are undertaken by the Department. These assessments, together with trends in catch and fishing activity, have been used to determine the sustainability status of the State's most significant commercial fisheries. Performance is measured as the proportion of fisheries (for which there is sufficient data) in which the breeding stocks of each target or indicator species are being maintained at sustainable levels given the fishing effort and normal environmental conditions; or they are recovering from a depleted state at an appropriate rate following management intervention. The Department's 2014/15 Budget Papers state that the target for the proportion of fisheries with breeding stocks at risk from fishing is less than 6%.

For the 2014/15 performance review, 38 fisheries have been reviewed, which is the same as for 2013/14.

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

Within the group of 36 assessed fisheries, 29 were considered to have adequate breeding stock levels and a further two fisheries – the West Coast Demersal Scalefish Fishery (WCDSF) and Shark Bay Crab Fishery – had breeding stocks considered to be recovering at acceptable rates (86% of fisheries). The WCDSF targets relatively long-lived species so its recovery is expected to take a number of years to complete. The management actions taken for the Shark Bay Crab Fishery includes a conservative Total Allowable Commercial Catch (TACC) being imposed since the resumption of commercial fishing to enable the recovery of

this stock from the impact of the heatwave event four years ago.

Of the remaining 14% of fisheries, only the Australian Herring Fishery has been assessed as having stock levels that are not considered at sustainable levels, given usual fishing effort and current environmental conditions. A further four fisheries were also assessed as having inadequate breeding stocks solely because of the negative impacts of environmental influences, not as a result of fishing. The increased mortality of adults and extremely poor recruitment levels for scallops in Shark Bay and the Abrolhos Islands region, which was initiated during the marine heatwave that began in 2011, has continued with limited recovery in parts of Shark Bay. Consequently, these scallop fisheries remained closed during the reporting period. The stock of crabs in Cockburn Sound is again showing signs of environmental impact on its growth and recruitment, as is the case for the West Coast Beach Bait Fishery. Therefore, while a total of 14% of fisheries have stock levels that are not considered adequate, only the stocks in the herring fishery (or 3% of those assessed) are considered inadequate mostly as a result of exploitation. Revised management arrangements are progressing to deal with this issue (Overview Figure 1).

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

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 involves assessing the actual catch or effort against a target catch or effort range that has been determined for each of the major commercial fisheries by the Department. The Department's 2014/15 Budget Papers state that the target is 95%.

For effort-managed fisheries in WA, each management plan seeks to directly control the amount of fishing effort applied to stocks, with the level of catch taken providing an indication of the plan's effectiveness. Where the plan is operating effectively, the catch by the fishery should fall within a projected range. The extent of this range reflects the degree to which normal environmental variations affect the recruitment of juveniles to the stock, which cannot be 'controlled' by the management plan. Additional considerations include market conditions, fleet rationalisation or other factors that may result in ongoing changes to the amount of effort expended in a fishery, which will, in turn, influence the appropriateness of acceptable catch ranges for certain fisheries.

For quota-managed fisheries, the management arrangements' success is determined by the majority of the Total Allowable Commercial Catch (TACC) being achieved with the catch taken using an acceptable amount of fishing effort. If unusually large effort is needed to take the TACC, or the industry fails to achieve the TACC by a significant margin, this may indicate that the abundance of the stock is

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significantly lower than anticipated. For these reasons, an appropriate range of fishing effort to take the TACC has also been incorporated for assessing the performance of quota-managed fisheries.

The major commercial fisheries that have target catch or effort ranges account for most of the commercial value of WA's landed catch. Comparisons between the actual catches (or effort) with the target ranges have been undertaken for 29 of the 38 fisheries referred to in the 'Stock status and catch ranges for major commercial fisheries' in Overview Table 1, which is one more than used last year.

There are still a relatively high number of fisheries not assessed. This is due to a combination of ongoing environmental issues affecting stocks in some regions (see previous page) and poor economic conditions for some fisheries. These factors meant a number of fisheries were either closed or did not have sufficient catch levels during this reporting period.

Three fisheries (Cockburn Sound Crabs, Shark Bay Scallops, Abrolhos Islands and Mid West (Scallops) Trawl), which were all affected by unusual environmental conditions, continue to have their recruitment impacted with the scallop fisheries' catches again set to zero (0) and with only very limited fishing for Cockburn Sound crabs occurring. The setting of zero or very limited catches in these fisheries highlights the significant management interventions we have made to recover and rebuild these stocks. These stocks are being closely monitored by the Department to allow the fisheries to re-open when stocks have rebuilt to the level to support sustainable fishing.

Of the 29 fisheries where 'target ranges' were available and a material level of fishing was undertaken in 2013/14, eleven were catch-quota managed with 18 subject to effort control management.

Ten of these 11 individually transferable quota (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 TACC is planned in the 2015 season.

In the 18 effort-controlled fisheries, 10 were within, one was acceptably above and six were acceptably below their target catch ranges. The catch of snapper in the West Coast Demersal Scalefish Fishery was unacceptably above the range for this species in some management areas, although the overall fishery catch was within the range. As a result, management arrangements for this fishery have now been adjusted. The West Coast Beach Bait Fishery catch was still well below historical levels, prompting a review of its status.

In summary, 26 of the 29 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 of 95%.

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

This indicator provides an assessment of the success of our management plans and regulatory activities in keeping fish

catches by this sector at appropriate levels. This includes both stock sustainability (including stocks in a recovery phase) and our ability to meet Integrated Fisheries Management (IFM) objectives. For shared fisheries (those that have a material – or significant – commercial and recreational catch level), IFM determines the appropriate catch allocations to each sector with this process being progressively phased in over the next ten years.

The Department is beginning to determine explicit target catch or effort ranges for each of the major recreational fisheries in conjunction with any IFM-based allocation decisions. This is only the second time this indicator has been measured and the Department's 2014/15 Budget Papers state that the target is 80%.

For the purposes of this indicator, 19 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 resources for which there are other material sectoral shares (e.g. customary fishing). Of these 19, only seven currently have explicit catch ranges developed and another six have implicit ranges that can be used to assess acceptability. Of these 13 stocks or fisheries, 11 had catch levels that were within an acceptable catch range.

The continuing 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 heatwave. In addition, the recreational catch of one demersal scalefish species, in the northern section of the Gascoyne Demersal Scalefish Fishery, may be too high and we are therefore considering recommending management adjustments.

Consequently, the percentage of recreational fisheries with acceptable catch levels was 85%, which exceeds the target level of 80%. This has improved from last year when the percentage of recreational fisheries with acceptable catch levels was 77%.

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 consistent with categories established by the International Union for the Conservation of Nature

(https://cmsdata.iucn.org/downloads/iucn_categoriesmpa_eng.pdf). 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
- Establishment of Fish habitat Protection Areas (FHPAs)
- Closures to fishing under section 43 of the Fish Resources Management Act 1994
- Establishment of marine parks through the Conservation and Land Management Act 1984 (CALM Act) and the Fish Resources Management Act 1994
- 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 and between Australian jurisdictions, 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 2014/15. 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 2014/15 and Activities of the Biosecurity Research Group 2014/15).

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 2014/15 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

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

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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.

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), Effort (days/hours) and Catch rate for season reported ^{1,2} 2013/14 or 2014	Catch (or effort or catch rate) level acceptable and explanation if needed
WEST COAST BIOREGION					
West coast rock lobster	Size-structured Population Model (Level 5)	Adequate	5,859 (Q)	5943 (t) 2 368 006 potlifts 2.51 kg/potlift	Acceptable A TACC of 5,859 t was set for the 2014 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	87 (Q) (530 – 640 days)	48.5 (328 days)	Acceptable Catch was less than the quota in Area 2 (62% caught), Area 5 (21% caught), Area 6 (10% caught) due to economic reasons (low value of catch) and high cost of accessing these areas. Area 8 fishery still closed due to catastrophic mortality by marine heat wave.
Octopus	Catch Rates (Level 2)	Adequate	50 - 250	204	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), Effort (days/hours) and Catch rate for season reported ^{1,2} 2013/14 or 2014	Catch (or effort or catch rate) level acceptable and explanation if needed
WEST COAST BIOREGION (Continued)					
					NA
Cockburn Sound crab	Direct Survey (Level 4)	Environ. Limited	Under Revision	25	Stock levels continued to decline during the 2013/14 season with females dominating the catch earlier than usual in March and April with catch rates around 0.5 kg/traplift. The 2013/14 egg production index was below the limit and the juvenile index for 2014 was also below the limit, so the fishery was closed to commercial and recreational fishing in April and May, respectively, 2014.
Estuarine finfish (west coast)	No Assessment	N/A	75 – 220 (Peel-Harvey only)	130 (PH only)	Acceptable Catches of west coast estuarine finfish have been stable since 2000.
West coast beach bait and south west beach seine	Catch (Level 1)	Environ. Limited	60 – 275 (whitebait only)	12 (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 in 2013/14, following a similarly low catch in 2012/13. Management intervention may be required.
West coast purse seine	Catch (Level 1)	Adequate	0 – 3,000 (Q)	1,065 t (scaly mackerel and pilchard combined)	Acceptable Increase in catch due to increase in effort, current levels are highest reported since mid-2000s. Catch reported here includes catches from the managed fishery and the northern and southern developmental zones.
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. TDGDLF catches of demersal species were too high. WCDSIMF catches of snapper in the Mid-west and Kalbarri areas were too high. Management action has been taken.

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Fishery / Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes), Effort (days/hours) and Catch rate for season reported ^{1,2} 2013/14 or 2014	Catch (or effort or catch rate) level acceptable and explanation if needed
GASCOYNE COAST BIOREGION					
Shark Bay prawn	Direct Survey/Catch Rate (Level 4)	Adequate	1,350-2,150	1907	Acceptable Western king and brown tiger prawn annual landings were both within the target ranges.
Exmouth Gulf prawn	Direct Survey/Catch rate (Level 4)	Adequate	771 – 1,276	463	Acceptable Brown tiger prawns were well below the target catch range and western king prawns slightly below their target range. Endeavour prawn landings were also below the target catch range. The adjusted effort for 2014 was very low and was constrained to maintain the spawning stock within target levels.
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 due to continued influence of the extreme environmental conditions from heat wave events. A recovery of the stock in Denham Sound has been observed while that in northern Shark Bay is still below the target levels despite no retention of scallops between 2012 and 2014.
Shark Bay Crabs	Catch Rates & Direct Survey (Level 4)	Recovering	400 (Q)	371 (175 trap + 196 trawl) 147,421 traplifts CPUE 1kg/traplift	Acceptable Partial recovery of the stock during 2013 provided confidence to resume commercial fishing with a conservative TACC of 400 tonnes of which 93% was achieved. Ongoing stock monitoring surveys indicates increasing levels of recruitment and spawning biomass during 2014.
Shark Bay beach seine and mesh net	Catch Rates (Level 2) Fishing mortality (Level 3)	Adequate	235 – 335	212	Acceptable Total catch remained below the target range due to a further reduction in effort (lowest on record) and low catches of sea mullet and tailor. Catches of whiting and yellowfin bream were above the 10-year average.

Fishery / Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes), Effort (days/hours) and Catch rate for season reported ^{1,2} 2013/14 or 2014	Catch (or effort or catch rate) level acceptable and explanation if needed
GASCOYNE COAST BIOREGION (Continued)					
West Coast Deep sea crab	Catch Rate (Level 2)	Adequate	140 (Q; crystal crabs) (55 000 - 105 000 standardised potlifts)	140 crystal crab (60 669 standardised potlifts)	Acceptable The effort is within the target effort range, with the standardised catch rate of legal crabs at one of the highest levels in a decade.
Gascoyne Demersal Scalefish (Pink snapper only)	Composite Assessment (Level 5)	Adequate	277 (Q) (380 - 540 days)	240 (364 days) plus 30 recreational catch	Acceptable Spawning biomass is just below the target level; under current levels of catch, biomass will exceed the target level by the start of the 2016-17 season. Catch rate remains well above the threshold and maintained at highest levels since 1990s.
NORTH COAST BIOREGION					
Onslow prawn	Catch (Level 1)	Adequate	60 - 180	Negligible	NA Minimal fishing occurred in 2014.
Nickol Bay prawn	Catch (Level 1)	Adequate	90 - 300	211	Acceptable The total annual landings of banana prawns were within the target catch range and slightly above the predicted range.
Broome prawn	Catch (Level 1)	Adequate	55 - 260	0	NA No commercial prawn fishing occurred in this fishery for 2014.
Kimberley prawn	Catch (Level 1)	Adequate	240 - 500	287	Acceptable Banana prawns were within the catch prediction and the target range (230-350 t). Endeavour prawns were within the range and brown tiger prawns were slightly below. Overall effort continues to be lower than observed between 1990 and 2006.
Kimberley gillnet and barramundi	Catch Rates (Level 2)	Adequate	33 - 45 (barramundi)	44	Acceptable The catch of barramundi is within the target catch range and the catch rate is at the highest level since 1990.

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Fishery / Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes), Effort (days/hours) and Catch rate for season reported ^{1,2} 2013/14 or 2014	Catch (or effort or catch rate) 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 1,111 (goldband 499) (red emperor 132)	NA Total catch is above the upper limit across the fishery due to an increase in catch in Zone B. Catches of goldband snapper and red emperor were both within the acceptable catch range. Full assessments are in progress.
Pilbara fish trawl	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	Adequate	Under revision	1,105 t and 591 days	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)	268 t and 208 days (trap) 40 t and 195 days (line)	Acceptable Trap and line catch were lower than the target catch ranges due to reduced effort in the fishery in 2014.
Mackerel	Catch (Level 1)	Adequate	246 – 410 (Q, Spanish Mackerel)	322	Acceptable Catches higher than previous year and remain within the acceptable range for the fishery.
Northern shark	No Assessment	NA	< 20 (sandbar)	0	NA There continued to be no fishing effort for this year.
Pearl oyster	Catch rate predictions, standardised CPUE (Level 3)	Adequate	754,800 oysters (Q) (14,071 – 20,551 dive hours)	627,634 oysters (12,976 dive hours)	Acceptable Quota this year also included 75,000 large mother-of-pearl (MOP) oysters. Only part of the Zone 1 quota (115,000 shell) was fished and some culture shell quota was not fished for economic reasons. Catch rate indices were above threshold levels.
Sea cucumber	Catch Rate (Level 2)	Adequate	Sandfish 20 – 100 Redfish 40 – 150	Sandfish 40 Redfish 48 Black teatfish 5	Acceptable Fishing recommenced in 2014 after a 1 year hiatus. New vessels fished the existing licences in 2014.

Fishery / Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes), Effort (days/hours) and Catch rate for season reported ^{1,2} 2013/14 or 2014	Catch (or effort or catch rate) level acceptable and explanation if needed
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, there was a coincidental decline in targeted effort. The standardised catch rate for southern rock lobsters remains within its target region. 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	201.5 (Q) (907 – 1,339 days) (3440 – 5270 hours)	193 (1,578 days) (6,581 hours)	Not Acceptable
Estuarine finfish (south coast)	Catch Rates (Level 2)	Adequate	200 – 500	190 (finfish) 39 (crab)	Effort range (in days) exceeded due to lower abundance. TAC reduced by 30% in the Area 2 and 10% in the Area 3 fishery for 2015. Effort ranges have been reviewed and are now expressed as hours from 2014
					Acceptable
WA salmon	Catch Rates (Level 2)	Adequate	1,200 – 2,800	364	Stock levels of key species are considered adequate. Crabs have replaced some finfish catches in recent years.
					Acceptable
Australian herring	Fishing mortality (Level 3)	Inadequate	Under revision	151	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.
					NA
Albany/King George Sound purse seine	Catch (Level 1)	Adequate	2,683 (Q)	885 t	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.
					Acceptable
Bremer Bay purse seine	Catch (Level 1)	Adequate	1,500 (Q)	Not reportable - less than three licences operated	Effort and catches both lower than in 2012/13.
					Acceptable
Bremer Bay purse seine	Catch (Level 1)	Adequate	1,500 (Q)	Not reportable - less than three licences operated	Effort and catches both slightly higher than in 2012/13.
					Acceptable

Fishery / Resource	Stock assessment method and level	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes), Effort (days/hours) and Catch rate for season reported ^{1,2} 2013/14 or 2014	Catch (or effort or catch rate) level acceptable and explanation if needed
SOUTH COAST BIOREGION (Continued)					
Esperance purse seine	Catch (Level 1)	Adequate	1,500 (Q)	Not reportable - less than three licences operated	Acceptable Effort and catches both slightly lower than in 2012/13.
Southern and West Coast demersal gillnet and longline	Gummy shark - CPUE (relative to previous Level 5 assessment) (Level 2)	Gummy and whiskery sharks: Adequate. Dusky and sandbar sharks: recovering.	725 – 1,095 (key species only)	841 (key species only)	Acceptable
	Dusky shark - CPUE (relative to previous Level 4 assessment) (Level 2)				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.
	Sandbar shark - CPUE (relative to previous Level 4 assessment) (Level 2)				
	Whiskery shark - Age Structured Model (Level 5)				
NORTHERN INLAND BIOREGION					
Lake Argyle catfish	Catch (Level 1)	Adequate	93 – 180	Not reportable - less than three licences operated.	Acceptable The catch was below the target range due to low effort In the fishery.

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 making up continental shelf waters (< 200 m depth) where habitats are protected from the physical disturbance of trawl fishing in each Bioregion. 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 2014/15 RESULTING FROM SURVEILLANCE AT MAJOR PORTS

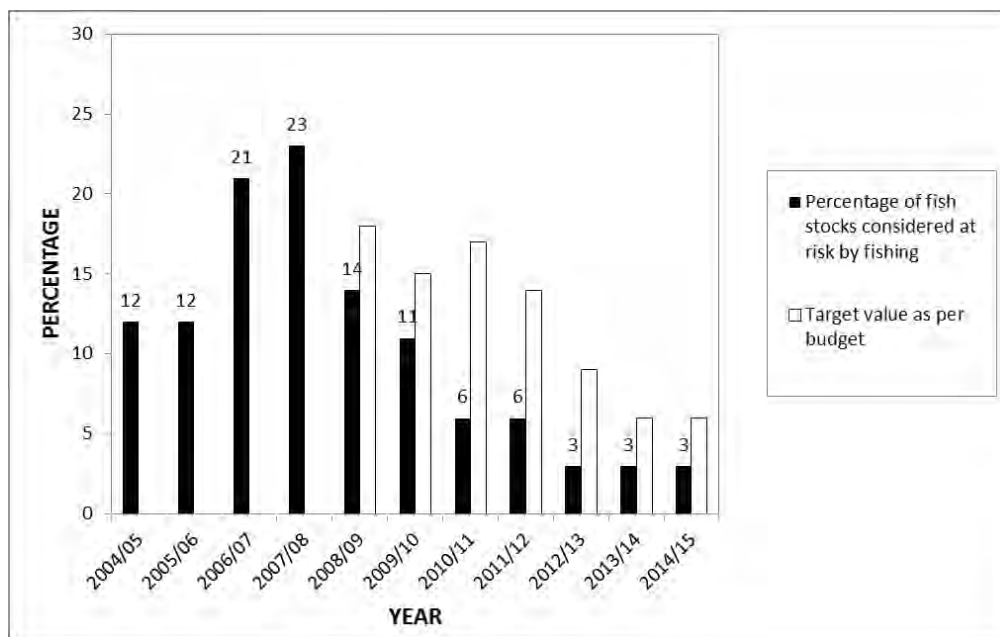
No pest monitoring was conducted in the Gascoyne in 2014/15.

Bioregion	Common Name	Scientific Name	Type of Organism	Pest status	Year detected
West Coast	Mediterranean fanworm	<i>Sabella spallanzanii</i>	Polychaete	Pest	2012/13
	Scallop	<i>Scaechlamys livida</i>	Mollusc	Introduced species	2012/13
	Aeolid nudibranch	<i>Godiva quadricolor</i>	Mollusc	Introduced species	2013/14
		<i>Alexandrium catanella</i>	Dinoflagellate	Pest	2012/13
	Ciona	<i>Ciona intestinalis</i>	Ascidian	Introduced species	2013/14
	Asian paddle crab	<i>Charybdis japonica</i>	Crab	Pest	2013/14
	Ivory barnacle	<i>Balanus improvisus</i>	Barnacle	Pest	2013/14
		<i>Balanus pulchellus</i>	Barnacle	Introduced species	2013/14
		<i>Amphibalanus amphitrite</i>	Barnacle	Introduced species	2014/15
	Asian green mussel	<i>Perna viridis</i>	Mussel	Pest	2013/14
	Asian date mussel	<i>Arcuatula senhousia</i> (previously <i>Musculista senhousia</i>)	Mussel	Pest	2012/13
		<i>Didemnum perlucidum</i>	Ascidian	Introduced species – pest-like characters	2012/13
		<i>Alexandrium sp.</i>	Dinoflagellate	Pest	2014/15
	Striped Sandgoby	<i>Acentrogobius pflaumi</i>	Goby	Introduced species	2014/15
North Coast		<i>Theora fragilis</i>	Mollusc	Introduced species	2012/13
		<i>Didemnum perlucidum</i>	Ascidian	Introduced species – pest-like characters	2012/13
South Coast		<i>Didemnum perlucidum</i>	Ascidian	Introduced species – pest-like characters	2014/15
		<i>Codium fragile</i> subsp. <i>fragile</i>	Algae	Pest	2014/15
	Mediterranean fanworm	<i>Sabella spallanzanii</i>	Polychaete	Pest	2012/13

OVERVIEW TABLE 4

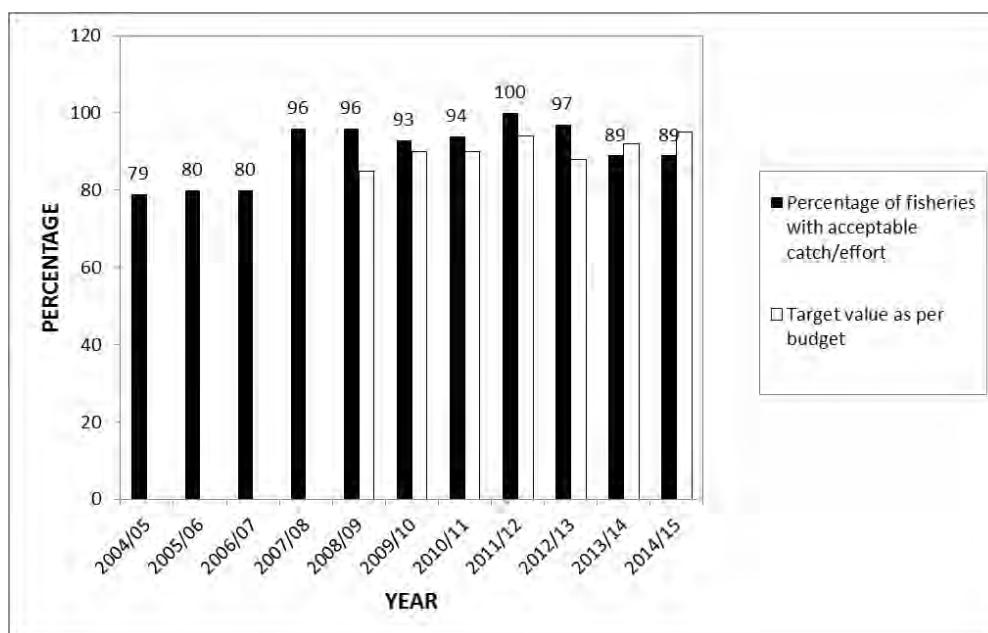
The number of significant fishkills investigated in Western Australia since the last SOE report

Year	Number of Fish Kills
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. Light 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. Light 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, finfish and the Department of Fisheries is in the process of securing strategic environmental approvals for the Mid-West Aquaculture Development Zone.

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 Day *et al*, 2012)¹.

¹ Day J., Dudley N., Hockings M., Holmes G., Laffoley D., Stolton S. & S. Wells, 2012. Guidelines for applying the IUCN Protected Area Management Categories to Marine Protected Areas. Gland Switzerland: IUCN. 36pp

Protection of fish habitat and biodiversity is also provided by marine protected areas consistent with IUCN categories 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 within this bioregion 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

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

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

As part of the Department of Fisheries project to secure strategic environmental approvals for the Mid-West Aquaculture Development Zone at the Abrolhos Islands FHPA. The Biodiversity and Biosecurity Branch have collected baseline data on water and sediment quality within the study areas as part of the projects Environmental Impact Assessment works.

The Department has established an ongoing monitoring and research program based on identified risks within the bioregion in conjunction with marine park management plan priorities. The program assesses the finfish community and the habitats they are associated with. Included in the program is the collection of environmental data to understand how natural factors influence the marine communities of the Ngari Capes region. .

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 implements a range of monitoring and research activities in the Bioregion focussed on detection of introduced marine pests (IMPs) at high risk locations and vessel risk analyses. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. Further details for these projects may be found in the "Introduced Pests Status Report" at the end of this section and also in the Appendix section entitled "Activities of the Marine Biosecurity Research Group during 2014/15".

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 fisheries¹. 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 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 km ²	%	Existing MPA km ²	%	Fisheries km ²	%	Existing MPA 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	LOW	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.
	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	Management actions to reduce commercial and recreational catch levels by 50% were implemented between 2007 and 2010 to allow stocks to recover. Monitoring has demonstrated that catches are being maintained at appropriate levels, other than for snapper. Further management actions have been taken in 2015 to address this. A stock assessment in 2013 provided evidence of the commencement of recovery of indicator species for the inshore demersal suite. Another assessment is scheduled for 2016/17 to ensure recovery is continuing.
	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	Research on the 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)	LOW	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.
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.

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., 2012¹).

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. Whale entanglements were reduced in 2014 after introduction of mitigation measures.

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.

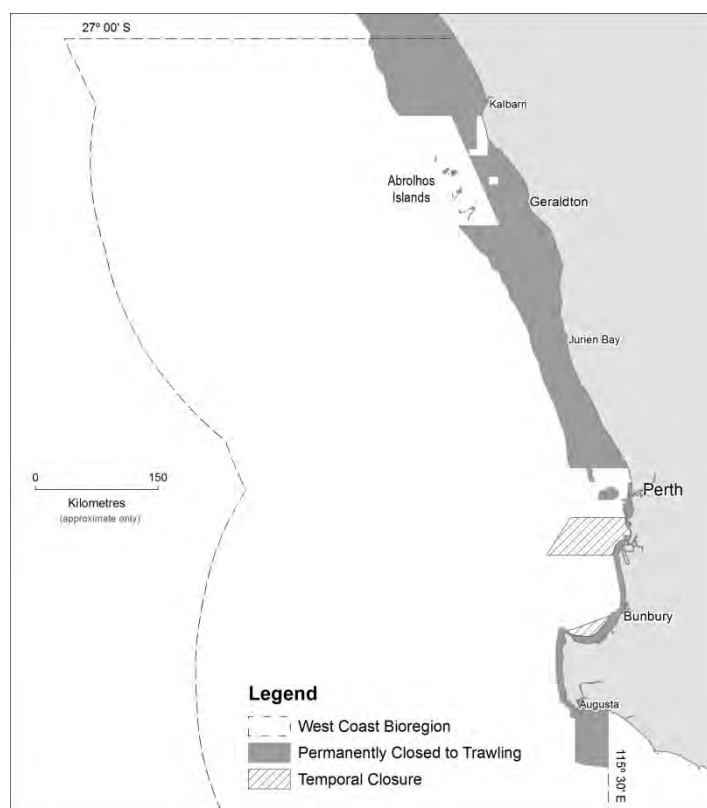
Listed species	Species	Risk	Status and Current Activities
Listed 'Fish' Species	Fish	LOW	Blue groper (Rottnest Island), cobbler (Swan Canning) and white sharks are within this category and are already unable to be landed by commercial or recreational fishers.

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	HIGH (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 West Coast Ecosystem Management Table 1) and high recovery rates.
	Seagrass	LOW	No destructive fishing methods allowed in these areas.
	Mangroves	LOW	No destructive fishing methods allowed in these areas
	Rocky Reef	LOW	Minimal direct impacts and high recovery rates.
	Coral Reef (Abrolhos)	LOW MODERATE	Minimal direct impacts. Regular monitoring of corals at the Abrolhos Is. Reduced levels of pot fishing effort in this area are likely to have reduced the risk and this should be reviewed.
Inshore demersal (20-250 m depth)	Sand/ Seagrass/ Rocky Reef/ Coral Reef/ Sponge	LOW	Minimal direct impacts. See Ecosystem Table 1 for details
Offshore demersal (>250 m depth)	Sand/ Rocky Reef/ Sponge	LOW	Minimal direct impacts. See Ecosystem Table 1 for details

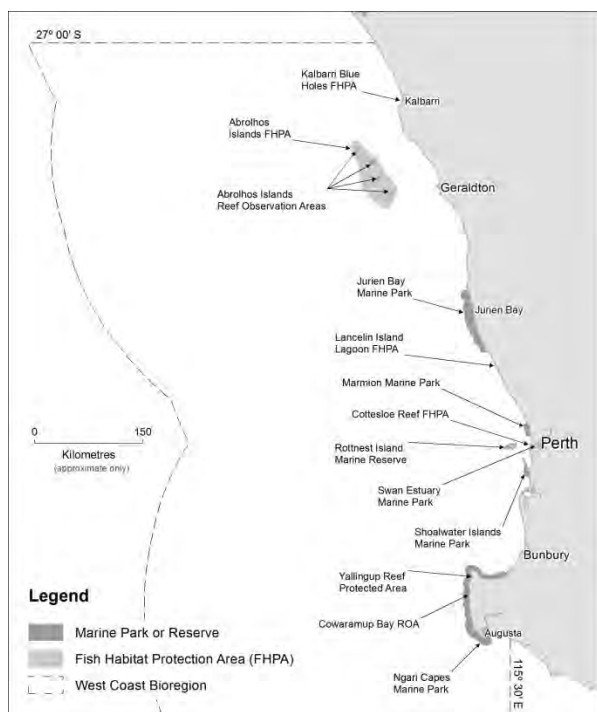
External Drivers: Details on some of the analyses used for these scores are located in the individual fishery reports plus there were whole of region assessments completed in the draft West Coast EBFM report.

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. The introduced species <i>Didemnum perlucidum</i> has recently been detected at the Abrolhos Islands
Climate	MODERATE in short term HIGH in medium term	Risk assessment of the impact of climate change effects on key species has been undertaken. Some climate change impacts on rock lobster biology had already been taken into account in the stock assessment process.



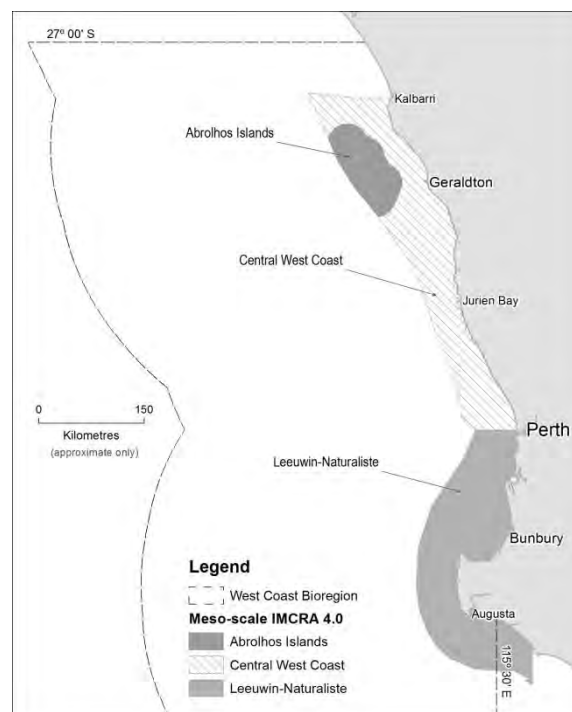
WEST COAST ECOSYSTEM MANAGEMENT FIGURE 1

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

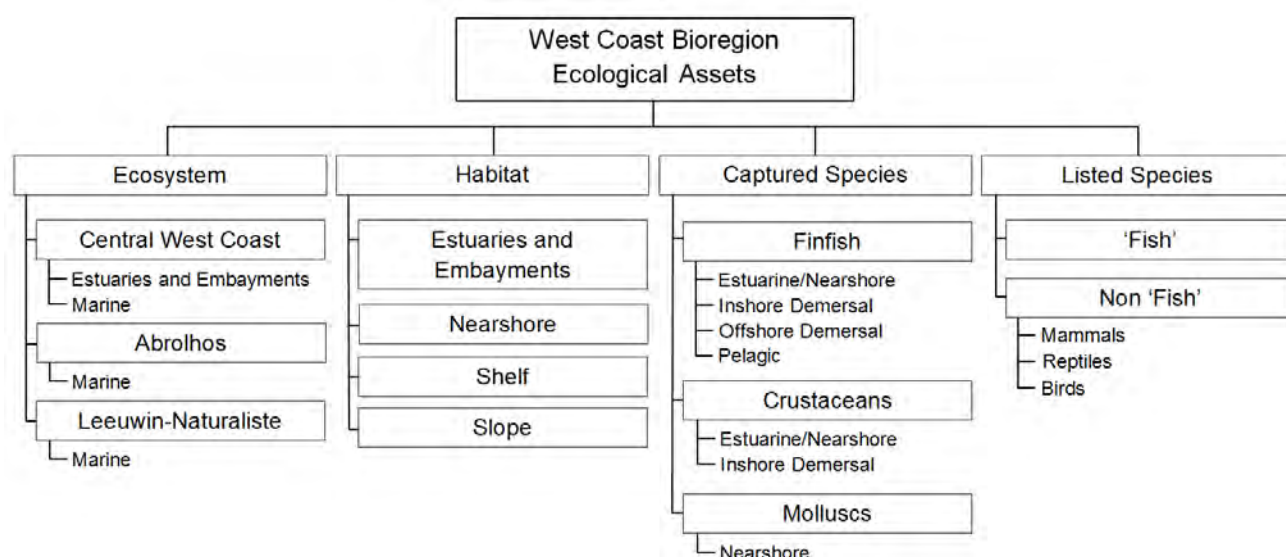
Map showing current and proposed formal marine protected areas in the West Coast Bioregion various areas of which are either consistent with IUCN categories I, II, III, IV or V.



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 Group continue to implement a series of biosecurity related projects in the West Coast Bioregion, ranging from detection and control of introduced marine pests (IMP) to vessel risk analyses.

Early detection of IMPs is vital if any attempt at eradication or other management strategies is to be successful. Thus the Marine Biosecurity Research Group regularly undertake marine pest monitoring at the high risk sites of Fremantle Port and HMAS Stirling (Garden Island). This monitoring incorporates a three tiered approach. First the undertaking of a nationally approved design, second a more targeted monitoring program and third a program using permanently in-situ sampling equipment (Early Warning System). The national system monitoring adheres to the Australian Marine Pest Monitoring Guidelines, is endorsed by the Commonwealth, and occurs every second year. The more targeted monitoring is a smaller more focussed survey designed to target select high risk sites in each port and was established by the Marine Biosecurity Research Group to fill in the gap between the national system surveys (i.e. the alternate years). The national system monitoring of Fremantle Port was completed in early 2015. The next round of complementary monitoring for Fremantle Port is scheduled for early 2016. National monitoring at HMAS Stirling was completed in late 2014, with the more targeted survey scheduled for late 2015.

The Early Warning System program, which uses *in-situ* sampling arrays to aid in the early detection of marine pests in both ports, is run by the Marine Biosecurity Research Group, with financial and in-kind assistance from Fremantle Port Authority and the Defence Services Group and provides a mechanism for the potential 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* first detected in 2012 by members of the public in the Swan River estuary. Since detection, the Marine Biosecurity Research Group have conducted extensive trap-based and diver surveillance of the target area in the lower reaches of the estuary. A recreational fisher caught and reported another single specimen of this species in later 2014, resulting in further delimiting trapping.

Through this combined surveillance the introduced marine pest species that have been detected since initiation of these projects in this bioregion are reported in Introduced Pests Table 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. The number of commercial vessels entering the West Coast Bioregion has significantly increased (~300%) over the past 12 years (2002 to 2014). As a result the group is analysing the change in numbers of commercial vessels as well as their visit and type profiles to

better inform management processes of the domestic and international risks to the Bioregion.

The group is currently quantifying the risk associated with recreational vessels for the introduction, harbouring and translocation of marine pests along our coast by analysing the biofouling associated with recreational vessels in marinas across the state, including the West Coast Bioregion. In addition marina-based vessel owners are being surveyed about their vessel management practices and vessel use profiles. The research outputs are designed to be applicable to biosecurity management across the state.

The group are also running a field trial to test the efficiency of different crab trap types to capture and retain crabs for monitoring purposes and a trial wrapping infrastructure to correlate length of time with mortality of biofouling.

Further details for these projects may be found in the Appendix section entitled “Activities of the Marine Biosecurity Research Group during 2014/15”.

INTRODUCED PESTS TABLE 1

Introduced marine species detected during MBRM activities in this bioregion.

Common name	Scientific name	Type of organism	IMS/IMP listing	Noxious Listing
Mediterranean fanworm	<i>Sabella spallanzanii</i>	Polychaete	Pest	No
Scallop	<i>Scaechlamys livida</i>	Mollusc	Introduced species	No
Aeolid nudibranch	<i>Godiva quadricolor</i>	Mollusc	Introduced species	No
	<i>Alexandrium catanella</i>	Dinoflagellate	Pest	Yes
Ciona	<i>Ciona intestinalis</i>	Ascidian	Introduced species	No
	<i>Didemnum perlucidum</i>	Ascidian	Introduced species – likely pest	Yes
Asian paddle crab	<i>Charybdis japonica</i>	Crab	Pest	Yes
Asian date mussel	<i>Arcuata senhousia</i>	Mussel	Pest	Yes
Streaked goby	<i>Acentrogobius pflaumi</i>	Fish	Introduced species	No

FISHERIES

West Coast Rock Lobster Fishery Status Report

S. de Lestang, M. Rossbach, J. Kennedy and F. Trinnie.

Main Features

Status		Current Landings (Season 2014)	
Stock level	Adequate	Commercial catch	5947 t
Fishing Level	Acceptable	Recreational catch (2013/14)	200 - 298 t

Fishery Description

Commercial

The West Coast Rock Lobster Managed Fishery (WCRLMF) 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 notional Total Allowable Commercial Catch (TACC) was introduced. The transition to an Individually Transferable Quota (ITQ) fishery, which began in 2010/11, is now complete.

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 Council (MSC) Certification. 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. The recreational fishing season now begins on the 15 October each year and runs until the following 30 June.

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* (Wildlife Trade Operation)

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 Annual Management Meetings with licensees. These meetings are convened on behalf of the Department by the Industry Consultative Unit within the WA Fishing Industry Council (WAFIC).

Recreational

Recfishwest: Primarily through its Rock Lobster Reference Group.

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 (Zone C), north of latitude 30° S (Zone B) and, within this northern area, a third offshore zone (Zone A) 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**Commercial**

In 2014, the Department implemented a Harvest Strategy and Control Rules (HSCR) for the fishery following extensive consultation with the Western Rock Lobster Council, broader industry stakeholders and Recfishwest.

The HSCR is now used as the basis for setting the Total Allowable Commercial Catch (TACC) and the Total Allowable Recreational Catch (TARC)

A copy of the HSCR can be found at the following link:
http://www.fish.wa.gov.au/Documents/management_papers/fmp264.pdf

The HSCR is based around managing rock lobster stock sustainably in accordance with Maximum Economic Yield (MEY). The HSCR also established fixed TACC proportions between each fishing zone. The catch share between the northern zones (Zone A and Zone B) and Zone C is now split at a ratio of 50:50. With the 50% share allocated to the northern zones being split 36% to Zone A and 64% to Zone B.

In 2014, the Department granted a short term exemption to enable commercial fishers to take setose rock lobster for a period from 1 September 2014 to 31 October 2014.

In 2013 an increase in interactions with migrating humpback whales resulted in the fishery's export approval being reduced from a five year exemption to a two year Wildlife Trade Operation. To reduce interactions with whales a number of measures, including gear modifications, were introduced in 2014. These measures were developed in consultation with industry and relevant Government agencies and included: restrictions on the amount of surface rope, number of surface floats and length of pot rope that could be used by fishers when operating in deep water areas of the fishery. In addition, other mitigation measures such as negatively buoyant rope requirements and pot retrieval restrictions were implemented. The gear modifications were applied for a period from 1 June 2014 until 14 November 2014

Recreational Fishery 2013/14

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.

Recreational management controls which applied in the 2013/14 season included:

- Maximum of two pots per licence holder (maximum of three licences able to be operated from a boat)
- Pots must meet specific size requirements and have gaps to allow under-size rock lobster to escape (escape gaps required to be 54 mm)
- Minimum legal size limit of 76 mm
- Bag limit of 8 per fisher, per day
- A maximum boat limit of 24 rock lobster when there are three or more licensed fishers on-board the boat (maximum of 8 if only if one licensed fisher on-board and, 16 if two licensed fishers are on-board).
- Regulations relating to the protection of breeding female lobster and maximum size restrictions for female lobsters.
- Night fishing for lobster by other diving or potting is prohibited
- A possession limit of 24 rock lobster per person.

In 2013/14, the recreational rock lobster season was extended by a month in the West Coast Bioregion (Cape Leeuwin to North West Cape), with the exception of at the Abrolhos Islands. Previously, the season in the West Coast Bioregion

commenced on 15 November each year. The season now runs from 15 October until 30 June.

In addition, to these changes, from the 2013/14 season, the seasonal restrictions on the taking of western rock lobster north of North West Cape were removed, allowing all species of lobster to be taken all year north of North West Cape.

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 trip based catch disposal records which contain a volunteer research section from fishers and daily landing returns from processors, and a commercial monitoring program, all of which are used for modelling and stock assessment.

A project to assess the economic performance of the fishery was funded by the Seafood CRC. This project examined maximum economic yield assessment, in light of the recent move to a quota management system, and ways to incorporate the economic assessment into the outputs generated by the stock assessment model (see Caputi *et al.*)¹.

The recent move to quota has resulted in a change in fishing behaviour, from maximising catches from limited effort to maximising profitability from limited catch (quota). As a result the relativity of commercial catch rates, and thus biomass estimates, between years has degraded. In order to develop new benchmark population biomass estimates and exploitation rates under quota management a tag-recapture FRDC project has recently started ("An industry based mark recapture program to provide stock assessment inputs for the WRLF following introduction of quota management"). This project aims to release over 20 000 lobsters throughout the fishery over a three year period in five separate pulses. This project will also investigate lobster release survival, which is integral in understanding the impact of high grading lobsters, a phenomenon associated with quota fisheries.

An 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 is being undertaken. 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 reef systems within the WRLF fishery. A paper from this research was presented in 2014 at the 10th

¹ Caputi, N., de Lestang, S., Reid, C., Hesp, A., & How, J. (2015). Maximum economic yield of the western rock lobster fishery of Western Australia after moving from effort to quota control. *Marine Policy*, 51, 452-464.

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 Rottne Island. This project consists of annual sampling using pots and underwater dive surveys at Armstrong Bay and Parker Point sanctuary zones. Results from the first 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.

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 licensed 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 2014) 5947 tonnes

Lobsters: Trends in the annual catches from the West Coast Rock Lobster Managed Fishery are shown in West Coast Rock Lobster Figure 1. During the WCRLF 2014 season the fishery landed 5947 t which was 4% higher than last year. This is slightly higher than the TACC because there is a small allowance made for water loss.

Octopus: Octopus are also caught in rock lobster pots within shallow water (<40 m). In 2014 the WCRLF landed 14 t, with a catch rate of 0.025 octopus per pot lift in waters <40 m. This represents a decline in landings from 2011/12 season of 34 t. Historically the shallow-water catch rate of octopus has been compared to a historical range as a performance

indicator for this fishery. However, with a recent change in the reporting system for octopus from catches to landings (i.e. not including returned octopus) current catch rates cannot be compared to their historical range. This comparison will be reinstated once a new time series of landed octopus is developed

The catch rate of octopus (incidental landings) is an indicator for this fishery. Currently the catch rate is based on a different measure to those in the past and cannot therefore be compared. This comparison will be reinstated once a new time series of landed octopus is developed

Finfish: Finfish are incidentally caught in lobster pots when they are hauled to the surface. Commercial western rock lobster fishers were allowed to retain these finfish during the 2014 fishing season. A total of 2 t were landed during the 2014 season, with not all fish being retained (i.e. a large proportion were returned to the water alive). The three dominate species/groups of finfish landed were Baldchin Grouper (*Choerodon rubescens*, 41%), Unknown (e.g. wrasse and “trash” fish 37%) and Pink Snapper (*Pagrus auratus*, 8%).

Recreational catch estimate (season 2013/14)

200 – 298 tonnes

The recreational catch of western rock lobster for 2013/14 was estimated within the range of 200-298 t, with 184t (148-219 C.I.) by potting and 66 t (51-80 t C.I.) by diving.

Comparative catch estimates for 2012/13 were 128 t, with 95 t by potting and 34 t by diving. The estimated recreational catch in 2013/14 was therefore 94% higher than the 2012/13 catch estimate.

Fishing effort/access level

Commercial

In 2014, 235 vessels fished for lobster which represented a decline of 6% from the 251 vessels that fished during the previous 2013/14 season. The season's management arrangements limited the maximum number of pots at 5% of a vessel's unit entitlement (with slightly different arrangements applying in Zone B). In 2014, the fishery recorded 2,369,158 potlifts an 18% decline on the previous extended season's potlifts of 2,874,088 (Figure 1). This decline primarily reflects the increased biomass of lobsters resulting in better catch rates and thus the quota being achieved with less effort.

Recreational

A total of 45,146 licences were sold that permitted fishing for lobsters during some part of the 2013/14 season with an estimated 16,634 (37%) utilised for lobster fishing. Sales of licences 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 licences used for rock lobster fishing in 2013/14 was 8% higher than the number of active licences in 2012/13.

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.

The average rates of usage by active pot and diving fishers (i.e. excluding all those who held a licence but failed to use it) were 16 and 6 days, respectively during the 2013/14 fishing season. These rates were similar in the 2012/13 fishing season.

Finally, the average diary-adjusted catch taken by active pot and diving fishers were 33 and 19 lobsters, respectively during the 2013/14 fishing season. In the 2012/13 season the average numbers of lobsters caught by pot and dive fishers were lower at 20 and 12, respectively.

Stock Assessment

Assessment complete:

Yes

Assessment method:

Level 5 - Length-structured population model

Breeding stock levels:

Adequate

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

Indices of egg production are the main indicators for assessing the sustainability of the lobster stock. These are derived from a fully integrated stock-assessment model that incorporates all available data sources to produce robust and spatially comprehensive estimates of egg production.

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 Figure 3). 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 recent 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 standardised catch per unit of effort (CPUE) achieved annually by the commercial fishery (West Coast Rock Lobster Figure 2). 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 indices have been standardised temporally and spatially and for high-grading to allow for continuity across the different management periods.

Commercial

The progressive upward trend from the 1970s to the 1980s reflects increasing efficiency during this period (West Coast Rock Lobster Figure 2), which led to better catches from the same number of effort. This trend was exacerbated in the early 1990s, especially in Zone A following a substantial management-induced reduction in effort (i.e. pot usage was reduced to 82% of the unit holding and 77 mm CL lobsters were protected during the whites).

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 for the 2008/09 fishing season, however, relates more to the significant reduction in effort levels during that season. The low TACC set for the subsequent two fishing seasons (2009/10 and 2010/11) of 5500 t, about half the long-term average annual landing of 11 000 t successfully maintained high levels of legal biomass and high catch rates in these two seasons. It should be noted that the catch rate does not directly reflect the overall abundance of lobsters, because legal catches do not include the large biomass of under-size animals and breeding females, which are both fully protected. Currently catch rates within the fishery (3.9, 2.6 and 2.5 kg/potlift in zones A, B and C, respectively) are at or close to record highs, well above the historical long-term levels in each zone.

Recreational

The average recreational pot and diving diary-adjusted catch rates were 2.1 and 3.2 lobsters per person per fishing day in the 2013/14 fishing season. These catch rates are higher than the 1.2 lobsters for potting and 2.1 lobsters for diving calculated for the 2012/13 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.

The puerulus settlement during the 2014/15 collection season has shown a very similar pattern to all settlements since 2006. The new pattern of settlement has a very poor August – October period relative to the pre-2006 period, with most settlement now occurring in November to February each year. As this pattern has now occurred for nine consecutive years this may represent a new long term pattern.

Settlement in 2014/15 in the southern sites Warnbro, Alkimos, Lancelin and Jurien are below their pre 2006 “historical” averages but similar to or just above where they have been over the past nine years. In the northern areas of Port Gregory and Dongara were at their historical average

while the Abrolhos was below its historical average. All these three sites were well above (almost double) the average levels experienced since 2006.

This represents significant improvement compared with the recent seasons (West Coast Rock Lobster Figure 4). The 2014/15 settlement will mainly affect catch rates during the 2018 fishing season.

Non-Retained Species

By-catch species impact:

Low

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 2014 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 2014 fishing season there was one interaction with a turtle and no deaths reported.

The performance measure for the fishery is that there is no increase in interactions with turtles. In 2014 one leatherback turtle were reported to have been entangled in lobster fishing gear. This incident rate is below the historical range of between two and five entanglements per season over the preceding five seasons. The fishery has therefore met this performance measure.

The humpback whale is the predominant species that interacts with the WCRLF, during both its northward migration from May to August and then during its subsequent southward migration from September to November. Owing to the fishery's historical closed season (July-November), there was a limited period for interaction. There has been a rise in the number of entanglements in commercial rock lobster gear in recent seasons. This is likely due to the combination of an increasing population of humpback whales, and the transition of the WCRLF to a quota fishery with year-round fishing..

Entanglements are reported by industry and other water users to the Department of Parks and Wildlife (DPaW) whose specialist teams attempt to disentangle the animal, with a 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 the Department of Fisheries. 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 function has been 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 outputs of these projects have and will continue to feed into future management arrangements to reduce whale entanglements.

For the 2014 whale migration season fishers were required to use modified gear on all fishing gear with ropes greater than 27.4m (15 fathoms).

The effectiveness of these modifications is still to be assessed but a significant decline in whale entanglements with rock lobster gear was recorded in 2014, declining from 18 in 2013 to six in 2014. Management measures remain in place for the 2015 whale migration season.

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 (1990–2010), commercial lobster fishing has resulted in zero to six whale/dolphin interactions per season. Six whale entanglements with lobster gear were recorded during the 2014 lobster season. The fishery has therefore 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 few 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 \$359 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 (2), Geraldton (1) and Cervantes (1), serviced practically every location where fishing occurred.

Recreational

With around 45,000 licensed to fish, of which about 16,500 people take 498,000 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 2014: \$359 million

The price that commercial fishers received for the western rock lobster in 2014 was an estimated to be \$60.40/kg averaged across all processors and all zones of the fishery. This was 26% increase on the \$48.02/kg paid in 2013/14, 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 by 32% from the previous season’s value of \$271 million. This was a result of a higher TACC and an improved market value (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 (2015): 6000 tonnes (TACC)

Between 1975/76 and 2014 commercial catches averaged 9,697 t with the maximum catch of 14,523 t being landed in 1999/2000 (West Coast Rock Lobster Figure 1). More recently (post 2008/09) the annual catch levels have been

based on much lower levels (down to 5,500 t). The pre-2008 variations in catches result primarily from varying levels both of recruitment, which were largely associated with the environmental conditions experienced by western rock lobster larvae and post-larvae, and 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 recommend their preferred TACC to the Minister. For the 2013 season industry recommended 5554 t. The same process occurred for the 2014 season with industry recommending a TACC of 5859 t and for the 2015 season industry recommended 6000 t.

Recreational

Current Fishing (or Effort) Level: Acceptable

Target recreational catch limit (2014/15):

404 tonnes

Between 1986/87 and 2013/14 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 7,370 t was 388 t. ($7370 \times 5/95 = 388$ t TARC). The estimated recreational catch for 2013/14 was approximately 64% of the TARC. The TARC for 2014/15 season is 422 t.

New management initiatives (2015/16)

In 2015, an application for further export approval will be made to the Commonwealth Department of the Environment. Existing whale entanglement mitigation measures will be reviewed with a view to making any necessary amendment prior to the 2015 humpback whale migration period. The

maximum legal lengths for female western rock lobsters will be removed for commercial fishers and there will be an extended trial (1 July – 14 November) removal of the prohibition on taking setose western rock lobsters in the commercial fishery. The Department will continue to work with Recfishwest to review recreational catch levels and determine any required management changes.

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.

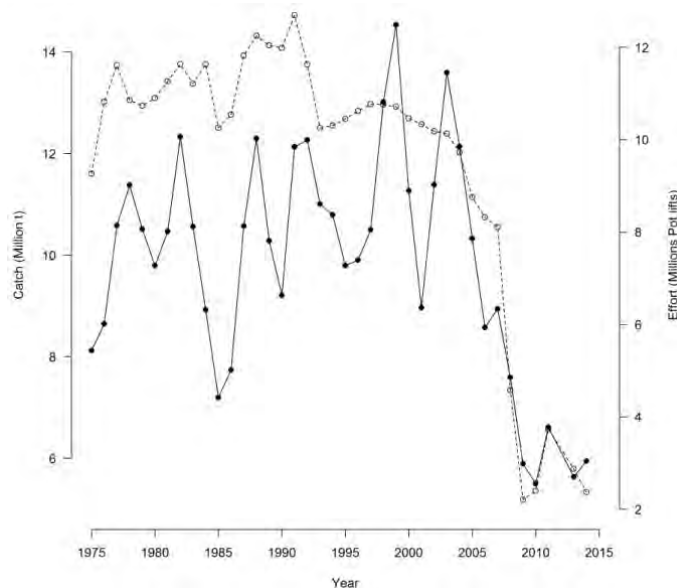
Investigation into the puerulus downturn have identified that when the spawning started early (temperature driven) and was coupled with low numbers of autumn and winter storms,

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.

During late 2014 and 2015 the El Niño conditions continued to develop which then usually results in a lower puerulus settlement occurring due to a weaker Leeuwin Current strength and westerly winds.

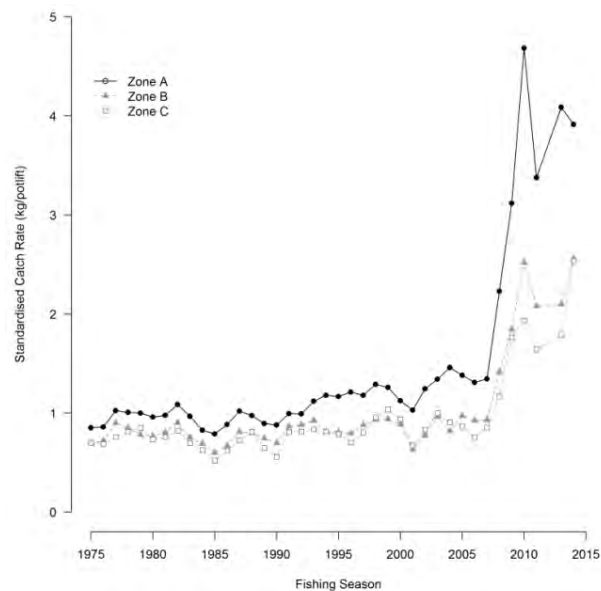
More details on the comprehensive FRDC/Department-funded research project are available on the Department's website http://www.fish.wa.gov.au/Documents/research_reports/fr255.pdf.

The economic performance of the fishery is strongly affected by the value of the Australian dollar (affecting the beach price of lobsters), fuel and labour costs. In addition to changes in management, WRL's are highly sensitive to environmental conditions, therefore were rated as a high risk to the effects of climate change.



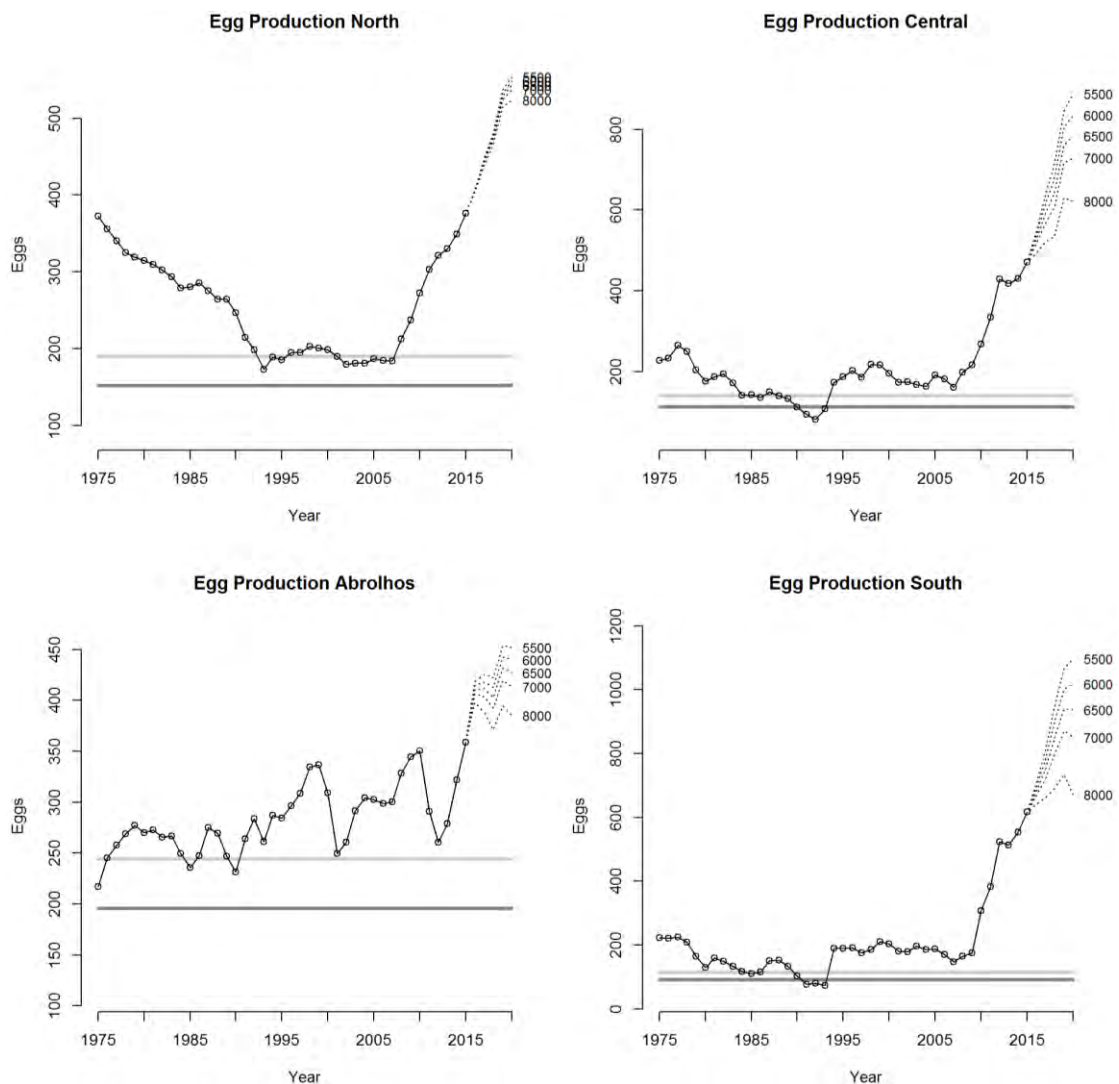
WEST COAST ROCK LOBSTER FIGURE 1

Annual catch (millions of kg - solid line) and nominal fishing effort (millions of pot lifts - dashed line) 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 2014.



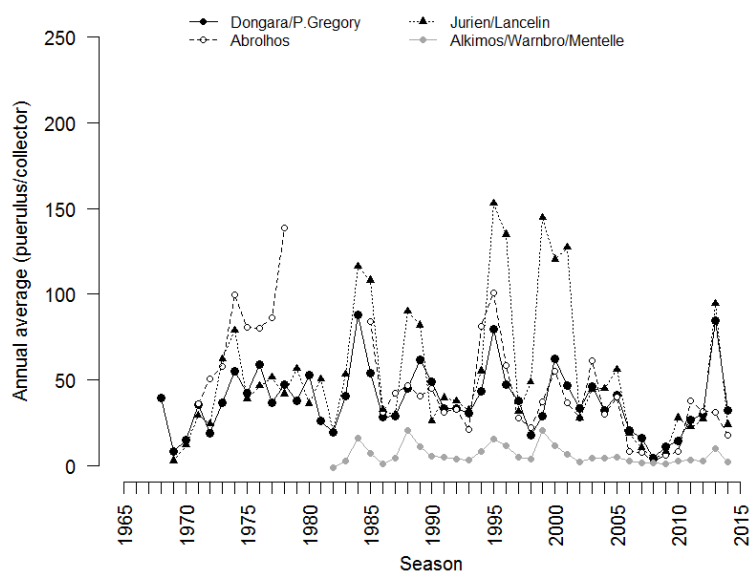
WEST COAST ROCK LOBSTER FIGURE 2

Catch rates (kg/potlift) standardised for fishing location, depth and intra-season month from fishers' compulsory monthly returns (pre 2010 season) and daily Catch Disposal Records for the three zones of the West Coast Rock Lobster Managed Fishery from 1975/76 to 2014.



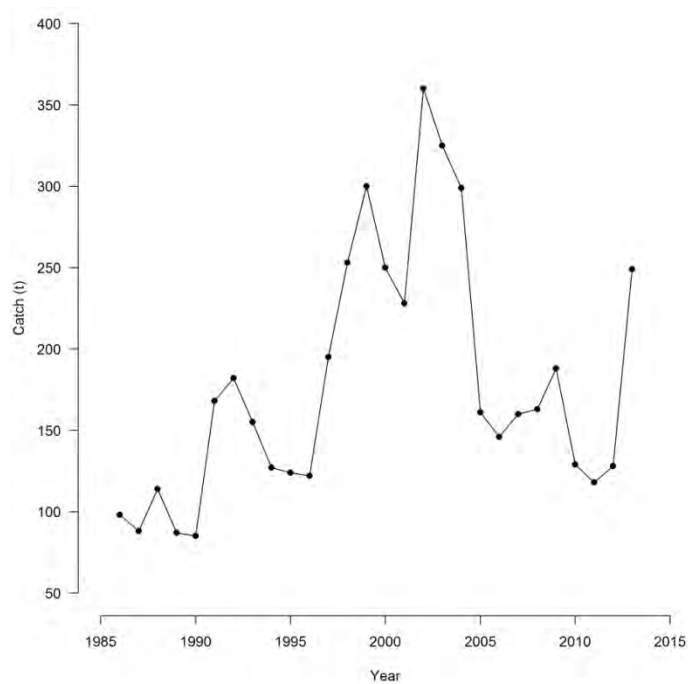
WEST COAST ROCK LOBSTER FIGURE 3

Egg production in the four Breeding Stock Management Areas of the fishery. Open points and the dotted line represent historic and future levels of mean egg production, respectively, under continued levels of current commercial catch. The horizontal light grey and dark grey lines represents the threshold and limit reference points.



WEST COAST ROCK LOBSTER FIGURE 4

Annual indices of puerulus settlement from 1968/69 to 2014/15 for the four main regions of the fishery.



WEST COAST ROCK LOBSTER FIGURE 5

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	32 t
		Other	17 t
		Recreational Catch	
		West Coast	15 – 25 t
		Other	14 t

Fishery Description

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

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

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

Boundaries

Commercial

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

Recreational

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

Governing legislation/fishing authority

Commercial

Abalone Management Plan 1992

Abalone Managed Fishery Licence

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

Recreational

Recreational Abalone Fishing Licence

Consultation process

Commercial

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

Recreational

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

Management arrangements

Commercial

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

The overall TACC for 2014 was 87 t whole weight (note this small species is generally landed in the whole condition). Area 8 is still closed as a result of catastrophic mortalities resulting from exceptionally high water temperatures in early 2011 associated with the marine heat wave (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 licence period (fishing year) runs from 1 April to 31 March the following year.

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

The legal minimum length for Roe's abalone is 60 mm shell length in most parts of the fishery. However, 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, however recent years of low catches indicate this quantity needs reviewing.

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 five days in total including the first Sunday of each month from November 2014 to March 2015. 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. Due to stock abundance concerns, the bag limit in the West Coast Zone was reduced to 15 abalone per person.

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

For Roe's abalone, the minimum legal size is 60 mm shell length, the daily bag limit for the West Coast Zone is 15 Roe's abalone per fisher per day and for the Southern Zone is 20 Roe's abalone per fisher per day. The Roe's 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.

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 harvest strategy 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 include the Waterman's Reserve Marine Protected Area (MPA), and the Cottesloe Fish Habitat Protection Area (FHPA). These data are being used to predict the abundance of legal-size abalone and assess the effect of spawning stock and environmental conditions on the recruitment of abalone.

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 1,100 interviews in 2014/15), and fisher counts conducted by Fisheries Volunteers and research personnel from shoreline vantage points and aerial surveys. This method provides a comprehensive assessment, but is too resource-intensive to be applied routinely outside of the Perth metropolitan area.

The telephone diary survey estimates the catch of all 3 species on a state-wide basis. In 2007, around 500 licence holders were randomly selected from the licence 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 2014: 49 tonnes whole weight

Metro only: 32 tonnes whole weight

The TACC for the 2014 quota year was 87 t whole weight for Roe's abalone. The 2014 catch of 49 t whole weight (Roe's Abalone Table 1) was a 33% drop from 2013 (73 t) and about 56% of the TACC. The catch is the lowest in the 25 year time series. The reductions in catch are driven mostly by economic reasons as there are few economically viable markets for Roe's abalone, and closures. The Area 8 fishery has still not been fished since the 2011 marine heat wave (Roe's Abalone Figure 1) as annual surveys show no recovery in this area.

Recreational catch**Season 2014: Roe's Metro Fishery 15 – 25 tonnes****(Season 2007): Roe's rest of state 14 tonnes
(41% of total catch)**

The recreational catch for Roe's abalone from the Perth metropolitan area in 2014 was 20.2 t (Roe's Abalone Table 2). This was almost identical to 2013 but with a daily bag limit reduction in place (from 20 to 15 abalone) and a 7% increase in effort.

Based on the Perth recreational fishery for 2014 (15 - 25 t), and using the 2007 phone diary estimate for the rest of the state (14 t), recreational fishing represented about 41% of the total (commercial and recreational) Roe's abalone catch (83 t) across the state in 2014.

Fishing effort/access level**Commercial**

Total effort for dedicated Roe's abalone divers in 2014 was 328 diver days, a 28% decrease in last year's effort of 457 diver days and the lowest effort over 25 years (Roe's Abalone Table 1).

Recreational

For the 2014 season, 16,315 abalone licences were issued which was 2% higher than last year (Roe's Abalone Figure 3). This was the fifth year in which only abalone specific licences were available to those wishing to fish for abalone. Umbrella recreational licences, which allow for the catch of multiple species, have been phased out (Roe's Abalone Figure 3).

Effort in the Perth fishery for 2014 was 9,139 hours, a 7% increase from 2013 effort of 8,512 hours (Roe's Abalone Table 2) and the third lowest in the 14 years of data collection. Lowered catches are primarily due to fishery restrictions; since 1999 the fishery had reduced from a 9 hour fishery to a 5 hour fishery, and bag limits from 20 to 15. 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 retained for comparative purposes.

The SCPUE for dedicated Roe's abalone divers for the 2014/15 fishing season was 24.2 kg/hr, which was the second lowest it has been (Roe's Abalone Table 1). This low SCPUE has been driven primarily by lack of growth in recent years.

Area 8 commercial (Northern Region for recreational) continues to be closed to all fishing to promote stock recovery following an environmentally-induced mass mortality in the marine heat wave in the summer of 2010/11 (Pearce *et al.* 2011).

The catch rate of recreational fishers in the Perth metropolitan fishery of 24 abalone/hour in 2014 was less than the 2013 catch rate of 27 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 2015 were 21 abalone m⁻², a drop of 1 m⁻² compared with 2014 and a 35% drop since 2011 (Roe's Abalone Table 4). This was the lowest abundance in the 18-year time series. 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 (7 m⁻²) in 2015 are the second lowest on record and similar to the previous 4 years (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 8 abalone m⁻² in 2015, which is similar to 2014 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 (Roe's Abalone Table 4). For sub-legal animals on the platform habitat, densities have significantly declined between 2010 (59 m⁻²) and 2015 (17 m⁻²) and are now similar to that for fished stocks (21 m⁻²) (Roe's Abalone Table 4). In the sub-tidal habitat of the Waterman's Reserve, the major declines in 2014 have continued into 2015 with both legal (10 m⁻²) and sub-legal sized stocks (1 m⁻²) being 50% and 93% 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 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 average size of animals harvested in both sectors is above 70 mm. However the effect of the recent years of low abundance of sub-legal and legal-size abalone, particularly on the platform stocks, on the breeding stock needs to be assessed,

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.

The total catch indicator was not met in the majority of fisheries, due primarily to poor economic return.

Standardised CPUEs were within the agreed ranges in Areas 2 and 5, but below agreed ranges in Area 6 and 7. Only 10% of catch was taken in Area 6, consequently the SCPUE is unlikely to be representative. In Area 7, a 10% TAC decrease has been undertaken due to 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 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 16,315 licences 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 2014:

Level 2 - \$1-5 million (\$1.2 million)

The estimated average price for Roe's abalone in 2014 was \$24.80/kg. This value was slightly lower than the value in 2013. On the basis of the average price, the fishery was worth approximately \$1.2 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 >\$US1.00 in 2011, and has since dropped back to an average of \$0.85 for the 2014 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 328 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.

**Recreational (West Coast)
Allocated Catch Target range:**

5 year moving average - 40 ± 2 tonnes

The governance range is based on the 3 year moving average of catch in the West Coast Fishery. This range takes in the permitted maximum tolerance of ± 2 t around the allocation of 40 t.

The 5-year (2010-2014) moving average for 2014 was 25 t. This was outside the governance range, and was caused by significant reductions in effort from 2010 to 2014, due primarily to poor weather conditions and changes in the fishing season (less days, lower bag limit) designed to reduce catch.

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 2015/16 season.

New management initiatives (2015/16)

The fourth year of the trial of a summer season for the West Coast Zone of the recreational fishery was undertaken for the 2014/15 summer. The season began on the first Sunday of November 2014 and extended till the first Sunday of March 2015, 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 licences, averaging around 15,500.

For the 2014/15 season, the same number of fishing days was maintained, however a decrease in daily bag limit from 20 to 15 abalone was adopted. 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 continuing to determine whether they can assist the recovery. The effect of the heat wave on the Perth metropolitan area stock is being evaluated. Roe's abalone were rated a high risk to the effects of climate change as it is highly sensitive to environmental conditions.

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 1Roe'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 (Roe's 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
2014/15	87,000	48,518	328	129	24.2

Notes

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

ROE'S ABALONE TABLE 2

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

Year	Effort (hours)	Catch rate	Field Survey Catch per fisher	Catch (number)	Catch (tonnes)	Mean weight (g)
1999	16,449	23	17.4	383,600	35.3	92
2000	15,818	21	16.7	330,300	30.2	91
2001	17,727	27	18.8	481,300	44.1	92
2002	18,127	22	17.9	401,500	36.0	90
2003	17,963	26	18.6	442,400	42.6	96
2004	14,614	24	19.0	342,900	31.7	93
2005	12,328	21	17.8	262,700	24.3	92
2006	10,435	29	18.9	297,000	30.2	101
2007	12,433	28	18.4	338,000	34.4	102
2008	14,490	29	18.2	420,000	44.4	106
2009	19,718	27	17.8	517,000	48.6	94
2010	18,010	26	18.7	468,000	43.9	94
2011	11,396	23	17.0	266,000	22.4	84
2012	7,972	25	17.9	205,500	18.6	90
2013	8,512	27	17.4	226,100	20.1	89
2014	9,139	24	14.4	220,400	20.2	92

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

1. Both areas are within the West Coast Bioregion.

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

ROE'S ABALONE TABLE 4

Mean densities[&] (abalone/m²) of sub-legal (<60 mm shell length) and legal-sized Roe's abalone (60 mm and over) from 13 monitoring sites (fished stocks) and the Marine Protected Area (MPA) in the Perth fishery. The platform habitat is primarily the recreational fishery, while the sub-tidal habitat is primarily the commercial fishery. Data has been standardised by a GLM (Generalized Linear Models) analysis, as the sites are not the same for all years.

Year	Platform habitat				Sub-tidal habitat			
	Fished stocks		Waterman's Reserve (MPA)		Fished stocks		Waterman's Reserve (MPA)	
	<60	60+	<60	60+	<60	60+	<60	60+
1998	39.0	20.2	31.6	21.0	3.2	7.8	7.3	31.3
1999	42.1	20.6	31.3	25.9	2.7	4.6	8.6	19.8
2000	41.1	18.2	17.6	18.2	2.0	6.5	8.4	23.3
2001	38.7	18.6	23.7	27.4	2.8	7.0	6.0	22.2
2002	30.9	21.7	27.8	29.8	2.3	6.3	4.7	22.3
2003	22.7	18.3	22.6	29.2	2.9	7.4	3.3	19.9
2004	21.9	13.9	21.0	41.5	2.5	6.1	3.4	14.1
2005	21.1	12.2	30.8	31.5	3.5	6.5	6.6	16.3
2006	18.8	10.9	36.1	30.0	4.3	6.8	4.2	13.3
2007	22.9	11.1	25.1	28.9	3.6	7.6	5.5	16.3
2008	23.4	12.5	51.0	31.1	4.2	8.1	4.4	13.7
2009	29.0	11.2	50.6	34.8	5.0	7.8	7.4	17.5
2010	31.7	9.3	59.2	28.6	6.4	8.7	5.8	17.5
2011	31.9	7.5	45.8	24.7	5.3	8.1	4.9	16.9
2012	33.7	7.2	40.0	15.3	5.9	7.5	7.5	18.3
2013	28.3	8.5	19.7	17.1	5.6	8.8	3.6	12.9
2014	22.0	7.7	16.9	21.7	4.7	8.2	0.9	10.2
2015	20.7	7.3	16.6	17.6	4.0	7.9	0.5	9.9

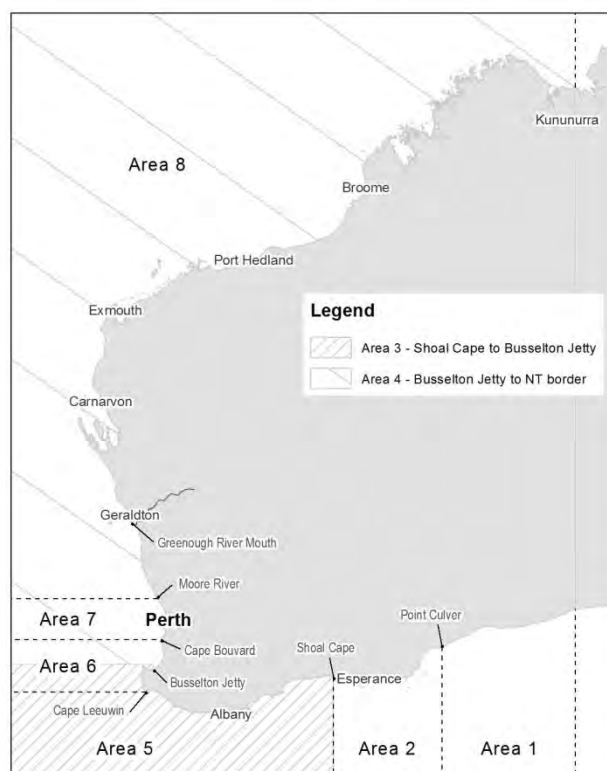
[&] Note that the GLM model used to estimate density in this report has changed from previous years. The overall trends in density have not altered, however values may vary from year to year.

ROE'S ABALONE TABLE 5

Assessment against agreed performance measures for 2014.

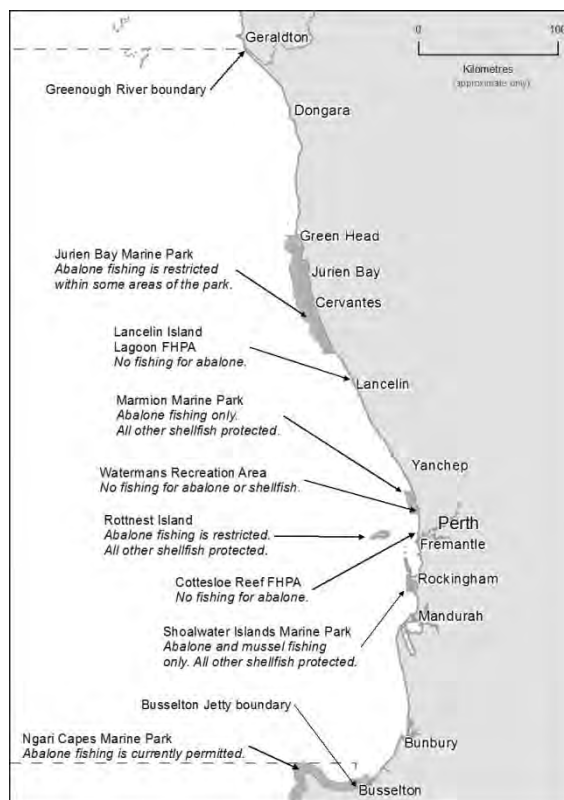
Performance Indicator	Performance Measure ¹	2014 Values	Assessment/Comments
Area 1			
Total catch (TACC)	5,000 kg	0 kg	Exploratory quota – No fishing in 2014.
Effort range (Diver days)	14 – 43	0	See above.
Area 2			
Total catch (TACC)	18,000 kg	11,105	Not met – 62% of quota caught.
Standardised CPUE	18 – 27	22	Met.
Area 5			
Total catch (TACC)	20,000kg	4,150	Not met – 21% of quota caught.
Standardised CPUE	16 – 24	22	Met.
Area 6			
Total catch (TACC)	12,000 kg	1,204	Not met – 10% of quota caught.
Standardised CPUE	19 – 28	11	Not met.
Area 7			
Total catch (TACC)	32,000 kg	32,000	Met – 100% of quota caught.
Standardised CPUE	29 – 42	28	Not met.
Area 8			
Total catch (TACC)	0 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 Fisheries Research Report No. 185¹.

**ROE'S ABALONE FIGURE 1**

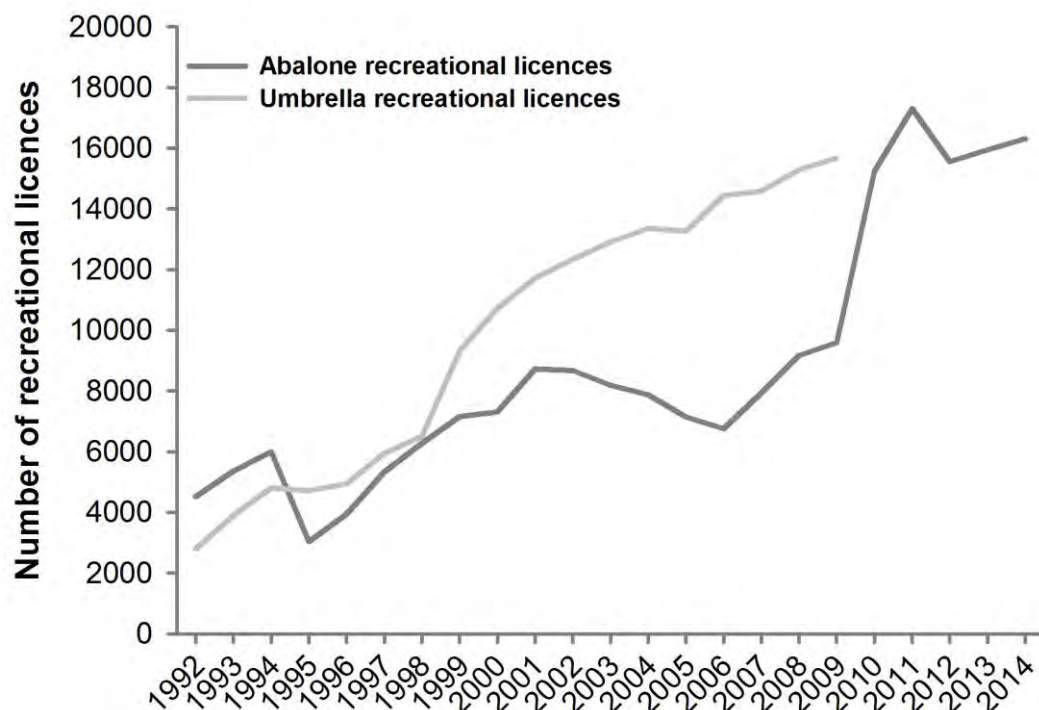
Map showing the management areas used to set quotas for the Roe's abalone commercial fishery in Western Australia.

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. 32p.



ROE'S ABALONE FIGURE 2

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



ROE'S ABALONE FIGURE 3

The number of licences issued in the recreational abalone fishery, by licence type, for the period since 1992. Umbrella licences were discontinued in 2010.

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

E. Sporer, M. Kangas, S. Wilkin, N. Blay and L. Pickles

Main Features

Status	Current Landings		
Stock level	AIMWTMF - Environ. Limited	AIMWTMF:	Scallops nil (whole weight)
Fishing level	Acceptable	SWTMF:	Scallops nil (whole weight)
			Prawns 3 t
		SCTF:	Scallops 437 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 and is a multi-species fishery.

The South Coast Trawl Fishery (SCTF) principally targets scallops (*A. balloti*) and associated byproduct. 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 on behalf of the Department by the Industry Consultative Unit (ICU) within the West Australian Fishing Industry Council. The ICU, is also responsible for statutory management plan and special purpose 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	(7 MFL's)
Zone C	North-east of Cape Naturaliste	(0 MFL's Closed to trawling)
Zone D	Comet Bay off Mandurah	(0 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° 00' east longitude on the landward side of the 200 m 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 is a maximum total net headrope capacity restriction, specified net mesh size, along with seasonal closures and significant spatial closures protecting all near-shore waters and sensitive reef areas. Bycatch reduction devices (grids) to release large species are fully implemented in the 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.

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 10-year export approval for the fishery until 2025.

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 are a total of 10 MFLs, in this fishery, however, three boats that have access to Zone A (one of which has dual access to Zone B) and seven boats are also permitted to operate in Zone B. The fishing season operates between 1 January and 15 November in Zone A and Northern Zone B as described in item 2 (a) of Schedule 2 in the Management Plan. There were three licences in Zone D, however these were removed from the fishery through a VFAS in 2014 and access to Zone D ceased, while access to Zone C ceased in 2002. The management plan also includes large permanent closures to protect sensitive coastal habitats (including seagrass beds) and nursery areas such as Cockburn Sound, Warnbro Sound, and inshore Geographe Bay. For the 2014 season voluntary temporal closures were in place in Zone A from 01 January 2014 until 28 February 2014, and in the Geographe Bay region of Zone B from 01 to 31 January 2014.

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, seasonal and spatial 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 an annual pre-season survey that provides the information required for assessing the fishery. This pre-season 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. A pilot project (jointly funded by the Department and Industry) has been implemented in 2014/15 to assess the cause of the decline in recruitment and examine the feasibility of restocking to assist the recovery. A funding application to FRDC for 2015/16 was submitted to extend this pilot project.

Retained Species

Commercial landings (season 2014)

AIMWTMF:	Scallops Nil
SWTMF:	Scallops Nil
	Prawns 3 tonnes
SCTF:	Scallops 437 tonnes (t) whole weight

AIMWTMF

No scallop fishing occurred in this fishery during 2014 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

For 2014 the SWTMF was a 2 boat fishery. Early in the year the vessel fishing Zone D gave up its licences to the Voluntary Fishery Adjustment Scheme (VFAS), and Zone D ceased to be fished and low landings of prawns (3 t) were reported as landed. Being a multi species fishery, other reported product retained were blue swimmer crabs and mixed finfish with a combined total of < 2t. The vessel fishing Zones A and B chose not to fish due to poor scallop recruitment for the 2014 fishing season.

SCTF

The South Coast trawl fishery is principally a scallop fishery with a relatively small amount of mixed finfish landings/recorded. The scallop catch has been increasing over the past eight years with a total annual catch of 87.4 t meat weight (437.2 t whole weight), the third highest catch on record, however, it is significantly less than the 544 t meat weight landed in 2000. Retained by-product was negligible with <0.1 t of bugs. (West and South Coast Scallop Figure 3).

Recreational catch:	Nil
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Fishing effort/access level**AIMWTMF**

In 2014, the AIMWTMF including the Port Gregory area was not opened for scallop fishing for the third consecutive year, due to low scallop abundance triggered by low recruitment due to unfavourable environmental conditions and very low breeding stock levels. (West and South Coast Scallop Figure 4).

SWTMF

A total of 27 boat days were fished in the SWTMF in 2014. This is very low compared to the effort levels of previous years, especially the period between 1990 and 2003, where typically 400 or more boat days were recorded per year. The effort (days fished) in 2014 has also declined significantly from previous years (80 in 2013 and 166 in 2012). This low effort reflects the cessation of fishing in Zone D and the lack of scallop recruitment in Zone A. However, if scallop recruitment improves there is potential for a commensurate increase in actual fishing effort in Zone A. (West and South Coast Scallop Figure 5).

SCTF

For the 2014 season, three boats fished for scallops between January and July, recording a total of 201 boat days (West and South Coast Scallop Figure 6). 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 (2015)

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 2014 recruitment survey abundance remains extremely low, 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 than the target range (95-1830 t whole weight) and therefore, the fishery was

not opened for 2014. The predicted landings for 2015 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 2014 fishing season was not fished due to the low stock available, which was all left as breeding stock.

Bycatch species impact:**Negligible**

Generally, 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 2014.

In the SWTMF trawling for scallops is focused on a few small offshore areas (at times with large-mesh (100 mm) trawl gear when focusing of scallops), while the prawn catch is mainly taken from Comet Bay (Zone D). Only 26 days of fishing (over two months) occurred in Zone D in 2014. Access to Zone D ceased during 2015.

The large-mesh (100 mm) trawl gear used in the SCTF results in 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:**Negligible**

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 (limited effort) and the SCTF endangered, threatened and protected species do not occur regularly in the fishing areas, despite frequenting the surrounding waters. Only 1 to 2 % of the allowable trawl area in the SW trawl Fishery and 2 to 3% in the South Coast Fishery is actually fished. There were no recorded captures of listed species in 2014 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 2014 was nil in the AIMWTMF, 6 in the SWTMF and 16 in the SCTF.

Economic Effects

Estimated annual value (to fishers) for year 2014:

AIMWTMF **Level 0 - \$ Nil**

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

SCTF: **Level 2 - \$3.1 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 \$7.00/kg whole weight. 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 \$16.00/kg.

Fishery Governance

Target catch range:

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

Current fishing level: **N/A**

Except for a small number of years (see External Factors for details), the historic catch range for this fishery is 95 – 1,830 tonnes whole weight. No fishing was undertaken in 2014.

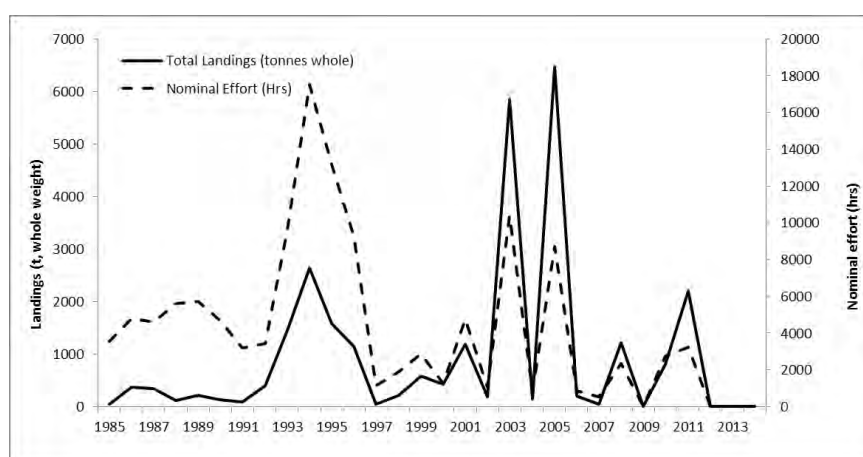
New management initiatives (2015)

Pre-assessment phase for the Marine Stewardship Council approval system was completed in 2014 for all three fisheries. The Department is currently working with licensees regarding the outcomes and recommendations of the Pre-Assessments.

The Department is continuing to progress a management plan amendment in consultation with licensees to incorporate changes to boundaries of the fishery, gear arrangements and administrative changes in the SWTMF.

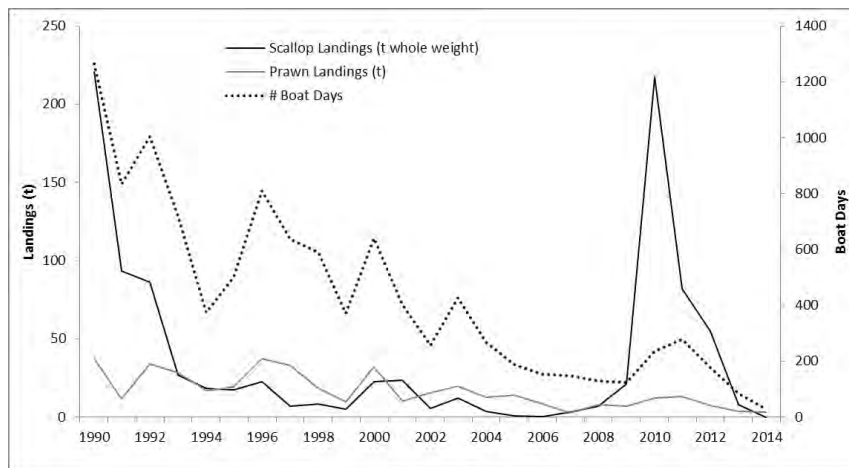
External Factors

High variability in the level of recruitment highlights the dependence of recruitment success upon environmental conditions, such as the Leeuwin Current and temperature, 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, 2013 and 2014 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.



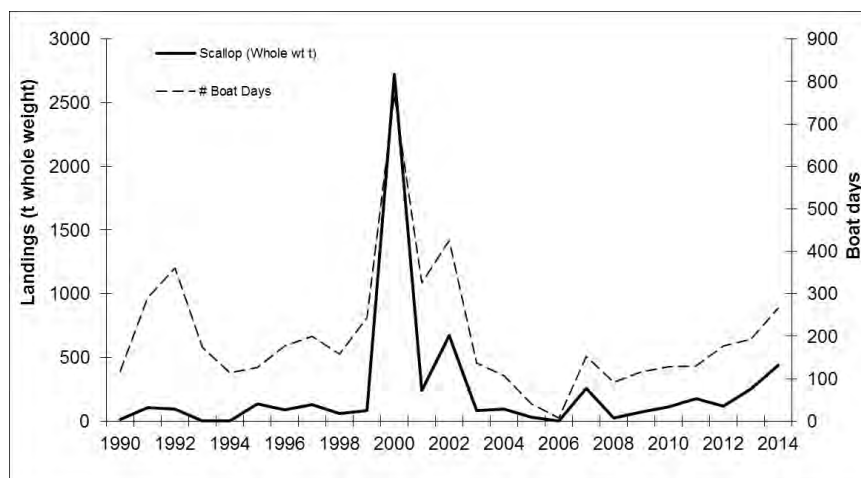
WEST AND SOUTH COAST SCALLOP FIGURE 1

Annual Scallop Landings (t whole weight) and Nominal Effort for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985 – 2011. Note no fishing in 2012-2014.



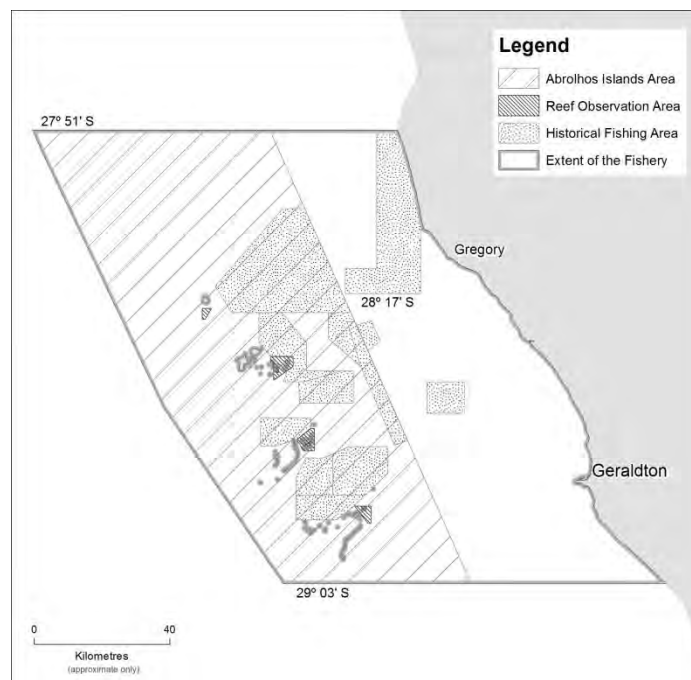
WEST AND SOUTH COAST SCALLOP FIGURE 2

Annual Scallop and Prawn Landings (t whole weight) and number of boat days for South West Trawl Fishery, 1990 – 2014.



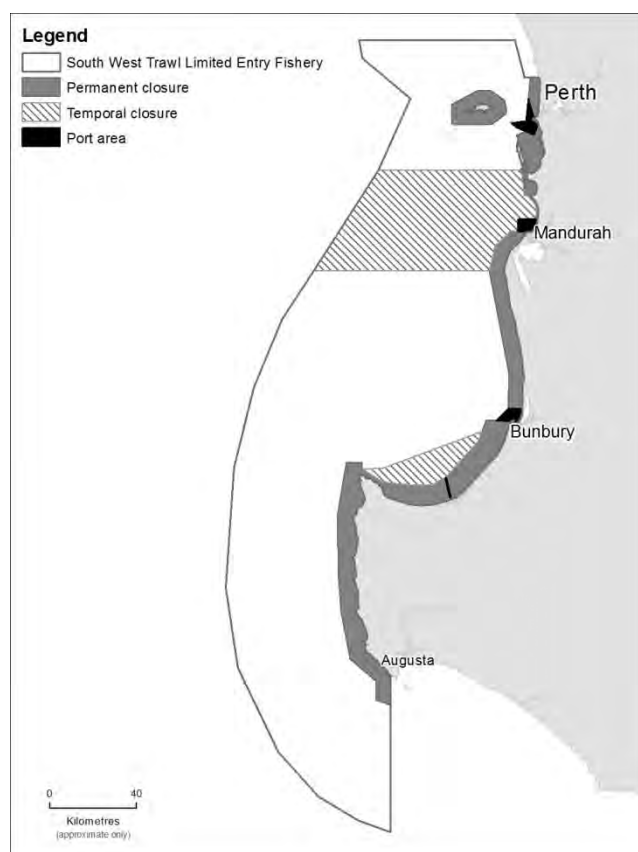
WEST AND SOUTH COAST SCALLOP FIGURE 3

Annual Scallop Landings (t whole weight) and number of boat days for South Coast Fishery, 1990 – 2014.

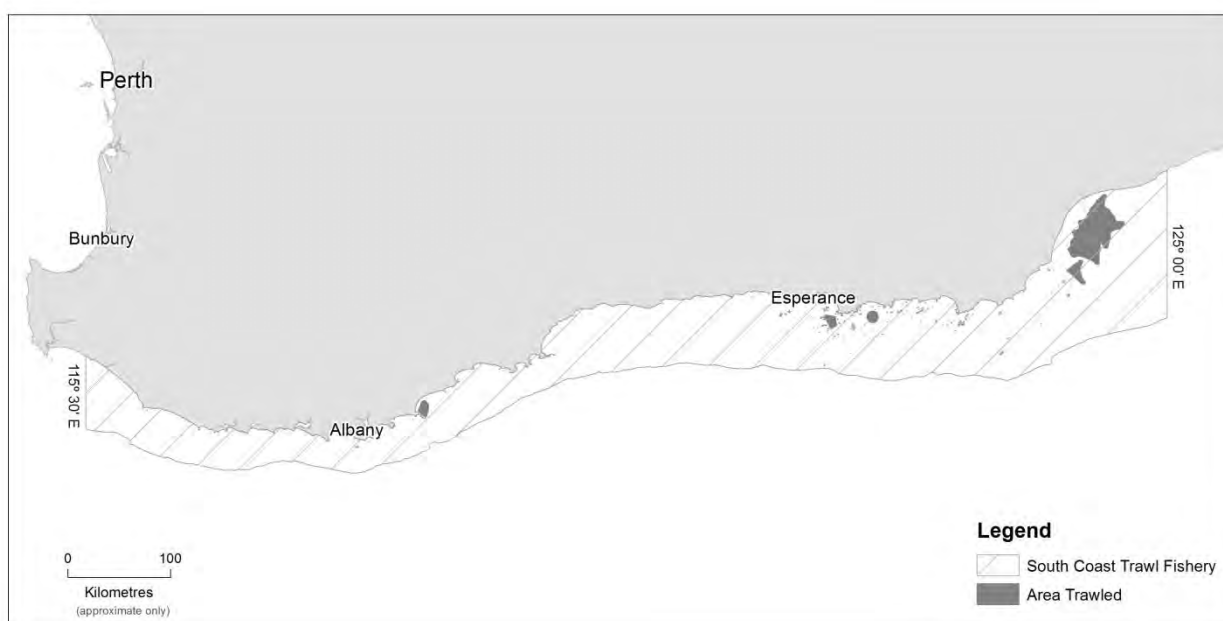


WEST AND SOUTH COAST SCALLOP FIGURE 4

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 2014.



WEST AND SOUTH COAST SCALLOP FIGURE 5
Boundaries of the South Coast Trawl Fishery.



WEST AND SOUTH COAST SCALLOP FIGURE 6
Boundaries of the South Coast Trawl Fishery and extent of fishing in 2014.

West Coast Blue Swimmer Crab Fishery Status Report

D. Johnston, R. Evans, M. Foster, R. Oliver and N. Blay

Main Features

Status		Current Landings	
Stock Level		Total commercial catch (2013/14)	163 t
Cockburn Sound	Environmentally Limited	Cockburn Sound	25 t
Peel-Harvey Estuary	Acceptable	Peel-Harvey Estuary	105 t
Fishing Level		Catch by other commercial fisheries	33 t
Cockburn Sound	Acceptable	Total recreational catch	
Peel-Harvey Estuary	Acceptable	West Coast Bioregion (boat-based) (May 13 - Apr 14)	50 – 66 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 occasionally retained as by-product by trawlers operating in the waters from Fremantle to Cape Naturaliste (Zone B of the South West Trawl Managed Fishery). In 2014 the 3 licences held by one operator in Zone D of the South West Trawl Managed Fishery (Comet Bay) were given up to a Voluntary Fishery Adjustment Scheme (VFAS), as the ongoing rise in fishing costs had resulted in this zone becoming uneconomic to fish. There are now no Zone D licence holders operating in this 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 Managed Fishery Management Plan 2014

Cockburn Sound Crab Managed Fishery Management Plan 1995

Warnbro Sound (Crab) Managed Fishery Management Plan 1995

South West Trawl Management Plan 1989

Prohibition on Fishing for Crabs (Cockburn Sound) Order 2014

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

Commercial

The Department undertakes consultation directly with licensees on operational issues and processes and is responsible for the statutory management plan consultation. Industry Annual Management 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.

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), the waters of the Peel Inlet and Harvey Estuary, together with the Murray, Serpentine, Harvey and Dandalup Rivers (Area 2) and waters of the Hardy Inlet (Area 3).

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 commercial and recreational 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 Managed 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 previous volumes).

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 14 May 2014.

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 Managed 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 Managed 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 pre-assessment process. The Peel-Harvey crab fishery is currently undergoing full MSC assessment.

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 2013/14):

	Total 163 tonnes
Cockburn Sound	25 tonnes
Peel-Harvey Estuary	105 tonnes
Other west coast commercial fisheries	33 tonnes

The total commercial catch from the West Coast Bioregion in 2013/14 was 163 t, representing a 25% decrease on the 215 t taken in 2012/13. This decrease was primarily due to significant decreases in crab catch from Cockburn Sound and the Mandurah to Bunbury Developing Crab Fishery (Area 1 and Area 2). The West Coast catch accounted for 29% of the state commercial blue swimmer crab catch of 552 t for 2013/14 (West Coast Blue Swimmer Crab Figure 1).

The commercial catch from the Cockburn Sound Crab Managed Fishery for 2013/14 was 25 t, a 59% decrease from the 62 t caught during the 2012/13 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 2013/14 was 105 t. This represents a 2% increase on the 102 t landed in 2012/13 and is the highest catch recorded since the conversion to crab traps (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 2013/14 of 6 t, representing an 60% decrease on the 15 t reported for the 2012/13 (West Coast Blue Swimmer Crab Figure 4). The trap fishery accounted for 5.3 t thus providing the majority of the Mandurah-Bunbury catch with only 0.8 t being taken by the South West Trawl Fishery.

Recreational catch estimate:

West Coast Bioregion (boat-based)

(May 13 – Apr 14) 50 – 66 tonnes

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 88% of the recreational crab catch reported in a statewide survey of boat-based recreational fishing in 2013/14 coming from this area (Ryan *et al.* 2015¹). The survey was conducted between 1 May 2013 and 30 April 2014. Approximately 3,000 fishers from the “Recreational Fishing from Boat” licence database participated in a 12 month phone-diary survey. Catch data were recorded in numbers of crabs, and have been converted to weight for this report using a mean statewide estimate of 254 g/crab (based on 346 crabs weighed during boat ramp surveys). The statewide boat-based recreational estimate of retained blue swimmer crabs for the 12-month period was 72 t (S.E.±4.8 t). The boat-based estimate for the West Coast Bioregion was 50 - 66 t.

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

¹ Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. Statewide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

estimate of 251-377 t from the last survey undertaken in 1998/99 (Lai *et al.* In, Johnston *et al.*, 2014¹).

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 1999²; Sumner and Malseed 2004³; Bellchambers *et al.* 2005⁴). However, the recreational catch for the 2005/06 financial year was estimated to be just 4 t (Sumner and Lai 2012⁵). 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 15 December 2009 to 31 March 2010. A survey quantifying recreational catch and effort in the West Coast Bioregion was conducted over a two-year period between July 2008 and June 2010. The survey provided a recreational catch estimate for the 3½ months of the 2009/10 season of 15.4 t (S.E.±3.3 t) of blue swimmer crabs, for an area covering Cockburn Sound (south of latitude 32°05'S), Shoalwater Bay and the northern half of Warnbro Sound (north of latitude 32°20'S). However, the survey covered only the period during the day between 9am and 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 15 December 2010 to 30 April 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 2001⁶). 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

Commercial fishers in Cockburn Sound reported a total of 38,602 trap lifts for the 2013/14 season, a 51% decrease on the 78,515 trap lifts during the 2012/13 season (West Coast Blue Swimmer Crab Figure 2). 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.

Commercial fishers in the Peel-Harvey Estuary reported 72,229 trap lifts during the 2013/14 season – representing a 5% increase on the 68,646 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 a further 48% in 2013/14, with a total of 8,960 trap lifts reported compared to 17,178 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

¹ 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.

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.

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.

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 and the following seasons were fished under a conservative management regime of a 20 % trap reduction to 640 traps, restricted season length and temporary increase in minimum size to 140 mm CW.

The juvenile abundance (0+) in 2013 was very low despite the egg production being at a reasonable level indicating that environmental conditions may have been the main reason for the low juvenile abundance. The residual abundance (1+) was also high in 2013 as a result of conservative management in recent years. The low juvenile abundance was confirmed with a catch rate in 2013/14 that was considerably lower than the previous year's catch rate, and resulted in the early closure of the fishery on 16 April 2014 for the commercial sector and 14 May 2014 for the recreational sector.

Nominal CPUE at the beginning of the 2013/14 season ranged between 0.7 and 0.8 kg/traplift from December to February and decreased to 0.5 kg/traplift in April and May. These low values of monthly CPUE were similar to those observed in the years immediately preceding the closure of this fishery in 2005 and 2006 indicating that stock levels were very low and similar to those in 2005 and 2006. The overall nominal catch rate for 2013/14 was 0.7 kg/traplift for this fishery.

A preliminary harvest strategy has been determined for the Cockburn Sound Crab Fishery where the primary performance indicators are the juvenile index and egg production index. A weight of evidence approach is used for the stock assessment where the indices, in addition to commercial catch rates and the proportion of females in the

commercial catch, are taken into account to assess stock status.

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 and below the limit of 0.4 juveniles/1000m² trawled. The juvenile index for 2014 of 0.02 juveniles/1000m² trawled was also below the limit and considerably lower than the past seven years (2007-2013), and lower than the level observed when the fishery was closed in 2006 (West Coast Blue Swimmer Crab Figure 6).

Egg Production index: The egg production (breeding stock) index during 2012/13 was just below the threshold of 1.3. A review was triggered and as the juvenile index was below the limit for 2013, an adaptive management approach was taken during the 2013/14 season and stocks were monitored very closely. The egg production index of 0.4 for 2013/14 was well below the limit of 0.9 and similar to the low levels (0.3) that resulted in recruitment failure in 2004/05. The very low levels of juvenile abundance observed in 2014, confirmed that the spawning potential of the breeding stock in the latter half of 2013 and early 2014 may have been impaired and were at very low levels (West Coast Blue Swimmer Crab Figure 7).

As the juvenile and egg production indices were well below the limit and the commercial catch rate dropped to 0.5 kg/traplift in March-April, with a high proportion of females in the catch, the fishery was closed early to both commercial (15 April) and recreational (14 May) sectors in 2014. The stock is currently at unsustainable levels and considered to be environmentally limited. Reasons for the stock decline are currently being investigated, including potential changes in growth rates and the proportion of berried females.

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 just above size at maturity (>87 mm CW) which would be spawning for the first time. Scaling the nominal egg production index using the proportion of berried females generated a substantially lower effective egg production index in 2012/13, which was consistent with the very low subsequent recruitment observed in 2013. The very low proportion of berried females in 2013/14 also contributed to the low recruitment in 2014. 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 105 t from 1717 fisher days in 2013/14. Crab catches have remained high in recent years, with 2013/14 reporting the highest recorded catch since the conversion to crab traps in 2000/01 (West Coast Blue Swimmer Crab Figure 3).

Since this complete gear conversion from nets to traps in 2000/01, annual commercial catch rates have fluctuated between 0.8 and 1.5 kg/trap lift, but have generally remained above 1 kg/trap lift. The nominal annual catch rate for 2013/14 in the Peel-Harvey Estuary was 1.45 kg/trap lift (West Coast Blue Swimmer Crab Figure 3). This catch rate is slightly lower than the 2012/13 and 2011/12 catch rate of 1.49 and 1.54 kg/traplift, respectively, which represented the highest catch rates 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.

A preliminary harvest strategy has been determined for the Peel-Harvey Crab Fishery where the primary performance indicator is standardised annual catch rate (taking into account factors of year, month and vessel) (West Coast Blue Swimmer Crab Figure 8). The reference period is between 2000/01 and 2011/12 as defined by when the fishery became trap only. As there is a season for this fishery the harvest strategy is based on fishing season (1 November – 31 August). The standardised catch rate of 1.2 kg/traplift for the 2013/14 fishing season was well above the threshold of 0.7 kg/traplift, so currently the risk to sustainability is low. Fishery-independent indices for recruitment and breeding stock are currently being investigated for this fishery, given its assessment for Marine Stewardship Certification.

Mandurah to Bunbury: 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 2013/14 of 0.59 kg/trap lift – a 26% decrease on the 2012/13 catch rate of 0.79 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, however the level of fishing is relatively low on this stock. This will need to be closely monitored to ensure overfishing the breeding stock does not occur.

A preliminary harvest strategy has been determined for Area 1 and Area 2 of the Mandurah to Bunbury Developing Crab Fishery where the primary performance indicator is nominal annual catch rate. The reference period for Area 1 Comet Bay is between 2005/06 and 2011/12 as defined by when the developing fishery status commenced and the operator commenced fishing. The reference period for Area 2 Mandurah-Bunbury is between 2004/05 and 2011/12 as defined by when the developing fishery status commenced and the operator commenced fishing. The harvest strategy is based on financial year. Nominal catch rate in 2013/14 for Comet Bay was above the threshold of 0.5 kg/traplift so

stocks were considered sustainable for that year. Nominal catch rate in 2013/14 for Mandurah-Bunbury fell below the limit of 0.7 kg/traplift, so currently the risk to sustainability is high. This fishery is currently under review and has not been fished during 2014/15. The review also includes the adjacent stocks in Comet Bay and Warnbro Sound.

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.

There may however be some impacts of wading on near shore habitats by the action of scoop netting recreational fishers in the Peel-Harvey Estuary.

Social Effects

During 2013/14, approximately 28 people were employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast Bioregion.

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

Economic Effects

Estimated annual value (to fishers) for year

2013/14: Level 1 - < \$1 million

The commercial blue swimmer crab catch in the West Coast Bioregion for 2013/14 was valued at approximately \$0.85 million, a decrease on the \$2 million generated in 2012/13. 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 2013/14 were set at \$5.24 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 2013/14 financial year was estimated to be \$2.9 million – a 13% increase on the estimated \$2.56 million generated in 2012/13.

Fishery Governance

Current fishing level

Cockburn Sound: Under review

Peel Harvey: 45 - 105 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)

On 1 July 2014, the West Coast Estuarine Fishery transitioned from an interim managed fishery to a managed fishery under the new *West Coast Estuarine Managed Fishery Management Plan 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°) 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 stock within the Cockburn Sound Crab Managed Fishery commercial fishers voluntarily ceased fishing on 16 April 2014 and a closure to recreational fishing was implemented on 14 May 2014. Noting that the stock is still at low levels, the closure remains in place for both the commercial and recreational sector.

On account of increasing blue swimmer crab catches by fishers operating in the South Coast Estuarine Managed Fishery, the Wilson and Irwin Inlet Crab Pot Trial commenced on 18 February 2015 by exemption, and allows the commercial take of blue swimmer crabs by nominated South Coast Estuarine Managed Fishery licence holders. Eight fishers have been authorised to use a restricted number of crab traps in a two year trial. A combined total of 199 traps has been authorised to be deployed across Wilson and Irwin Inlets, although in practice less than this number may be deployed at any one time. The trial seeks to test alternative methods of catching blue swimmer crabs, to determine if fishers can more efficiently target the species, resulting in better catch-care, improved market prices and reduced bycatch of finfish species. The Department is monitoring the catch rates of blue swimmer crabs through the trial, with fishers required to fill in log-books for research purposes. The exemption period extends until 28 February 2017, with a 12 month review scheduled within this time frame.

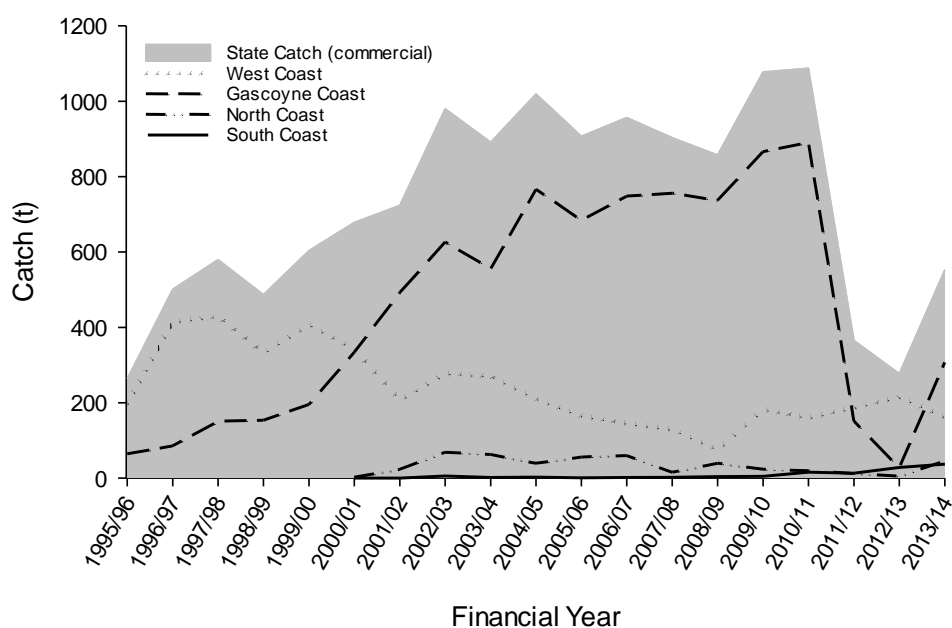
External Factors

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 for Cockburn Sound (and adjacent coastal areas), as well as the cause of the low proportion of berried females in the 2012/13. These temperature changes have also resulted in the increased abundance of crabs in the South Coast estuaries. Blue swimmer crabs were rated a high risk to climate change due to their sensitivity to water temperature changes.

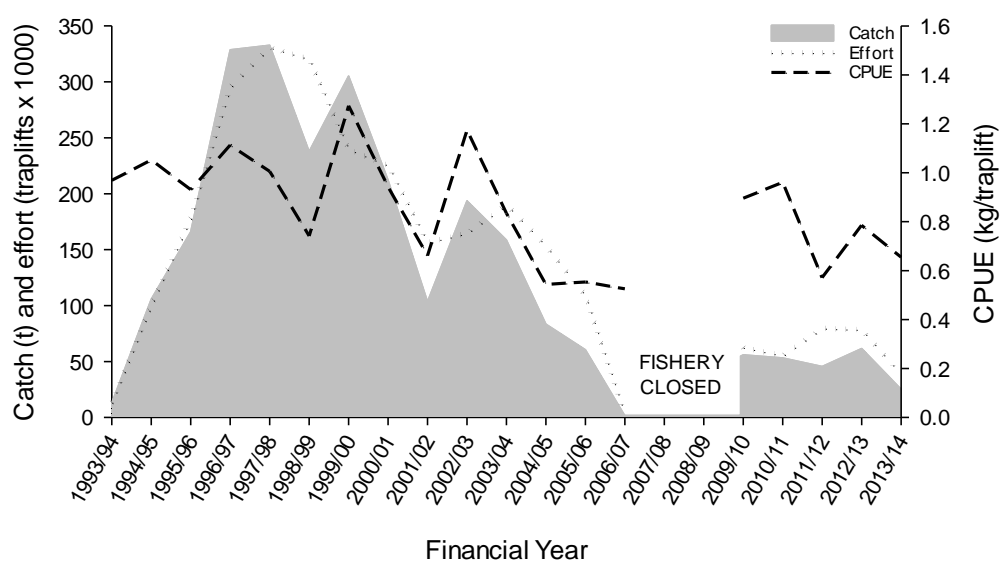
WEST COAST BLUE SWIMMER CRAB TABLE 1

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

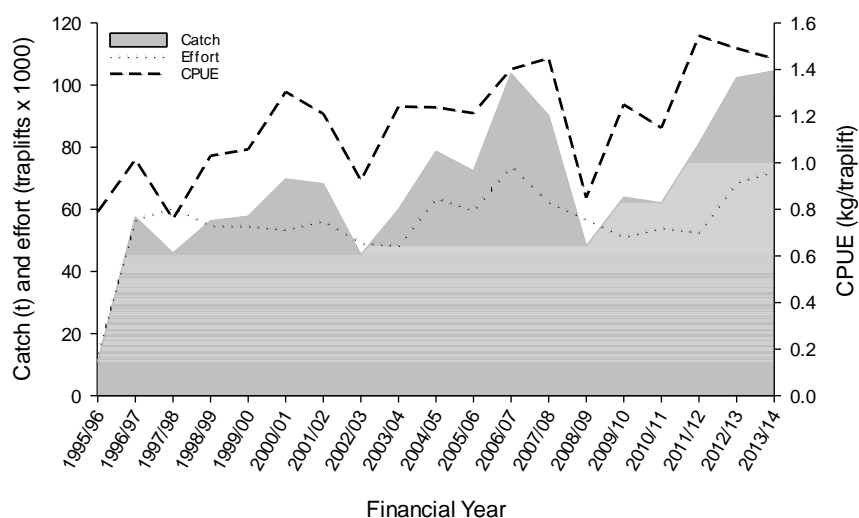
West Coast Bioregion Fishery	Minimum Legal Carapace Width
Area 1 of West Coast Estuarine Fishery (Swan-Canning Estuary)	127 mm
Area 2 of the West Coast Estuarine Fishery (Peel-Harvey Estuary)	127 mm
Cockburn Sound (Crab) Managed Fishery	130 mm
Warnbro Sound (Crab) Managed Fishery	127 mm
Mandurah to Bunbury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

**WEST COAST BLUE SWIMMER CRAB FIGURE 1**

State and bior

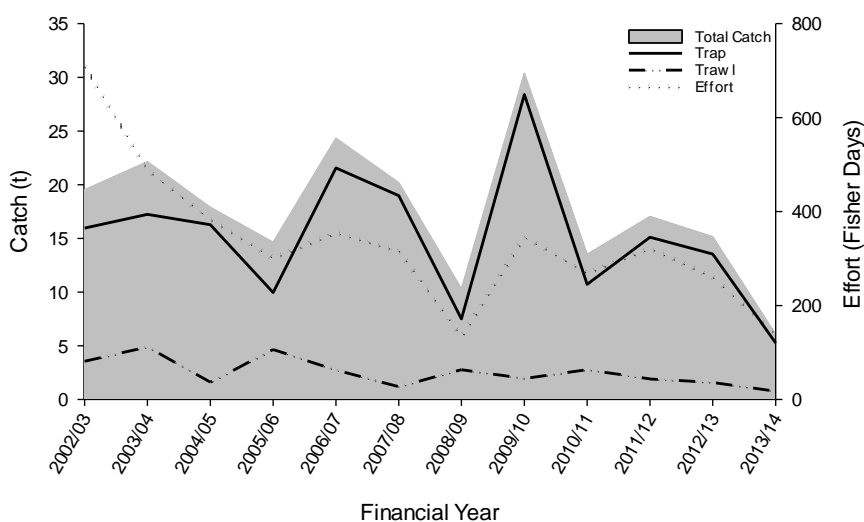
**WEST COAST BLUE SWIMMER CRAB FIGURE 2**

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



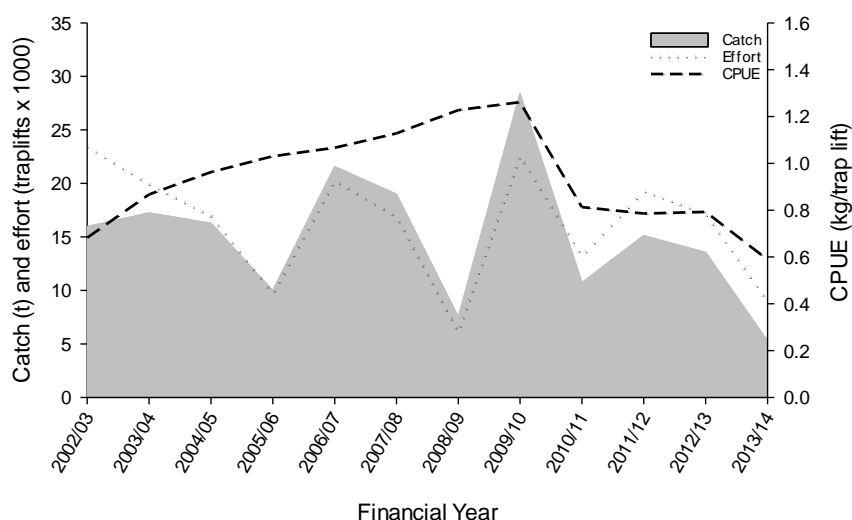
WEST COAST BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (t), effort (trawlifts x 1000) and catch per unit effort (kg/trawlift) in Area 2 of the West Coast Estuarine Managed Fishery (Pe)



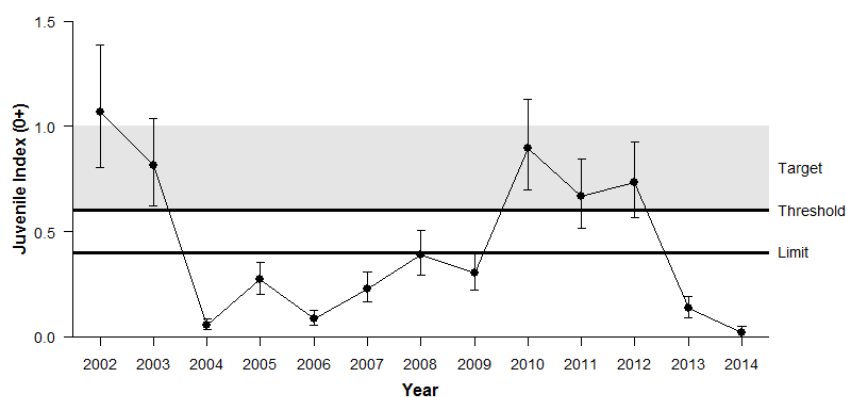
WEST COAST BLUE SWIMMER CRAB FIGURE 4

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



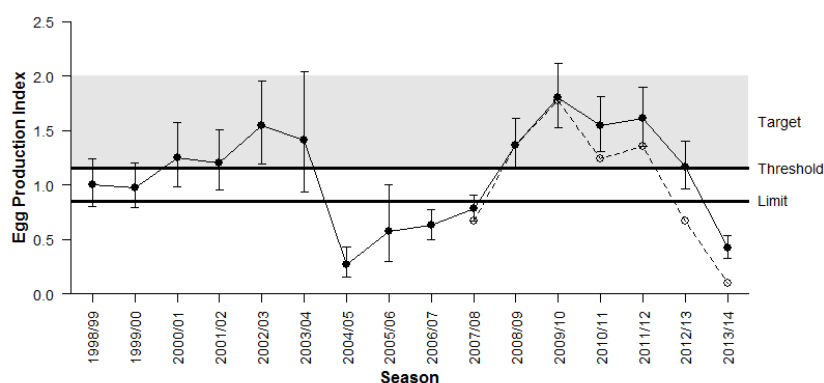
WEST COAST BLUE SWIMMER CRAB FIGURE 5

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



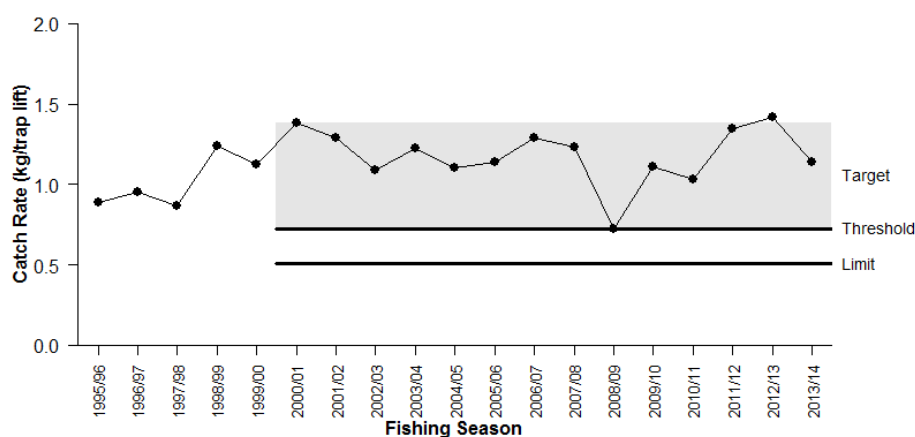
WEST COAST BLUE SWIMMER CRAB FIGURE 6

Annual standardised index of juvenile (0+) blue swimmer crabs in Cockburn Sound calculated using data from juvenile research trawl conducted in April, May and June of each year. The index units are numbers of juveniles/1000m² trawled. The associated reference points (target, threshold and limit) for the preliminary harvest strategy and the 95% confidence intervals are shown.



WEST COAST BLUE SWIMMER CRAB FIGURE 7

Annual standardised breeding stock (egg production) index based on female crabs caught during all trawl surveys aboard the *RV Naturaliste* (2001-2014) and all catch monitoring surveys aboard commercial crab vessels in Cockburn Sound (1998/99-2013/14). 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). Effective egg production index (dotted line) was obtained by scaling the nominal egg production index by the proportion of berried females relative to a reference year (2008/09 when the proportion of berried was at a maximum of 55%) for years berried data was available. The associated reference points (target, threshold and limit) for the preliminary harvest strategy and the 95% confidence intervals are shown.



WEST COAST BLUE SWIMMER CRAB FIGURE 8

Annual standardised commercial catch rate (kg/traplift) of blue swimmer crabs in the Peel-Harvey crab fishery relative to the associated reference points (target, threshold and limit) for the preliminary harvest strategy. The reference period is from 2000/01 to 2011/12; defined as the period where the fishery was operating with traps only and during which time the threshold (lowest historical catch rate), limit (20% below the lowest catch rate) and target (range between the threshold and highest historical catch rate) were set. Fishing season is defined as 1 November to 31 August.

West Coast Nearshore and Estuarine Finfish Resources Status Report

K. Smith, A. Quinn and M. Holtz

Main Features

Status		Current Landings (2014)	
Stock level:		Commercial total	377 t (finfish only)
Australian herring	Inadequate	South West Coast Salmon Fishery	60 t (salmon only)
Southern school whiting	Adequate	West Coast Beach Bait & South West Beach Seine Fisheries	63 t (whitebait only)
Tailor	Adequate	West Coast Estuarine Fishery	145 t (finfish only)
Southern garfish	Inadequate	Other commercial	108 t (finfish only)
King George whiting	Adequate	Boat-based recreational catch range (2013/14) Top 10 species 69 – 87 t	
Sea mullet	Adequate		
Whitebait	Environmentally Limited		
Black bream (Swan-Canning)	Adequate		
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 (WCB) using a combination of gill nets and beach seine nets.

The Cockburn Sound (Fish Net) Managed Fishery uses haul nets in Cockburn Sound. The main target species are southern garfish (*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 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 WCB estuaries are gill nets and seine nets.

Seven 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 WCB 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 WCB, 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 with the Department, although the Department undertakes direct consultation with the community on specific issues.

Boundaries

Commercial - Estuarine

WCEF: The management plan encompasses all estuaries in the WCB between 27° S and 34° 22.715' 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.

Commercial - Nearshore

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

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

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

South-West Coast Salmon Managed Fishery includes all WA waters north of Cape Beaufort except Geographe Bay.

Recreational

Recreational line fishing is permitted in most areas within estuaries and nearshore waters of the WCB. 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 WCB are open to recreational netting. Recreational net fishers must hold a licence. Recreational net fishing regulations are complex – refer to the 'Recreational Net Fishing Guide¹' for details.

Management arrangements

Commercial

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

¹ http://www.fish.wa.gov.au/Documents/recreational_fishing/licences/rec_licence_netting.pdf

Recreational

Recreational fishers in WCB nearshore and estuarine waters take a diverse array of finfish species. Size and possession limits apply to these species when caught recreationally in WA. A Recreational Fishing from Boat Licence is required to undertake any general fishing activity (including crabbing) conducted with the use of a powered boat anywhere in the State.

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

Indicator species

The Department of Fisheries has selected indicator species for monitoring and assessing the status of the finfish resources in the WCB¹. The list of indicators is periodically reviewed. Australian herring, tailor, southern garfish, southern school whiting, whitebait and sea mullet are indicators for this Bioregion's nearshore finfish suite and black bream, Perth herring (*Nematalosa vlaminghi*) and cobbler (*Cnidogobius macrocephalus*) are indicators for the estuarine finfish suite. Although not an indicator, the status of King George whiting (*Sillaginodes punctata*) is also reported here because it is a significant component of nearshore fishery landings in this Bioregion.

Research summary

The status of the fish resources in nearshore and estuarine waters of the WCB is assessed by monitoring the status of indicator species¹. 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 the stock. Fish collected from commercial and recreational fishers are generally 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 WCB 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 WCB 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.

In 2010-2012, a project undertaken by Murdoch University researchers, in collaboration with the Department of Fisheries, conducted level 3 assessments of King George whiting and silver trevally (*Pseudocaranx georgianus*)

populations in the Perth metropolitan area. Results of this project were considered in determining the stock status of King George whiting (see 'Stock Assessments' below).

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.

Retained Species

Total commercial finfish landings (2014):

231 tonnes in nearshore waters

145 tonnes in estuarine waters

Commercial landings by fishery (2014):

South West Coast Salmon:

60 tonnes (western Australian salmon only)

WC Beach Bait + SW Beach Seine:

63 tonnes (whitebait only)

West Coast Estuarine: 145 tonnes (finfish only)

In 2014, the total commercial catch of finfish by estuarine and beach-based fisheries in the WCB was 377 t and included approximately 27 species. The majority of the catch consisted of sea mullet (33% by weight), whitebait (17%), western Australian salmon (16%) and Australian herring (12%) (West Coast Nearshore and Estuarine Table 1).

Catches are taken by these fisheries using gill nets, haul nets and beach seines. The minor quantities of the same species taken by other methods (e.g. purse seine, demersal gill nets and long-lines) are not included in Table 1, 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 WCB. 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.

Historically, 80-90% of total annual commercial landings of Australian herring in WA have been taken in the South Coast Bioregion (SCB), with the remaining 10-20% taken in the WCB. In 2014, 69% of landings were taken in the SCB, and the remaining 31% was taken in the WCB. The majority of landings in the SCB were taken by the ocean beach-based herring trap net fishery. In 2014, the trap net fishery reported 55% of the total commercial herring catch in WA and 79% of the total commercial herring catch in the SCB. In 2014, the remainder of the South Coast commercial catch was taken in estuaries (16%) and in nearshore ocean waters (4%).

Within the WCB in 2014, 43% of Australian herring commercial landings were taken in Cockburn Sound, 43%

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

taken in the Geographe Bay/Bunbury area and 7% taken in the Peel-Harvey Estuary.

In the SCB, the total annual commercial catch of Australian herring reached an historical peak of 1,427 t in 1991 and then steadily declined to an historical low of 104 t in 2014 (West Coast Nearshore and Estuarine Figure 1). Recent low catches in the SCB 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 WCB, 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 WCB mainly reflected declining catches by the south west beach seine fishery 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 2014, 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 2014, total WA landings were 150 t. In SA, landings peaked at 498 t in 1987/88 and reached an historical low of 99 t in 2011/12. In 2013/14, SA landings were 143 t¹.

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. In 2014, SA landings were 49% of the national catch.

Whiting: The vast majority of ‘whiting’ (*Sillago* spp.; i.e. excluding King George whiting) landed by commercial fishers in this Bioregion are yellowfin whiting. The commercial catch of ‘whiting’ in the WCB was 37 t in 2014. The majority (66%) of this catch was taken in the Peel-Harvey Estuary.

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 2014, the total WA commercial catch of tailor was 20 t. Approximately half of this catch was taken in the WCB (51% by weight), with the remainder from the Gascoyne Coast Bioregion (38%) and SCB (11%).

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. Since 2000, annual landings have gradually declined. In 2014, the Gascoyne catch was 7.8 t, almost all of which was taken by the Shark Bay Beach Seine Fishery. This is the lowest annual commercial catch of tailor in Shark Bay since records began in 1956.

In the WCB, the total commercial catch has ranged from 2 t (in 2008) to 42 t (in 1975). The commercial catch in this Bioregion has typically been less than 20 t per year since records commenced in 1912. The catch was 10 t in 2014. The majority (78%) of West Coast landings in 2014 were taken in the Peel-Harvey Estuary.

Southern garfish: In 2014, 42% of total WA commercial landings of southern garfish were taken in the WCB, with the remainder in the SCB. Different breeding stocks are targeted in each Bioregion.

In the WCB, total annual southern garfish landings peaked at 44 t in 1999 (West Coast Nearshore and Estuarine Figure 3). Subsequently, annual landings have followed a downward trend. An historic minimum catch of 4 t was taken in 2013 and remained similarly low (5 t) in 2014. Since 1995, 84% of total commercial landings of southern garfish in the WCB 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 followed the same downward trend as total WCB landings, reaching historic minimum levels in 2013 and 2014.

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. The recent catch decline reflects a stock decline due to overfishing and environmental factors.

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 2014, the total commercial catch of King George whiting in WA was 16 t (West Coast Nearshore and Estuarine Figure 4). Less than 1 t was taken in the WCB in 2014, representing 6% of the total annual commercial catch in WA. The remainder was taken in the SCB.

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 2014, the WA total catch was 205 t. In

1 Fowler A.J., McGarvey R., Steer M.A. & Feenstra J.E. (2014). The South Australian Marine Scalefish Fishery Status Report - Analysis of Fishery Statistics for 2013/14. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000565-9. SARDI Research Report Series No. 816. 44 pp.

2014, 60% of the total WA catch was taken in the WCB, 26% in the Gascoyne Coast Bioregion and 14% in the SCB.

In the WCB, 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 5). After 1988, the total annual catch in the WCB 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 likely to be due to annual changes in targeted effort. In 2014, total WCB landings were 123 t. In 2014, 61% of total commercial landings of sea mullet in the WCB 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 typically 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 SCB, commercial landings of sea mullet have been stable for decades, with an average annual catch of 33 t since 1976 (range 11-92 t per year). In 2014, the catch was 28 t (West Coast Nearshore and Estuarine Figure 5). The vast majority (>90%) of annual landings of sea mullet in the SCB have historically been from estuaries. In 2014, 60% of total commercial landings of sea mullet in the SCB were taken in Wilson Inlet, 18% in Oyster Harbour, 8% in Irwin Inlet, 4% in Princess Royal Harbour and 3% in Stokes Inlet. Minor sea mullet landings were also reported in 3 other estuaries in 2014.

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 WCB, 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 6). The decline in total landings mainly reflects declines in Area 2. In 2013/14, the total catch was 12 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. Since 2010/11, 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 WCB of WA and constitutes a single stock over this range¹. 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 WCB 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 WCB 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 SCB, with most of the remaining 5%, in estuaries of the WCB. Virtually all West Coast landings over this period were in the Peel-Harvey Estuary.

Historically, commercial catches of cobbler in WCB 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 2014, less than 200 kg 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 per year, 1955-65). Landings declined from 17 t in 1978 to 2

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

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 WCB estuaries since 1990. However, deteriorating environmental conditions in 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 2014, 98% of commercial landings of black bream were in the SCB, with the remaining 2% from the WCB.

In the WCB, 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 WCB. Since 2000, total WCB commercial landings of black bream have ranged from <1 to 5 t per year.

Recreational catch estimate (2013/14): N/A

Boat-based 2013/14: 69 – 87 tonnes

State-wide surveys of boat-based recreational fishing were conducted in 2011/12 and 2013/14^{1,2}. During these surveys, nearshore and estuarine species (including whiting species, Australian herring, silver trevally, tailor, southern garfish, black bream, and mullet species) comprised over 80% of all finfish retained by boat-based fishers in the WCB (West Coast Nearshore and Estuarine Table 2).

The top 10 nearshore and estuarine species (or species groupings) in 2013-14 represented 95% of the total catch (by numbers kept) in the West Coast Bioregion. The estimated recreational catch for nearshore and estuarine species, particularly those harvested with high proportions of shore-based effort, will be underestimated. Comparison of estimated recreational catches of the top 10 nearshore and estuarine species in the West Coast Bioregion between 2011/12 and 2013/14 indicated estimated catches decreased from 111 t (95% confidence intervals from 99–123) to 78 t (95% confidence intervals from 69–87).

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 Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

State-wide surveys are scheduled to be repeated at regular intervals in future. Catches from shore-based fishers, who take the majority of nearshore species, are not currently estimated.

Boat-based recreational fishing in the WCB was surveyed in 1996/97, 2005/06, 2008/09 and 2009/10 and is now included in the state-wide surveys which have occurred in 2011/12 and 2013/14.

Recreational catch share

The recreational catch share of total finfish landings in nearshore and estuarine waters of the WCB cannot be determined for the current year.

Fishing effort/access level

Commercial

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

Fishing effort in nearshore and estuarine fisheries is 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 WCB 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. In 2014, 68% of method days were spent targeting crabs (i.e. using crab traps). The remainder of effort (32% of method days) was spent targeting finfish using 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. There are currently eleven licences entitled to operate in this estuary. Ten licensees targeted finfish in 2014.

Swan-Canning Estuary: There is a single licensee entitled to operate in this 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. All commercial effort in 2014 was targeted towards blue swimmer crabs.

Hardy Inlet: There is a single licensee entitled to operate in this estuary. 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 has been 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 2014 was 475. In 2014, 7 licensees reported finfish landings by netting methods in this region.

South West Coast Salmon Fishery: From 1997 to 2005, there were 15 licences in the South West Coast Salmon Managed Fishery. This number was reduced via VFAS to 12 in 2006 and then to 8 in 2010 and subsequent years. Only 2 of the 8 licensees reported salmon catches in 2014.

West Coast Beach Bait and South West Beach Seine Fisheries: There is a single licensee in the West Coast Beach Bait Managed Fishery. There are 9 fishing units entitled to operate in the south west beach seine fishery. All licensees in these fisheries were active in 2014.

Recreational

Current estimates of total recreational effort expended on targeting nearshore or estuarine finfish in the WCB are unavailable.

State-wide 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 WCB, including effort expended on all species. In 2011/12, 52% of total annual boat-based fishing effort (boat days) in the WCB was estimated to have occurred in nearshore habitats (i.e. bottom depth <20m) and 18% in estuaries. In 2013/14, 57% of total boat-based effort was in nearshore habitats and 17% in estuaries.

Stock Assessments

Assessments complete: Yes

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) Uncertain

Perth herring Not assessed

Indicator species - nearshore

Australian herring: A level 3 assessment of the stock was completed in 2012¹. 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 inadequate². 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.

Southern school whiting: This is one of the most common species retained by recreational fishers in the West Coast and South Coast Bioregions. A level 3 assessment of the WCB component of the stock was completed in 2012³. The stock level was assessed as adequate. The rate of fishing mortality (F) was estimated from the age structure of recreational landings in the WCB during 2011. The estimated F was around the target reference level for this species. The majority (>90%) of the recreational catch is comprised of mature fish.

Tailor: A level 2 assessment of the stock was completed in 2012⁴. An independent review of this assessment was conducted, and supported the conclusion that the stock level is currently adequate (Department of Fisheries 2013). Tailor in Shark Bay are believed to be part of the same breeding stock as those within the WCB.

Catch rates from a volunteer fishing program in the Swan-Canning Estuary have provided an indicator of the strength of annual recruitment by juvenile tailor to the WCB since 1996. Annual recruitment fluctuates in response to environmental factors. Recruitment was relatively strong from 2006/07 to 2011/12 (West Coast Nearshore and Estuarine Figure 7). Increased recreational catch rates of adult tailor throughout the WCB recently are consistent with this period of higher

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 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.

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

1 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:

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 2014, but this is attributed to lack of targeting rather than low stock abundance (see *Inner Shark Bay Scalefish Fishery Status Report*).

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 distinct¹ 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^{2,3}. 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)⁴. 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 completed in 2013⁵. 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 currently inadequate. Commercial catch rates suggest the abundance of garfish in Cockburn Sound has been declining gradually since 1996 (West Coast Nearshore and Estuarine Figure 8). Recreational catch rates in the Perth region, available since 2006, also indicate a decline (West Coast Nearshore and Estuarine Figure 9). Catch rates dropped sharply between 2011 and 2012, which suggested a strong negative impact arising from the 2011 'heatwave' event. Catch rates declined further in 2013 and 2014. During 2010 and 2011, the majority (~95%) of the 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).

King George whiting: A level 2 assessment of the stock was completed in 2012⁶ and a Level 3 assessment completed in 2014⁷. The rate of fishing mortality (F) was estimated from the age structure of fishery landings during 2010-2012. F estimates indicated that the stock was not experiencing overfishing. 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.

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 WCB (and 94% in the SCB) are immature fish that are yet to spawn¹. The majority (>95%) of the commercial catch in both Bioregions also consists of immature fish.

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 WCB since 1980 (West Coast Nearshore and Estuarine Figure 10). The annual commercial catch rate in Oyster Harbour suggests an increase in the availability of sea mullet in the SCB 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. Shark Bay abundance appears to have declined after 2011. Refer to the *Inner Shark Bay Scalefish Fishery Status Report* for details of the catch rate in this fishery. Overall, the bioregional trends in abundance suggest a southwards range shift by sea mullet in WA in response to ocean warming.

Whitebait: The WA stock of whitebait is primarily located in the lower WCB (i.e. between Perth and Busselton). Highly variable annual catches and catch rates are characteristic of the commercial whitebait fishery. Variations in catch level were historically correlated with the strength of the Leeuwin Current in the previous year and with rainfall⁸. However, these factors have not been strongly correlated with catches in recent years.

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

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

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

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

5 Smith K, Dowling C., Mountford S., Hesp A., Howard A. & Brown J. (in prep.) Status of nearshore finfish stocks in south-western Western Australia. Part 4: Southern garfish. Fisheries Research Report. Department of Fisheries, Western Australia.

6 See footnote 3, previous page

7 Fisher E.A., Hesp S.A., Hall N.G. & Sulin E.H. (2014). Predicting the impacts of shifting recreational fishing effort towards inshore species. FRDC Project No. 2010/001. Fisheries Research and Development Corporation.

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

Since 2003/04, almost all landings of whitebait have occurred within Area 1 (Bunbury), with negligible landings in Area 2 (Perth/Mandurah). Anecdotal reports and fishery-independent recruitment surveys by the Department in the Perth area are in agreement with 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. 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 11). However, recent catch and catch rates suggest sharply declining stock abundance over the past 4 years in the Bunbury area.

Recent commercial catches of 13 t in 2012/13 and 12 t in 2013/14 were the lowest since the commencement of the commercial whitebait fishery in the early 1970s (West Coast Nearshore and Estuarine Figure 11). The 2012/13 and 2013/14 catch rates were also the lowest recorded (West Coast Nearshore and Estuarine Figure 12).

Whitebait has a lifespan of only 3–4 years, and so trends in stock level (and catches) are strongly linked to recruitment variability. The onset of the decline coincided with a 'heatwave' event along the west coast in autumn 2011¹. It is possible that this event contributed to spawning failure by whitebait in winter 2011, which (when accompanied by fishing mortality) could explain the sharp decline in stock level.

All evidence suggests that the whitebait stock was previously distributed from Perth to Busselton, but that this range has contracted over the past decade and the stock is now mainly located around Busselton. Furthermore, declining catch rates suggest that stock abundance has gradually decreased over the past decade and is currently at an historically low level.

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 2006². Voluntary recreational logbook fisher catch rates suggest stable availability of black bream in this estuary from 2004 to 2014 (West Coast Nearshore and Estuarine Figure 12). 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 2014 was stable (i.e. non-directional) (West Coast Nearshore and Estuarine Figure 13). In 2014, the catch of cobbler in the Peel-Harvey Estuary was negligible and the catch rate was the lowest since 1990. It is unclear whether this reflects low stock abundance or a shift in targeting by the fishery.

Cobbler in the Swan-Canning Estuary was assessed via catch rate trends until a fishing ban was imposed in 2007. Anecdotal information suggests ongoing low abundance of the estuarine stock. Cobbler reported from the lower part of

the Swan-Canning Estuary are likely to belong to a separate oceanic stock. Cobbler in Leschenault Estuary has not been assessed since the commercial fishery closure in 2000.

Perth herring (Not assessed): Perth herring was assessed via commercial catch rate trends in the Swan-Canning Estuary until cessation of fishing for this species in 2007. Catch rates suggested a major decline in the availability of Perth herring after 1980. A single breeding stock of Perth herring occurs in the WCB. Swan-Canning catch rates were 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. Perth herring is anadromous (i.e. spawns in rivers then migrates back to ocean waters after spawning). 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 protected 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 protected species.

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

Ecosystem Effects

Food chain effects: **Low**

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

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

2 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.

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 years¹.

Habitat effects: **Low**

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

Social Effects

Commercial - nearshore

In 2014, 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 2014, there were 2 licensees operating within the West Coast Salmon Fishery, employing approximately 12 crew. There were 8-35 commercial fishers per month employed in various fisheries targeting Australian herring during 2014. Australian herring and western Australian salmon fishers in the WCB supply local bait and human consumption markets.

Commercial - estuarine

In 2014, there was an average of 19 commercial fishers operating per month in estuaries of the WCB, largely supplying fresh fish to meet demand for locally-caught product.

Recreational

The nearshore and estuarine waters of the WCB 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 2014:

Level 2: \$1 to 5 million (finfish only)

Fishery Governance

Commercial

Current Fishing (or Effort) Level:

West Coast Estuarine Fishery **Acceptable**

Cockburn Sound (Fish Net) Fishery **Not Acceptable**
South West Salmon Fishery **Under review**
West Coast Australian herring fisheries **Under review**
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 are being reviewed. However, the 2014 catches are reported (below) against their existing governance arrangements.

In the West Coast Estuarine Managed Fishery, the commercial catch of finfish in the Peel-Harvey Estuary in 2014 was 130 t, which was within the target range. In 2015, the 'total commercial catch range' for the Peel-Harvey Estuary will be replaced with other performance indicators, outlined in the new Harvest Strategy for this fishery (see 'New management initiatives').

In the Cockburn Sound Fish Net Fishery the total catch of finfish in 2014 was below the target range. The Cockburn Sound finfish catch has been below the target range for 7 of the past 9 years. New governance arrangements are needed for this fishery.

The total catch of western Australian salmon (West Coast and South Coast landings combined) in 2014 (364 t) was well below the target range. The catch has now been below the target range for 7 consecutive years. New governance arrangements are needed for this fishery.

The West Coast herring catch by all fisheries in 2014 (47 t) was below the target range. The West Coast herring catch has been below the target range for 10 of the past 11 years (similar to the trend in the South Coast herring catch, which has been below the target range for 12 consecutive years). Recent research outcomes regarding stock status were used as a basis for new management arrangements introduced in 2014/15 to ensure the sustainability of this iconic species (see 'New management initiatives'). A formal Recovery Strategy for the Australian herring stock is being developed.

In 2013/14, the commercial catch of whitebait (12 t) was well below the target range. The catch has now been below the target range for 3 of the past 4 years. New governance arrangements are needed for this fishery.

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.

Recreational Current Fishing (or Effort) Level	NA
Target catch range:	Not developed

New management initiatives

A Harvest Strategy for the finfish resources of the Peel-Harvey estuary was developed in 2014/15¹. The Strategy will remain in place for five years and then be subject to a full review. The Strategy includes performance measures, based on catch and/or catch rate, for each key finfish species and for other retained finfish. The sea mullet component of the catch from the Peel-Harvey Estuary is in the process of seeking full Marine Stewardship Council accreditation.

On 1 March 2015 the recreational fishing daily bag limit for Australian herring was reduced from 30 to 12 and commercial fishing using herring (G) trap nets was prohibited.

These management measures have been implemented to reduce the total statewide catch of herring by at least 50% following a recent stock assessment indicating an unacceptably high risk to the sustainability of the stock.

All West Coast Nearshore and Estuarine Finfish fisheries underwent pre-assessment for Marine Stewardship Certification (MSC) in 2014. Currently the Peel-Harvey sea mullet and blue swimmer crab fishery is undergoing full MSC assessment for both the commercial and recreational sectors. If successful, this will be the world's first recreational fishery to be MSC certified.

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 ecosystems². 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 fishery³.

In 2011, a very strong Leeuwin Current resulted in unusually warm ocean temperatures in coastal waters of the southern WCB and the western SCB. This 'heatwave' event caused widespread fish kills in the WCB. 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 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 WCB 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 degradation⁴. Juveniles of King George whiting are also strongly associated with seagrass and so may be impacted by habitat loss in Cockburn Sound.

WCB 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 WCB 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 earlier⁵. Stock declines in WCB estuaries are most pronounced among 'estuarine-dependent' species, i.e. those that rely on estuarine habitats for spawning, feeding and/or nursery areas (e.g. cobbler, Perth herring, black bream). Whilst not strictly estuarine-dependent, sea mullet and yelloweye mullet exhibit a strong preference for estuarine habitats when available. The status of these species may also be affected by the availability and quality of estuarine habitats. A variety of barriers to fish passage occur in estuaries (e.g. weirs, dredge plumes) which can disrupt the life cycle of migratory species (e.g. mullet, Perth herring).

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

1 Finfish Resources of the Peel-Harvey Estuary Harvest Strategy 2015-2020. Version 1.0. West Coast Estuarine Managed Fishery (Area 2). Fisheries Management Paper No. 274. Department of Fisheries, Perth.

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.

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

5 See footnote 2, page 73

WEST COAST NEARSHORE AND ESTUARINE TABLE 1

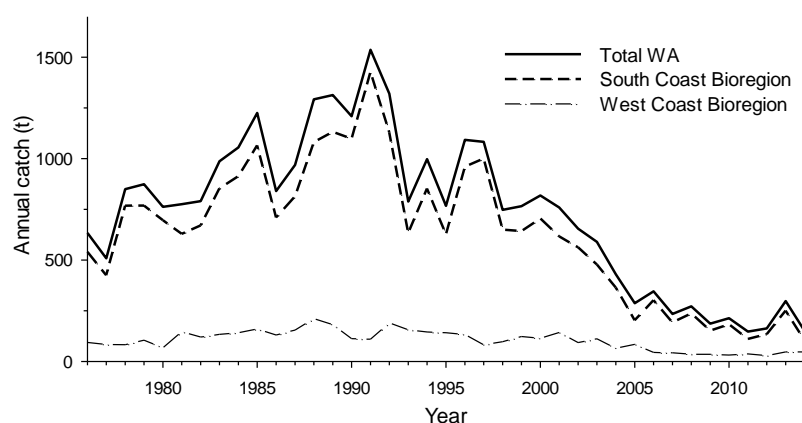
Total annual catches of finfish from the estuarine and beach-based nearshore commercial fisheries in the West Coast Bioregion, 2010 to 2014.

Species	Scientific name	Catch (tonnes)				
		2010	2011	2012	2013	2014
Australian salmon	<i>Arripis truttaceus</i>	69.0	6.3	47.1	92.7	60.1
Whitebait	<i>Hyperlophus vittatus</i>	100.6	34.8	65.7	18.6	63.5
Sea mullet	<i>Mugil cephalus</i>	102.1	77.7	103.0	100.1	123
Australian herring	<i>Arripis georgianus</i>	30.6	36.3	28.4	47.1	46.6
Yellow-eye mullet	<i>Aldrichetta forsteri</i>	24.7	16.2	22.5	18.6	19.3
Whiting species	<i>Sillago spp.</i>	22.5	24.6	19.6	25.8	37.2
Southern sea garfish	<i>Hyporhamphus melanochir</i>	15.8	19.2	5.8	4.3	4.8
Cobbler	<i>Cnidogobius macrocephalus</i>	5.4	7.4	5.2	1.8	0.2
Perth herring	<i>Nematalosa vlamingi</i>	0.1	0.4	1	1.5	2.1
Tailor	<i>Pomatomus saltatrix</i>	4.8	7.2	8.8	14.2	10.3
Hardyheads/Silversides	Atherinidae	4.1	4.7	3.5	1.2	-
Scaly mackerel	<i>Sardinella lemura</i>	0.9	-	3	5.7	-
Trumpeters/Grunters	Teraponidae	0.5	1	1.6	2.8	2.6
King George whiting	<i>Sillaginodes punctata</i>	5.9	5.1	3.7	2	0.9
Trevally	Carangidae	3.5	2.4	2.3	2.8	2.2
Yellowtail scad	<i>Trachurus novaezelandiae</i>	0.9	1.2	0.9	1.5	-
Black bream	<i>Acanthopagrus butcheri</i>	2.6	0.7	1.4	1.3	0.8
Blue sprat	<i>Spratelloides robustus</i>	0.1	0.3	0.3	0.8	1.7
Other finfish	Teleostei	0.2	0.3	0.1	3.4	0.7
TOTAL		394.3	245.8	323.9	346.2	376.7

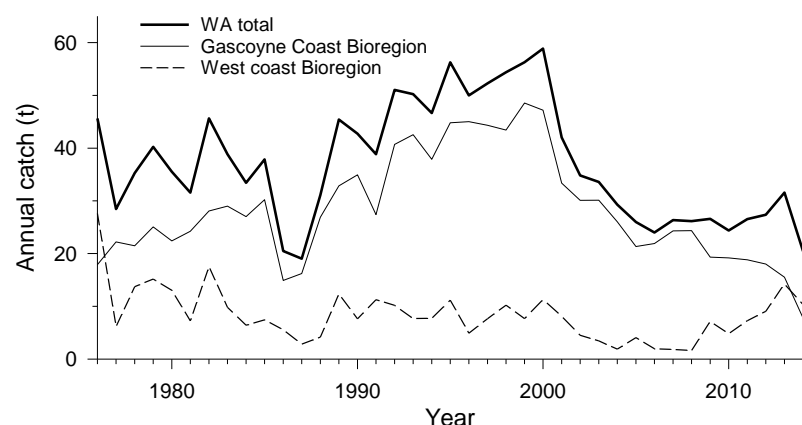
WEST COAST NEARSHORE AND ESTUARINE TABLE 2

Annual catches of key nearshore finfish species in the West Coast Bioregion by boat-based recreational fishers, estimated by surveys conducted by the Department of Fisheries in 2011/12 and 2013/14. The percentage of the total boat-based finfish catch represented by each species is also shown.^{1, 2}

Common name	Species	Catch (no. of fish)		% of total finfish catch	
		2011/12	2013/14	2011/12	2013/14
School whiting	<i>Sillago spp.</i>	238,411	253,064	45.4	32.2
Australian herring	<i>Arripis georgianus</i>	183,940	102,053	18.3	24.9
Silver trevally	<i>Pseudocaranx spp.</i>	54,573	29,251	5.2	7.4
King George whiting	<i>Sillaginodes punctatus</i>	48,678	27,599	4.9	6.6
Tailor	<i>Pomatomus saltatrix</i>	21,092	7,400	1.3	2.9
Southern garfish	<i>Hyporhamphus melanochir</i>	16,168	1,628	0.3	2.2
Black bream	<i>Acanthopagrus butcheri</i>	9,996	4,493	0.8	1.4
Sea mullet	<i>Mugil cephalus</i>	7,372	12,590	2.3	1.0
Yelloweye mullet	<i>Aldrichetta forsteri</i>	5,417	2,609	0.5	0.7
All other finfish		154,221	117,078	21.0	20.8

**WEST COAST NEARSHORE AND ESTUARINE FIGURE 1**

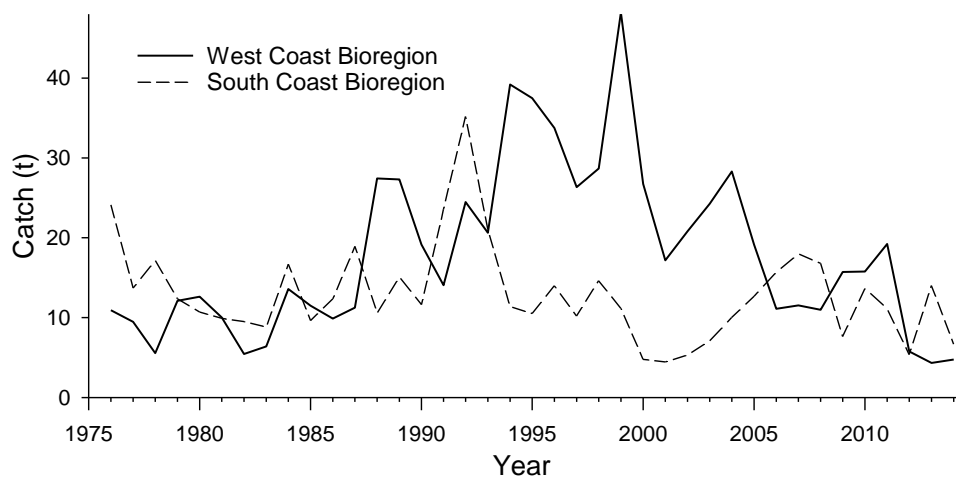
Annual commercial catches of Australian herring, by Bioregion, 1976 –2014.

**WEST COAST NEARSHORE AND ESTUARINE FIGURE 2**

Annual commercial catches of tailor, by Bioregion, 1976 –2014. Minor catches in South Coast Bioregion are not shown, but are included in WA total.

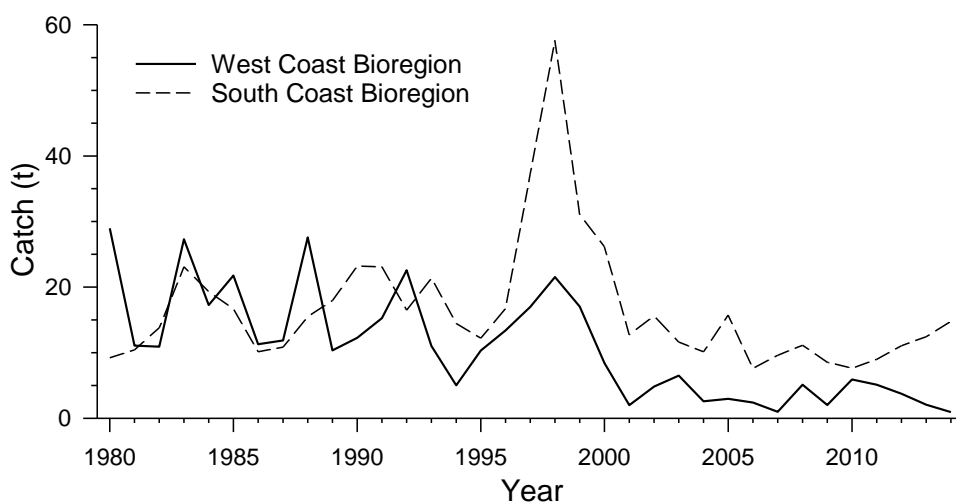
¹ See footnote 1, page 70.

² See footnote 2, page 70.



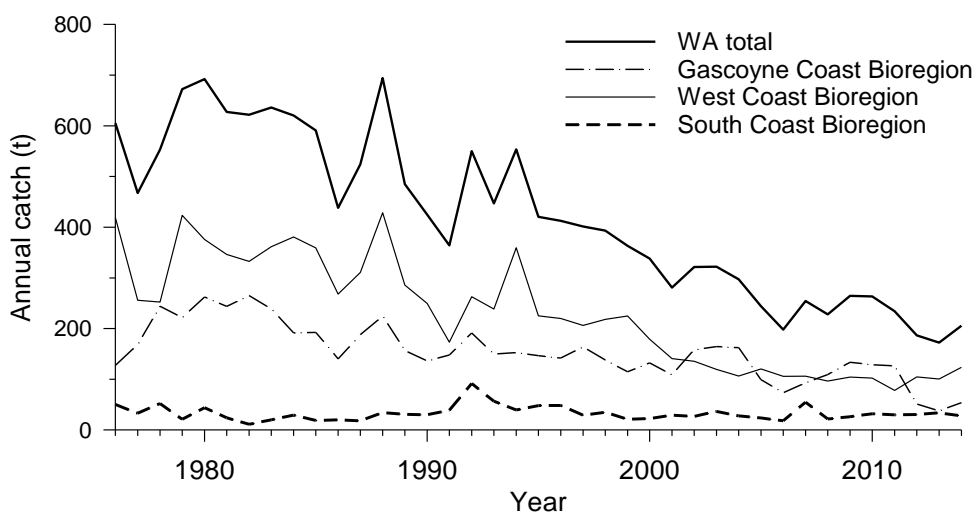
WEST COAST NEARSHORE AND ESTUARINE FIGURE 3

Annual commercial catches of southern garfish, by Bioregion, 1976 –2014.



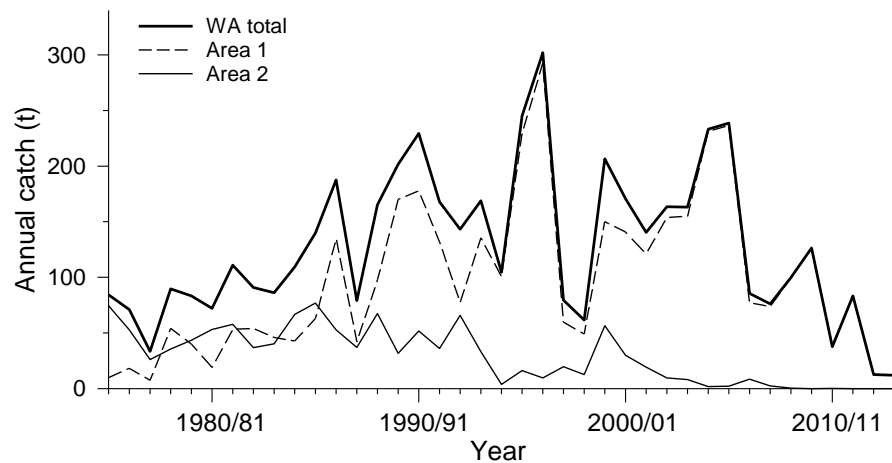
WEST COAST NEARSHORE AND ESTUARINE FIGURE 4

Annual commercial catches of King George whiting, by Bioregion, 1980 –2014.



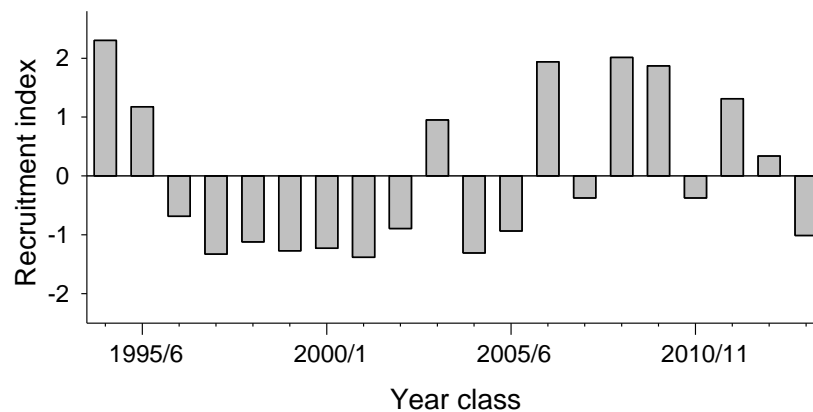
WEST COAST NEARSHORE AND ESTUARINE FIGURE 5

Annual commercial catches of sea mullet, by Bioregion, 1976 –2014.



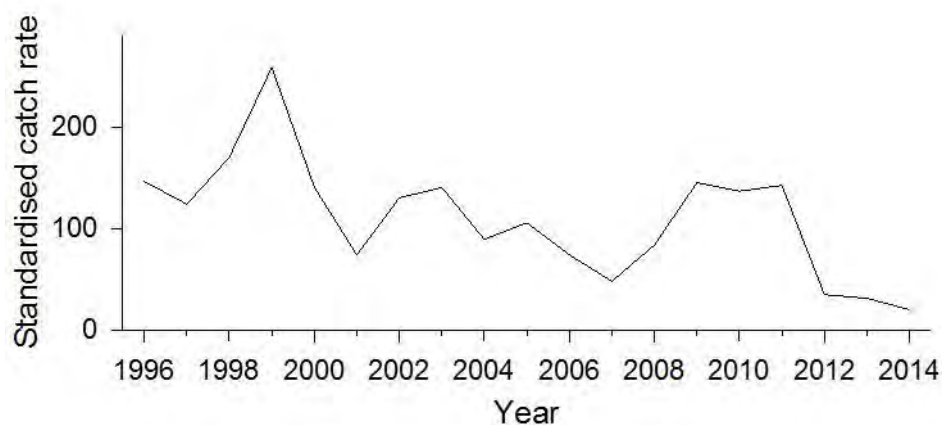
WEST COAST NEARSHORE AND ESTUARINE FIGURE 6

Annual commercial catches of whitebait in West Coast Bioregion, by fishing area, 1975/76 – 2013/14. Area 1 = Bunbury; Area 2 = Perth/Mandurah.



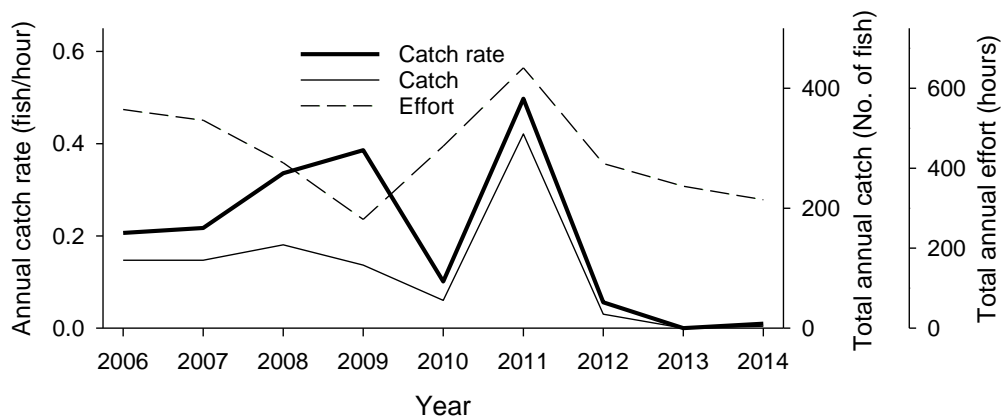
WEST COAST NEARSHORE AND ESTUARINE FIGURE 7

Annual recruitment index for tailor in the West Coast Bioregion, 1994/95 – 2013/14, 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.



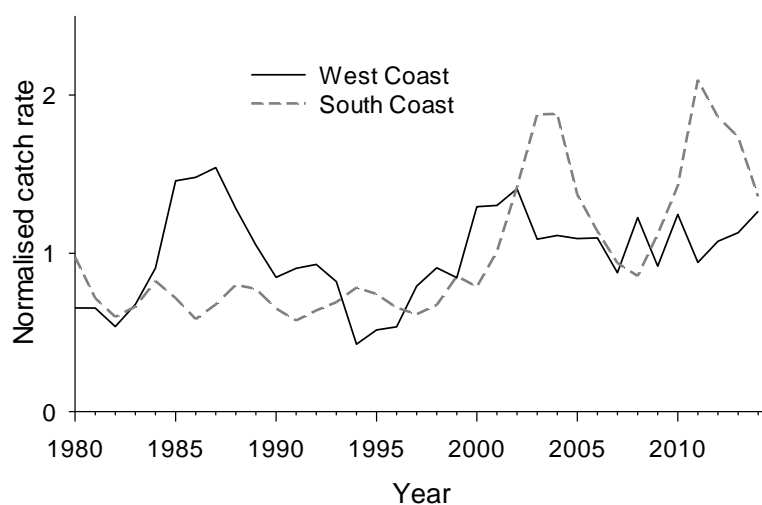
WEST COAST NEARSHORE AND ESTUARINE FIGURE 8

Annual commercial catch rate of southern garfish in Cockburn Sound, 1996 – 2014.



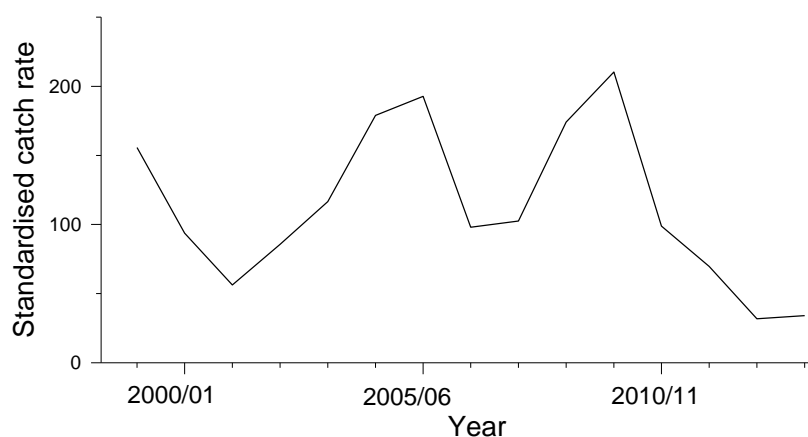
WEST COAST NEARSHORE AND ESTUARINE FIGURE 9

Total annual catch, effort and catch rate of southern garfish by shore-based voluntary recreational logbook fishers in the Perth metropolitan area, 2006 – 2014.



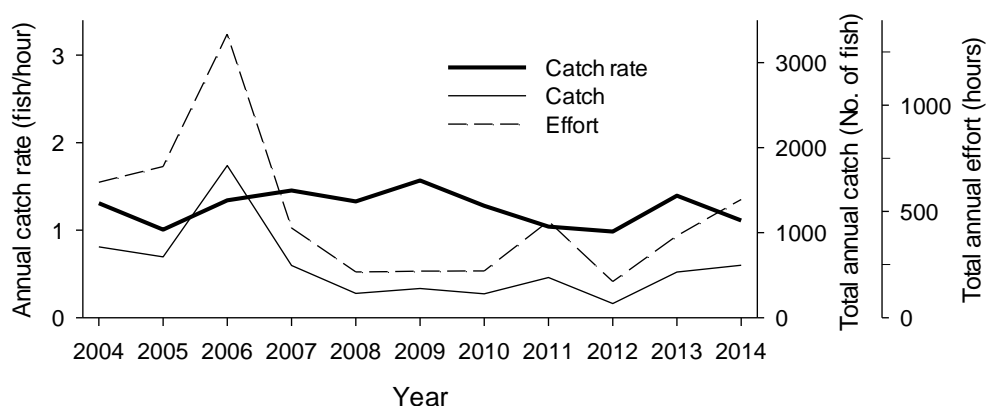
WEST COAST NEARSHORE AND ESTUARINE FIGURE 10

Annual commercial catch rates used as indices of sea mullet abundance in West Coast and South Coast Bioregions, 1980 – 2014 (catch rates are standardised and normalised; 3-point moving average applied).



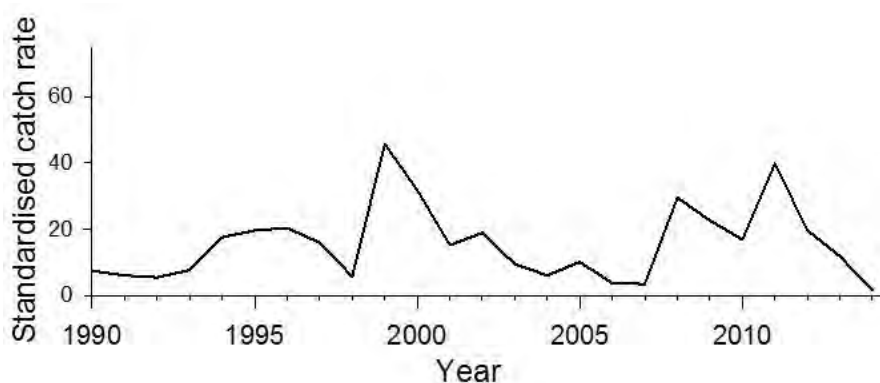
WEST COAST NEARSHORE AND ESTUARINE FIGURE 11

Annual commercial catch rate of whitebait in Area 1 (Bunbury) 1999/2000 – 2013/2014.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 12

Total annual catch, effort and catch rate of black bream by voluntary recreational logbook fishers in the Swan-Canning Estuary, 2004 – 2014.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 13

Annual commercial catch rate of cobbler in the Peel-Harvey Estuary, 1990 – 2014.

West Coast Purse Seine Fishery Report: Statistics Only

G. Jackson, S. Turner and E. Smith

Fishery Description

The West Coast Purse Seine Fishery (WCPSF) is based on the capture of sardine (pilchards, *Sardinops sagax*) and tropical sardine (scaly mackerel or sardinella, *Sardinella lemuru*) by purse seine in the West Coast Bioregion. The *West Coast Purse Seine Limited Entry Fishery Notice 1989* also permits the take of small quantities of Perth herring (*Nematalosa vlaminghi*), yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*), and maray (*Etrumeus teres*).

Boundaries

The WCPSF incorporates three separate fisheries that operate in defined zones as follows (West Coast Purse Seine Figure 1):

- Perth Metropolitan Zone – waters between 31° 00' S and 33° 00' S;

- Southern Development Zone - waters between 33° 00' S and Cape Leeuwin;
- Northern Development Zone - waters between 22° 00' S and 31° 00' S.

Management arrangements

The WCPSF is managed through a combination of input and output controls incorporating limited entry, capacity setting and gear controls.

Access to the Perth Metropolitan Zone is limited to 12 licences with pilchards and sardinella the primary target species. There are three Fishing Boat Licences (FBL) with a specific condition that permits the taking of fish by purse seine net hauled by power block within specific waters of the Southern Development Zone. Two of those FBLs can also retain pilchards. A further three FBLs permit the taking of fish using a purse seine hauled by power block in the

Northern Development Zone where sardinella is the primary 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 2013/14 licence period (1 April 2013 – 31 March 2014) a notional TAC of 2,328 t for pilchards and a separate TAC of 672 t for other small pelagic species (including sardinella) was in place. The notional TAC for pilchards has been in operation since 2006/07 and is assumed to represent approximately 10% of the west coast pilchard stock. Reaching or exceeding the notional TACs will trigger a management response.

The fishery underwent MSC pre-assessment in 2014.

Landings and Effort

Commercial Landings: **1,065 tonnes**

For the 2014 reporting year, catches from all zones of the WCPSF are reported. Fishery effort and catches cannot be reported separately for each zone as fewer than three vessels fished in any single zone. Effort and catch levels reported here therefore reflect the total effort and total catches.

Effort levels increased slightly in 2014 to 480 fishing days undertaken by seven vessels. The total catch of pilchards and sardinella was 1,065 t in 2014, the highest reported since 2006 but still well below catches in the late 1990s and early 2000s (West Coast Purse Seine Figure 2). Recent catch rates have been around the long term average and there are no concerns for stock sustainability.

Catches were dominated by sardinella (scaly mackerel, 1,051 t) with approximately 14 t of pilchards landed.

Approximately 10 t of other species were landed, mainly blue mackerel.

Fishery Governance

Target commercial catch range: 0 – 3,000 tonnes

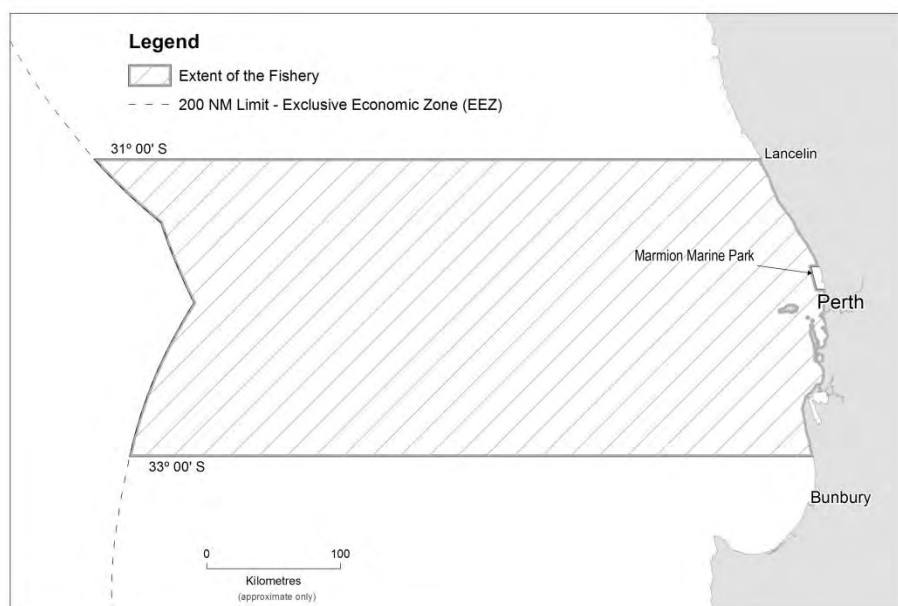
Current Fishing (or Effort) Level: Acceptable

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, possibly related to changing oceanic conditions. No surveys to estimate pilchard spawning biomass are scheduled for the West Coast stocks. The most recent pilchard spawning biomass estimate (2004) indicated that pilchard stocks on the west coast had recovered to pre-virus levels of approximately 20,000 – 30,000 tonnes. A recent national assessment (Ward *et al.* 2012¹) concluded that the stock was being fished at sustainable levels with current exploitation rates being very low. Less information is available for the sardinella stock but it too has been fished at very 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 is very low and the effort expended in this fishery has not returned to historic levels since the second pilchard mass mortality event in 1999.

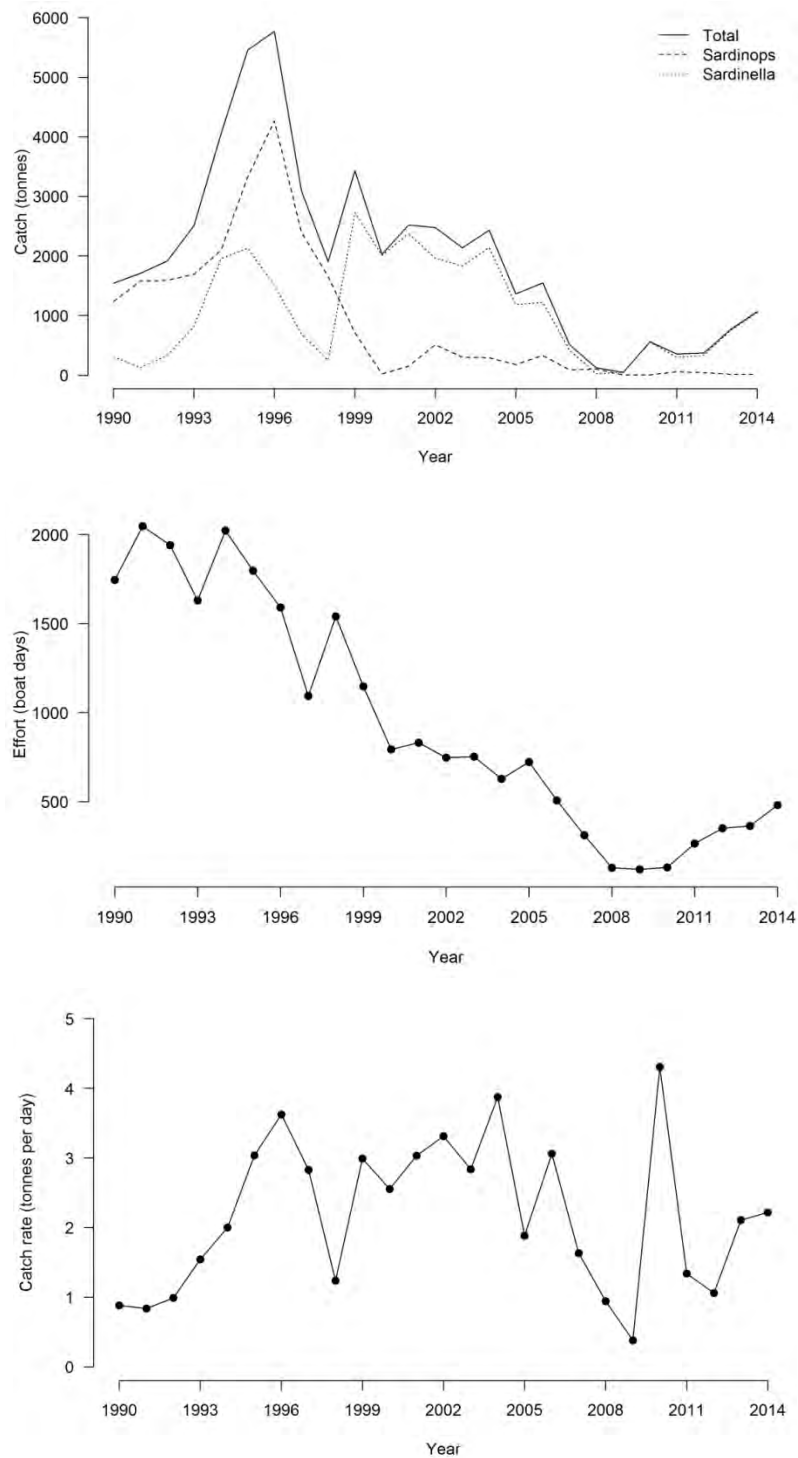
Subject to priorities, the Department may in the future develop a new management plan for this fishery which will formally incorporate the Southern and Northern Development zones with the Perth metropolitan fishery and establish a single consolidated West Coast Purse Seine Fishery.



WEST COAST PURSE SEINE FIGURE 1

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

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 2

Total annual catch of pilchards (*Sardinops*) and sardinella (upper panel), total effort (days) (middle panel) and nominal catch rate (tonnes per day) (lower panel) in the West Coast Purse Seine Fishery, 1990–2014.

West Coast Demersal Scalefish Resource Status Report

D. Fairclough, E. Lai and M. Holtz.

Main Features			
Status		Current Landings	
Stock level	Recovering	Commercial sector	
Fishing Level		All scalefish:	
Commercial:	Not Acceptable (Pink snapper)	WCDSIMF (2014)	334 t
Recreational:	Acceptable	Demersal suite:	
		WCDSIMF (2014)	309 t
		Other (TDGDLF, WCRLF, CSLPF, SWTMF; 2014 or 2013/14)	
			87 t
		Total demersal suite	396 t
		WCDSIMF	Other
		(2014)	(2014 or 2013/14)
	Indicator species		
	West Australian dhufish	48 t	14 t
	Pink snapper	140 t	45 t
	Baldchin groper	9 t	4 t
	Redthroat emperor	51 t	4 t
	Bight redfish	18 t	< 1 t
	Boat-based recreational fishers (2013/14)		
	Top 15 species:		139 – 166 t
	Indicator species:		
	West Australian dhufish		75 – 87 t
	Pink snapper		28 – 33 t
	Baldchin groper		19 – 22 t
	Redthroat emperor		2 t
	Bight redfish		1 – 2 t
	Charter fishers (2013/14)		
	Top 15 species		43 t
	Indicator species:		
	West Australian dhufish		13 t
	Pink snapper		11 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* 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, which 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 permit holders 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 with the Department, 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).

Until 1 January 2015 the commercial fishery was 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, extended outwards from the shore to the 250 m depth contour, while the Offshore Area extended the entire length of the fishery from the 250 m depth contour to the 200 nm 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).

On 1 January 2015 the boundaries of the fishery were amended as described in the section 'New Management Initiatives (2014/15)'.

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 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 (hours spent in the Fishery) 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 at or 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, West Australian Dhufish and Baldechin 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 at or 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 at or 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 provides a state-wide database of recreational boat fishers for survey purposes.

Research summary

Research on demersal species in the WCB focuses on monitoring the catch levels and stock status of indicator species. Level 3 stock assessments based on a weight of evidence approach, which now incorporate estimation of fishing mortality rates and spawning potential ratios, are conducted at periodic intervals for each of the indicator species within the West Coast Inshore Demersal Suite. Along with the existing indicator species for that suite (West Australian dhufish, Pink snapper and Baldchin groper), the next level 3 assessment will include Redthroat emperor and Bight redfish. 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 commercial and recreational 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 last stock assessment of West Australian dhufish, Pink snapper and Baldchin groper was completed in 2013 (see Fisheries Management Paper 262¹ and Fairclough *et al.*, 2014²).

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.

The second integrated survey of boat-based recreational fishing in WA was conducted during 2013/14, providing estimates of catch and effort for demersal species in the WCB (Ryan *et al.*, 2015³). Studies are being conducted to determine the comparability of these data with those from 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 molecular study demonstrated variable success in the visual identification of snapper eggs (given visually similar eggs of other species are present in this region). Thus, routine molecular validation may be required if this approach to estimating spawning stock biomass was to be adopted.

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. The study is also examining the stock structure of Bight redfish between south-western Australia and the Great Australian Bight, where it is fished by Commonwealth fisheries.

Retained Species

Commercial production

All scalefish

WCDSIMF (2014) **334 tonnes**

Demersal suite

WCDSIMF (2014) **309 tonnes**

TDGDLF, WCRLF, CSLPF, SWTMF (2014 or 2013/14)
87 tonnes

Total **396 tonnes**

Indicator species

WCDSIMF (2014)

West Australian dhufish **48 tonnes**

Pink snapper **140 tonnes**

Baldchin groper **9 tonnes**

Redthroat emperor **51 tonnes**

Bight redfish **18 tonnes**

TDGDLF, WCRLF, CSLPF, SWTMF (2014 or 2013/14)

West Australian dhufish **14 tonnes**

Pink snapper **45 tonnes**

Baldchin groper **4 tonnes**

Redthroat emperor **4 tonnes**

Bight redfish **< 1 tonne**

Total

West Australian dhufish **62 tonnes**

Pink snapper **185 tonnes**

Baldchin groper **13 tonnes**

Redthroat emperor **55 tonnes**

Bight redfish **18 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 2014 for the WCDSIMF, CSLPF, SWTMF and WCRLF (15 Jan-14 Jan) and 2013/14 for the TDGDLF.

In 2014, the catches of all scalefish by the WCDSIMF fell to 334 t from 379 t in 2013 and the catches of demersal species fell from 357 t to 309 t. This is as a result of decreased entitlement consumption in the fishery. Inshore demersal species' catches fell to 296 t in 2014 from 348 t in 2013, while offshore demersal species' catches increased to 12 t from 10 t in 2013. Nearshore/estuarine species catches

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., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp..

increased in 2014 to 10 t from 7 t in 2013. The catch of pelagic species of 14 t in 2014 remained similar to 2013.

In 2014, the catch by the WCDSIMF in the Kalbarri Area of all scalefish (133 t) and demersal species (123 t) decreased from the respective 164 t and 156 t landed in 2013. Similarly, the WCDSIMF catch in the Mid-west Area in 2014 of all scalefish (155 t) and of demersal species (142 t) fell from the respective catches of 173 t and 160 t in 2013. In contrast, catches of all scalefish and of demersal species in the South-west Area increased slightly to 45 t and 43 t, respectively, in 2014, from 41 t and 40 t in 2013.

In 2014, the WCDSIMF catch consisted of 75 scalefish (teleost) species or species groups. This comprised 54 inshore and offshore demersal species, 11 estuarine/coastal species and nine pelagic species.

Four demersal species/species groups comprised 77 % of the total catch of the WCDSIMF in 2014, i.e. Pink snapper (140 t), Redthroat emperor (51 t), West Australian dhufish (48 t) and redfish species (*Centroberyx* spp., 19 t). Catches of offshore demersal species in 2014 were low, i.e. Hapuku, 4 t, Eightbar grouper, 4 t; Bass groper, 2 t, Blue-eye trevalla, 2 t and Ruby snapper, < 1 t.

In 2013/14, catches of demersal scalefish by the TDGDLF in the WCB increased to 85 t from 37 t in 2012/13. Other commercial fisheries permitted to land demersal scalefish species in the WCB (WCRLF, CSLPF and SWTMF), reported a catch of 2 t combined.

West Australian dhufish: The total catch of West Australian dhufish by the WCDSIMF decreased to 48 t in 2014 from 63 t in 2013. The catch of 4 t of WA dhufish in the Kalbarri Area in 2014 was similar to 2013. In the Mid-west Area, the catch in 2014 decreased to 34 t from 47 t in 2013. In the South-west Area, the catch in 2014 of 10 t of WA dhufish fell slightly from the 13 t landed in 2013 (West Coast Demersal Scalefish Figure 2). Catches of WA dhufish by the TDGDLF in the WCB increased to 14 t in 2013/14 from 9 t in 2012/13, while the SWTMF and CSLPF did not report any landings of this species in 2014.

Pink snapper: The total catch of Pink snapper by the WCDSIMF in 2014 of 140 t, decreased from 185 t in 2013. This was due to the decrease in catches of snapper in the Kalbarri area, from 105 t in 2013 to 75 t in 2014 and in the Mid-west Area from 77 t to 62 t. In the South-west Area, the catch in 2014 remained low and similar to previous years at 3 t (West Coast Demersal Scalefish Figure 3). Catches of snapper by the TDGDLF in the WCB increased to 45 t in 2013/14 from 9 t in 2012/13, due to increased long-line fishing. Pink snapper landings by the other commercial fisheries combined in the WCB in 2014 remained very low (< 1 t).

Baldchin groper: The catch of Baldchin groper by the WCDSIMF in 2014 of 9 t was slightly lower than the 11 t landed in 2013 (West Coast Demersal Scalefish Figure 4). This was taken mostly in the Mid-west Area (8 t). Approximately 6 t of the catch was taken in the Abrolhos Zone A of the WCRLF, similar to 2013. 3 t of Baldchin groper was landed by the TDGDLF in 2013/14 in the WCB and 1 t was landed by the WCRLF in 2014.

Redthroat emperor: A total catch of 58 t of emperors (Lethrinidae) was reported by the WCDSIMF in 2014, increasing from the 51 t landed in 2013. This catch comprised

predominantly Redthroat emperor, with 51 t landed in 2014, being an increase from 44 t in 2013 (West Coast Demersal Scalefish Figure 5). In 2014, 27 t of the WCDSIMF Redthroat emperor catch was taken in the Kalbarri Area, a slight decrease from 29 t in 2013. 25 t was caught in the Mid-west Area in 2014, an increase from 15 t in 2013. Combined catches of Redthroat emperor in 2014 or 2013/14 in the WCB by other commercial fisheries totalled 4 t.

Bight redfish: A total catch of 19 t of redfishes (Berycidae) was reported by the WCDSIMF in 2014, increasing from 16 t in 2013. This catch comprised almost exclusively Bight redfish (99 %), which was taken in the South-west Area (West Coast Demersal Scalefish Figure 5). Less than 1 t of Bight redfish were landed by other commercial fisheries in the WCB in 2014 or 2013/14.

Recreational fishing (boat-based, non-charter) (2013/14)

Top 15 demersal scalefish species 139 – 166 tonnes

Indicator species

West Australian Dhufish	81 tonnes
Pink snapper	30 tonnes
Baldchin Groper	20 tonnes
Redthroat emperor	2 tonnes
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 152 t in 2013/14 and thus slightly less than the estimate for 2011/12 of 159 t (West Coast Demersal Scalefish Figure 6). Estimated catches of West Australian dhufish in 2013/14 of 81 t increased from the 74 t landed in 2011/12. In contrast, catches of Pink snapper and Baldchin groper in 2013/14 of 30 t and 20 t, respectively, were lower than the 33 t and 29 t estimated for 2011/12. Estimated catches of both Redthroat emperor and Bight redfish in 2013/14 of ≤ 2 t were similar to 2011/12. Less than 1 t of each of the offshore demersal species (e.g. Eightbar grouper, Bass groper) was estimated to have been landed in 2013/14, which is consistent with 2011/12.

Charter fishing (2013/14)

Top 15 demersal scalefish species/species groups

43 tonnes

Indicator species

West Australian Dhufish	13 tonnes
Pink snapper	11 tonnes
Baldchin Groper	10 tonnes
Redthroat emperor	< 1 tonne
Bight redfish	< 1 tonne

A total of 43 t of the top 15 demersal species/species groups were landed by charter fishers in 2013/14, which is similar to the 42 t landed in 2012/13 (West Coast Demersal Scalefish Figure 6). The catches of each of the indicator species in 2013/14 were also similar to 2012/13, i.e. West Australian

dhufish: 13 t in both years, Pink snapper: 11 t in 2013/14 vs 10 t in 2012/13, Baldchin groper: 10 t in both years, and Redthroat emperor and Bight redfish both ≤ 1 t in both years. Very small catches of offshore demersal species were reported in 2013/14, as in previous years (< 1 t in total).

Fishing effort/access level

Commercial

In 2014, 42 licensed fishing boats fished in the WCDSIMF, two less than in 2013. Eleven vessels fished in the Kalbarri Area, 35 in the Mid-west and 6 in the South-west, which was one less in each area than in 2013. Thirteen vessels fished in the Offshore Area. Some vessels have entitlements to fish in more than one inshore area, while in 2014 all could access the Offshore Area.

The total number of days on which fishing occurred by all vessels in the WCDSIMF in 2014 (1,261) was lower than the 1,381 days reported in 2013. This is reflected in the slight decrease in consumption of fishing entitlement (hours) by the whole fishery from 61 % in 2013 to 58 % in 2014 and in the total number of hours fished (hours searching + hours fishing) from 15,970 h in 2013 to 14,750 h in 2014. Similarly, the number of hours of fishing alone decreased from 10,900 h in 2013 to 9,750 h in 2014. Units of entitlement consumed in 2014 vs 2013 decreased in the Kalbarri Area (80 to 65 %), remained steady in the Mid-west Area (61 %) and increased slightly in the South-west Area (38 to 40 %). Entitlement consumed in the Offshore Area was similar to that in 2013 at 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

The estimated number of boat days (days on which fishing occurred by a 'boat party') decreased from 293,112 days ($\pm 10,688$) in 2011/12 to 249,719 ($\pm 10,563$) days in 2013/14. The number of hours fished decreased from 820,693 h ($\pm 31,111$) to 716,722 h ($\pm 31,144$). Errors reported are one standard error. These effort estimates (fishing days and hours fished) are not directly comparable with estimates of effort from previous surveys, which were based on different survey methods.

Fishing and Aquatic Tour Industry (Charter)

The number of charter licences that reported fishing activities increased to 62 in 2013/14 from 53 in 2012/13. However, the total number of fisher days decreased to 22,800 in 2013/14 from about 23,500 in 2012/13, reflecting a small decline in the number of clients reported to 24,800, from ca 26,000.

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 had improved. Thus, F decreased and SPR 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 above 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 that 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

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/>

See footnote 2, page 87

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.*, 2013¹). 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.*, 2010²). The inshore suite has moderate risks associated with meeting social and economic objectives for the community. This combination of factors means that this suite of species still has a high priority for the Department with the inshore demersal suite requiring continued close monitoring and assessment. The offshore demersal suite is currently considered to have a low risk level.

Non-Retained Species

Bycatch species impact Low

Line fishing for demersal species using baited hooks is highly selective³ for demersal fishes. While 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) may not all survive this still represents a minor impact on these stocks.

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 WCDSMF and charter fishers are required to record listed species interactions in their statutory returns. During 2014, two grey nurse sharks were caught by the WCDSMF and both released alive. In 2013/14, charter fishers caught and released one grey nurse shark alive and two Goldspotted rockcod using a release weight (greater than the maximum legal size limits of 1 m or 30 kg).

Ecosystem Effects

Food chain effects Low

An FRDC study⁴ 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

1 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

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

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

4 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.

changed over time. This may be a function of changes in targeting or differences in reporting methods but there was no evidence of a decline in the trophic level or mean size in catches representing a low risk to the ecosystem.

Habitat effects Negligible

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

Social Effects

Commercial

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

Fishing and Aquatic Tour Industry (Charter)

In 2013/14, 96 charter operators were licensed to operate in the WCB via a Fishing Tour Operators Licence, compared with 98 in 2012/13. Sixteen held a Restricted Fishing Tour Operators Licence in 2013/14, as in 2012/13. The number of people employed in the charter industry has not been estimated.

Recreational Fishing

There were approximately 131,000 Recreational Fishing from Boat Licence holders in Western Australia between May 2013 and April 2014⁵.

Economic Effects

Estimated annual value (to fishers) for 2014:

Level 2 - \$1-5 million

The estimated economic value of the WCDSMF in 2014 was in the range of \$1-5 million, as for recent years.

Fishery Governance

Commercial

Current Fishing (or effort) level

Not acceptable (Pink snapper)

Catch (or effort) limit range:

All scalefish

WCDSMF 449-469 tonnes

Demersal suite

WCDSMF 410 tonnes

All fisheries combined (WCDSMF, TDGDLF, WCRLF,

CSLPF, SWTMF) 450 tonnes

The primary management objective for the WCDSMF is to maintain the total catch of all scalefish, of the demersal suites

⁵ See footnote 3, page 87

and of each of the indicator species, i.e. West Australian dhufish, Pink snapper and Baldchin groper, at no more than 50 % (the 'benchmark') of those caught by wetline fishers in the WCB during 2005/06. This is also proposed for the two recently-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 2014, catches of all scalefish (334 t) and of the suite of demersal species (309 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 2013/14 or 2014) by the WCDSIMF, TDGDLF, WCRLF, CSLPF and the SWTMF was 396 t, which is also below the benchmark of 450 t.

The catches of 48 t of West Australian dhufish by the WCDSIMF in 2014 was below the benchmark for the whole fishery of 72 t and this was also the case for each management area in which it is an indicator, i.e. Mid-west: 34 t landed vs 44 t benchmark; South-west 10 t vs 19 t benchmark. Similarly, the WCDSIMF catch of Baldchin groper (9 t) in 2014 remained below its benchmark of 17 t, as did Redthroat emperor (51 t) and Bight redfish (19 t) with respect to their proposed benchmarks of 95 t and 37 t. Although catches of Pink snapper have declined since 2013, they remained above the 120 t benchmark for the whole fishery in 2014, i.e. 140 t. This was also the case in both the Kalbarri Area (75 t landed vs 65 t benchmark) and the Mid-west Area (62 t vs 43 t). The increase in 2013/14 of Pink snapper catch by the TDGDLF was due to opportunistic targeting of scalefish by long-line.

As in previous years, WCDSIMF entitlements were not fully utilised in 2014. 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 of demersal species begin to recover, catches of the indicator species will need to be monitored closely. 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)

Retained 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, 2013¹).

The latest available catch data for recreational fishers in 2013/14 was estimated via an integrated 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 was 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 the recreational sector (charter and recreational boat-based fishers) in 2013/14 was 195 t, which was below the adjusted 250 t IFAAC value. The total catch of West Australian dhufish (94 t) was less than 50 % of the 2005/06 catch of 126 t, as were catches of Baldchin groper (30 t landed vs 33 t benchmark) and catches of emperors (5 t) and redfish (2 t) species were below the nominal benchmark from 2005/06 of 11 and 6 t, respectively. However, the catch of 41 t of Pink snapper was slightly greater than the 50% of 2005/06 benchmark of 37 t – but within tolerance levels.

New management initiatives (2014/15)

Commercial

Amendments to the WCDSIMF management plan were implemented on 1 January 2015 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.

Although the total retained catch of demersal scalefish within the WCB has been reduced to below the target levels (50% of the 2005/06 catch) the catch of Pink snapper within the Mid-West and Kalbarri areas of the WCDSIMF has remained high and in recent years increased to levels significantly above the target for this indicator species.

The amendments were as follows:

- A 33.3% reduction of the unit value for the Mid-West Area of the WCDSIMF Fishery (from 60 minutes to 40 minutes per unit);
- A 25% reduction of the unit value for the Kalbarri Area of the WCDSIMF Fishery (from 60 minutes to 45 minutes per unit); and
- An amalgamation of the Offshore Area with the three inshore areas resulting in the WCDSIMF Fishery being comprised of three broader areas. The amalgamation was accompanied by the removal of the 2400 hours currently allocated to the Offshore Area.

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.

Pre-assessment of the WCDSIMF against MSC criteria was completed in 2015.

Recreational/Charter

The Department of Fisheries has completed two Statewide Recreational Boat Fishing Surveys in 2011/12 and 2013/14 and has commenced the third survey in mid-2015. The Department is now able to estimate the quantity of fish retained and released by boat based fishers for each WA

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.

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. Size limits are now being formally reviewed across the state.

Integrated Fisheries Management

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

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

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

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

External Factors

Recruitment success of both West Australian dhufish and Pink snapper varies from year to year and is influenced by environmental factors. Thus, the stocks of those species 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.

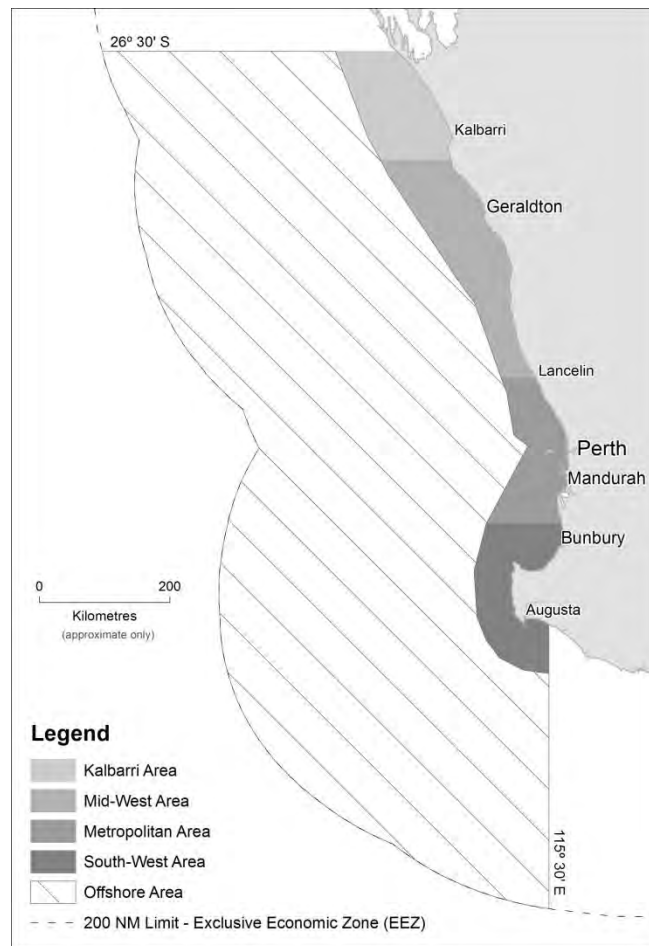
The Commonwealth Western Deepwater Trawl Fishery and Great Australian Bight Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery fish in waters of the WCB from the 200 m isobath to the boundary of the AFZ. These fisheries target species such as Deepwater Flathead *Platycephalus conatus* 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 have still not been implemented and 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 2011², may have severe negative effects, including increased mortalities.

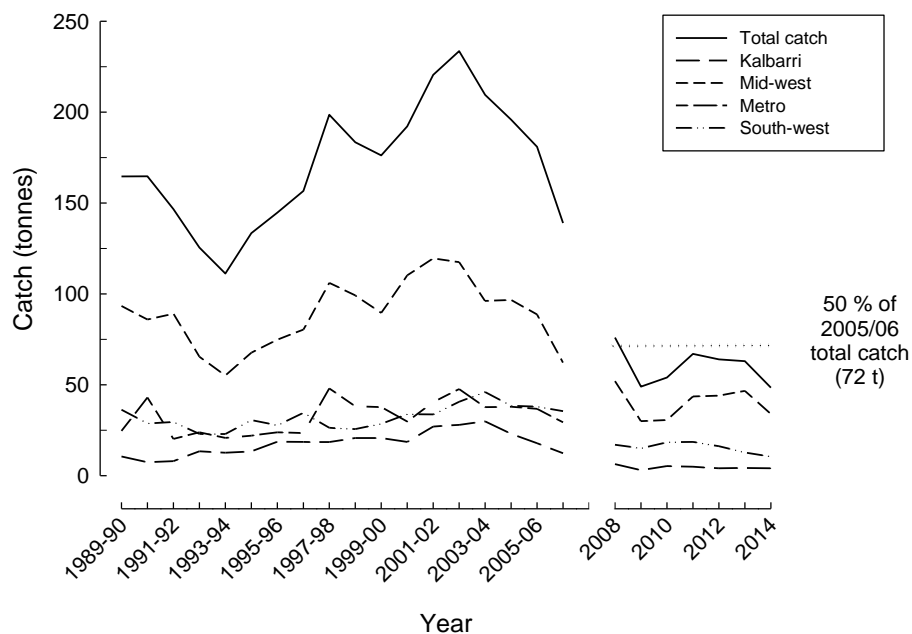
¹ See Fisheries Management Papers 237 and 247 <http://www.fish.wa.gov.au/About-Us/Publications/Pages/Fisheries-Management-Papers.aspx>.

² See http://www.fish.wa.gov.au/Documents/research_reports/fr222.pdf.



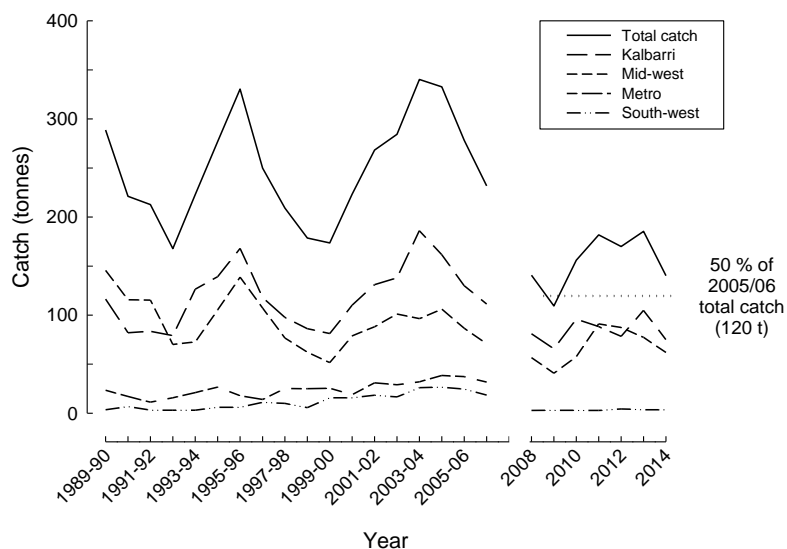
WEST COAST DEMERSAL SCALEFISH FIGURE 1

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.



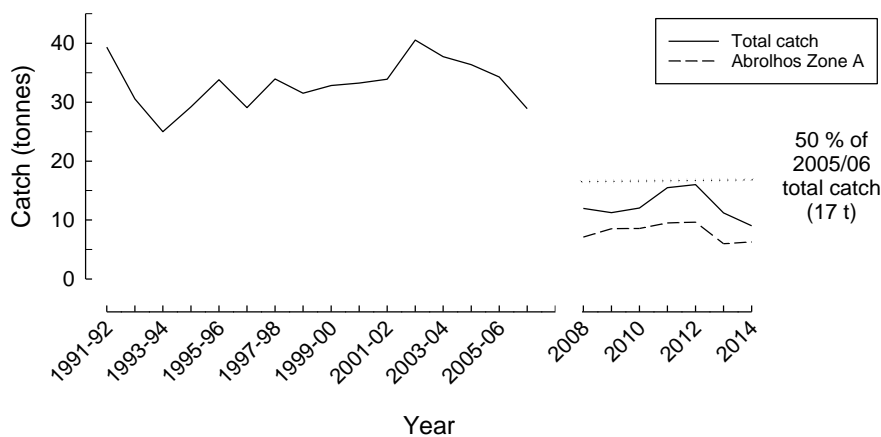
WEST COAST DEMERSAL SCALEFISH FIGURE 2

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 2014.



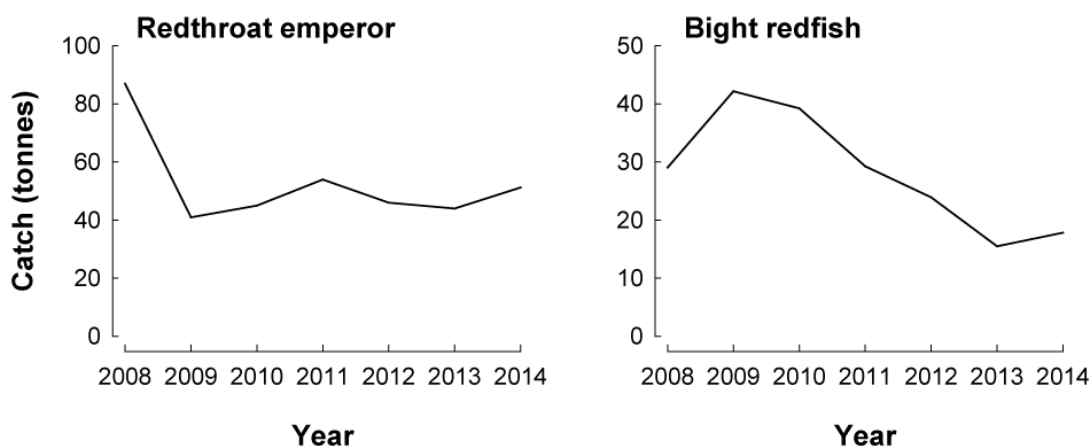
WEST COAST DEMERSAL SCALEFISH FIGURE 3

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 2014.



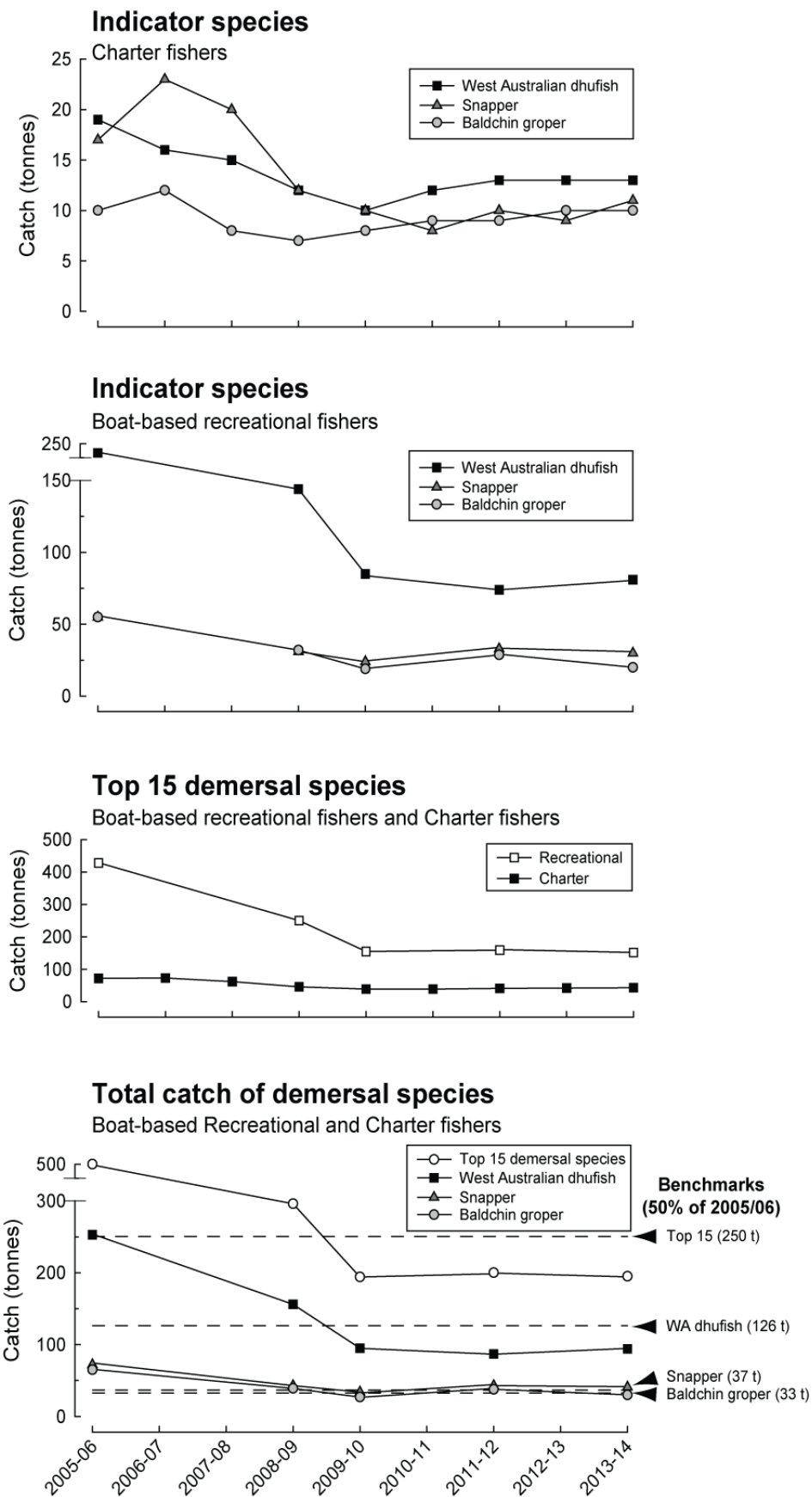
WEST COAST DEMERSAL SCALEFISH FIGURE 4

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 2014.



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 2014. 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 indicator species (West Australian dhufish, Snapper, Baldchin groper) and of the top fifteen demersal species by boat-based recreational and charter fishers in the West Coast Bioregion between 2005/06 and 2013/14. Note that catches of both Redthroat emperor and Bight redfish have remained low in each year between 2005/06 and 2013/14 and are not shown on these graphs.

Octopus Fishery Status Report

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

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial – Statewide	204 t
Fishing level	Acceptable	Recreational – Statewide (2013/14 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) pots and active (trigger pots) pots 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 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 with the Department, 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 trap allocations for the DOF will be finalised in 2015 with the implementation of a Management Plan and establishment of an Interim Managed Fishery.

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 2014):

204 tonnes (live weight)

Recreational catch estimate (season 2013/14):

2.0 tonnes (live weight)

Landings

Commercial: In 2014 the total commercial octopus catch was 204 t live weight, an 8 % decrease over last year's catch of 226 t (Octopus Figure 1).

On a sector-specific level, octopus catch from the WCRLF declined between 2011 and 2014, from 34 to 14 tonnes. Catch from the CSLP declined 17% in 2014, from 47 t to 39 t but was still over 100 % increase from 2012 (20 t). Catch from the DOF, 149 t, has decreased by 7 % from 2013, 160 t (Octopus Figure 1).

The DOF has steadily risen from 4% of the total catch in 2001 to an average of 71% between 2010 and 2014 (Octopus Table 1). At the same time, share of catch from the lobster fishery has declined from 86% to 8%, 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 2013/14 (Ryan *et al.*, 2015¹). The estimated total number of octopus captured

during this period for all bioregions was 2,800 (92% in the West Coast Bioregion) which equates to a total weight of 2.0 tonnes.

Fishing effort/access level

Commercial: Fishing effort in the commercial octopus fishery is measured as the amount of days fishing in which octopus was caught. 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 492 and 812 respectively, an increase of 24% and decrease of 18% respectively, from 2013 (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 2.9 kg/day, which was a 22% reduction from 2013 (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)..

The CPUE for octopus in the CSLPF and DOF sectors was 92 and 184 kg/day respectively. CPUE decreased 12 % for the CSLPF and increased 13 % for the DOF over the last year (Octopus Figure 2). In the case of the DOF the increases in CPUE is due to gear efficiency increases caused by significant number of fishers using longlines, which allows more pots to be set per day.

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.

SCPUE for trigger pots showed a slight increasing trend between 2013 and 2014 (Octopus Figure 3). 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.

Future year's stock assessment will include a more in-depth assessment using techniques currently under development.

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

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

¹ Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14.

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 2014 there were two reported whale entanglements (Humpback whale: *Megaptera novaeangliae*) in octopus fishing gear. This was a reduction from the three that were reported in 2013. All whales were successfully disentangled. Fishers have also adopted gear changes to mitigate entanglements.

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 10 days in the DOF and 20 days in the CSLP.

Social Effects

Each dedicated octopus fishing vessel employs between 2 and 3 people. In 2014, ~ 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 12 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 2014:

Level 2 - \$1 - 5 million (\$1.6 million)

The estimated annual value for 2014 was \$1.6 million based on the total catch of 204 t and an average product price of \$7.91 /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 204 tonnes is within the target range. The fishery governance ranges will be reviewed in 2015 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 formal management arrangements for the DOF. Following the conclusion of an independent panel process on access and allocation, the Department is currently developing an Interim Management Plan for the DOF. It is anticipated that the Interim Plan will be in place in late 2015.

The *Cockburn Sound (Line and Pot) Limited Entry Fishery Notice 1995* was reviewed following the Minister for Fisheries’ decision on octopus pot entitlement allocation in the CSLPF. Amendments to the *Cockburn Sound (Line and Pot) Limited Entry Fishery Notice 1995* were made on 1 May 2015 to introduce an octopus pot scheme of entitlement.

External Factors

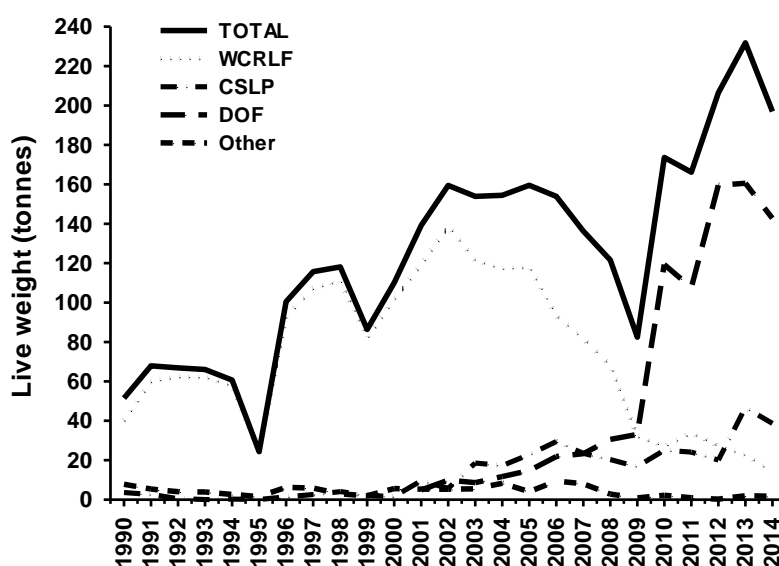
Cephalopods in general, including octopus, are known to be subject to large environmentally-driven fluctuations in abundance. If the fishery expands to reach a catch level approaching maximum sustainable yield, this year-to-year variability in abundance may prove a significant issue for the fishery. 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. Octopus was rated as a medium-low risk to climate change.

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

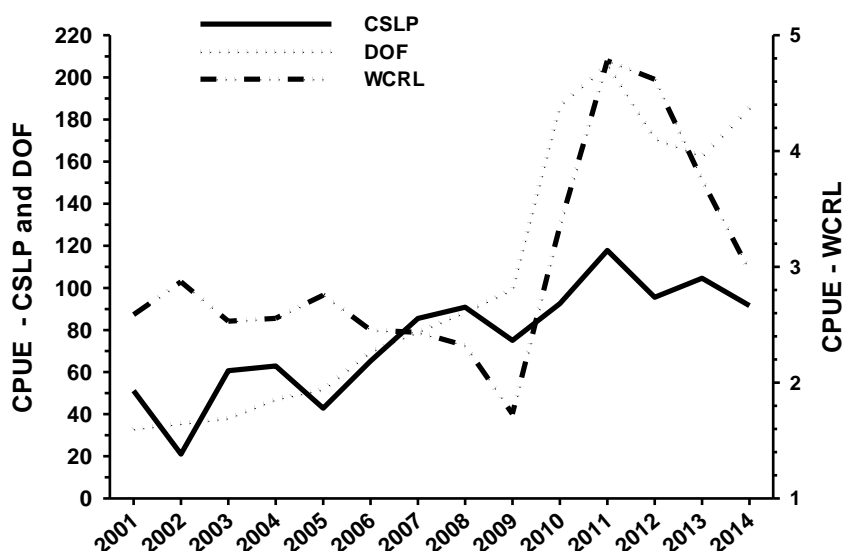
OCTOPUS TABLE 1

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

Year	WCRLF	CSLPF	DOF	Other	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
2014	7	19	73	0.8	492	812

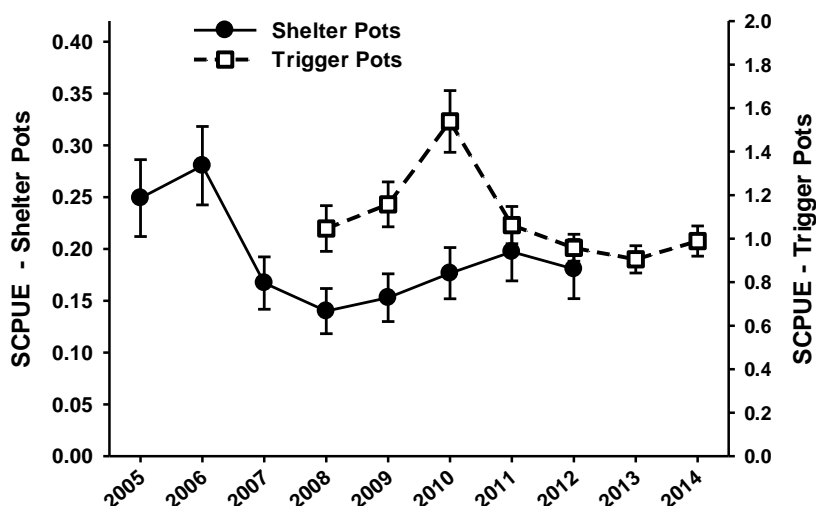
**OCTOPUS FIGURE 1**

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



OCTOPUS FIGURE 2

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



OCTOPUS FIGURE 3

Standardised catch per unit effort (SCPUE) ($\pm 95\%$ CL) in kg / pot (kg in live weight) of Octopus in all sectors. Trends are for two pot types – passive shelter pots, and active trigger pots.

AQUACULTURE

Regional Research and Development Overview

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

The *Fish Resources Management Act 1994* now includes several new and amended provisions for aquaculture, mainly in relation to the environmental management of the industry and the establishment of offshore zones for aquaculture development.

The Department of Fisheries is now responsible for the environmental management of aquaculture in WA waters under the terms of a Memorandum of Understanding it has

executed with the 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 and, increasingly, the naturally-occurring Akoya oyster (*Pinctada imbricata*). The production of pearls from several other species such as *Pinctada albina* and *Pteria penguin* is also increasing in importance. 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.

Given the increasing interest in aquaculture in the area, the Department of Fisheries is starting the development of an Abrolhos Islands Aquaculture Policy.

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 and is expected to start in September 2015.

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, the sampling work has been completed and modelling is under way.

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.

The Department of Fisheries has completed a review of mussel aquaculture activity in Cockburn Sound. The review identified licence and lease holders who could demonstrate a history of use of the sites for mussel farming and with an interest in continuing aquaculture activities. It also resulted in the development of improved licence conditions, to ensure effective and efficient long term management of aquaculture activities in Cockburn Sound. Following the completion of the review, new aquaculture licences were granted for mussel farming in Cockburn Sound.

A Fisheries Research and Development Corporation 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 those 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, licence 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 2013/14

During 2013/14, Fisheries and Marine Officers delivered a total of 21,917 hours of compliance and community education services in the field (West Coast Bioregion Compliance Table 1). This represents a slight 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. There was an increase in recreational contacts and an increase in warnings and infringements in this sector. Commercial prosecution briefs also increased during the year.

The West Coast Rock Lobster Managed Fishery is the largest commercial fishery in the state and within the Bioregion 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, prawn and scallop (trawl) and estuarine fisheries.

The West Coast Rock Lobster Fishery entered its third season under a Quota Management System. A focus remains on the continual support to Fisheye users and encouragement to fishers and receivers to transition into using the online reporting system.

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 reasonable although there was a large increase in the number of prosecution offences from 75 to 230 as FMOs dealt with commercial rock lobster quota offences. However the number of offences on a single prosecution brief can vary dramatically and the number of prosecution briefs actually decreased from 35 in 2013/14 to 34 in 2012/13. Infringements remained steady at 40 while infringement warnings decreased from 159 to 133 compared to 2012-13.

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 more generally is supported by statewide recreational mobile patrol units.

Field contacts with the recreational fishing community increased from 82,531 to 84,615. Overall compliance was good with decreases in prosecution offences from 227 to 189, infringements increased from 841 to 1,046 and infringement warnings increased from 1,227 to 1,610.

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 still relatively low.

Throughout the year FMOs undertook joint patrols with other agencies including the Department of Transport, Australian Customs Service and WA Police. The Department also continued to provide at sea resources to assist DPaW officers 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 2014/15

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

A re-structure of the Geraldton, Jurien and Dongara offices will support a dedicated team of FMO's to implement the commercial compliance program for the West Coast Rock Lobster fishery with support from other District Offices.

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.

Support will be provided to allow the Developing Octopus Fishery to move into an interim quota managed fishery under a management plan.

Staff will continue to work with the MSC assessment teams for our commercial fisheries to achieve positive pre-assessment and certification outcomes.

The extension of the West Coast Rock Lobster season for recreational fishers will be a significant change in the Bioregion.

Marine Park Collaborative Operational Plans formalising the cooperative and collaborative servicing arrangements between DPaW and the Department of Fisheries will be updated using a new template developed for this purpose. In the South West of the Bioregion the compliance program aimed at improving compliance with recreational abalone fishing rules in the Capes region will continue.

WEST COAST COMPLIANCE TABLE 1

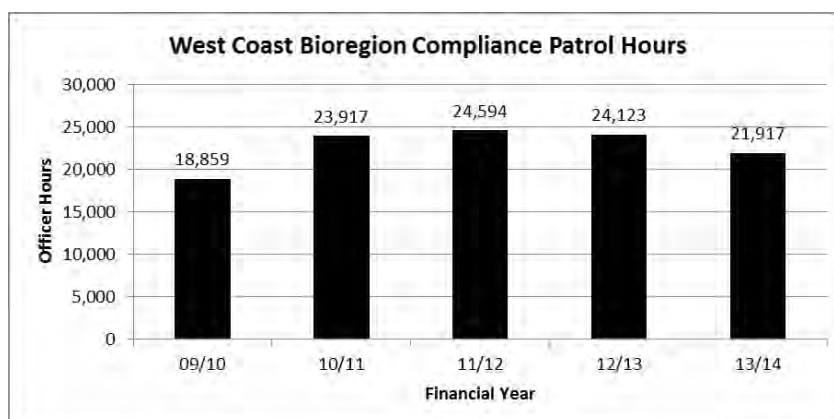
Summary of compliance and educative contacts and detected offences within the West Coast Bioregion during the 2013/14 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	21,917 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY¹	
Field Contacts by Fisheries & Marine Officers	1,378
Letters of warning	
Infringement warnings	133
Infringement notices	40
Prosecution Offences	230
Fishwatch reports ²	39
VMS (Vessel Days) ³	16,043
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	84,615
Infringement warnings	1,610
Infringement notices	1,046
Prosecution Offences	189
Fishwatch reports	950
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY	
Field Contacts by Fisheries & Marine Officers	5,451
Fishwatch reports	27

¹Contacts 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.

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

³VMS (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 13/14 total gives the patrol hours in the Bioregion that resulted in the contacts detailed in Table 1. (The totals exclude: time delivered by the Department’s large patrol vessels *PV Walcott* *PV Houtman* and *PV Hamelin*; time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.. Time spent in Marine Park sanctuary zones is also excluded because this time may overlap field time outside a sanctuary zone and as a result, the historic data is slightly lowered compared to that reported in previous reports).

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.

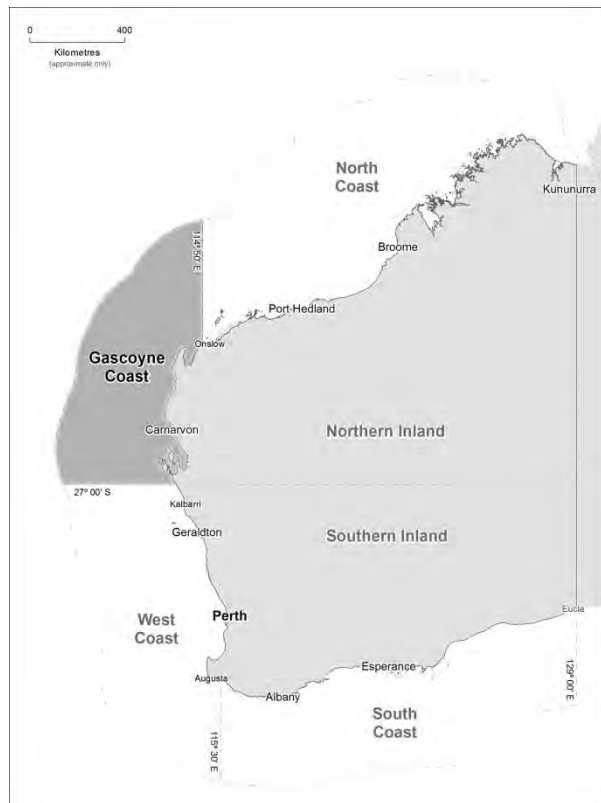
The coastline is characterised by high cliffs in the southern half changing to fringing coral reefs in the north. Coastal waters are generally high-energy in terms of wave action due to the strong trade wind system. The Exmouth Gulf section of the Gascoyne Coast Bioregion is seasonally influenced by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

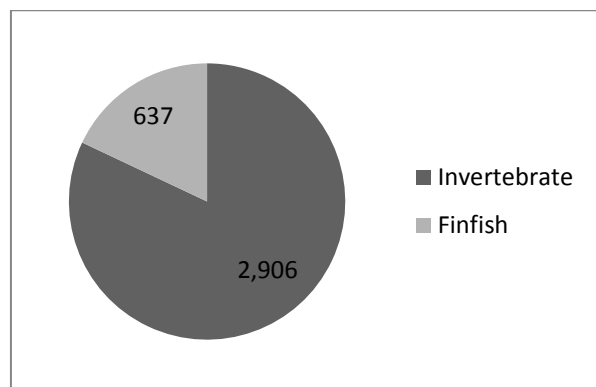
It is apparent that climate change will impact the biological, economic, and social aspects of many fisheries, and both positive and negative impacts are expected. Climate change can influence biological systems by modifying the timing of spawning, range and distribution, composition and interactions 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 including the marine aquarium fishery which collects small numbers of a wide variety of species but is not permitted within some areas of the Ningaloo Marine Park, Shark Bay 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

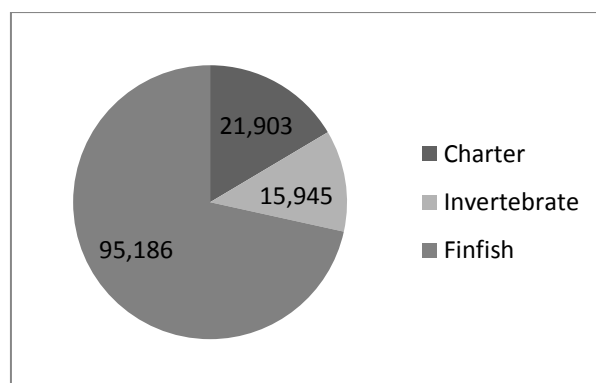
Relative contribution of finfish and invertebrates to the total commercial wild fishery catch originating from the Gascoyne Bioregion. Numbers represent total catch (in tonnes).

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.



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.

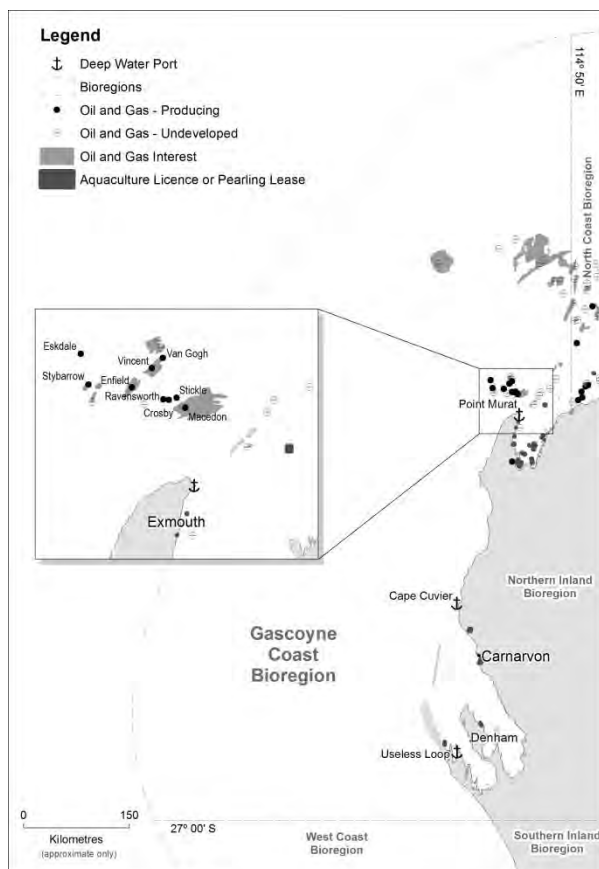
Tourism

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

Oil and Gas Activity

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

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



GASCOYNE OVERVIEW FIGURE 4

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

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 Mural, 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, large passenger cruise vessels and fishing vessels operating out of the numerous small ports along the coast.

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

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

ECOSYSTEM MANAGEMENT

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

Climate Change

Extensive work has been undertaken as part of a three-year FRDC-funded project (Caputi et al. 2015a,b) that assessed 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 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 Gascoyne 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 and Day *et al* 2012¹). 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

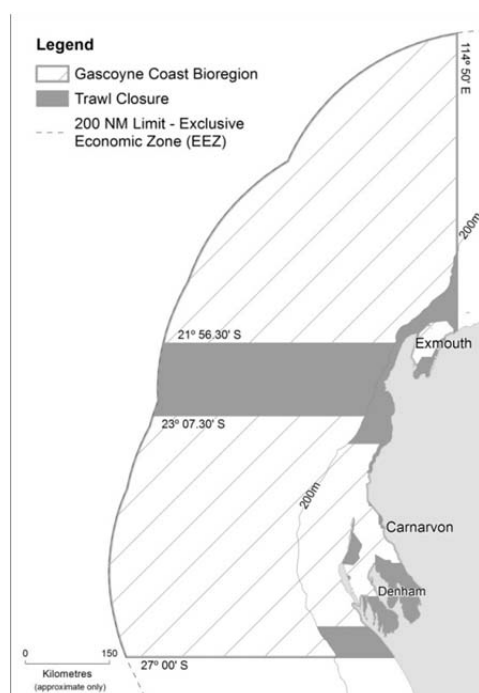
the Ningaloo and Shark Bay marine parks, the Murion Islands Marine Management Area, and the Quobba and Miaboolya Beach Fish Habitat Protection Areas. Commercial and recreational fishing activities are restricted in these regions.

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

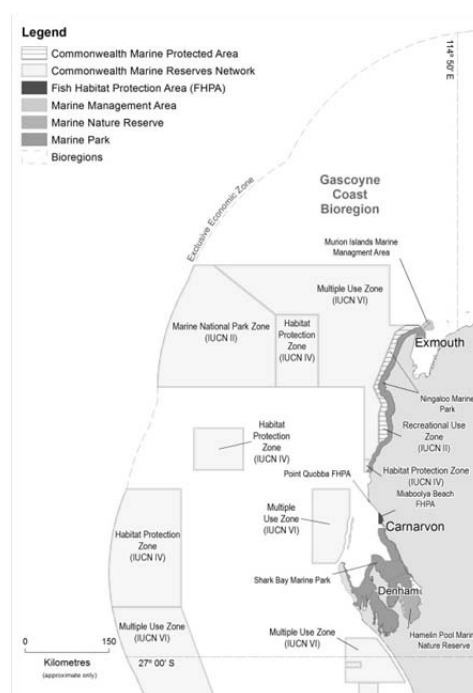
The areas and proportions of the Gascoyne Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which are consistent with IUCN criteria for classification as marine protected areas.

IUCN category or equivalent	State Waters only (24,100 km ²)				All Waters (416,300 km ² (including State waters))			
	Fisheries km ²	%	Existing MPA km ²	%	Fisheries km ²	%	Existing MPA km ²	%
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



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.

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

Day J. *et al*, 2012. Guidelines for applying the IUCN Protected Area Management Categories to Marine Protected Areas. Gland Switzerland: IUCN. 36pp

Management of Commercial Fisheries

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

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

Strict limits on the use of fishing gear that can result in unwanted interactions with non-targeted species provide similar protection for bycatch and 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' licence was also introduced.

A number of recreational fishing surveys have been undertaken in the region, including recent statewide recreational fishing from boat surveys in 2011 and 2013. The results of such surveys are used to estimate recreational catch and effort of targeted finfish and crustaceans and to maintain a sustainable bioregional-specific management strategy.

Compliance and Community Education

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

Biosecurity Risk Management

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

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

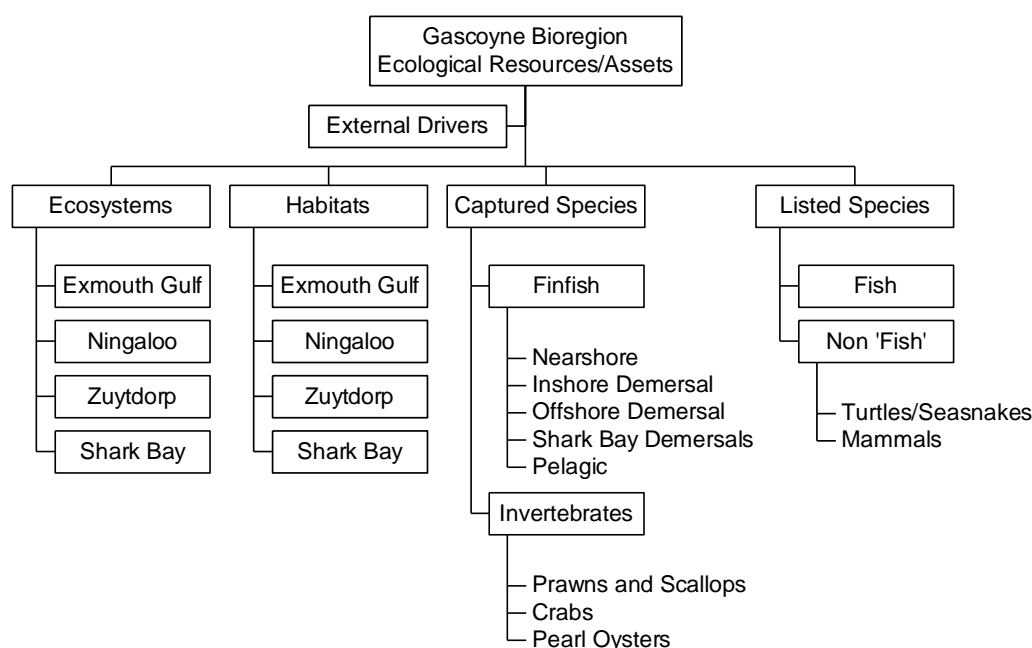
Management of Aquaculture Activities

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

ECOSYSTEM MONITORING AND STATUS

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

These key ecological assets identified for the Gascoyne Bioregion are identified in Gascoyne Overview Figure 7 and their current risk status reported on in the following sections.



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

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

interactions within communities, exotic species invasions and impacts, community structure and productivity. Waters off the Gascoyne coast are strongly influenced by the Leeuwin current which brings warm low salinity water southward. After experiencing a weakening trend from the 1960's to the early 1990's, the strength of the Leeuwin Current has rebounded in the past two decades which has been driven by changes in frequency of El Niño/La Niña Southern Oscillation (ENSO) patterns. During the summer of 2010/11, a significant warming event took place off the coast of Western Australia, with widespread reports of fish kills and of tropical species being found further south than their normal range.

Sea-surface temperatures were $> 3^{\circ}\text{C}$ above the normal summer averages in some regions. The "marine heat-wave" was associated with extremely strong La Niña conditions, leading to a record strength Leeuwin Current for that time of year, which resulted in record high summer sea levels along the mid-west and Gascoyne coast. The heat wave resulted in what is considered to be the first WA regional-scale coral bleaching event, affecting corals south to Rottnest Island and north to the Montebello and Barrow Islands. 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 Marine Biosecurity Research and Monitoring Group is implementing research activities in the Bioregion focussed on vessel risk analysis. Further details for these projects may be found in the "Introduced Pests Status Report" at the end of this section and also in the Appendix section entitled "Activities of the Marine Biosecurity Research Group during 2014/15".

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 ($23^{\circ} 07.30' \text{ S}$ to $21^{\circ} 56.30' \text{ S}$) 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 nm²) of Exmouth Gulf is trawled. Trawling is prohibited in a designated nursery area in the southern and eastern section of the Gulf. The nursery area covers 344 nm² and represents 28 % of Exmouth Gulf. A major project surveying biodiversity on and off the trawl grounds in Exmouth indicated that trawled areas have similar diversity to the larger adjacent untrawled areas, indicating that the current level of trawling activity does not affect overall biodiversity and cannot be distinguished from other sources of variation in community structure. The ecosystem in this region could be at increased risk if a number of proposed developments are implemented.

Habitat

There is a large permanent closure to trawling on the eastern and southern sides of the Gulf which protect sensitive habitats that operate as nursery areas. In the area open, trawling effort is focused in the deeper central and north-western sectors of Exmouth Gulf. Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. The total area trawled each year has to remain below 40%. The area trawled each year is monitored.

Trawling effort is focused in the deeper central and 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 km² from the shoreline to continental slope. No commercial fisheries operate in the waters of the NMP and 34% of the park is zoned as no-take sanctuary areas. A significant level of research and monitoring is being undertaken in the Ningaloo marine park region by 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).

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.

Zuytdorp

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

Ecosystem

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

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

Habitat

The benthic habitats of the Zuytdorp ecosystem are dominated by mud/sand bottoms, likely to support a relatively sparse invertebrate community. The majority of non-trawl based fishing takes place over sand habitats in depths of 20-250 m, depending on which species is being targeted. Underwater video work, in 20-250m, has shown that the habitat is dominated by sponges, soft corals and gorgonians (DoF 2002)¹. The Gascoyne Demersal Scalefish Fishery operates in this ecosystem and is based on using hook and lines, meaning that there is virtually no impact on benthic habitats. Fishing typically occurs over harder patches of hard bottom around the entrance to Shark Bay and the adjacent ocean. Fishing does not normally occur over sensitive seagrass or hard coral habitats. The West Coast Deep Sea Crustacean Fishery operates in this area in depths from 150-1200m. Crab traps in the Zuytdorp are mainly set over mud bottom areas and occasionally bring up solitary corals or sponges that get entangled in the pot. The footprint of the pots and effort levels are both extremely small in relation to the extent of this habitat. There are thus few direct impacts of fishing activity to these habitats.

Shark Bay

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

Ecosystem

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

Habitats

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

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

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

² Kangas, M.J., 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.

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) that since the 1960s has provided most of the whiting catch for the state.

Nearshore (0-20m depth)

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

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

Inshore demersal (20-250 m depth)

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

The main fishery operating in this region is the Gascoyne Demersal Scalefish Fishery, for which a detailed status report is provided at the end of this chapter. The key indicator species for this suite is pink snapper which is currently in a rebuilding phase and spangled emperor, in northern part of the bioregion, is considered to be suffering overfishing (but the overall stock is at an acceptable level). Pink snapper are sampled to provide representative catch-at-age data for used in an integrated stock assessment model which is updated every 3 years (most recently in 2014). 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 the Eastern Gulf, Denham Sound Freycinet Estuary. 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 waters 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 had a significant impact on the 2011/12 and 2012/13 fishing seasons.

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 licence 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 brown tiger prawn breeding stocks above the target abundance level. Of the 4000 km² waters contained within the Exmouth Gulf Prawn Managed fishery boundary, 1100 km² is closed to trawling and of the remainder only 1200km² is actually 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

There are four commercial fisheries that operate within Shark Bay. These are the Shark Bay Prawn and Shark Bay Scallop Managed Fisheries, which are both trawl-based and also capture blue swimmer crabs; the Shark Bay Crab Fishery, which is a trap-based fishery for blue swimmer crabs; and the Shark Bay Seine and Mesh Net Managed Fishery which targets whiting and mullet.

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 brown tiger prawn breeding stocks above the target abundance level.

Of the 41,500 km² waters legislated within the boundaries of the Shark Bay Prawn and Scallop Managed Fisheries, 10000 km² is closed to trawling and only approximately 3000 km² is actually trawled.

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

Specific commercial fishing regulations implemented in the 1970s and 1980s preclude the use of large-mesh gillnets and long-lines throughout the region, to prevent the incidental entanglement of dugongs and turtles. These controls have also provided protection for the large shark species which are a feature of this region. More recently, bycatch reduction devices ('grids') installed in all trawl nets in this bioregion have further increased the protection for sharks, rays and any turtles encountered on the trawl grounds. In a further effort to protect sharks and rays, line-fishery vessels are not permitted to use wire snoods.

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.

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.

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 Group are implementing biosecurity related projects in the Gascoyne Coast Bioregion targeted at vessel risk analysis.

Due to prioritisation of risk and resources the Marine Biosecurity Research Group did not undertake any introduced marine pests monitoring in the Gascoyne Coast Bioregion in 2014/15. However, given the increase in vessel 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.

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. The number of commercial vessels entering the Gascoyne Coast Bioregion has significantly increased (~12000%) over the past 12 years (2002 to 2014). As a result the group is analysing the change in numbers of commercial vessels as well as their visit and type profiles to better inform management processes of the domestic and international risks to the Bioregion.

The Marine Biosecurity Research Group is also quantifying the risk associated with recreational vessels for the potential introduction, harbouring and translocation of marine pests along our coast. This research focusses on surveying marina-based vessel owners about their vessel management practices and their vessel use profiles. The research outputs are designed to be applicable to biosecurity management across the state.

For further details on the above projects see the Appendix section entitled "Activities of the Marine Biosecurity Research Group during 2014/15".

FISHERIES

Shark Bay Prawn and Scallop Managed Fisheries Status Report

E. Sporer, M. Kangas, S. Wilkin and P. Cavalli

Main Features			
Status		Current Landings	
Stock level		King Prawns	1282 t
Prawn	Adequate	Tiger Prawns	625 t
Scallop	Environmentally limited	Endeavour Prawns	17 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 2014 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 head-rope 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.

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, optimise 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 to provide advice on when to open/close areas. The Vessel Monitoring System (VMS) monitors the location of all activities by licensed fishing boats and adherence to closures.

The Commonwealth Government’s Department of the Environment (DoE), has assessed the fisheries under the provisions of the *Environmental Protection and Biodiversity Conservation Act 1999* and accredited both fisheries for a period of ten years (re-assessment in 2025), 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. The SBPMF commenced full MSC accreditation in 2014.

For the 2014 prawn season, the fishing arrangements included an opening date of 24 March and closing date of 31 October, providing a total of 176 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 2014 scallop season did not open because of environmentally-induced low scallop abundance and is the third 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. In 2014 a standard for naming areas within Shark Bay was implemented and these area names will be referred to in this report (Shark Bay map showing area names Figure 1). Research activities continue to focus on stock assessment and annual monitoring of the target stocks, by fishery-independent surveys and commercial catch rates, particularly brown 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 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 brown tiger prawn breeding stocks above the threshold abundance level.

The fishery uses moon closure periods because western 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 2014, the moon closures were; the first two, five days and the remaining five closure periods, seven days per month and these were set out in the season arrangements.

In addition to the permanent closures described above, there are two areas deemed as key spawning areas, the north Carnarvon/Peron Line (CPL) and the south CPL (Shark Bay Figure 1) that are closed during the key spawning period.

In 2014, the north CPL (NCPL) was closed to fishing on 10 June and the south CPL (SCPL) was closed 8 August. From early August onwards, the SCPL is generally closed to protect smaller prawns (primarily western king prawns) and provide protection as a buffer to the remaining brown tiger prawns during the key spawning period before they move onto the trawl grounds from the nursery area. Closure of the SCPL in early August was implemented in 1983 but the brown tiger prawn spawning stock abundance within this area was never assessed during the closure period until 2013.

Generally Denham Sound opens around July/August each year for prawn fishing, which gives protection to smaller prawns early in the season as well as allowing a higher spawning biomass in this region prior to fishing.

During August, trawling was permitted in a limited area below the Snapper Trawl Line (STL) in Denham Sound for a maximum period of 10 days and the opening was subject to prawn catch rate levels (western king and brown tiger prawns) and pink snapper numbers. Fishery-independent surveys undertaken in these waters prior to fishing indicated that the risk to juvenile pink snapper stock was very low due to low numbers of snapper being observed whilst prawn abundance was above the opening target level.

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.

Retained Species

Commercial production (season 2014)

Prawns 1924 tonnes

Scallops Nil

Landings

Prawns

The total landings (whole weight) of major prawn species for this fishery was 1924 tonnes (t), comprising 1282 t of western king prawns, 625 t of brown tiger prawns and 17 t of

endeavour prawns (Shark Bay Prawn and Scallop Figure 3). Western king prawns were above last year's total landings of 1139 t, whereas, the brown tiger prawns were slightly below last years total landing of 661 t. In addition, 100 t of coral prawns (various species, but mainly *Metapenaeopsis crassissima*) were landed. The total landings of major prawn species were within the target catch range of 1350 to 2150 t.

Western king prawn landings (1282 t) and brown tiger prawn landings (625 t) were within the historical target catch range.

Scallops

No landings of scallops were allowed in 2014 due to low scallop stock abundance in the fishery.

Byproduct

Byproduct landings from the prawn fleet included 196 t of blue swimmer crab (*Portunus armatus*), 13.5 t of squid, 42.7 t of cuttlefish, 4.1 t of bugs (*Thenus australiensis* and *T. parindicus*), 1 t of octopus and 40 t mixed finfish species.

Fishing effort/access level

The 2014 prawn season fishing arrangements had a season opening date of 24 March and closed on 31 October, providing a total of 176 nights fishing and all the nights available to fish were utilised. Eighteen prawn boats operated in 2014 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 current nominal effort for the increased headrope (37.5% per boat) towed by the 18 quad boats with the 2014 adjusted effort being 41,533 hours (twin-gear equivalent) (Shark Bay Prawn and Scallop Figure 3). This adjusted effort is 16% higher than last year and the highest level of effort since the introduction of quad gear.

Scallops

A target 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 2013 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 2014.

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: Environmentally Limited

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 rates from logbook data. Conservative brown tiger prawn target 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 western king and brown tiger prawn stocks, which are monitored and assessed for size and catch rates from recruit surveys in March and April, brown tiger prawn breeding stock surveys in June (NCPL only) and during August and September in both the NCPL and SCPL and western king and brown tiger prawn surveys in Denham Sound in August.

Fishery-independent recruitment surveys are undertaken as fishery-dependent data on key recruitment grounds are no longer available due to later start date of fishing. Each survey is conducted over two nights of sampling at 19 standardised sites east of the CPL where prawns have migrated from nursery areas onto the trawl grounds. The information is also used to forecast a catch range for brown tiger and western king prawns and to determine the extent of areas to be opened to fishing to meet market requirements.

The recruitment levels of brown tiger prawns during the 1980s were demonstrably affected by reduced spawning stock biomass. Management practices have subsequently been tailored to maintain the level of brown tiger prawn spawning stocks at sustainable levels. The implementation of a temporal closure of the CPL was aimed at reducing effort on brown tiger prawns early in the season. In addition, since 1982, the Extended Nursery Area (ENA) (now referred to as the SCPL) was closed to fishing from August each year and provided protection of brown tiger prawns as this area does not re-open to fishing after the closure. Also, the introduction of the brown tiger prawn spawning area (TPSA) closure (now referred to as the NCPL), in combination with all of the areas east of the CPL remaining closed until after the second recruitment survey appears to have had a favourable impact on the brown tiger prawn stock since its inception in 1996.

The breeding stock surveys are undertaken to verify brown tiger prawn catch rates. The first survey is undertaken in June or July after the NCPL is closed to fishing. Some of the western king prawn breeding stock is also protected by this closure and their catch rates are also recorded during the surveys. Two additional standard breeding stock surveys are undertaken around the third moon phase in August and September, in the NCPL, and since 2013 the survey was also extended to include the SCPL to undertake an additional assessment of the spawning stock (spawning condition and abundance) for brown tiger and western king prawns around the same lunar phase as the NCPL. An adjustment of a spawning index time series will be undertaken in a few years to take into account the revised sampling months.

The NCPL was closed to fishing on 10 June to maintain a level of spawning stock of brown 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 western king prawn catch rate of 30.9 kg/hr (for adjusted effort equivalent to twin gear units) was slightly lower than in 2013 (31.7 kg/hr), however, it was relatively

high when compared with the previous ten years mean catch rate (27.6 kg/hr). The overall brown tiger prawn catch rate of 15.1 kg/hr was lower than in 2013 (18.4 kg/hr) but higher than the previous 10 years mean catch rate (13.3 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 2014, the western king and brown tiger prawn mean survey catch rates during the combined recruitment surveys (March and April) were 49.3 kg/hr and 53.3 kg/hr respectively and the catch predictions for western king and brown tiger prawns were 905 t (725 to 1085 tonnes) and 535 t (430 to 645 tonnes) respectively. The actual landed catch of western king prawns (1282 t) was above the predicted range with that of brown tiger prawns (625 t) being within the predicted range. The relationship between survey indices and landings will continue to be reviewed.

To control fishing effort and maintain adequate brown tiger prawn breeding stock levels, fishing is delayed on the brown tiger prawn stock by not opening the CPL at the commencement of the season. The aim is to close the NCPL at a target catch rate level of 25 kg/hr.

The survey catch rate for brown tiger prawns in the NCPL just after it was closed in June was 30.8 kg/hr, while in August it was 23.9 kg/hr with a mean catch rate of 27.4 kg/hr which was above the target level. The NCPL is an important area for brown 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. The catch rate had declined to 13.0 kg/hr by September which was expected as prawns migrate through this area and recruitment declines to a low level therefore the tiger prawn abundance at this time of year is not appropriate for measuring the entire spawning stock.

Conversely, the SCPL becomes an important area for spawning after it closes from August. This area retains both brown tiger and western king prawns (including spawning stock) throughout the latter part of the key spawning period. The surveys conducted in June, August and September 2014 showed brown tiger prawn catch rates of 35.4 kg/hr, 24.5 kg/hr and 19.9 kg/hr respectively. The overall catch rate from the north and south CPL combined may better represent the total spawning stock level of brown tiger prawns but these cannot be directly compared to previous spawning stock surveys at this stage. In the future a revised index will be determined for these two areas combined and will be used in stock assessment and developing the harvest strategy.

The western king prawn catch rates during the spawning stock survey in the NCPL in June, August and September were 46.3 kg/hr, 58.2 kg/hr and 30.9 kg/hr respectively. Western king prawn spawning stock remains above the level (25 kg/hr) where it may significantly affect the recruitment and is therefore adequate. Fluctuations in the annual western king prawn catches are most likely to have resulted from varying effort levels and environmental effects on recruitment, not from the spawning stock abundance. The surveys conducted in June, August and September 2014 in SCPL showed western king prawn catch rates of 81.5 kg/hr, 29.6 kg/hr and 25.1 kg/hr respectively.

An additional survey was undertaken in both the north and south CPL in November as part of the annual 'scallop' survey. The catch rate of brown tiger prawns in the NCPL

had declined to 1.5 kg/hr, and to 4.9 kg/hr in the SCPL. The western king prawn catch rates also declined to 4.7 kg/hr in the NCPL and 7.9 kg/hr in the SCPL.

The survey results for both species showed that catch rates decreased from July to September, indicating very little migration into these areas during the latter part of the season. At the same time, migration out of the areas is clearly evident. Two other in-season surveys were also carried out during May and June to obtain size (grade) information of western king and brown tiger prawns to determine if part of the area within the CPL remains closed. These surveys assisted with in-season harvesting strategies and optimising returns to fishers.

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 (2015):

King prawns	905-1360 tonnes
Tiger prawns	410-615 tonnes

The recruitment survey results for March-April 2015 showed a slight increase in western king prawn abundance and a slight decrease in brown tiger prawn abundance.

The main performance measures for the prawn fishery relate to the maintenance of breeding stocks for each of the major target prawn species. The survey catch rate for tiger prawns in the NCPL just after it was closed in June was 30.9 kg/hr, while in August it was 23.9 kg/hr with a mean catch rate of 27.4 kg/hr. It is therefore highly likely that the mean catch rate of brown tiger prawns in the NCPL would have been above the 25 kg/hr catch rate level. Furthermore, the mean catch rate of brown tiger prawns in the SCPL was 24.5 kg/hr in August.

The SCPL provides an additional level of protection for both species during the key spawning period as it closed early August. Sampling of this area will be incorporated into future surveys for a combined spawning stock index.

The western king prawn annual landing was within the acceptable catch range and the mean catch rates in NCPL was 46.3 kg/hr 58.2 kg/hr in June and August respectively well above the target level.

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) for generating the forthcoming season's recruits.

A stock-recruitment-environment relationship has been developed in northern Shark Bay and Denham Sound to assess the cause of the decline. The series of poor recruitment since 2010/11 heat wave has resulted in the

spawning stock falling to historic low levels which may also be affecting the recruitment.

The 2013 survey indicated that there was inadequate recruitment in both northern Shark Bay and Denham Sound and the fishery remained closed in 2014 to provide full protection to the breeding stock. In addition, a small area was closed to prawn trawling in Denham Sound in 2013 and 2014 to provide increased protection for a few sites with a higher concentration of scallops that were identified in the annual November scallop surveys in 2012 and 2013. When these sites were re-sampled in November 2014 they showed: i) an increased abundance of residual scallops compared to areas outside the closure; and ii) higher abundance of recruit scallops compared to other sites outside the closure area. Based on the average abundance inside and outside the closed area from the 2014 survey, about 30% of the scallop abundance in Denham Sound is in the area that was closed, but significantly, 48% of the residual scallops reside in this small area. The survey also showed increased abundance for two sites in the area open to trawling due south of the closed area.

A plausible hypothesis for the increased abundance of scallops (particularly recruits) in 2014 compared to last three years is that there may have been some direct benefit of this closure to the recruitment of scallops by maintaining higher abundance of scallops undisturbed during the spawning period and for the entire fishing season of 2013 and 2014. An alternative hypothesis is that the increase in abundance observed is only driven by improved environmental conditions which has resulted in higher survival of both residual scallops and resultant recruits and/ that the area where the closure area was located 'naturally' attracts or retains a higher concentration of recruits.

The performance measure is to ensure adequate breeding stock levels. This is normally achieved by cessation of fishing at the appropriate catch rate target. However as the catch predictions were below the minimum abundance level for fishing, breeding stocks were protected in 2014 through a full closure of the fishery. In addition, in Denham Sound a small area was completely closed from all trawling to protect the main aggregation of scallops found within Denham Sound as a further precautionary measure. The November 2014 showed that the spawning stock in Denham Sound had returned to acceptable levels but in Northern Shark Bay spawning stock abundance was still inadequate.

Projected scallop catch next season (2015):

500 tonnes (whole weight)

The catch projection for the 2015 season is based on the fishery-independent November 2014 annual survey results. The mean index for Denham Sound indicates that approximately 100 t meat weight (a precautionary level to allow the residual stock to improve) is available for harvest in Denham Sound. To assist in continued stock recovery fishing should not be undertaken prior to August after the peak spawning time (April to July). The catch prediction for Northern Shark Bay is approximately 40 tonnes meat weight, which is well below the limit reference level required for the fishery to open and this part of Shark Bay will remain closed to scallop fishing for 2015.

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 2014.

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 2014 prawn fishing season, 27 turtles were recorded as caught in nets in the prawn fishery with all being recorded as returned to the sea alive. With improved reporting of listed species interactions, 564 sea snakes were reported as caught with 511 returned to the sea alive. Thirty syngnathids were reported as captured. No scallop fishing was undertaken in 2014.

Ecosystem Effects

Food chain effects: **Low**

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

Habitat effects:

Prawn fishery **Moderate**

Scallop fishery **Low**

There are extensive permanent and temporary closures in the Shark Bay trawl fisheries. The total area inside Shark Bay is 4652 nm² and represents 38% of the total fishery area (including closed areas) (Shark Bay Prawn and Scallop Figure 1).

Prawn trawlers

The prawn fleet operates in approximately 7% of the overall fishery boundaries. The permitted trawl area inside Shark Bay is 1768 nm² and represents 38% of inner Shark Bay (excluding the closed areas) but trawling does not occur across this whole region. Trawl fishing is focused in the deeper areas (predominantly sand/shell habitats) of the central bay, north and northeast of Cape Peron and in the northern area of Denham Sound. The majority of sponge/coral habitats are contained within specific trawl closures to protect these areas.

Scallop trawlers **Nil**

Performance measures for habitat impact relate to the spatial extent of prawn trawling within Shark Bay's sand/shell and coral/sponge habitats. Both the prawn and scallop fleet permitted trawl areas are below the 40% level of the inner Shark Bay area. Most sponge/coral habitats in Shark Bay are now protected by fishery permanent closures, which will limit the actual trawl area below 40% at any time. In 2014 the performance measure was met as the total area trawled within inner Shark Bay by the prawn fleet was approximately 808 square nautical miles or 17.4% of inner Shark Bay.

Social Effects

These industries are a major contributor to regional employment. During 2014, 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 2014:

Prawns **Level 5 - > \$20 million (\$25.1 million)**

Scallops **Level 0 - Nil**

The value of the fishery including coral prawns, cuttlefish, squid and bugs to the prawn fleet is \$25.4 million (excluding blue swimmer crabs). 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:

Western king prawns	\$12.49/kg
Brown tiger prawns	\$13.86/kg
Coral prawns	\$3.50/kg
Endeavour prawns	\$6.50/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 1350 – 2150 t. Similarly, the target catch ranges for individual species were western king prawns 950 – 1450 t, brown tiger prawns 400 – 700 t and endeavour prawns 1 – 30 t. Western king prawn and brown tiger prawn annual landings were both within the target ranges.

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 (<10 t whole weight), based on a pre-season survey, is below the target catch range and the fishery remained 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. This is scheduled for completion in late 2015.

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

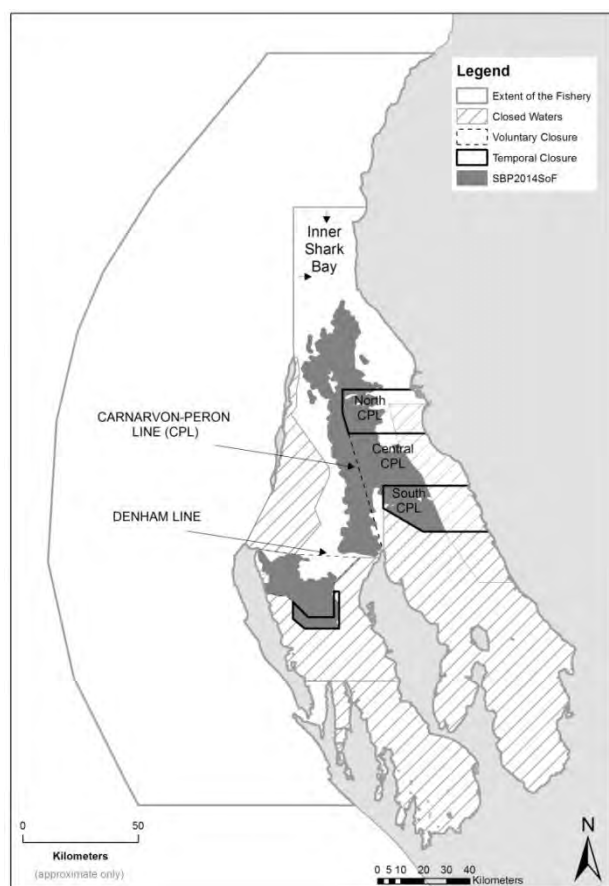
on targeting larger prawns during efficient catch rate periods and shifting the emphasis to domestic markets rather than export markets. This has also provided the prawn industry the opportunity to maximise the return from all species taken in the fishery where possible, particularly scallops and blue 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 western 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.

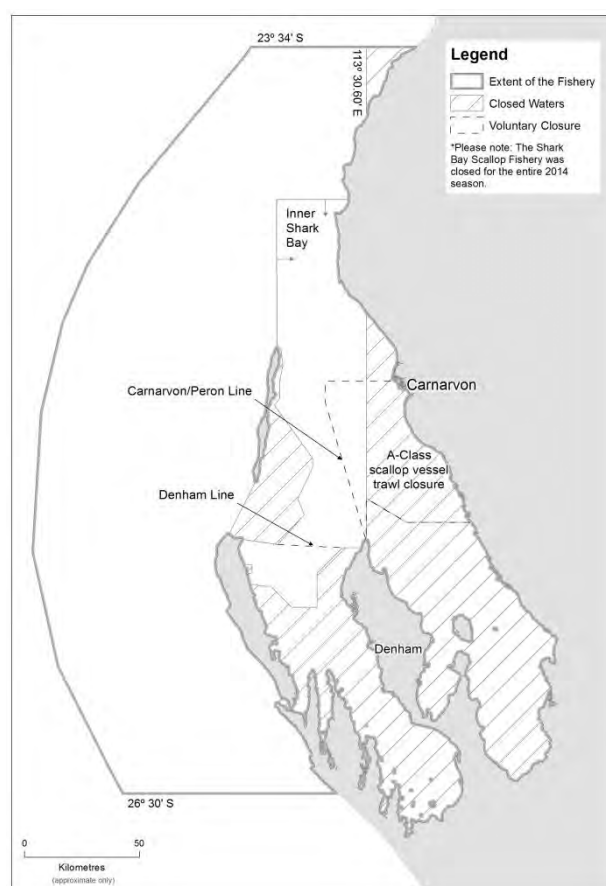
The Department of Fisheries is currently examining the mechanisms that control recruitment success in greater detail, in order to explain more of the inter-annual variation that occurs and the unprecedented low scallop stock levels observed between 2012 and 2014.

Brown tiger prawns and scallops were ranked as high risk to climate change effects while western king prawns were ranked as medium-high risk.



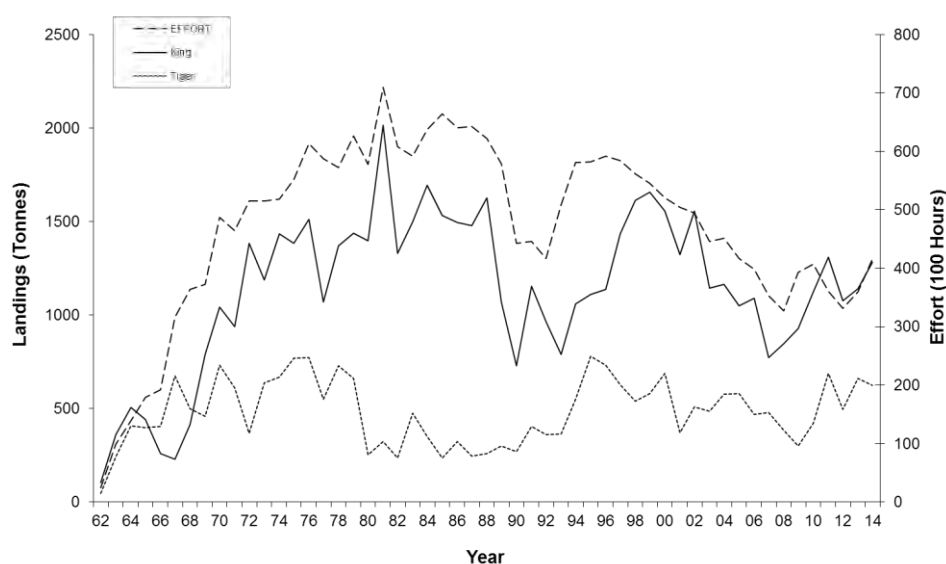
SHARK BAY PRAWN AND SCALLOP FIGURE 1

The main boundaries of the Shark Bay Prawn Managed Fishery, Inner Shark Bay, North CPL, Central CPL, South CPL, trawl closures, permitted trawl area (extends out to the 200m isobath) and area trawled in 2014.



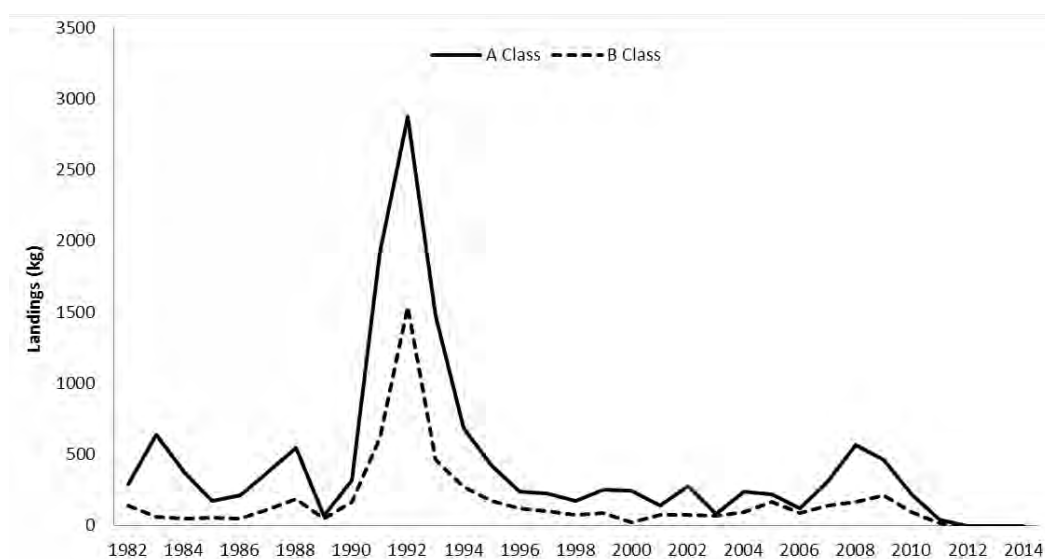
SHARK BAY PRAWN AND SCALLOP FIGURE 2

The main boundaries of the Shark Bay Scallop Managed Fishery permitted trawl area (extends out to the 200 m isobath).



SHARK BAY PRAWN AND SCALLOP FIGURE 3

Shark Bay Prawn Managed Fishery annual landings and effort (adjusted to twin gear units) 1962 – 2014.



SHARK BAY PRAWN AND SCALLOP FIGURE 4

Shark Bay Scallop Managed Fishery annual landings 1983 – 2014.

Exmouth Gulf Prawn Managed Fishery Status Report

E. Sporer, M. Kangas, S. Wilkin and N. Blay

Main Features			
Status	Current prawn Landings		
Stock level	Adequate	Brown tiger	162 t
Fishing level	Acceptable	Western King	171 t
		Endeavours	101 t
		Banana	29 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 endeavouri*) and banana prawns (*Penaeus merguensis*).

Governing legislation/fishing authority

Exmouth Gulf Prawn Managed Fishery Management Plan 1989

Exmouth Gulf Prawn Managed Fishery Licence Exemptions under Section 7 of the Fish Resources Management Act 1994

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

Consultation process

Meetings between the Department of Fisheries and licence holders to consider the status of the stocks and recommend the opening and closing dates and fishing arrangements that operate within the season. These are designed to protect smaller prawns and allow access to the various target species, primarily brown tiger and western king prawns, at appropriate times.

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 2014, the Brown 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 brown tiger prawns). 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 allocation 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 stock sustainability. These measures will continue to be applied, while incorporating a flexible fishing regime to optimise size and value of 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.

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 escape 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 and reviewed in 2014. This certification allows licensees to export product to the US market. A review of the conditions, of its BRD-compliance, for reducing the potential for turtle captures by the US Department of State was 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. The grids are required to be modified by the commencement of the 2015 season. 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 (DoE), assessed the fishery in 2015 under the provisions of the *Environmental Protection and Biodiversity Act 1999* (EPBC Act), and has accredited the fishery for a period of ten years (re-assessment in 2025), 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 focus on stock assessment and surveys to monitor annual recruitment of prawns and spawning stock levels of brown tiger and western king prawns. The prawn season start date is set on the historical understanding of prawn biology and migration onto the trawl grounds, which includes consideration of the lunar phase. The objective of the start date is to protect small (pre-spawning) prawns and ensure flow-through to the breeding stock for sustainability purposes (particularly for protection of pre-spawning brown tiger prawns). When fishing actually commences, the extent of area to fish each season is based on pre-season and within season surveys. These surveys also provide prawn size structure information to assist with harvesting strategies (detailed above in the management arrangements) and understanding of prawn movement in this fishery. An annual catch prediction for both species is also provided using an index derived from the recruitment surveys and this catch prediction informs the level of overall fishing effort required to harvest the available catch in any year.

In 2014, three fishery-independent pre-season recruitment surveys were undertaken. These surveys showed low catch rates and small size prawns for both species, therefore, a follow up survey was undertaken in May and these results indicated that fishing could commence this month based on prawn size structure and catch rates obtained from the survey.

The stocks of western king prawns in Exmouth Gulf are assessed throughout each fishing season and at the end of each fishing season, noting that the annual assessments are based on all of the stock status information collected using fishery-dependent information throughout the year. Due to lower than target catch levels in some of the recent years, the status of the western king prawn stock has been more closely monitored to provide a better understanding of environmental factors influencing recruitment.

Monitoring of fishing activity is undertaken in real time and using target catch rates to determine the specific timing of the closure of the brown 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.

Funding has been obtained from Fisheries Research and Development Corporation for a three year project (commencing July 2015) to examine, through remote sampling methods, seagrass/algal habitats in Exmouth Gulf. These habitats are important brown tiger prawn nursery areas and which may have been affected by the heat wave in 2010/11 and subsequent higher than average water temperatures in 2012 and 2013.

Retained Species

Commercial production (season 2014): 463 tonnes

Landings

The total landings of major penaeids for the 2014 season were 463 t, comprising 162 t of brown tiger prawns, 171 t of western king prawns, 101 t of endeavour prawns and 29 t banana prawns (Exmouth Gulf Prawn Figure 2). The brown tiger prawn landings were well below the normal catch range (250-550 t). The trend in recovery is in line with past years when the brown tiger prawn stock declined but presently it is recovering from an unprecedented extremely low stock abundance level (46 t annual landings) in 2012 with a slight improvement of annual landing in 2013 (95 t).

The western king prawn landings were also well below the target catch range (350-500 t) and only half of that caught in 2013. The decline in the annual catches is mainly attributed to the environmental conditions.

Endeavour prawn landings were also below the normal catch range of 120-300 t but were an increase on the previous two years. Endeavour prawns are primarily caught incidentally when fishing brown tiger prawns and with lower targeted effort on brown tiger prawns, the low endeavor landings are expected. The banana prawn landings declined compared to 2013, but landings were within expectations for this species.

Recorded landings of byproduct were; 2 t of blue swimmer crab (*Portunus armatus*), 3 t of squid, 1 t of bugs (*Thenus australiensis*), 5 t of coral prawns, 2 t of cuttlefish and <1 t of

octopus. Landings of blue swimmer crabs were slightly below the historical range (8 to 58 t). The coral prawn catch was low and is primarily because coral prawn abundance was low in areas where they are normally taken in the northern part of the fishery. Crabs and other byproduct are taken incidentally and are variable depending on abundance available on the trawl grounds each year and the level of trawl effort.

Fishing effort/access level

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 2014 season, official opening and closing dates were set at 1 April and 29 November, providing a maximum of 185 nights fishing. This is a flexible arrangement and the season actually commenced on 20 May based on results from pre-season surveys and fishing ceased 15 November, 5 days later than in 2013 for a total of 146 days fishing. There were spatio-temporal closures during the entire fishing season to avoid fishing on small prawns to maximise the value of the limited brown tiger and western king prawn stocks available in 2014.

In 2014 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).

Total nominal effort for the 2014 season was 9433 hours, slightly lower than 2013. The adjusted effort (to twin gear) in 2014 was 16,841 hours in 2014 which was the second lowest in 40 years (Exmouth Gulf Prawn Figure 2), and reflects the low prawn abundance. Generally the effort on western 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 2014 year mainly because of the late start to the season and low effort during the early part of the season shifting effort onto western king prawns in the latter part of the season.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Level 4 - Direct survey/catch rate

Breeding stock levels: Adequate

Projected catch next season (2015):

275 (220-330) tonnes brown tiger prawns

155 (125-185) tonnes western king prawns

The stock status of brown tiger prawns and western king prawns in the EGPMF is assessed annually through monitoring of fishery-independent and fishery-dependent catch rates for the two species (used as indices of recruitment and spawning stock levels) relative to specified reference points. Each year, the total catch of each species is also compared to a target catch range calculated from catches

observed in the fishery during periods considered to be sustainable. The adjusted commercial 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.

Catch assessment

The preliminary adjusted annual catch rate of 9.6 kg/hr for brown tiger prawn was close to the reference catch rate of 10 kg/hr. This catch rate was maintained, however, by conservatively fishing brown tiger prawns. The likely cause of the continued low overall abundance (low recruitment levels) may be a result of three years of very high water temperatures since the marine heat wave in the summer of 2011 (highest observed in 2013) and its possible continued impact on the spawning stock and/or inshore structured habitats.

During 2014 not all of the Central area was open to fishing and fishing for brown tiger prawns was undertaken from 20 May, which was the commencement of the season, to 20 July after which the TPSA closed. There were five subsidiary openings in the Central area whilst the Eastern area remained closed for the entire season. The TPSA was re-opened to fishing for two periods, 2 to 4 August and 30 October to 13 November.

The mean adjusted catch rate of 10.1 kg/hr for western king prawns is slightly below the reference catch rate level of 11.7 kg/hr but effort was commensurate with the recruitment level maintaining overall catch rate at a reasonable levels.

Western king prawns were fished conservatively during the early part of the season and effort in the northern area (the main western king prawn fishing grounds) was focused mainly in the latter part of the season (after 1 July). Also when fishing commenced on the western king prawn grounds, areas where small-size prawns were located were closed to fishing to ensure that size and quality were maintained. Overall, fishing ceased in 2014 because of the fishing protocol set out in the season arrangements related to western king prawn size composition.

Survey assessment

The brown tiger and western 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 brown 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 brown 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 brown tiger prawn breeding stock levels are maintained at adequate levels by monitoring the brown tiger prawn commercial catch rates to cease fishing at levels that will maintain the survey spawning index above the target reference level. The harvest strategy provides a set of transparent and verifiable measures which one can and report on the performance of the fishery and demonstrate its sustainability. The present target reference point is 25 kg/hr based on 6-fathom nets in quad gear configuration (which is reduced to 19 kg/hr after 1 November).

Three brown tiger prawn recruitment surveys were carried out in March and April 2014. The survey indices provided brown tiger prawn catch prediction of 275 t (range of 220 to 330 t). For the 2014 season the annual total landings (162 t) were below the prediction range,

For the 2014 season it was difficult (as it was in 2012 and 2013) to monitor the brown tiger prawn catch rates because of the intermittent nature of fishing between the brown tiger prawn area and the northern western king prawn area as well as, the presence of banana prawns in the Central area which fishers targeted instead of brown tiger prawns. 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 during low abundance years.

Three standardised brown tiger prawn breeding stock surveys are carried out in August, September and October each year. The 2014 survey results showed an average quad gear CPUE for all three surveys of 21.5 kg/hr and 33.7 kg/hr in the spawning areas (Q1 and Q2 respectively) with an overall mean catch rate of 27.6 kg/hr (Exmouth Gulf Prawn Figure 3). This is an increase on the spawning stock abundance observed in 2012 and 2013 and is well above the limit (10 kg/hr) and is slightly above the target level (25 kg/hr).

Western king prawn breeding stock levels in the fishery are maintained at adequate levels through controls on fishing effort. Western king prawns are regarded as having a lower risk for recruitment overfishing compared to brown tiger prawns. Furthermore, the species is widely dispersed and has significant unfishable (economically) populations in the general Exmouth area and has a history of recruitment being unaffected by the level of fishing. Within this broad distribution there are several areas (the "Gutters" area [trawl ground R1] and around Sunday Island [trawl ground S2]) where the offshore migration related to spawning results in the prawns accumulating in sufficient numbers to allow economically viable trawling. Adult densities decrease further offshore and decrease as the stock disperses over time. While these offshore areas do not have viable fishable abundances, these large areas in total, at low densities, are likely to hold a spawning biomass significantly larger than that which occurs in the main fishery.

Before fishing commences, the western king prawn stock status is also assessed on the basis of fishery-independent recruitment surveys. These surveys were undertaken in the northern part of the fishery and provided prawn size structure and abundance information. The combined pre-season surveys (March and April) provided a catch prediction of 125 t with a range between 100 and 150 t which was well below the target (historical) catch range.

Fishery-independent spawning stock surveys have not previously been undertaken specifically for the western king prawns and the mean commercial (fishery-dependent) catch rate of western king prawns in fishing grounds R1 and S1 during August and September is considered to represent an appropriate index of spawning stock abundance. These catch rates are derived from key western king prawn fishing grounds during the spring spawning period at a time when the fleet is focusing their fishing effort on western king prawns. This index is assessed annually, against reference points and in 2014 the mean western king prawn commercial catch rate was 31.6 kg/hr above the target level (25 kg/hr). In addition, in 2014 a fishery-independent survey of western king prawn

fishing grounds (in areas where historically most fishing effort for western king prawns has occurred) was undertaken the night after the entire fishery closed to fishing, to provide a measure of the remaining western king prawn spawning stock at the end of the key spawning period. It is planned to sample these sites in August, September and October to provide additional information to supplement the fishery-dependent catch rate information used for stock assessment and in the longer term may provide a fishery-independent spawning stock index for western king prawns. Towards the end of the season for western king prawns the cessation of fishing this species is based on size structure (i.e. to prevent fishing on new 0+ recruits).

There is no formal stock assessment for endeavour prawns whose distribution overlaps that of brown tiger prawns however, data on catch rates of endeavour prawns during fishery independent surveys are available and will be analysed in the future. Endeavour prawns - are fished to varying levels depending on the abundance of (and hence the fishing effort applied to) the more valuable brown tiger prawns. The breeding stocks of endeavour prawns are considered to be at adequate levels because their distribution overlaps that of the brown tiger prawns and the brown 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 brown tiger and western 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 brown 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 10 kg/hr. The mean brown tiger prawn spawning stock catch rate of 27.6 kg/hr was above the target level. The strategy for western prawns is to maintain the spawning biomass above mean historical commercial catch rates during August and September in key western king prawn fishing grounds with the present target of 25 kg/hr with a limit of 15 kg/hr. The mean western king prawn spawning stock catch rate of 31.6 kg/hr was above the target level. Stocks of western king prawns are also monitored using catch levels which were below the target catch range. However, there is a conservative harvesting strategy in place for this species. The lower banana prawn annual landings corresponded to the relatively low 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 effort in 2014 slightly decreased compared to the 2013 season and was the second lowest 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 2014 twenty turtles (all unidentified) were reported as captured in nets and returned to the sea alive. Sixty sea snakes (unidentified) were reported as captured and fifty were reported as returned to the sea alive. Three sawfish were reported as captured one returned alive, two dead and one seahorse and one pipefish were reported as captured in nets.

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 previous three years has also been reduced with the area trawled below 25% of the fishery compared to around 30% in past years. There was some additional searching for western king prawns in the northern area to ensure that the western king prawns available were fished. Also more endeavour prawns migrated into the northern grounds. For these reasons there was a slight increase in the area trawled in 2014 compared to past three years.

Performance measures for habitat impact relate to the spatial extent of trawling within the licensed area of the Exmouth Gulf fishery. In 2014 the performance measure was met as the total area trawled, at approximately 302 square nautical miles (26.5%) per cent of Exmouth Gulf, was below the 40% level.

Social Effects

The estimated employment in the fishery for the year 2014 was 18 including skippers and other crew. Twenty three additional support staff are based in Exmouth Gulf and additional support staff in Fremantle for refitting of boats. Within the Exmouth area, the fishery is an important regional employers contributing to the economic viability of the Exmouth township.

Economic Effects

Estimated annual value of major prawns for 2014:

Level 3 - \$5 - 10 million
(\$6.1 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 (\$6.1 million). Although there was a decline in the prawn total landings it was compensated by a slight increase in the prawn prices received in 2014 compared to 2013. It is, however, below the expected value of the fishery under normal environmental conditions. Estimated prices for prawns were as follows:

Western king prawns	\$14.45/kg
Brown tiger prawns	\$14.51/kg
Banana prawns	\$10.75/kg
Endeavour prawns	\$9.49/kg
Coral prawns	\$3.41/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 463 t is below the range due to low recruitment this season. The long-term target catch ranges for individual species are western king prawns 350–500 t, brown 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). These overall and individual figures are generally based on a 10-year average (1989–1998). Brown tiger prawns and western king prawns were below their target range. Endeavour prawn landings were also below the target catch range, however, the effort in 2014 was very low. Banana prawn landings (29 t) were within the target catch range.

New management initiatives (2015)

The fishery completed the Marine Stewardship Council pre-assessment during mid-2013 and underwent full assessment in 2014/15 which is scheduled for completion late-2015.

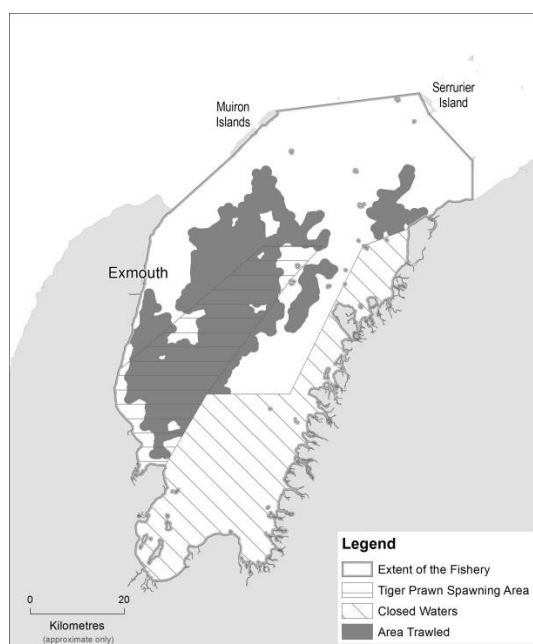
External Factors

Increasing costs of fishing and lower returns due to the global economic climate 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 such as water temperature, may also impact on recruit survival, but have yet to be fully investigated.

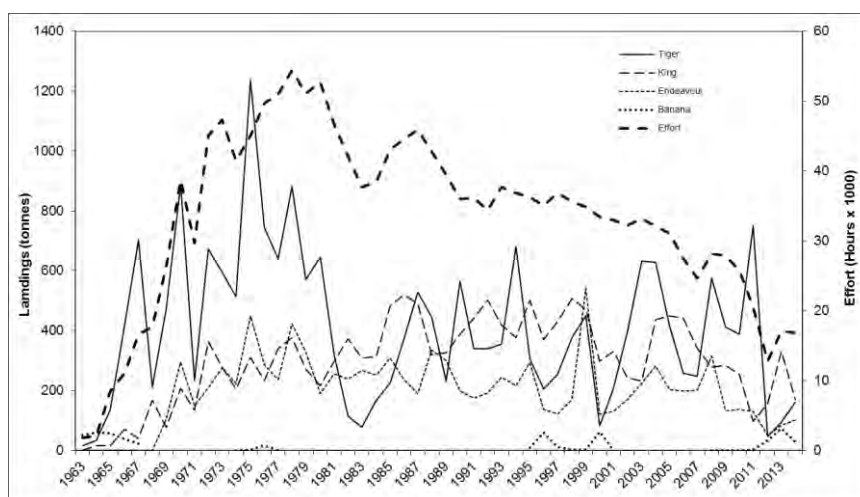
The heat wave event may have contributed to the recent extremes in abundance of brown tiger prawns in Exmouth Gulf. In 2011, the brown tiger prawn recruitment and landings were one of the highest recorded which led to a very high spawning stock abundance. However in 2012, the lowest recruitment was observed resulting in the lowest catch. This in turn has resulted in low spawning stock in 2012 although it is at levels that have 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 a project will commence in 2015 to further investigate impacts on inshore habitats.

Brown tiger prawns were ranked as a high risk to climate change effects and western king prawns as a medium-high risk so therefore both species need to be monitored closely.



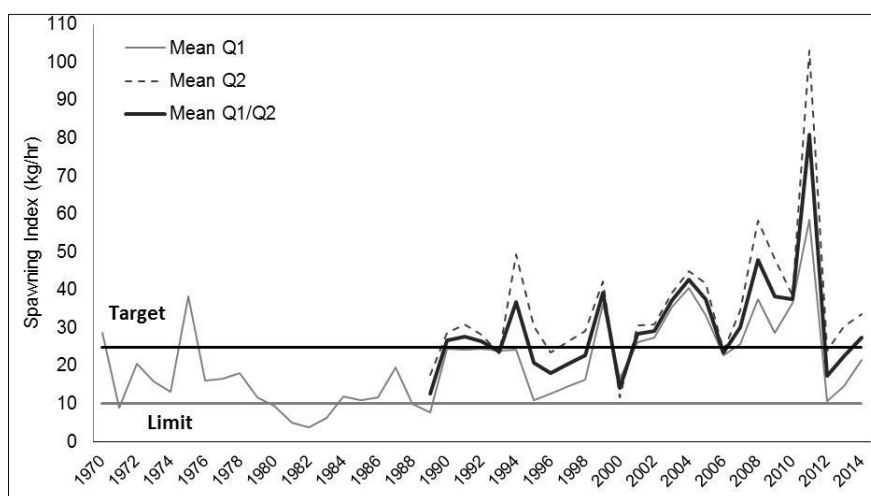
EXMOUTH GULF PRAWN FIGURE 1

The main boundaries of the Exmouth Gulf Prawn Fishery, extent of fishery closed waters, TPSA (Q1 and Q2), and area trawled in 2014.



EXMOUTH GULF PRAWN FIGURE 2

Exmouth Gulf Prawn Managed Fishery annual landings and adjusted effort (twin-gear) 1963 – 2014.



EXMOUTH GULF PRAWN FIGURE 3

Exmouth Gulf Prawn Managed Fishery mean brown tiger prawn spawning stock index (kg/hr) in areas Q1 and Q2 relative to the target and limit reference points (25 and 10 kg/hr respectively) between August and October 1970 – 2014. Note that prior to 1989 the mean value reflects the catch rates in area Q1 only.

West Coast¹ 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	Giant Crabs	1.5 t

Fishery Description

The West Coast Deep Sea Crustacean Managed Fishery targets Crystal (Snow) crabs (*Chaceon albus*), Giant (King) crabs (*Pseudocarcinus gigas*) and Champagne (Spiny) crabs (*Hypothalassia acerba*) using baited pots operated in a long-line formation in the shelf edge waters (>150m) of the West Coast 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).

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 licences (which replaced permits in the previous interim management plan). Unitisation allowed greater transfer of units between licence 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 licence to permit these species to be specifically targeted while still retaining a "B" class quota of 14 t.

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

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 used to achieve quota.

A recent 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 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 estimates by fishers recorded through the volunteer logbook program. 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 2014):

Crystal crab	139.8 tonnes
Giant crab	1.5 tonnes
Champagne crab	<0.1 tonnes

The catch of 139.8 tonnes of Crystal crab in 2014 was similar to all years since the introduction of 140 t. quota in 2008 (Deep Sea Crab Figure 1). There was a small catch of 'B' class quota (Champagne or Giant crab). The very small Champagne crab catch is due to low market demand, with the majority of 'B' class quota being some targeted fishing for Giant crabs. The catch of Giant crabs above the threshold level of 0.8 t has resulted in a review of the management arrangements for this species. 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 2014) Nil

Fishing effort/access level

Nominal commercial effort increased by 4 % from an estimated 53,178 pot lifts in the 2013 season to 55,203 pot lifts in the 2014 season. The standardised commercial effort similarly increase from 58,341 pot lifts in the 2013 season to 60,669 pot lifts for the 2014 season, a 4% increase. 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 139.8 t, which is within the target catch range (90% of the TAC; 126-140 t). The standardised catch rate of legal crabs decreased by 3% in 2014 to 2.31 kg/pot compared with 2.39 kg/pot in 2013 (Deep Sea Crab Figure 2). The 2013 standardised catch rate represented the highest in a decade (Deep Sea Crab Figure 2), and the 2014 value is above the threshold reference point with a large degree of certainty.

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

crystal crabs, and will provide more information on crystal crab age and growth.

The standardised catch rate of berried female crystal crabs has remained relatively stable since 2003, noting fluctuations from 2009 to 2012 (Deep Sea Crab Figure 3a). Over the last three seasons the standardised catch rate of berried female crabs has regained stability, ranging from a high of 3.46 (in 2012) to 3.08 berried female crabs in 2014. This catch rate is still well above the threshold reference point of 1.74 (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 2014, the level is above the threshold level (Deep Sea Crab Figure 3b).

The performance measures for the fishery are that: a) quota has been achieved (>90% TAC caught), b) the standardised catch rate of legally-retainable crabs is within the target range; and c) the standardised catch rates of sublegal crabs and berried females are above the threshold levels. All of these measures were met.

Non-Retained Species

The fishery is undergoing a Marine Stewardship Certification assessment, and all aspects associated with non-retained species were scored such that they pose little or 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. One humpback whale was entangled in deep sea crustacean gear in 2014, and was successfully disentangled and released. This is the first recorded interaction with a cetacean in this fishery since records began in 1990

The performance measures for the fishery are that: a) Less than three interactions with any particular ETP species in a year; and b) Fishing impacts are considered to generate an acceptable level of risk to all ETP species' populations, i.e. moderate risk or lower. Both of the measures were met.

Ecosystem Effects

The fishery is undergoing a Marine Stewardship Certification 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 km². Assuming that all the ground is equally productive, at catch levels experienced in the past seasons about 3 kilograms of crabs are being removed each year per square kilometre of ground.

The performance measures for the fishery are that: a) Fishing impacts are considered to generate an acceptable level of risk to ecological processes within the ecosystem, i.e. moderate risk or lower; and b) Fishing impacts on each ecological resource / asset impacts are considered to generate an acceptable level of risk, i.e. moderate risk or lower. Both of the measures were met.

Habitat effects**Low**

Crab potting is considered to have a low impact on the largely soft mud habitat over which the fishery operates. Effort levels and the spatial extent of fishing remain well below historical levels, indicating any impact, however small, has further reduced

The performance measures for the fishery are that: a) The area fished is ≤ 113 (10' x 10') blocks; and b) Fishing effort is $\leq 169\,000$ trap lifts. Both of the measures were met.

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 2014.

Economic Effects**Estimated annual value (to fishers) for 2014****Level 2 - \$1 - 5 million (\$3.1 million)**

The beach value of the fishery was about \$3.1 million in 2014 with the majority of the catch sold live to Asian markets both locally and internationally.

Fishery Governance**Target catch range** **126-140 tonnes****Standardised Catch Rate** **1.34-2.54 kg / pot lifts****Current fishing (or effort) level** **Acceptable**

A harvest strategy which was adopted by industry resulted in a formalisation of reference levels for a range of performance measures including those associated with stock assessment.

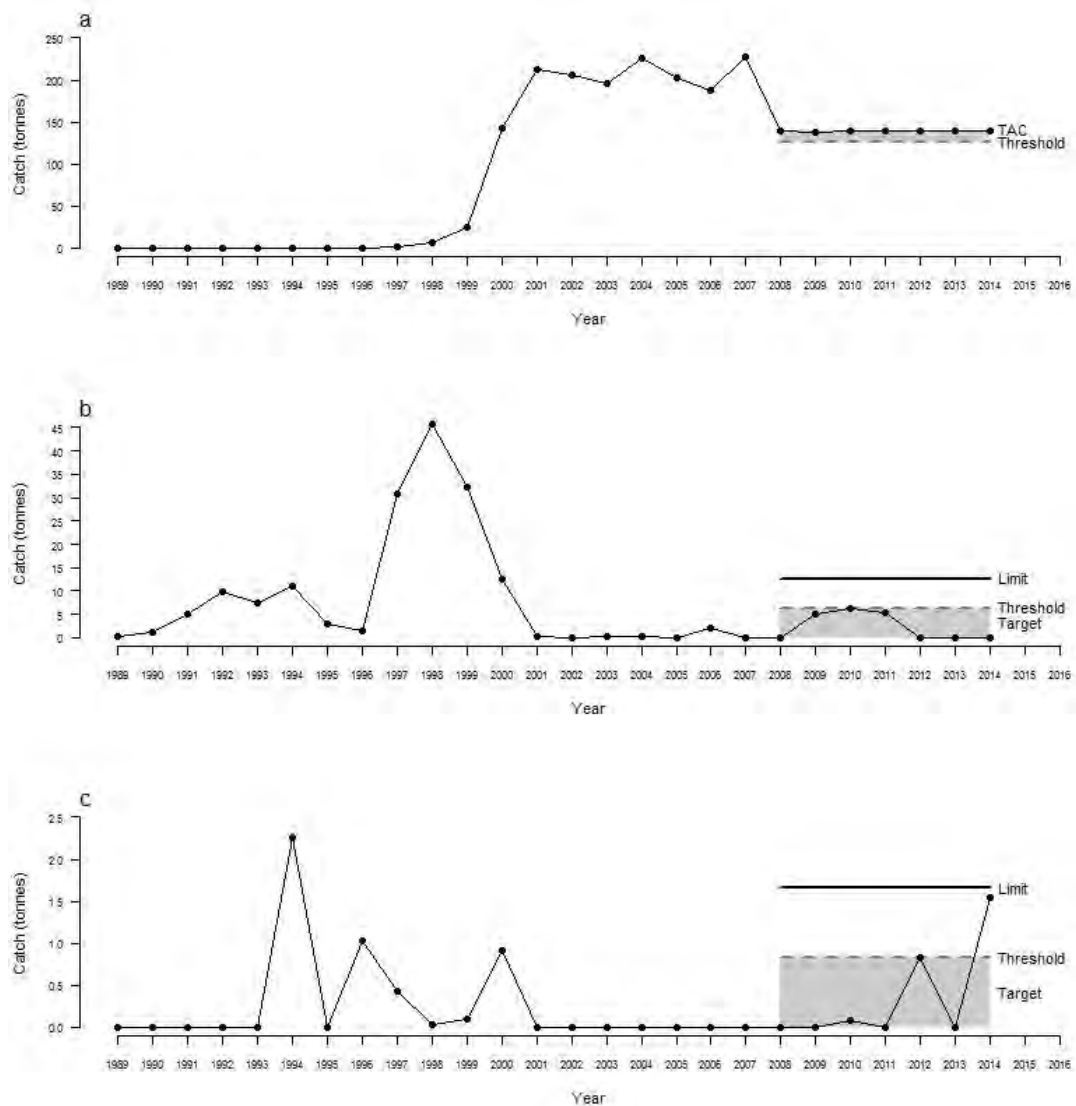
New management initiatives (2015)

The *West Coast Deep Sea Crustacean Managed Fishery Management Plan 2012* will be amended during 2015, to increase the annual Total Allowable Catch (TAC) for Crystal Crab by 14 tonnes, to 154 tonnes.

External Factors

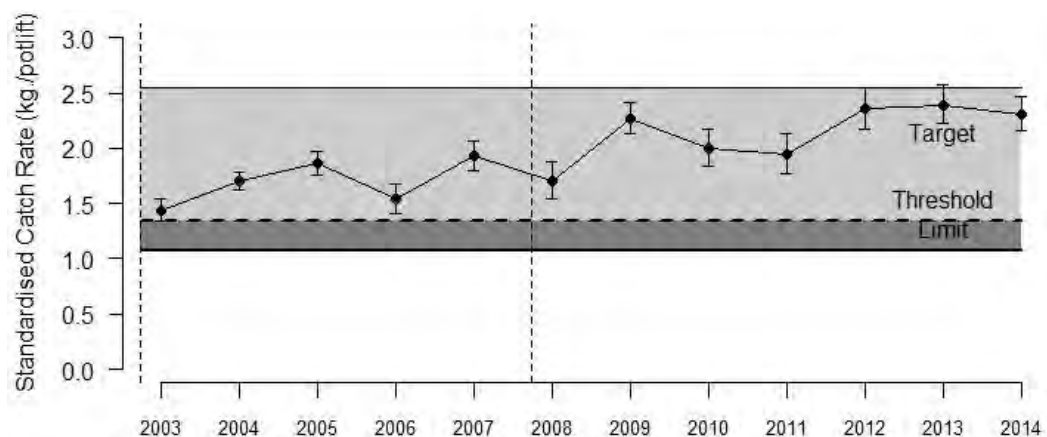
Given product is exported; fluctuation in the Australian dollar can have impacts on the economic performance of the fishery.

The fishery is thought to be relatively robust to environmental change due to the depth of fishing operations.



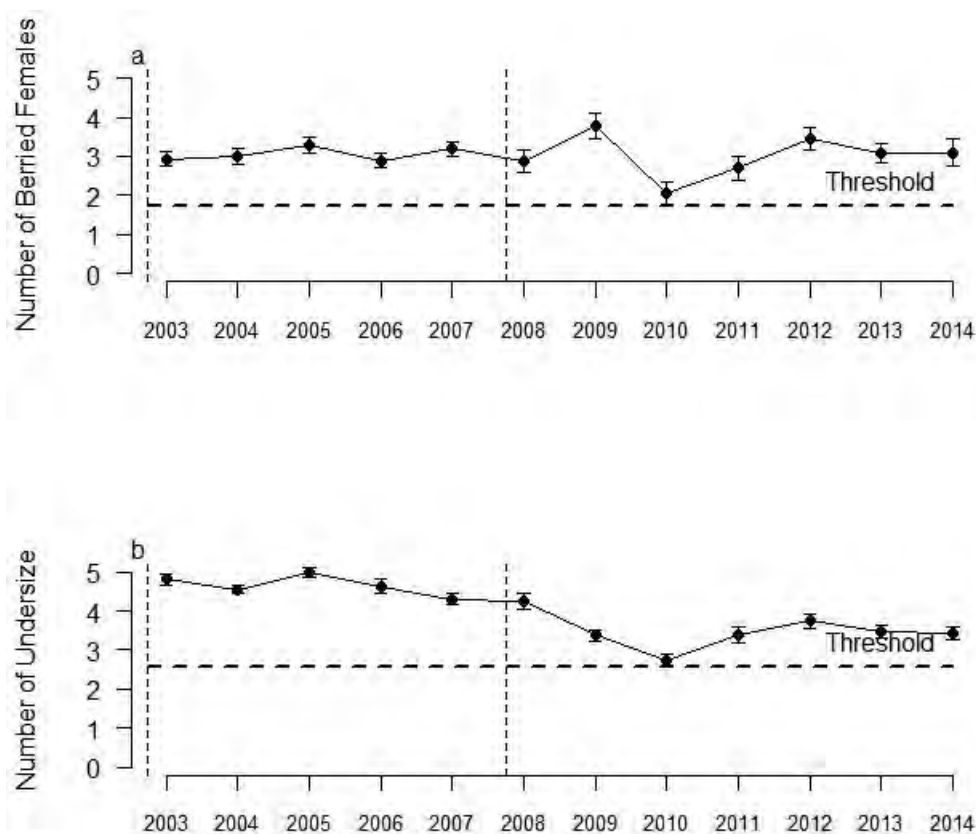
WEST COAST DEEP SEA CRUSTACEAN FIGURE 1

Annual catches of a) crystal b) champagne and c) giant crabs since 1989. Target regions (grey), threshold (dotted) and limit (solid line) are indicated for each species



WEST COAST DEEP SEA CRUSTACEAN FIGURE 2

Standardised catch per unit effort ($\pm 95\text{CI}$) since 2003 for crystal crabs. Area between vertical dashed lines indicate period when management required fishing in all zones. Horizontal lines represent the threshold (dashed heavy line) and limit (solid heavy line) reference points for crystal crabs in the fishery. The target standardised catch rate area is denoted by the light grey filled area. The method of standardizing catch rates was revised this year which has resulted in minor changes to the annual values.

**WEST COAST DEEP SEA CRUSTACEAN FIGURE 3**

Standardised catch per unit effort ($\pm 95\text{CI}$) since 2003 for a) berried and b) undersized crystal crabs relative to their respective threshold reference point.

Gascoyne Demersal Scalefish Fishery Status Report

G. Jackson, S.J. Newman, S. Turner and H. Zilles

Main Features			
Status		Current Landings (2014)	
Stock level		Pink snapper:	
Pink snapper	Adequate	Commercial	240 t
Goldband snapper	Adequate	Recreational	21 t
Spangled emperor	Adequate	Charter	11 t
Fishing Level		Goldband snapper:	
Pink snapper	Acceptable	Commercial	54 t
Goldband snapper	Acceptable	Recreational	15 t
Spangled emperor		Charter	8 t
North Gascoyne - Unacceptable		Spangled emperor:	
South Gascoyne - Acceptable		Commercial	2 t
		Recreational	17 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). GDSF vessels are not permitted to fish in inner Shark Bay. No state-licensed commercial vessels are permitted to fish between 21°56' and 23°07'30"S ('Point Maud-Tantabiddi Well' closure). Management arrangements for the West Coast Demersal Scalefish Fishery (WCDSF) permit a limited number of commercial vessels to operate in Gascoyne waters up to the southern boundary of the GDSF (26°30'S).

Recreational (including 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 fishing 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 late 2015). This fishery 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 (including 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.

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 2013-14 licence period for the GDSF, i.e. 1 September 2013 – 31 August 2014 (referred to as 'season 2014'). 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 second statewide integrated survey of recreational boat-based fishing undertaken between 1 May 2013 and 30 April 2014 (Ryan *et al.* 2015)¹. Because the integrated surveys only provide 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 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 2011³).

Pink snapper: Detailed research on the oceanic snapper stock and the associated SBSF was undertaken throughout the 1980s and early 1990s. Commercial catches are sampled throughout the year to provide representative catch-at-age data. An integrated stock assessment model has been used to determine stock status since 2003 and is updated every 3 years (most recently in 2014).

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

the Gascoyne Coast Bioregion are managed as a single biological stock (there are separate biological stocks in each of three management regions in Western Australia (Kimberley, Pilbara and Gascoyne)). Marriott *et al.* (2012) assessed the stock status of the Gascoyne biological stock of goldband snapper based on a 'weight of evidence' assessment approach that included deriving estimates of fishing mortality from catch curve analysis from representative samples of the age structure from the GDSF. These fishing mortality-based assessments use reference levels that are based on ratios of natural mortality for each species, such that $F_{target} = 2/3M$, $F_{threshold} = M$ and $F_{limit} = 3/2M$. The fishing mortality-based assessments indicated that the estimated fishing level on goldband snapper in this biological stock was below the target level in 2006 and 2008. This indicates that fishing is not having an unacceptable impact on the age structure of the population. The biological stock is not considered to be recruitment overfished (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 is managed as a single biological stock. Marriott *et al.* (2012) assessed the stock status of spangled emperor in the Gascoyne Bioregion on a 'weight of evidence' assessment approach that included deriving estimates of fishing mortality from catch curve analysis from representative samples of the age structure from two areas (North and South Gascoyne). 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 2014):

Total	373 tonnes
Pink snapper	240 tonnes
Goldband snapper	54 tonnes
Spangled emperor	2 tonnes
Other species	77 tonnes

The total commercial catch taken by the GDSF in the 2014 season was 373 t which is similar to the catch level in 2013 (Gascoyne Demersal Scalefish Fishery Figure 2). The catch comprised 240 t of pink snapper (oceanic stock, TACC = 277 t), plus 133 t of other species including 54 t of goldband snapper, 2 t of spangled emperor and 77 t of other scalefish species (Gascoyne Demersal Scalefish Table 1).

Recreational catch estimate (includes charter sector):

Pink snapper	ca. 30 tonnes
Goldband snapper	ca. 25 tonnes
Spangled emperor	ca. 20 tonnes

1 Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

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.

In 2014 the recreational catch of pink snapper (oceanic stock) reported by licensed charter boats was 11 t (same as in 2013). In 2013/14, an estimated 21 t (se 2.3 t) of pink snapper (oceanic stock) was taken by boat-based recreational fishers 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 30 tonnes.

The recreational catch of goldband snapper reported by charter boats in 2014 was 8 t (same as in 2013). The recreational catch of goldband snapper in 2013/14 is estimated to have been 14.7 t (se 3.7). The total catch of goldband snapper taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 25 tonnes.

The recreational catch of spangled emperor reported by charter boats in 2014 was 4 t (same as in 2013). The recreational catch of spangled emperor in 2013/14 is estimated to have been 16.8 t (se 2.4). The total catch of spangled emperor taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 20 tonnes.

Fishing effort/access level

Commercial

There were 55 licences with pink snapper quota in the 2014 season with 17 vessels actively fishing (16 in 2013). 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 729 days (748 days in 2013). The level of overall effort in this fishery is the lowest on record and 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 195 boat days during June–July in 2014 (was 181 in 2013).

Recreational

Total recreational boat fishing effort across the entire Gascoyne between 1 May 2013 and 30 April 2014 was estimated at approximately 54,000 fisher days (equates to approximately 212,000 hours fished) (Ryan *et al.*, 2015).

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 2014 season, the pink snapper catch rate was 658 kg pink snapper/standard boat day (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 2014, the catch rate at 658 kg pink snapper/standard boat, while slightly lower than in 2013, remained well above the threshold and at the highest levels not seen since the late 1990s.

Goldband snapper: Historical monthly catch rate data from the SBSF cannot be used 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 2014 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 cannot be used as an index of abundance because the species has never been consistently targeted by commercial vessels. 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.* 1993¹). 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 reduction in the Bioregion-wide catch for this species in 2013/14 (21% less than estimated in 2011/12) is expected to increase levels of spawning biomass and assist in reducing F . There is a need for an updated assessment of spangled emperor in the North Gascoyne.

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 2014, commercial fishers in the GDSF reported no interactions with listed species. No interactions were reported in 2014 by the charter fishery in the Gascoyne Coast Bioregion.

Ecosystem Effects

Food chain effects

Low

Pink snapper and other species in this suite are generalist feeders and are just some of a number of such species inhabiting the continental shelf waters in this Bioregion. Food chain effects due to fishing for species within this suite are considered to be low because the quota system restricts overall GDSF catches to a relatively small percentage of the total biomass. The juvenile components of these stocks are likely subject to large, mostly-environmentally driven fluctuations in abundance even in the absence of fishing, resulting in significant variability in annual recruitment strength. A study by Hall and Wise (2011)² 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 2014 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 2014, 17 vessels fished during the entire season, 10 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

2013:

Level 2 - \$1 - 5 million

The gross value of production (GVP) of the commercial component of the Gascoyne Demersal Scalefish Fishery was

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.

2 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 the range \$1-5 million in 2013. 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 2014):

Acceptable

Current catch level Goldband (season 2014):

Acceptable

Target catch (and effort) range:

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

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

In 2014, GDSF vessels with pink snapper quota required 364 boat days to catch 240 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 658 kg pink snapper/boat day during the peak season for the 2014 was again 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 2014 was again below the preliminary maximum commercial catch limit.

Recreational:

Current effort level (2013/14):

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. The estimated boat-based catch of spangled emperor in 2013/14 had decreased by approximately 21% on the estimated catch in 2011/12.

New management initiatives (2015/16)

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.

The GDSF underwent Marine Stewardship Council pre-assessment in 2013.

External Factors

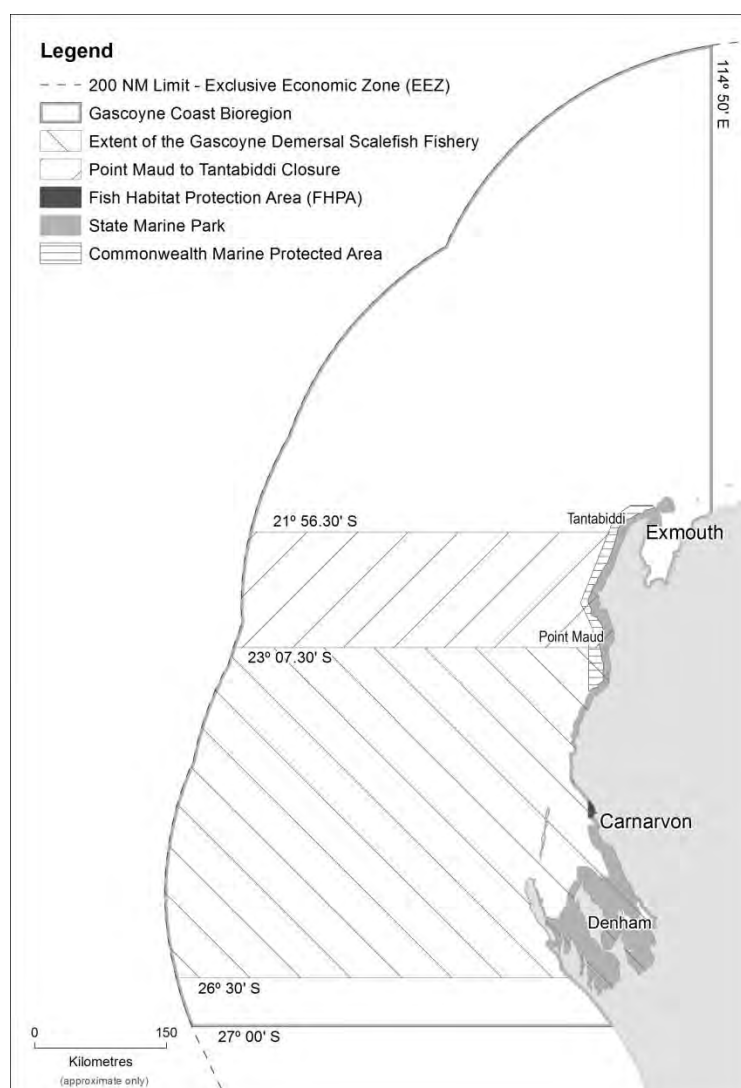
Under the Offshore Constitutional Settlement, commercial vessels licensed by the Commonwealth may operate in state waters off the Gascoyne coast, outside the 200 m isobath, as part of the Western Deepwater Trawl Fishery. In the 2014 season, total effort in this fishery was very low (around 110 hours, AFMA unpublished data), as has been the case in recent years.

Climate change has the potential to impact fish stocks through increasing sea surface temperatures, changes in major ocean currents (e.g. Leeuwin Current), rising sea level and ocean acidification. A review of the impacts and responses to marine climate change in Australia was undertaken by CSIRO in 2009. More recently, an FRDC-funded project assessed the effects of climate change on key fisheries in Western Australia (Caputi *et al.* 2014). Pink snapper was considered in some detail 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 egg and larval dispersal.

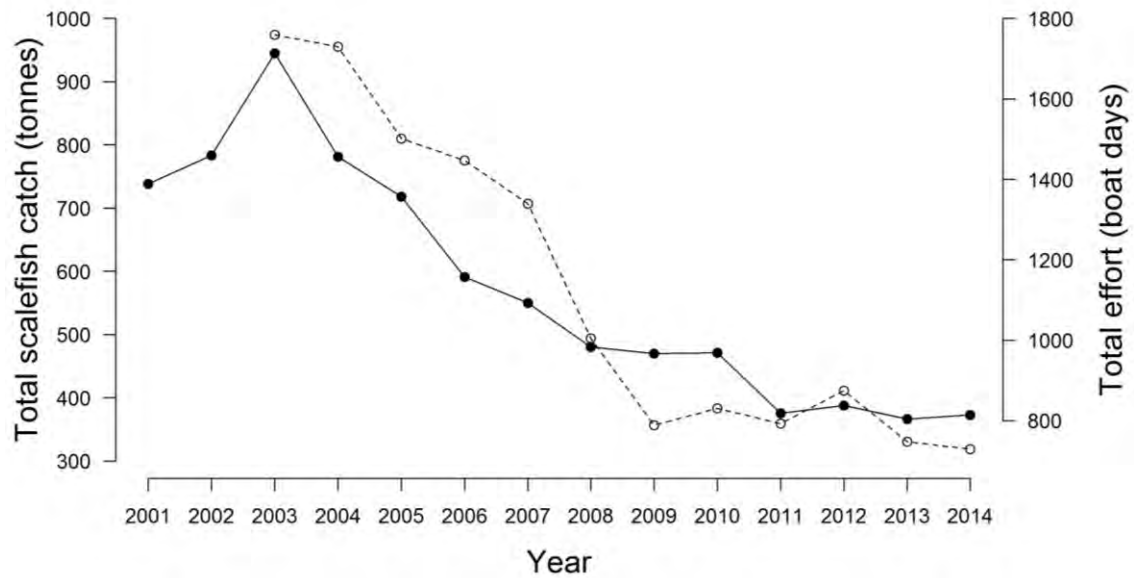
GASCOYNE DEMERSAL SCALEFISH FISHERY TABLE 1

Total commercial catch of demersal scalefish species other than pink snapper taken in Gascoyne waters between 2005/06 and 2013/14 (excludes mackerels, sharks and tunas). Units are tonnes.

Species	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Goldband snapper	105.8	107.2	121.1	143.8	104.6	53.2	64.2	73.2	54.4
Red emperor	19.4	17.0	12.8	11.7	9.8	8.2	13.1	7.9	10.1
Spangled emperor	18.1	7.0	7.0	3.3	3.8	3.7	4.3	2.3	2.0
other emperors	29.2	34.3	26.8	13.8	9.2	10.4	11.6	5.1	6.4
Cods	21.9	21.5	15.0	9.5	13.4	11.4	21.1	14.0	15.6
Other	78.1	77.1	65.8	64.8	72.9	50.7	38.9	30.8	51.2
Total	272.5	264.1	248.5	246.9	213.7	137.5	153.0	133.4	133.2

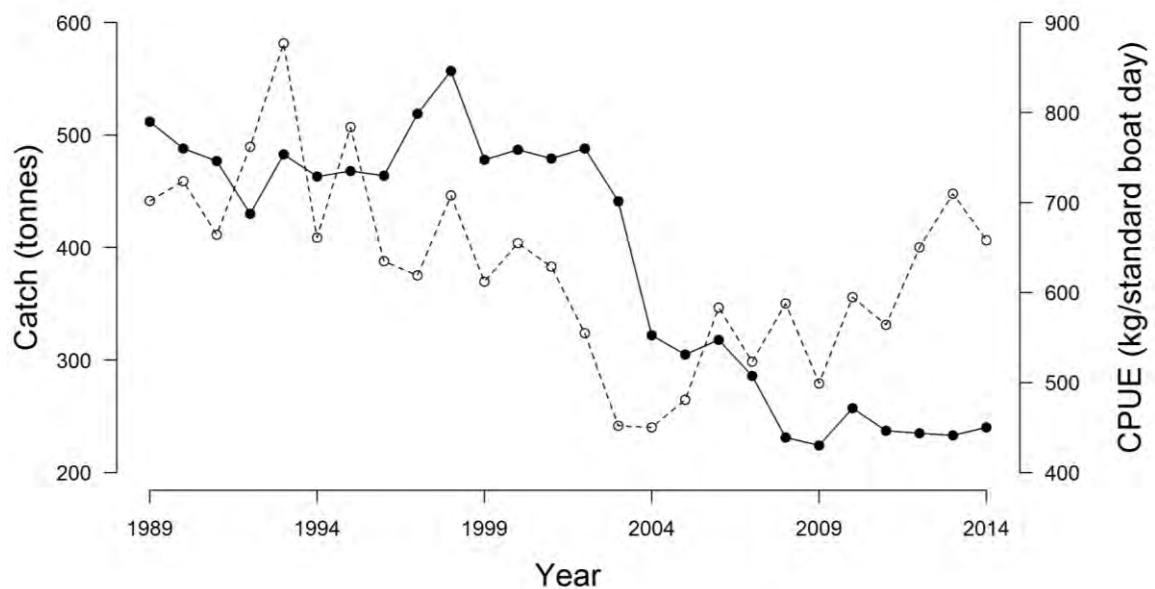
**GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 1**

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) (solid line) and total fishing effort (days) (hatched line) from 2001 to 2014.



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 3

Gascoyne pink snapper catch (solid line) and catch per unit effort (hatched line) by quota year from 1988/89 (equates to 1989) to 2013/14 (equates to 2014). 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 and H. Zilles

Main Features

Status		Current Landings	
Stock level:		Commercial (2014)	
Whiting	Adequate	Whiting	118 t
Sea mullet	Adequate	Sea mullet	51 t
Tailor	Adequate	Tailor	8 t
Western yellowfin bream	Adequate	Western yellowfin bream	19 t
Pink snapper	Eastern Gulf - Adequate	Pink snapper	0.4 t
	Denham Sound – Adequate	Recreational (Pink snapper only)	
	Freycinet Estuary – Adequate	Eastern Gulf	4 t (2010)
Fishing Level:		Charter	<0.5 t (2014)
Whiting	Acceptable	Denham Sound	6 t (2010)
Sea mullet	Acceptable	Charter	1.5 t (2014)
Tailor	Acceptable	Freycinet	1.5 t (2010)
Western yellowfin bream	Acceptable	Charter	<0.5 t (2014)
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 beach seine and mesh net gears to mainly take four species/groups: whiting (mostly yellowfin, *Sillago schomburgkii*, 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.), 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 Management 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.

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, the Denham foreshore). A unit in this fishery comprises one primary vessel, a maximum of three netting dinghies and a maximum fishing team of three individual fishers. Commercial line fishing for pink snapper 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 Fishing from Boat Licence while net fishers require a statewide Recreational Net Fishing Licence. For pink snapper more complex management arrangements apply within the Eastern Gulf, Denham Sound and Freycinet Estuary (Inner Shark Bay Fishery Figure 1), including seasonal closures and a quota tag system. These stocks are managed separately with explicit Total Allowable Catch (TAC) targets. In 2014, 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 2011¹). These indicators were selected to represent the finfish suites of nearshore/estuarine (waters of 0-20 m depth), inshore demersal (waters of 20-250 m depth), offshore demersal (waters greater than 250 m depth) and pelagic 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 inner Shark Bay.

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. Level 2 assessments based on trends in commercial catch and catch rates (CPUE) are assessed against reference points (target catch ranges and threshold catch rates) which have been determined on a reference period (1990-2002) when catch and effort in the fishery were considered stable. The SBBSMNF underwent Marine Stewardship Council (MSC) pre-assessment in 2013. A Level 3 assessment of yellowfin whiting that involved age-based sampling of the commercial catch to determine fishing mortality (F) was undertaken in 2014.

The stocks of pink snapper in 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 (most recently in 2015). A Level 3 assessment of grass emperor was undertaken in 2005.

Research on pink snapper in the inner gulfs in recent years has been 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. Catches of pink snapper taken by licensed commercial and charter vessels are derived from compulsory monthly catch returns.

Estimates of recreational catch and effort in the inner gulfs were derived each year 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 and second statewide surveys of boat-based recreational fishing in WA were undertaken in 2011/12 and 2013/14 (Ryan *et al.* 2013³, 2015⁴). This survey method 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 currently available from these survey data.

Retained Species

Commercial landings (season 2014):

Whiting	118 tonnes
Sea mullet	51 tonnes
Tailor	8 tonnes
Western yellowfin bream	19 tonnes
Pink snapper	0.4 tonnes

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.

4 Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

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.

The total catch taken by SBBSMNF licensed vessels in 2014 was 212 t (was 219 t in 2013). This total catch comprised 118 t of whiting, 51 t of sea mullet, 8 t of tailor, 19 t of western yellowfin bream and 16 t of other mixed scalefish species. Of the other mixed scalefish species category, the majority (9.4 t) comprised of two species of garfish (three-by-two garfish, *Hemirhamphus robustus* and longtail garfish, *Hyporhamphus quoyi*). A small amount (0.4 t) of pink snapper was also taken as byproduct in the net fishing gears.

Recreational catch estimates

(including charter, 2014)

Pink snapper	Eastern Gulf ca. 4-5 tonnes
	Denham Sound ca. 7-8 tonnes
	Freycinet Estuary ca. 2-3 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). There are no more recent estimates of recreational catch in inner Shark Bay for both species.

In 2014, licensed charter vessels landed approximately 1.5 t of pink snapper in Denham Sound and <0.5 t in both the Eastern Gulf and Freycinet Estuary. Less than 0.5 t of grass emperor (all three areas combined) was reported by charter vessels in 2014.

Fishing effort/access level

Commercial

In 2014, of the 10 SBBSMNF licences, eight vessels were actively involved in fishing (seven in 2013). During 2014, the total effort in the fishery was 620 boat days (646 boat days in 2013) which represents the lowest effort level on record for the fishery.

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 inner Shark Bay are currently not available from the statewide integrated survey of recreational boat-based fishing.

Stock Assessment

Assessment complete

Whiting	Yes
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Sea mullet	Yes
Tailor	Yes
Western yellowfin bream	Yes
Pink snapper	Yes
Grass emperor	Yes

Assessment level and method:

Whiting	Level 3 - Fishing Mortality (2014)
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Sea mullet/Tailor/Western yellowfin bream	Level 2 - Catch, Catch Rate (2014)
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Pink snapper	Level 5 - Composite Assessment (2013)
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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 - Adequate
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 addition, a Level 3 assessment of yellowfin whiting was undertaken in 2014.

In 2014, the total commercial catch (all species) taken by the SBBSMNF was 212 tonnes, a decrease of 7 tonnes from 2013, was the lowest reported level for the fishery on record (Inner Shark Bay Scalefish Fishery Figure 2).

In 2014, the catch of whiting (118 t) was within the target catch range and the CPUE (191 kg/boat day) well above the threshold catch rate at the second highest level observed since 1990 (Inner Shark Bay Scalefish Fishery Figure 3). Recent increases 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. The estimates of fishing mortality (F) for yellowfin whiting in 2014 were around the target ($F=\frac{2}{3}M$, natural mortality) and below the threshold reference level ($F=M$, natural mortality) and were considered acceptable (sustainable).

In 2014, the catch of sea mullet was 51t, an increase of 19 t from 2013, although still 50 t below the long-term average (1990-2013). This continues three consecutive years of sea mullet catch below the acceptable target range. The CPUE (83 kg/boat day) in 2014, however, is above the threshold level and around the long-term average (Inner Shark Bay Scalefish Fishery Figure 4). The decrease in the sea mullet catch is partly explained by a lower market demand with 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 2014, the tailor catch (8 tonnes) was the lowest on record and continues the declining trend for this species with catches since 2004 below the target range. The CPUE (12 kg/boat day) was below the threshold level and is the lowest value since 1987 (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 (30 kg/boat day) of western yellowfin bream in 2014 were similar to in 2013 and 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 was previously observed 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 estimated that the spawning biomass of the Eastern Gulf pink snapper stock in 2015, and its lower 95% confidence limit, lay above the target level (40%). For the Denham Sound pink snapper stock, the spawning biomass in 2015, and its 95% confidence limits in 10 out of 16 model runs, lay above the target level (40%). For the Freycinet Estuary pink snapper stock, while the majority of the point estimates of the spawning biomass in 2015 lay above the target level, the point estimates for 2 of the 16 runs fell below the target level (40%). The lower 95% confidence limit exceeded the target reference point in 5 of the 8 trials, and fell just below in the other 3 trials, while the 80th percentiles exceeded the target reference point in all 8 trials.

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 are 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 2014, 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 18 commercial fishers are employed in the SBBSMNF based on eight fishery licences operating in 2014. 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 2014

Level 2 - \$1 - 5 million

Commercial

The gross value of production (GVP) of the SBBSMNF in 2014 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 in Shark Bay and generates significant income for the regional economy.

Fishery Governance

Commercial

Current effort level (2014): **Acceptable**

Target catch range (2014):

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 620 boat days in 2014 and was the lowest level reported for the fishery. The total commercial catch in 2014 at 212 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. 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 byproduct by SBBSMNF vessels in 2014 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 (2014):

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' surveys were undertaken in 2011-2014) and therefore within the respective TACs in each area.

In 2014, a total of 727 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 (2015/16)

As an outcome of the 'Wetline Review' (see Fisheries Management Paper No. 224 for details), a management review is proposed. The review will incorporate the existing SBBSMNF, the Exmouth Gulf Beach Seine Fishery and commercial net fishing in the Carnarvon area.

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 222¹ & 250²). The impact of these events on key scalefish species in inner Shark Bay has not been determined.

Climate change has the potential to impact fish stocks through increasing sea surface temperatures, changes in major ocean currents (e.g. Leeuwin Current), rising sea level and ocean acidification. A review of the impacts and responses to marine climate change in Australia was undertaken by CSIRO in 2009. More recently, an FRDC-funded project assessed the effects of climate change on key fisheries in Western Australia (Caputi *et al.* 2014³). Pink snapper, yellowfin whiting, sea mullet and tailor are temperate species and Shark Bay is near their low-latitude range limit and forecasted increases in ocean water temperature associated with climate change may result in a contraction of the species' ranges southwards in the longer term.

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.

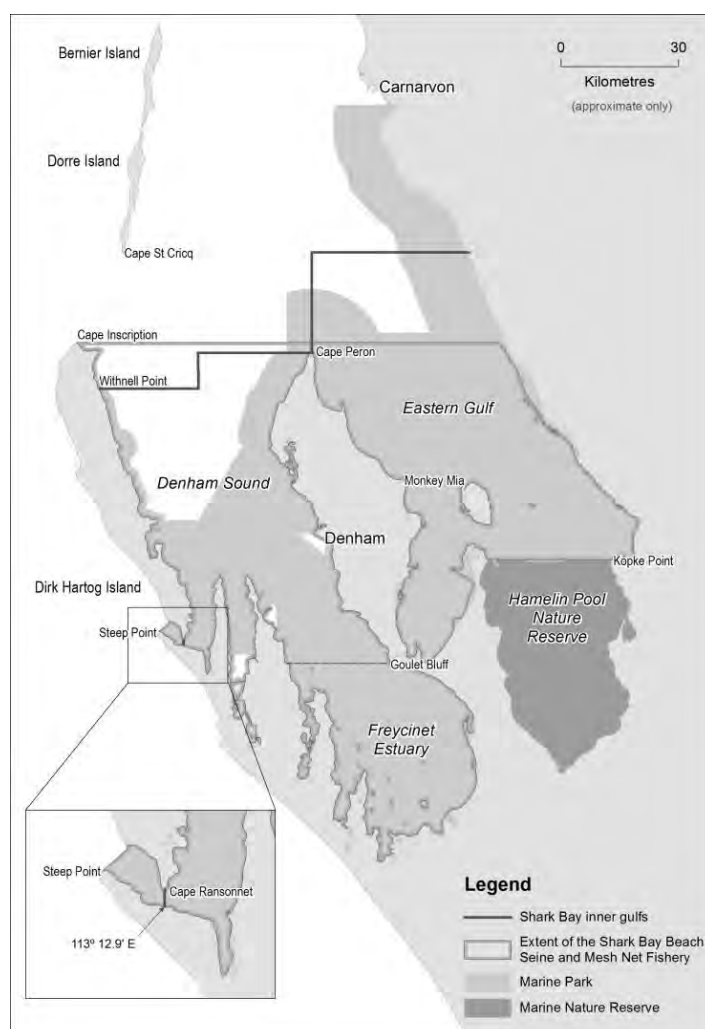
3 Caputi *et al.* (2014). Management implications of climate change effect on fisheries in Western Australia: Parts 1 & 2. FRDC Project 2010/535 Final Report. Department of Fisheries, Western Australia, Perth.

INNER SHARK BAY SCALEFISH FISHERY TABLE 1

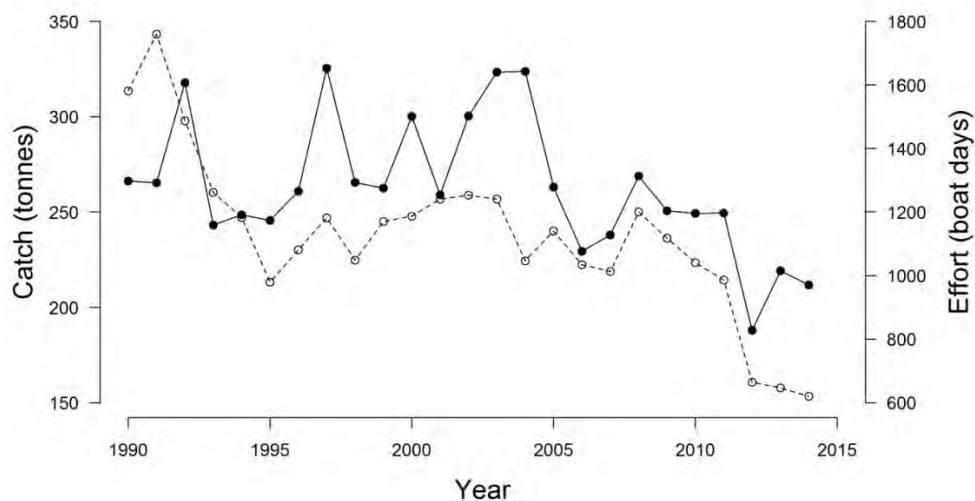
Annual catch and target catch range (tonnes) (upper), and annual CPUE and threshold level (kg/boat day) (lower) for key species taken by Shark Bay Beach Seine and Mesh Net Managed Fishery vessels for the period 2005-2014

Species	Acceptable catch range	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Whiting	93-127	116	113	102	117	115	118	105	116	142	118
Mullet	77-144	85	62	91	107	124	117	116	40	32	51
Tailor	25-40	19	21	23	23	19	19	17	16	15	7
Bream	7-15	27	23	14	8	8	10	9	9	18	18

Species	Trigger level	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Whiting	75	102	110	100	98	100	112	105	175	220	191
Mullet	62	74	60	90	89	106	107	116	61	50	83
Tailor	21	17	20	22	19	16	17	17	25	23	12
Bream	5	23	22	14	6	7	10	9	14	28	30

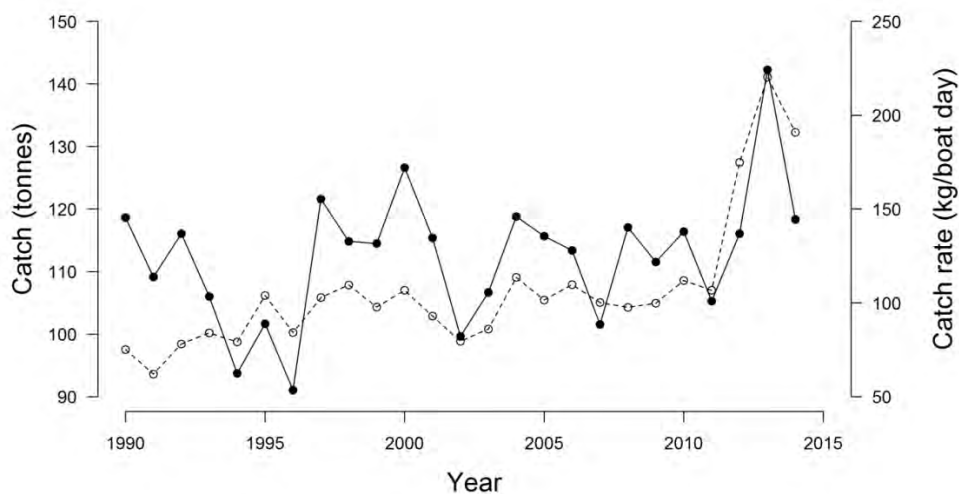
**INNER SHARK BAY SCALEFISH FISHERY FIGURE 1**

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



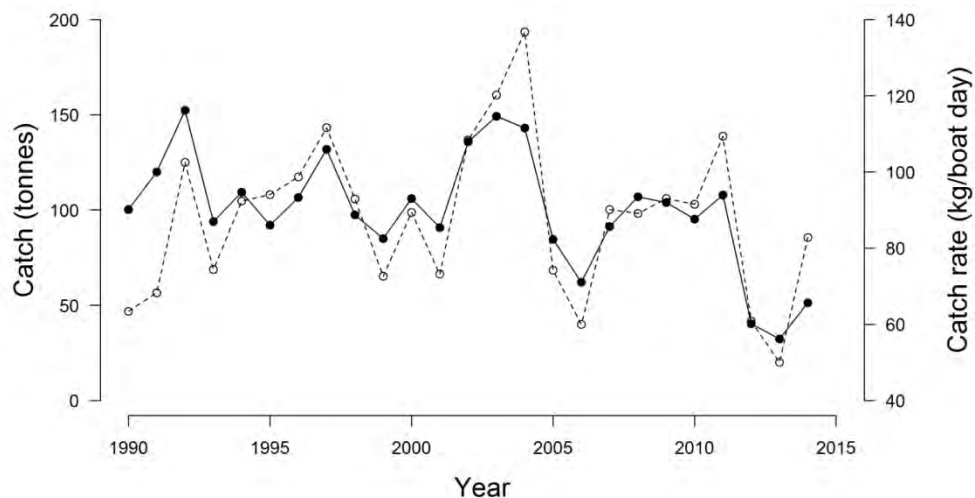
INNER SHARK BAY SCALEFISH FISHERY FIGURE 2

The total annual catch (solid line) and effort (hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.



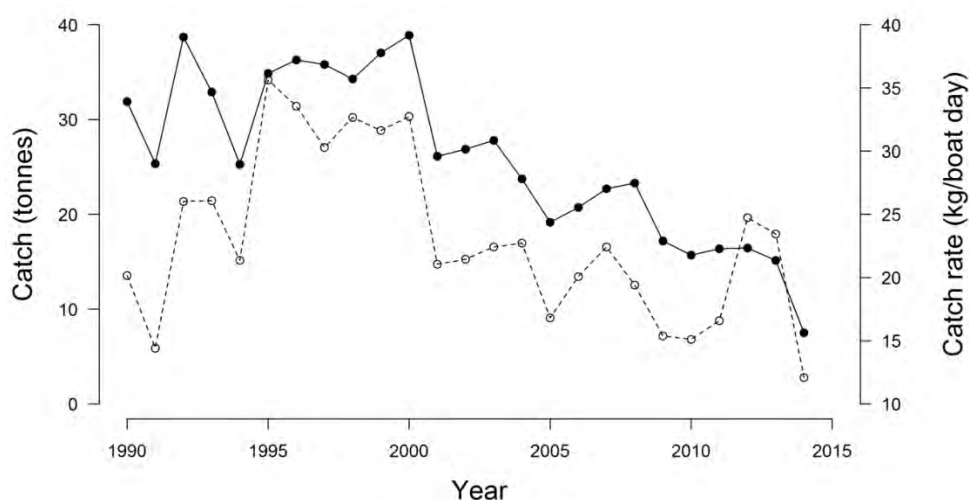
INNER SHARK BAY SCALEFISH FISHERY FIGURE 3

The annual whiting catch (solid line) and catch per unit effort (CPUE, hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.



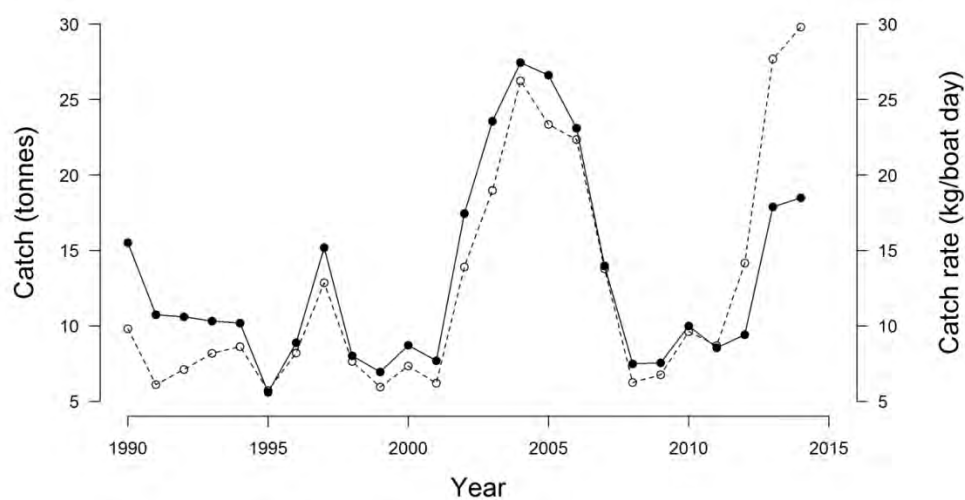
INNER SHARK BAY SCALEFISH FISHERY FIGURE 4

The annual sea mullet catch (solid line) and catch per unit effort (CPUE, hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.



INNER SHARK BAY SCALEFISH FISHERY FIGURE 5

The annual tailor catch (solid line) and catch per unit effort (CPUE, hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.



INNER SHARK BAY SCALEFISH FISHERY FIGURE 6

The annual western yellowfin bream catch (solid line) and catch per unit effort (CPUE, hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.

Shark Bay Blue Swimmer Crab Fishery Status Report

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

Main Features

Status		Current Landings	
Stock level	Recovering	Commercial catch	371 t
Fishing level:	Acceptable	Shark Bay trap fleet	175 t
		Shark Bay trawl fleet	196 t
		Recreational catch	~ 2.2 t (Gascoyne bioregion estimate)

Fishery Description

The blue swimmer crab (*Portunus armatus*) resource in Shark Bay is harvested commercially by the Shark Bay crab trap, Shark Bay prawn trawl and Shark Bay scallop trawl fisheries. This crab stock also supports a small (~2.2 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 heat wave, 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. Since the closure, intensive monitoring of the resource has been undertaken using a combination of trawl and trap based surveys. The fishery reached a partial stock recovery status in late 2013 and this provided some confidence for the resumption of commercial fishing for crabs in Shark Bay. A precautionary TACC of 400 tonnes was set for the 2013/14 season.

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 some 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 were managed under an input control system, through the regulation of licence and trap (hourglass) numbers or length of headrope of trawl net. However, since the resumption of commercial fishing for crabs in 2013, an appropriate TACC with clear stock monitoring and decision points has been used as the key management tool for the Fishery. The management arrangements for the Fishery are currently based on a notional quota system where licensees were allowed to trade quota between sectors. The Shark Bay crab resource is allocated across the prawn trawl, scallop trawl and trap sectors based upon the proportional catch history of each sector between 2007 and 2011, resulting in the following allocations: trap sector – 66.00%; prawn trawl sector – 33.80%; and scallop trawl sector – 0.20%.

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*. The Plan 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 traps than authorised under their respective Permits across all of the waters of Shark Bay.

There are currently 29 trawl (18 prawn and 11 scallop) licences that are excepted from the *Shark Bay Crab Fishery (Interim) Management Plan 2005* to the extent that they can 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 Commonwealth Department of the Environment (DoE) 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 have been 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 2013/14): 371 tonnes

Shark Bay trap fleet 175 tonnes

Shark Bay prawn trawl fleet 196 tonnes

Shark Bay scallop trawl fleet 0 tonnes

A precautionary TACC of 400 tonnes was set for 2013/14 season (27 September 2013 to 31 October 2014) and in accordance with the catch share arrangement between the trap and trawl sectors, the TACC provides for a harvest of up to 264 tonnes by the trap sector (66%) and up to 135.2 tonnes by the prawn trawl sector (33.8%) and 800 kg by the scallop trawl sector (0.2%). In August 2014, a private leasing

arrangement resulted in 75 646 kg of quota being transferred from the trap to the trawl sector.

The total catch achieved for the 2013/14 season was 371 t (~93% of the TACC) with a total of 28.7 tonnes of unfished quota allocation. The trap sector's total catch was 175 t over a total of 388 fishing days (all taken in the northern fishing grounds). This represented 47% of the total landings for this season.

The prawn trawl sector's total catch was 196 t which represented 53% of the total landings. Approximately 43 tonnes of the catch was taken in the Denham Sound fishing grounds (Western Gulf). There was no retention of crabs by the scallop trawl sector due to the closure of the Shark Bay Scallop Managed Fishery.

Recreational catch: < 1 % of total

The 2013/14 state-wide recreational fishing from boat surveys found only 4% of the state's blue swimmer recreational catches came from the Gascoyne region. The total number of blue swimmer crabs that were kept was 8 716 ± 2312 crabs which is approximately 2.2 tonnes by weight. Within Shark Bay, blue swimmer crabs were the most common invertebrate recreational species.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Level 4 - Direct survey/Catch rate/Size Distributions

Breeding stock levels: Recovering

The standardised trap CPUE was 1 kg/traplift which is on par with the proposed threshold level for this stock.

Fishery-independent trawl surveys established in 2012, continue to monitor the recovery of the crab stock in Shark Bay. Four surveys are undertaken in February, April, June and November which provide indices of legal, sublegal, spawning and recruitment catch rates.

Research data suggests an approximate 18-month life cycle from spawning to commercial sized crabs. The cohorts of legal-sized crabs (> 135 mm CW) that were fished during the 2013/14 season would have spawned between June 2012 and April 2013. The juveniles (new recruits) are detected between November 2012 and June 2013, approximately 5-6 months later (30 – 60 mm CW). Within the next 12 months crabs attain sexual maturity (between 100 - 110 mm CW) and reach commercial sizes.

Stock-environment relationships also continue to be monitored since the heat-wave event, where 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. This relationship can be used to foreshadow low, average or high abundance based on environmental conditions around the time of spawning and recruitment. It provides an early warning to potential climate driven changes to stock abundance and allow appropriate management actions to be considered.

The summer SST in 2013/14 have returned to within historic average levels but the winter 2013 SST is slightly cooler than

average. The predicted trap catch rate for 2013/14 was 1.05 kg/traplift and the actual catch rate was 0.97 kg/traplift. The predicted trap catch rate for the 2014/15 fishing season is 1.2 kg/traplift.

The TACC determination for the 2013/14 season was based on improved indices from 2013 surveys in comparison to 2012 which suggested partial recovery of the stock. This was substantiated by a short-term commercial crab fishing trial that was undertaken in June 2013 to assess 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. This led to resumption of commercial fishing for 2013/14 season based on a conservative TACC of 400 t with clear stock review points. Commercial catch and catch rates were used to evaluate the progress of the fishing season in conjunction with ongoing stock monitoring surveys.

The TACC for the 2014/15 season was increased to 450 t to reflect the stronger recruitment and sublegal indices associated with this cohort.

A number of indices of stock performance are currently being developed for the assessment and TACC determination of the Shark Bay crab fishery. Indices of spawning, juvenile, sublegal and legal crabs from fishery-independent trawl surveys will be assessed after each survey and reviewed annually, and when sufficient time-series of data is available, reference levels will be developed for these indices. The annual trap catch rate will also be reviewed annually and this year is on par with the proposed threshold reference level of 1.0 kg/traplift. The proportion of the TACC achieved will also serve as an additional indicator.

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. seastars, 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.

Bycatch from the prawn and scallop trawl fleets are described in the relevant status reports specific to the trawl fisheries elsewhere within this document.

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 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

Prior to the closure, the trap sector 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. The closure of the Shark Bay crab fishery during 2012/13 had a significant socio-economic impact on both the trap and trawl sectors. Resumption of fishing has relieved some economic pressure but there are ongoing logistical issues with retaining crew and staff.

Economic Effects

Estimated annual value (to fishers) for 2013/14

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

The average beach price for uncooked crabs across WA was \$5.24/kg. The estimated value of the commercial blue swimmer crab resource from Shark Bay was \$1.9 million which was a combination of \$1 million from the prawn trawl sector and \$0.9 million from the trap sector.

Fishery Governance

Current fishing (or effort) level:

Acceptable

Target catch (or effort) range:

400 tonnes (TACC)

A precautionary TACC of 400 t was set for the 2013/14 season of which approximately 93% was achieved (371t). Harvest control rules based on standardised catch rates have also been proposed.

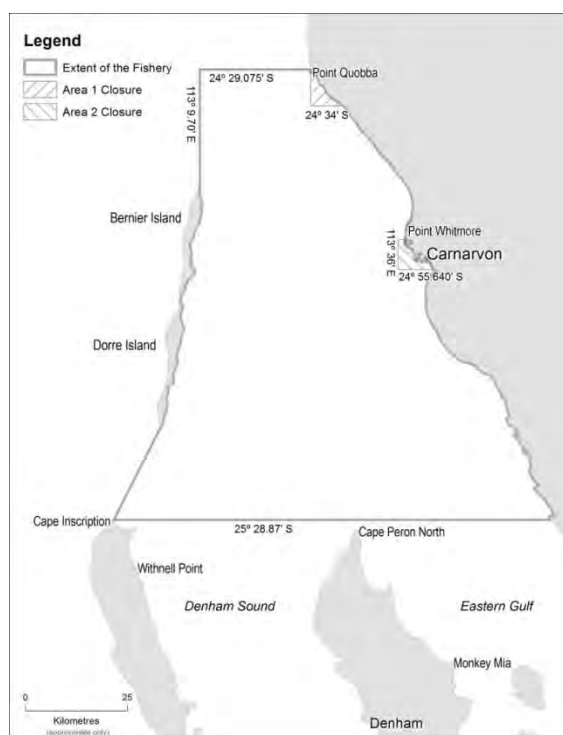
New management initiatives (2014/15)

Approval was 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 2015. 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 November 2015.

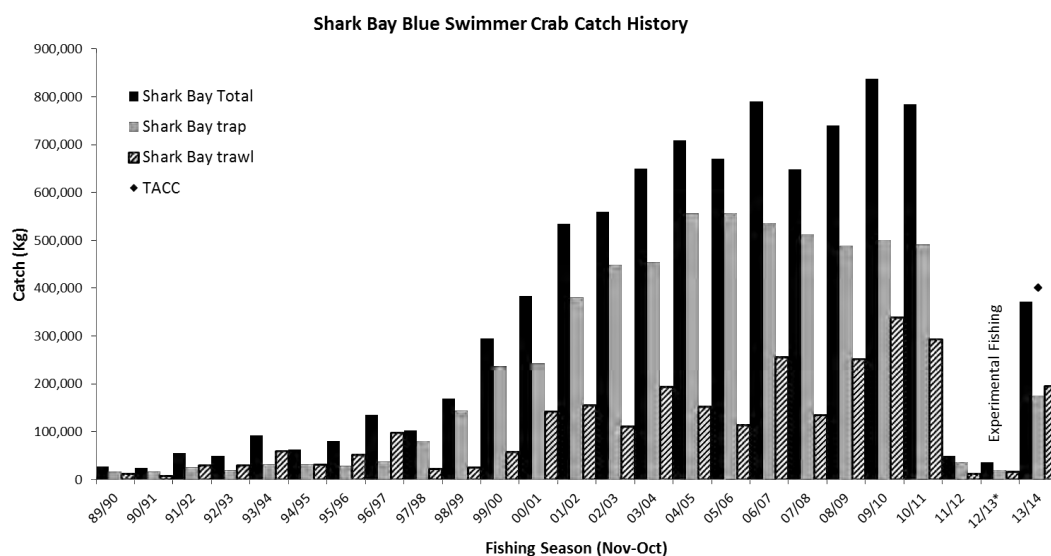
External Factors

Environmental factors have been identified as having a major effect on the recruitment of crabs throughout their distribution in WA, including Shark Bay. They were also ranked as a high risk to climate change and therefore need to be carefully monitored in the future.



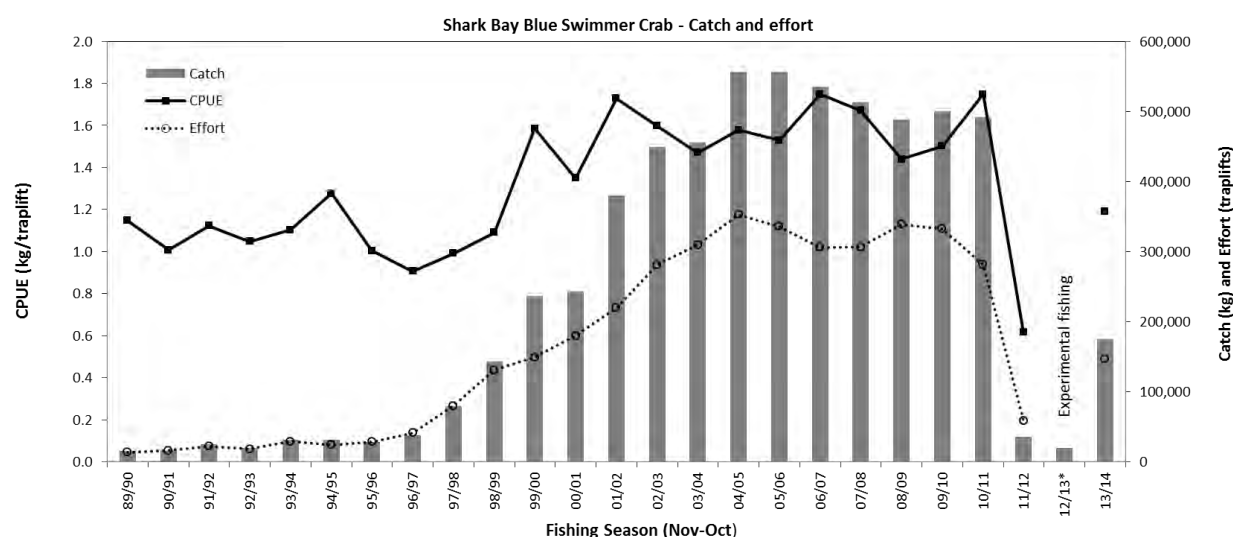
SHARK BAY BLUE SWIMMER CRAB FIGURE 1

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. A TACC of 400 tonnes was set for the 2013/14 fishing season.



SHARK BAY BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab trap catch (t), effort (traplifts x 1,000) and nominal 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 near Exmouth is in the process of being modified to operate as a biosecure hatchery for marine prawns. The licence holder's aquaculture licence has been varied accordingly and an associated conditional translocation authorisation has been granted, subject to inspection of the facility by the Department of Fisheries before the movement of any prawns.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services in the Gascoyne Coast Bioregion are delivered by Fisheries and Marine Officers (FMOs) with associated management and administrative support staff based at District Offices in Denham, Carnarvon and Exmouth. During 2013/14 the three district offices supported a total of six FMO positions allocated to deliver services to several client groups including commercial and recreational fisheries, marine parks, bio-security, 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 Parks and Wildlife (DPAW), FMOs monitor and deliver compliance and education programs covering some 30 Sanctuary Zones and Marine Managed Areas and other protected areas.

As a result of using a compliance delivery model based on a risk assessment process and subsequent operational planning framework, FMOs undertake regular land, and sea patrols and occasionally undertake aerial surveillance. A high visibility Recreational Fishing Mobile Patrol is also an integral part of the Gascoyne pool of compliance resources, as this dedicated education and compliance team has the

ability to patrol coastal areas from Onslow through to Denham.

Based in Exmouth is a 13-metre Patrol Vessel (PV) the PV *Edwards*. This vessel is utilised to conduct compliance activities throughout the Gascoyne bioregion and the lower parts of the Northern bioregion. With services provided within Shark Bay and its associated islands, throughout the Ningaloo Coast and Exmouth Gulf, and north through the Mackerel, Barrow and Monte Bello Islands. 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. Collectively, all 3 Districts FMOs spend approximately 90 days a year at sea on patrol duties.

In addition to the afore mentioned maritime assets, Gascoyne FMO's also engage the services of a large patrol vessel the PV *Houtman* to conduct at sea compliance inspections of vessels operating the Shark Bay and Exmouth Gulf Prawn Fisheries and Gascoyne Demersal Scalefish fishery.

Other compliance activities undertaken are intelligence based investigations into offences by commercial and recreational fishers, catch inspections, licence checks, gear inspections and marine safety inspections.

Activities during 2013/14

During 2013/14, a reduced number of Fisheries and Marine Officers delivered a total of 6,036 hours of compliance and community education services in the field (Gascoyne Bioregion Compliance Table 1). This represents a slight increase in field compliance over the previous year. Contact numbers increased, but the numbers of warnings, infringements and prosecutions remained similar to previous years.

Other activities undertaken within the Gascoyne have included

- Commencement of the West Coast Deep Sea Crustacean Fishery Marine Stewardship Council certification
- Further development of the Gascoyne Demersal Phase II management plan amendments to move from an ITQ regime for Pink Snapper and ITE for other non- Pink Snapper demersal species to ITQ for both pink and non pink demersal scalefish.
- Progression of the Shark Bay Crab fishery from an "interim" management plan to management plan

- Recruitment of a Supervising Fisheries and Marine Officer into Carnarvon

FMOs delivered compliance activities directed at commercial fisheries mostly through pre-season inspections, catch inspections and quota monitoring, as well as at-sea inspections. A number of investigations resulting from suspected breaches detected via the Vessel Monitoring System and intelligence based operations were also conducted. Management and FMO effort was again directed at building stronger relationships with industry through higher levels of contact both at sea and in port and through meeting with Licence Holders and Masters. During 2013/14 the Marine Stewardship Council (MSC) and the DoF continued 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 sanctuary zones and 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 delivered 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.

Initiatives in 2014/15

For the 2014/15 year a number of initiatives across the Gascoyne Bioregion have been planned. These include:

MSC certification of Shark Bay Prawn and Exmouth Gulf Prawn fisheries.

Full assessment of West Coast Deep Sea Crustacean Fishery by the Marine Stewardship Council.

Implementation of a new Management Plan for the Gascoyne Demersal Scalefish Fishery

Implementation of a new Management plan for the Shark Bay crab Fishery

Introduction of a quota based fishery management framework for Shark Bay Scallop

Renewal and implementation of new state-wide marine park Collaborative Operational Plans with the Department of Parks and Wildlife

Recruit FMOs into Exmouth, Carnarvon and Denham

Amalgamate the Gascoyne and Midwest Regions

GASCOYNE COAST COMPLIANCE TABLE 1

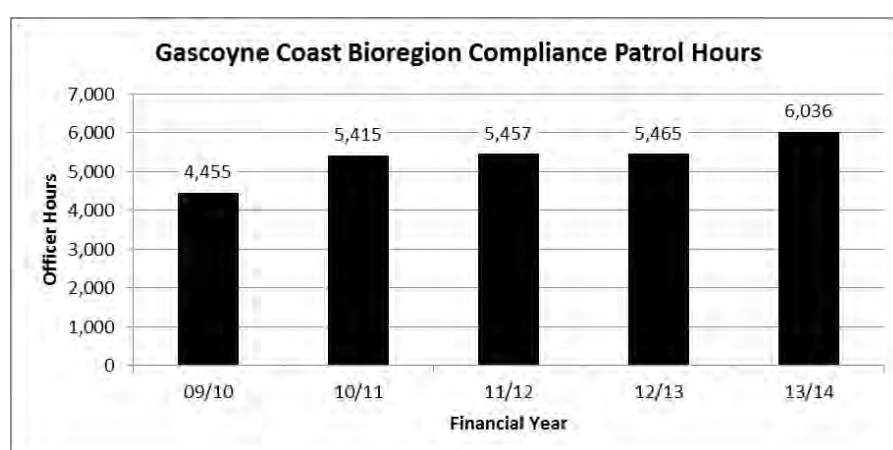
Summary of compliance and educative contacts and detected offences within the Gascoyne coast bioregion during the 2013/14 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION		6,036 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY		
Field Contacts by Fisheries & Marine Officers		135
Infringement warnings		10
Infringement notices		11
Prosecutions		0
Fishwatch reports**		0
VMS (Vessel Days)***		7,606
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY		
Field Contacts by Fisheries & Marine Officers		20,268
Infringement warnings		69
Infringement notices		137
Prosecutions		20
Fishwatch reports		41
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*		
Field Contacts by Fisheries & Marine Officers		2,722
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 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 five years. The 2013/14 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. (The totals exclude: time delivered by the Department's large patrol vessels PV Walcott PV Houtman and PV Hamelin; time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.. Time spent in Marine Park sanctuary zones is also excluded because this time may overlap field time outside a sanctuary zone and as a result, the historic data is slightly lowered compared to that reported in previous reports).

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.

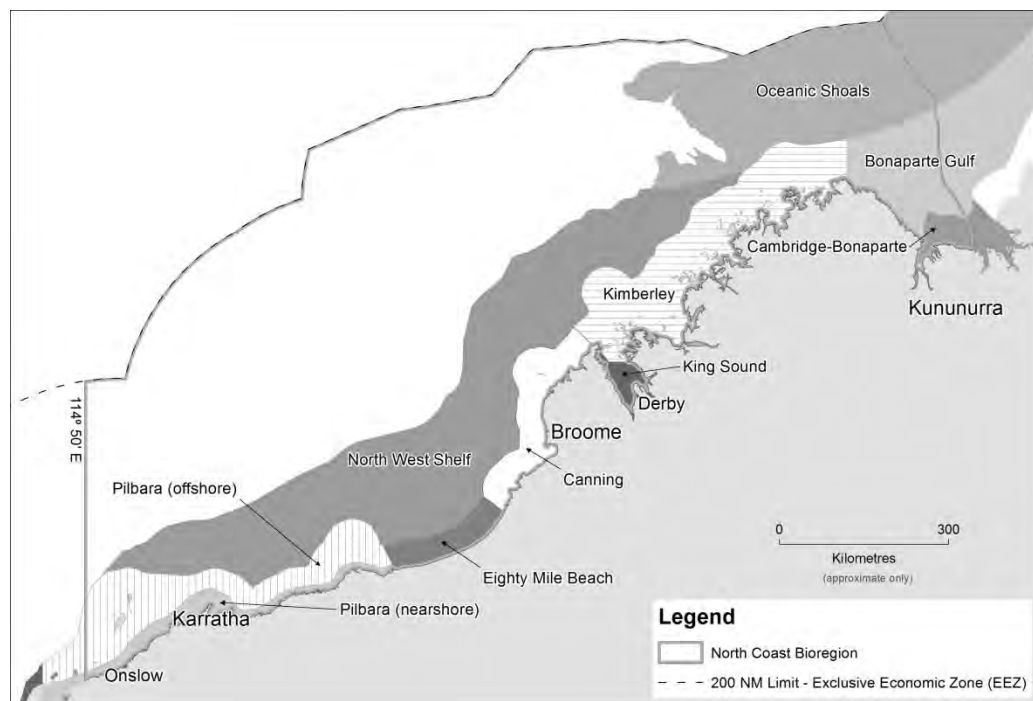
Significant river run-off and associated localised coastal productivity can be associated with cyclone events, with run-off ceasing during winter. Despite localised areas of high productivity the region is generally oligotrophic and large areas of the coastline receive no riverine input. The entire North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

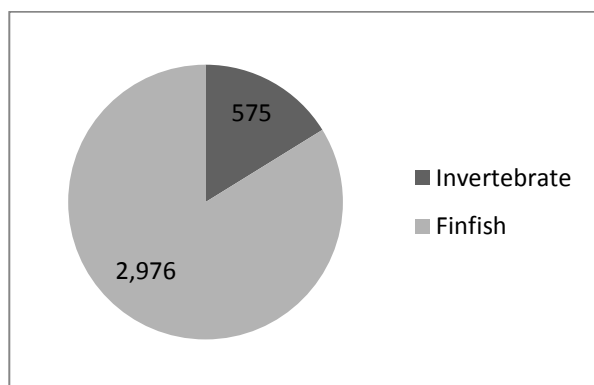
Commercial fishing

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 trap, line and trawl fisheries and the Northern Demersal Scalefish (trap and line) Fishery. 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 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).

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 operational since 1974.



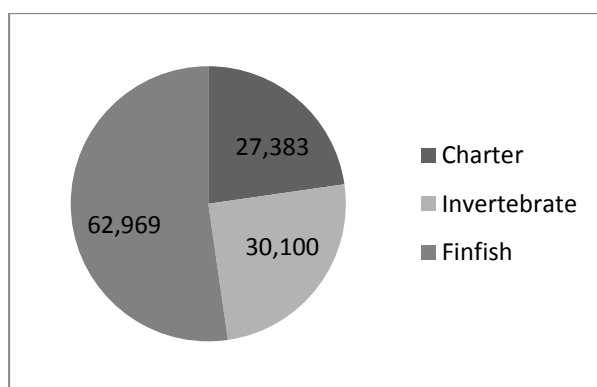
NORTH COAST OVERVIEW FIGURE 2

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.

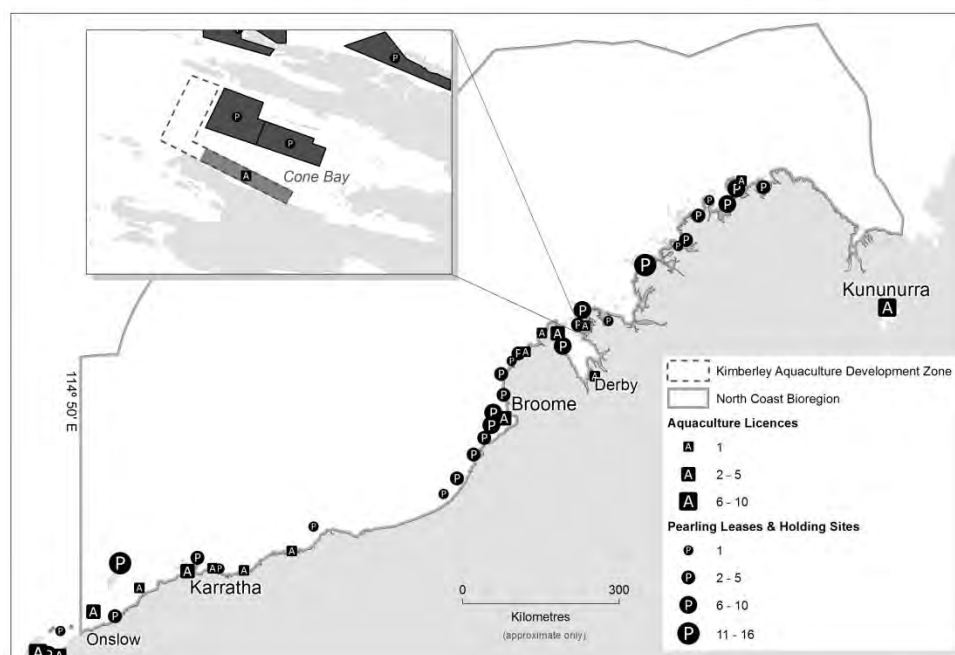


NORTH COAST OVERVIEW FIGURE 3

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.

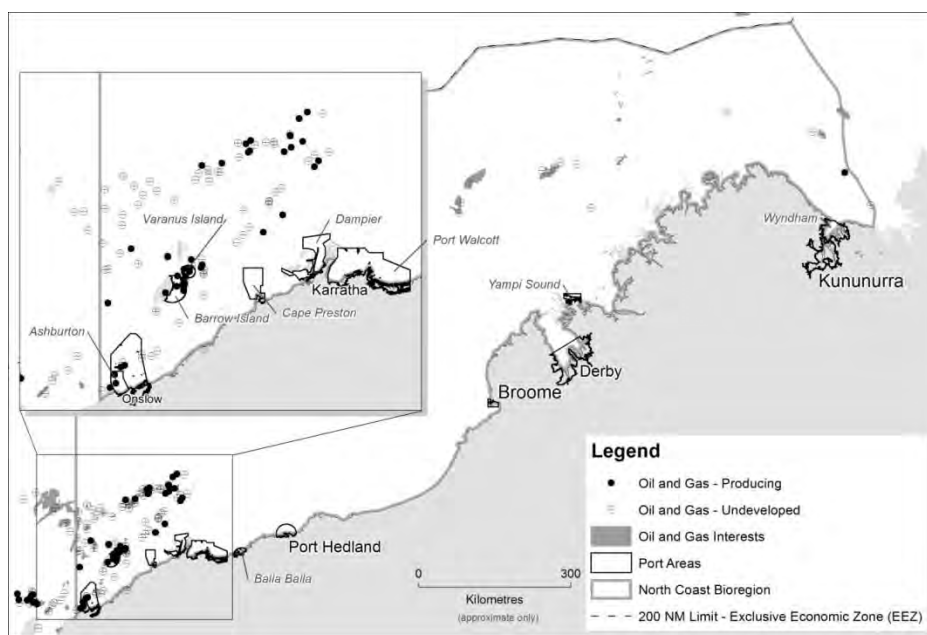
Tourism

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

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

Extensive work has been undertaken as part of a three-year FRDC-funded project (Caputi et al. 2015a,b) that assessed 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. Although these studies focused on Bioregions more susceptible to increases in SST to the south, there were no documented effects of climate change occurring on the species selected (Caputi et al. 2015a,b). However, if anecdotal information is quantified on a southward shift in the range of Narrow-Barred Spanish Mackerel then it is possible that the total biomass of this species in Western Australia will increase due to various factors associated with breeding and availability of suitable habitats (Caputi et al. 2015b).

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 and Day *et al* 2012¹; North Coast Ecosystem Management Table 1).

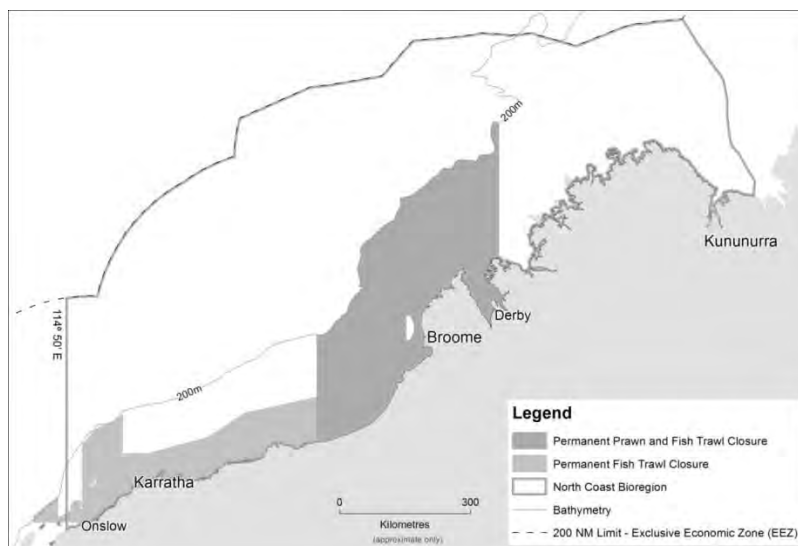
NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

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

IUCN category or equivalent	State Waters only (65,400 km ²)				All Waters (837,500 km ² (including State waters))			
	Fisheries km ²	%	Existing MPA km ²	%	Fisheries km ²	%	Existing MPA km ²	%
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.

Day J., Dudley N., Hockings M., Holmes G., Laffoley D., Stolton S. & S. Wells, 2012. *Guidelines for applying the IUCN Protected Area Management Categories to Marine Protected Areas*. Gland Switzerland: IUCN. 36pp



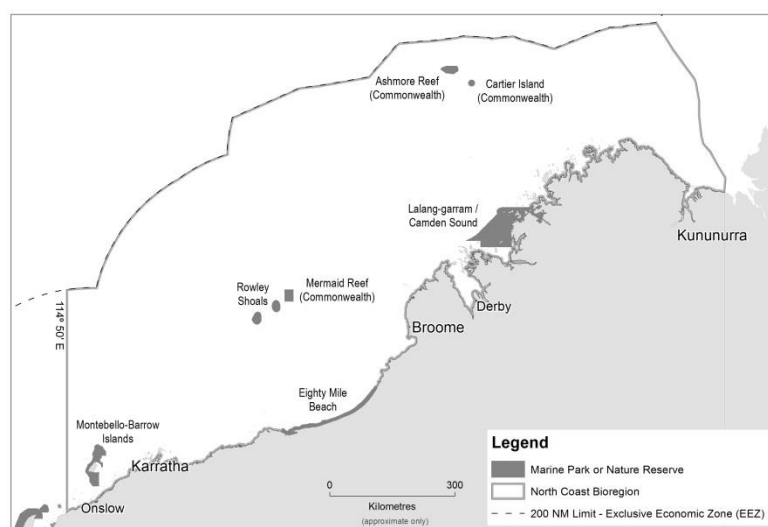
NORTH COAST OVERVIEW FIGURE 6

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 Bioregion and has established baseline and ongoing monitoring and research to underpin ecosystem management. There is considerable interest in developing further marine protected areas within the Kimberley region, and the State Government is developing management plans, Indigenous Land Use Agreements (ILUA) and zoning arrangements for marine protected areas at Eighty Mile

Beach, Roebuck Bay, Horizontal Falls and the North Kimberley. 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 was managed via a Bioregional-specific management strategy from 2003 until Statewide management was largely re-introduced in 2013. 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' licence 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

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.

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 implements a range of monitoring and research activities in the bioregion focussed on detection of introduced marine pests (IMPs) at high risk locations and vessel risk analyses. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. Further details for these projects may be found in the “Introduced Pests Status Report” at the end of this section and also in the Appendix section entitled “Activities of the Marine Biosecurity Research Group during 2014/15”.

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

Management of Oil and Gas Impacts

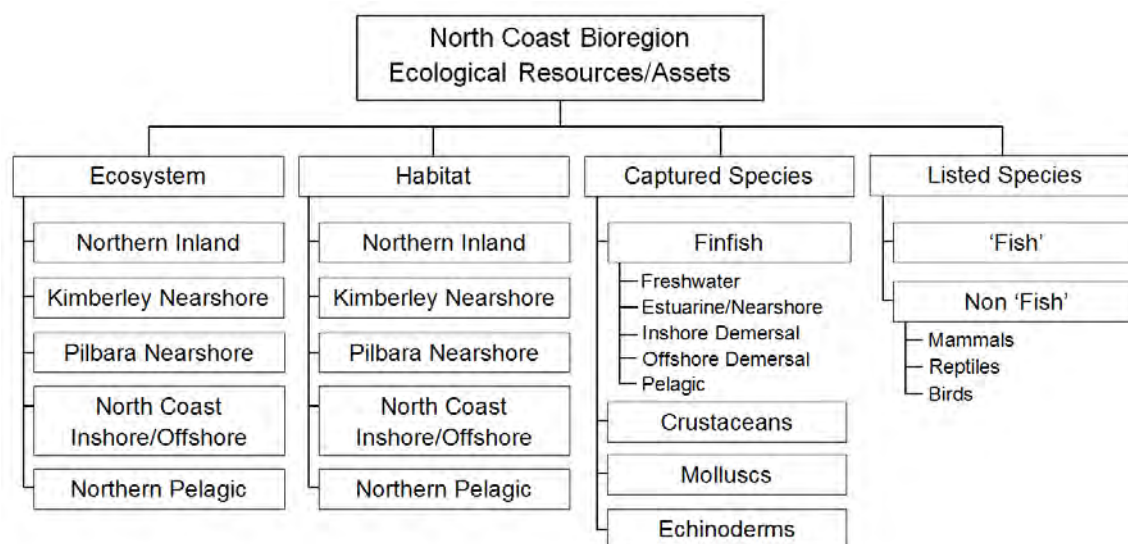
Marine habitats within the North Coast Bioregion of Western Australia are experiencing increasing pressure through a range of activities but most notably as a result of increased resource development activity that is occurring in the area. The Department continues to engage with the Environmental Protection 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.*, 2010¹)(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.

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



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.

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. The Department implements a range of monitoring and research activities in the Bioregion, focussed on early detection of potential marine pests. Further details for these projects may be found in the "Introduced Pests Status Report" at the end of this section and also in the Appendix section entitled "Activities of the Marine Biosecurity Research Group during 2014/154".

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

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.

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 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 preceding "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 Nickol 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 trawling occurs. The trawl grounds of the OPMF and the NBMPF 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: Pilbara 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

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.

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 (trap and line). 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 Scalefish 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, 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 as 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 Kimberley 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 protected¹ (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

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

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 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 Group continues to implement a series of biosecurity related projects in the North Coast Bioregion which include detection strategies and vessel risk analyses.

Early detection of IMPs is vital if any attempt at eradication or other management strategies is to be successful. Thus the Marine Biosecurity Research Group undertakes regular and comprehensive marine pest monitoring at the ports of Dampier and Port Hedland. This monitoring incorporates a three tiered approach. First the undertaking of a nationally approved design, second a more targeted monitoring program and third a program using permanently in-situ sampling equipment (Early Warning System). The national system monitoring adheres to the Australian Marine Pest Monitoring Guidelines and is endorsed by the Commonwealth, and occurs every second year. The targeted monitoring is a smaller more focussed survey designed to target select high risk sites in each port and established by the Marine

Biosecurity Research and Monitoring Group to fill in the gap between the national system surveys (i.e. the alternate years). The national system monitoring of Dampier port was completed in early 2015, with monitoring in Port Hedland Port scheduled for later in 2015. The next round of complementary monitoring for these ports is scheduled for 2016. The Early Warning System program, which uses *in-situ* sampling arrays to aid in the early detection of marine pests in both ports, is run by the Marine Biosecurity Research Group, with financial and *in-kind* assistance from the Pilbara Ports Authorities and stakeholders, and the private ports of Cape Preston and Cape Lambert. This program provides a cost-effective mechanism for the potential early detection of marine pests in these waters. Through this combined surveillance the introduced marine pest species that have been detected since initiation of these projects in this bioregion are reported in Introduced Pests Table 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. The number of commercial vessels entering the North Coast Bioregion has significantly increased (~1600%) over the past 12 years (2002 to 2014). As a result the Marine Biosecurity Research Group is analysing the change in numbers of commercial vessels as well as their visit and type profiles to better inform management processes of the domestic and international risks to the Bioregion.

The group is also examining the risk recreational vessels pose with respect to introducing, harbouring and translocating IMPs around the State. This project involves surveying marina-based vessel owners about their vessel management practices and their vessel use profiles. The research outputs are designed to be applicable to biosecurity management across the state.

For further details on the above projects see the Appendix section entitled “Activities of the Marine Biosecurity Research Group during 2014/15”.

INTRODUCED PESTS TABLE 1

Introduced marine species detected in this bioregion.

Scientific name	Type of organism	IMS/IMP listing	Noxious Listing
<i>Theora fragilis</i>	Mollusc	Introduced species	No
<i>Didemnum perlucidum</i>	Ascidian	Introduced species – likely pest	Yes

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:	<0.5 t
Fishing level	Acceptable	Nickol Bay:	211 t
		Broome:	0 t
		Kimberley:	287 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 merguensis*).

The BPMF operates in a designated trawl zone off Broome and targets western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species).

The KPMF operates off the north of the state between Koolan Island and Cape Londonderry. It predominantly targets banana prawns (*Penaeus merguensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*).

Governing legislation/fishing authority

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Broome Prawn Managed Fishery Management Plan 1999

Broome Prawn Managed Fishery Licence

Kimberley Prawn Fishery Management Plan 1993

Kimberley Prawn Managed Fishery Licence

Exemptions under Section 7 of the *Fish Resources Management Act 1994*Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)**Consultation process**

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

Boundaries

The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114°39.9' on the landward side of the 200 m depth isobath'. The fishery is divided into three parts with associated Size Management Fish Grounds (SMFGs) and nursery areas as follows: Area 1, incorporating the Ashburton SMFG; Area 2, incorporating the Mangrove Island and Weld Island SMFGs and Coolgra Point Nursery; and Area 3, incorporating the Fortescue SMFG (Northern Prawn Figure 1).

The boundaries of the NBPMF are 'all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120° east longitude on the landward side of the 200 m isobath'. The NBPMF incorporates the Nickol Bay, Extended Nickol Bay, Depuch and De Grey SMFG's (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 KPMF 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. 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 2014 season officially opened on 21 April and closed on 8 October with subsidiary openings and closings of SMFG's. The specific SMFG openings were as follows:

Areas 1, 2, 3	21 April – 8 October
Fortescue SMFG	01 June – 8 October
Ashburton SMFG	21 May – 12 July
Weld Island SFMG	21 May– 31 August
Mangrove Island SFMG	21 May –8 October

NBPMF: The management arrangements in the NBPMF provide for authorised boats to tow standard otter trawl nets not exceeding 29.27 metres (16 fathoms) each boat. The 2014 season opened on 24 March and closed on 31 October with subsidiary openings and closings of SMFG's. Nickol Bay and Depuch SMFGs were open for daylight fishing only (0600 hrs and 1800 hrs) between 21 May and 4 June. The specific SMFG openings were as follows:

Nickol Bay	21 May – 2 October (Day fishing only 21 May – 4 June)
Extended Nickol Bay SMFG	21 May –31 October
Depuch SMFG	21 May – 2 October (Day fishing only 21 May – 4 June)
De Grey SMFG	21 May –2 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. The Fishery opened on 1 June and officially closed on 8 October, providing for 128 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 121 boats licensed 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 fishery 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 slight change of the southern boundary area to the Admiralty Gulf closure designed was trialled for the 2014 season to increase access to prawn abundances. This trial will be in place for the 2015 and 2016 season.

A comprehensive Ecologically Sustainable Development 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, KPMF and BPMF trawl fisheries and export approval has been granted for ten years (re-assessment in 2025) 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 2014 limited commercial fishing was undertaken and uncertainty of fishing viability in Area 1 the most productive area in this fishery still remains as in 2013. 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. A preliminary harvest strategy with control rules has been developed for these fisheries.

Retained Species

Commercial production (season 2014):

Onslow:	<0.5 tonnes
Nickol Bay:	211 tonnes
Broome:	0 tonnes
Kimberley:	287 tonnes

Landings

OPMF: The total recorded landings in the OPMF were <0.5 t comprising of brown tiger prawns and banana prawns (Northern Prawn Figure 5).

NBPMF: The total recorded landings of major penaeids for the 2014 season reported by the Nickol Bay fishers was 211 t, comprising: 171.1 t of banana prawns from the Nickol Bay fishery, and 14.8 t from Onslow, Area 3, (providing a total of 185.9 t), 24.9 t of tiger prawns, and negligible amounts of western king and endeavour prawns. These are the highest

catches of banana and brown tiger prawns since 2006. (Northern Prawn Figure 6).

Byproduct has been reported since 2000. For 2014, byproduct comprised; 4.9 t of blue swimmer crabs (*Portunus armatus*), and <1 t of bugs (*Thenus orientalis*), cuttlefish and squid species. Since 2000 the total recorded byproduct landings have been very low except for 2004 when high squid and bugs landings were recorded. Generally bugs are sought after because of their high relative value but since 2007 recorded annual landings have been less than 1 t.

BPMF: No landings were recorded as no boats fished in 2014. Boats briefly sampled the area on two occasions, but the catch rate was considered to be low and no commercial fishing was therefore undertaken (Northern Prawn Figure 7). The cost to fish, particularly high fuel prices was a major factor in fishers deciding not to fish.

KPMF: The total recorded landings in the KPMF were 287 t, comprising 269 t of banana prawns, 8 t of brown tiger prawns and 10 t of endeavour prawns (Northern Prawn Figure 8). Banana prawns landings were within the target catch range and within the catch prediction range of 230 to 350 t calculated using the relationship between summer rainfall and annual landings. Since 1980, banana prawn landings have ranged between 150 and 450 t. The endeavour prawn annual landings were within the target catch range and the tiger prawns annual landings were slightly below the target catch range. Fishing occurred in both fishing periods and the second part of the season produced catches comparable with historical monthly catches. Negligible quantities of byproduct were reported.

Recreational component:

Nil

Fishing effort/access level

OPMF: Area 1 boats are authorised to use two trawl nets each having a maximum headrope length of 10.98 metres (6 fathoms), a maximum of total headrope of 87.84 metres (48 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. There was limited fishing by one boat during the 2014 season in Area 1 only. All other catch recorded for the fishery was taken from Area 3 by Nickol Bay boats and these catches are reported in the Nickol Bay section.

NBPMF: 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). Seven boats fished during the 2014 season for a total of 272 boat days. Most of the fishing effort was applied in May, June and July where 7 boats fished in May and June and 4 boats in July, after that only two boats fished in August, one boat in September and October. This is the highest effort reflecting the higher abundance of banana prawns since 2006.

BPMF: Each of the five licences in this fishery has an equal allocation of net headrope of 73.16 metres (40 fathoms) and the maximum total headrope length for the entire fleet is 365.8 metres (200 fathoms). No effort was expended in the BPMF in 2014 (Northern Prawn Figure 7).

KPMF: Although a total of 121 managed fishery licences have access to the KPMF, only nine boats operated in the fishery during 2014. The number of boats is low compared to the years prior to 2008 (Figure 6). The total number of days recorded by VMS when boats were physically within the fishery boundaries were 570 days and well below the allocated fishing days (1500) (Table 2). The data from daily logbooks indicate that 437 boat activity days were recorded in the fishery which includes searching. However of these 437 boat days there were only 389 days when boats actually recorded fishing effort and catch (Northern Prawn Figure 8).

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 (2015):

NBPMF: 61 t banana prawns

KPMF: 260 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 2014. The total landings of prawns were extremely low. There has been disruption and disturbance to some productive Area 1 fishing grounds. Approval for trawl fishing activity must be sought from the Regional Authority before fishing can be undertaken. Also parts of Area 1 had exclusions zones restricting parts of the area from trawling operations because of pipeline on the seabed from the offshore gas platforms and general boat movement in the area making fishing operations difficult. Since there was little catch and also effectively no effort on the brown tiger prawn stock in this part of the fishery, adequate breeding stock would remain. This also applies for the western king prawn stock.

NBPMF: The recorded landings of banana prawns in 2014 from Nickol Bay were slightly above the predicted catch range (114 to 171 t) but within the target range (40 – 220 t). The brown tiger prawn catch was within the target range (2 – 40 t) and the western king prawn landings were extremely low and below the target range for this species. 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 2014 and March 2015 (at Roebourne) was 74.2 mm and the predicted catch for 2015 is 61 t with a range of 48–73 t of banana prawns. However, there has been late rainfall in the region and this could provide increased abundance of banana prawns but is recognized as being outside the normal environmental conditions range that has historically been used.

BPMF: No landings were recorded as no boats fished the BPMF in 2014.

KPMF: Throughout the history of the fishery, the stock of banana prawns in the Kimberley has been assessed using the annual catch (tonnes). 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 2014 landings are within the target catch range for banana prawns. Several additional indicators of stock abundance based on raw catch per unit effort (CPUE) have been explored and may have potential for use in future assessments, once a longer time series is available of daily logbook records. Also a preliminary biomass dynamics model was developed as part of the MSC pre-assessment. The relationship between annual catches and rainfall is used to broadly predict the amount of banana prawn catch likely to be available to fishers during the fishing season however, the relationship is relatively weak. The relationship is based on the rainfall in Kalumburu and Derby in January and February (which was 475 mm in 2015). The predicted catch of banana prawns in 2015 is 260 t, with a range of 210 to 315 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 2014 the breeding stock indicators in the OPMF (catches within specified ranges, as set out in the 'Fishery governance' section) could not be assessed as negligible fishing and hence landings occurred which would have provided maximum protection to the entire stock from fishing.

The main performance measures for the Nickol Bay fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2014 the breeding stock indicators (catches within specified ranges i.e. 40 to 220 t of banana prawns, as set out in the 'Fishery Governance' section) for banana prawns were met. There is no trend of an increased prevalence of low catch years in the last two decades. In 2014, the annual catch was within the target catch range, despite low effort, indicating adequate overall stock (and breeding stock) abundance. Brown tiger prawn landings were within the target range (2-40 t) whilst western king prawn landings were extremely low and below the acceptable range (2-70 t). Whether these low western king prawn catches are due to low stock levels, very limited targeting on this species or due to environmental factors is

not known at this stage. The endeavour prawn landings are negligible and they are not a target.

An assessment of breeding stock could not be made for the BPF as there was no fishing effort.

The breeding stock indicators in KPMF (catches within specified ranges) for banana prawns were within the target range whereas the brown tiger prawns were slightly below the target range but the endeavor were within their range.

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 was negligible due to very low effort. No fishing was undertaken in the BPF. All trawl nets have grids to exclude large fish and most listed species.

Listed species interaction:

OPMF, BPF: **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.

NBPMF: In 2014, 12 turtles (8 green, 1 hawksbill and 3 unidentified) were recorded as captured and released back to the sea alive. Twenty two sea snakes were reported as caught. Twelve were released alive and 10 reported as dead. Fifteen sawfish (status unknown) were reported as captured.

KPMF: Nineteen sea snakes were reported as captured. Fifteen were returned to the sea alive whereas 4 were reported dead. Six 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 limited fishing and no fishing in the BPF the limited spatial coverage of the Onslow fishery 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, BPF: **Negligible**

NBPMF, KPMF: **Low**

In 2014 the area fished in the three northern fisheries where fishing took place ranged from 2.1% in the Kimberley fishery to <1% in the Nickol Bay and Onslow fisheries whereas the Broome fishery was not fished, are 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 2014 was 40 to 60 including skippers and other crew with additional people involved in local processing.

Economic Effects

Estimated annual value (to fishers) for 2014:

OPMF/NBPMF/BPF/KPMF:

Level 3 - \$5 - 10 million (\$5.3 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

BPF Target catch range: **55 – 260 tonnes**

Current fishing level: **Nil**

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 (2015):

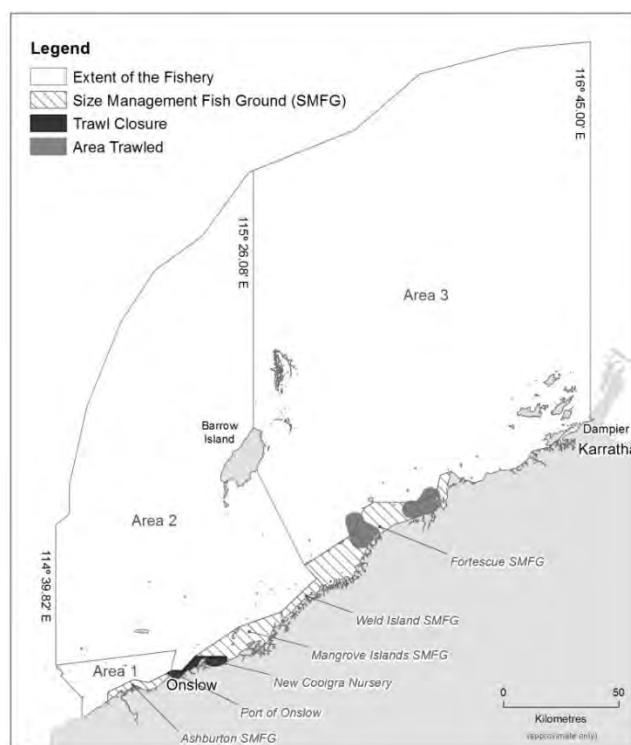
The KPMF is scheduled for a management review in 2015. As part of the review the Department will be liaising with licensees in the KPMF regarding the options to implement management arrangements aimed at increasing the viability of the KPMF operators.

External Factors

The resource industry developments in the OPMF during 2014 continue with uncertainty about the access to prawn abundance in traditionally high catching fish grounds and overall viability of operations.

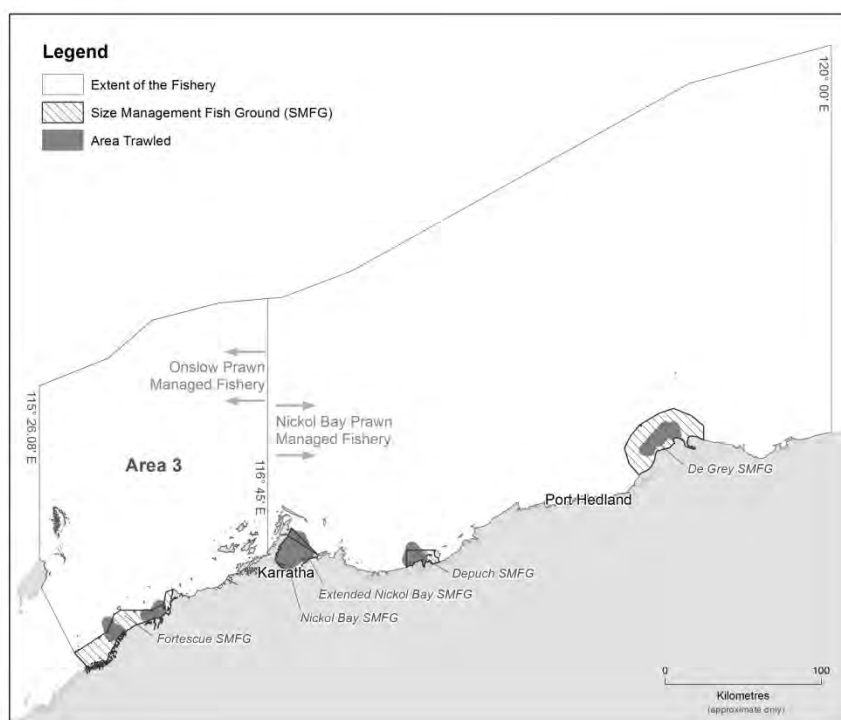
Banana prawns are rainfall dependent and can be highly variable annually in the KPMF, NBPMF and for the OPMF where banana prawns may be in some years be taken predominantly off the mouth of the Ashburton River. Due to high costs of fishing and low prawn prices, some boats in these fisheries are choosing not to fish in years of relatively low banana prawn catches. 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 western king prawns which could also be contributing to the very low landings of this species in all of these northern fisheries.

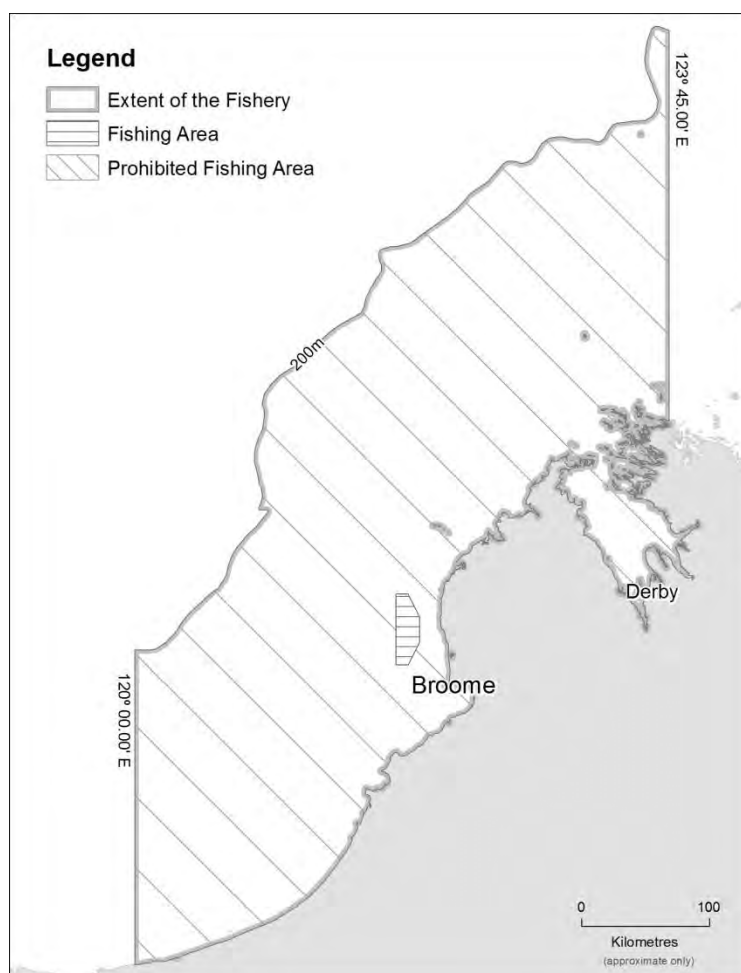


NORTHERN PRAWN FIGURE 1

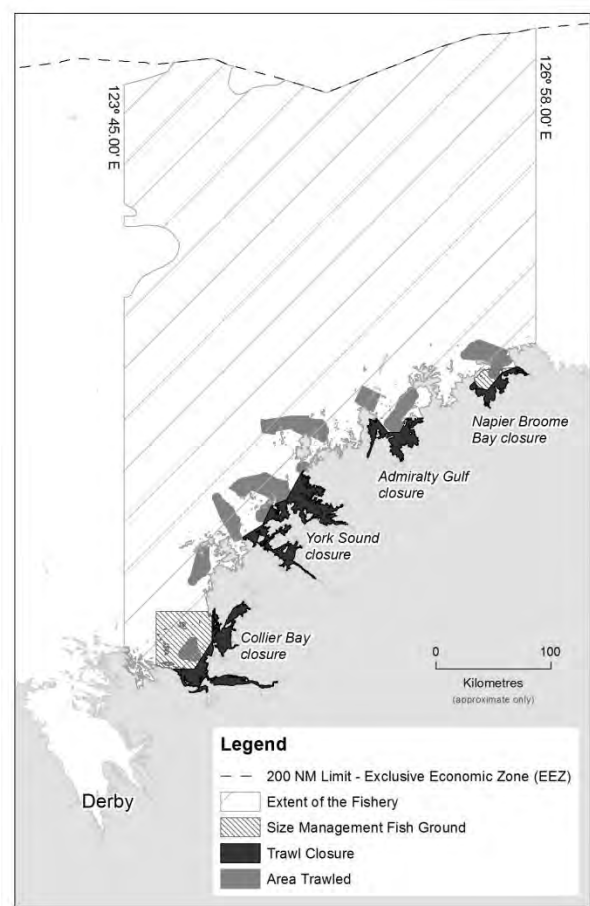
Boundaries of the Onslow Prawn Managed Fishery indicating trawl closures and size management fish grounds area. Negligible fishing occurred in 2014.

**NORTHERN PRAWN FIGURE 2**

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2014.

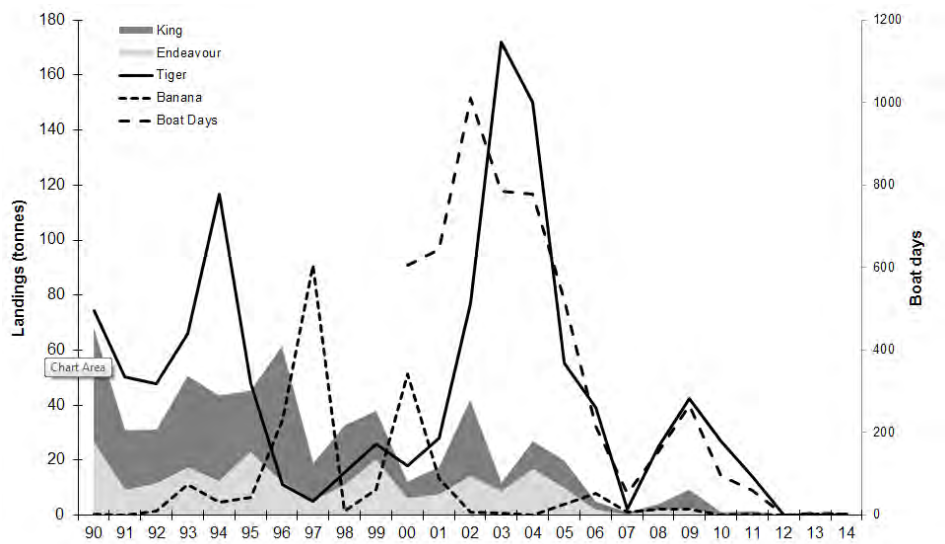
**NORTHERN PRAWN FIGURE 3**

Boundaries of the Broome Prawn Managed Fishery. No fishing occurred in 2014.



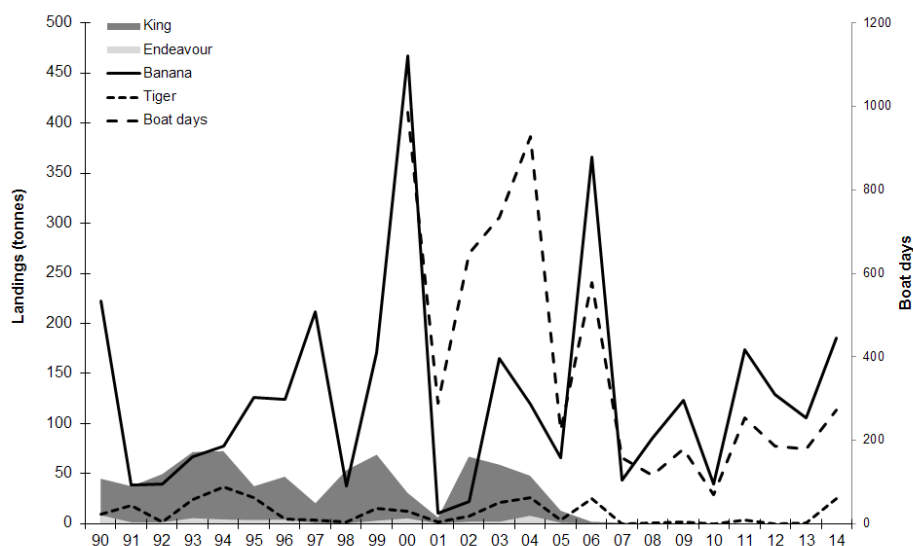
NORTHERN PRAWN FIGURE 4

Areas fished in the Kimberley Prawn Managed Fishery in 2014, Size Management Fish Grounds and the inshore trawl closures.



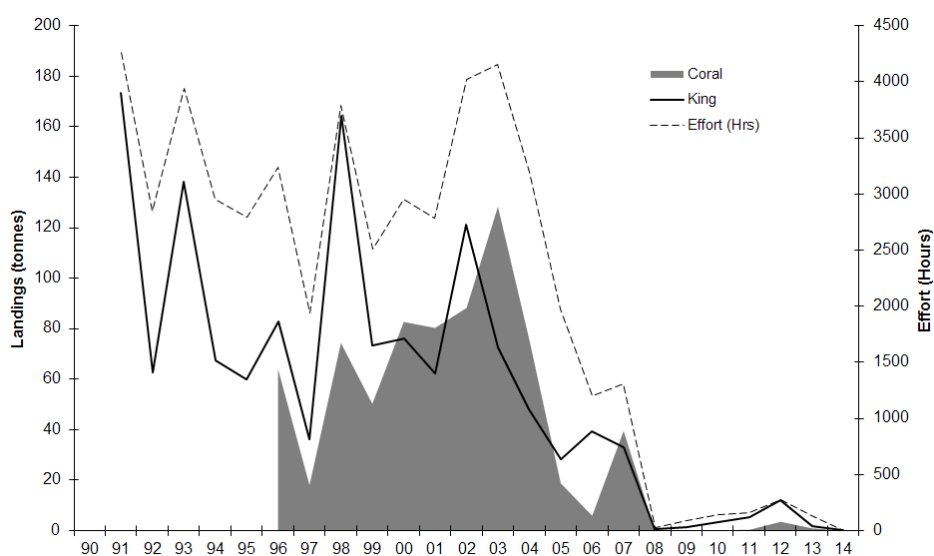
NORTHERN PRAWN FIGURE 5

Annual landings and number of boat days (from 2000) for the Onslow Prawn Managed Fishery, 1990 – 2014.



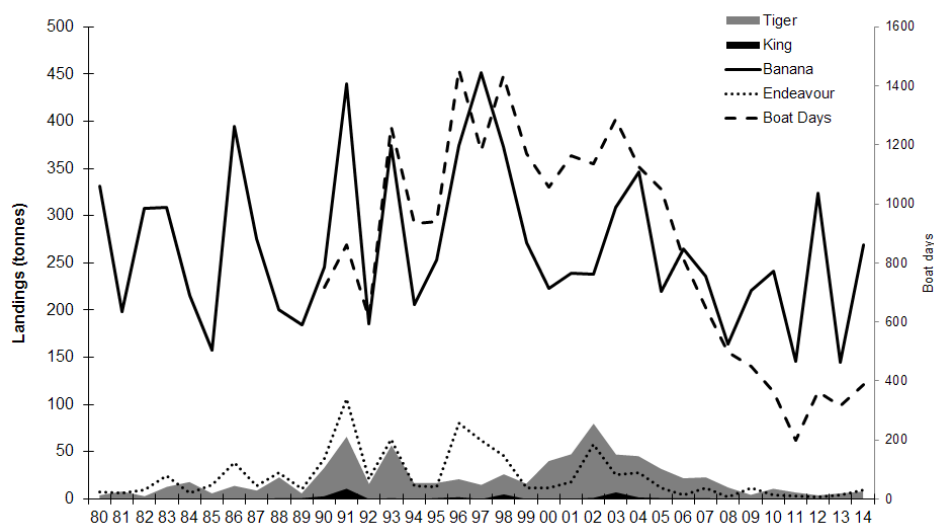
NORTHERN PRAWN FIGURE 6

Annual landings and boat days (from 2000) for the Nickol Bay Prawn Managed Fishery, 1978 – 2014.



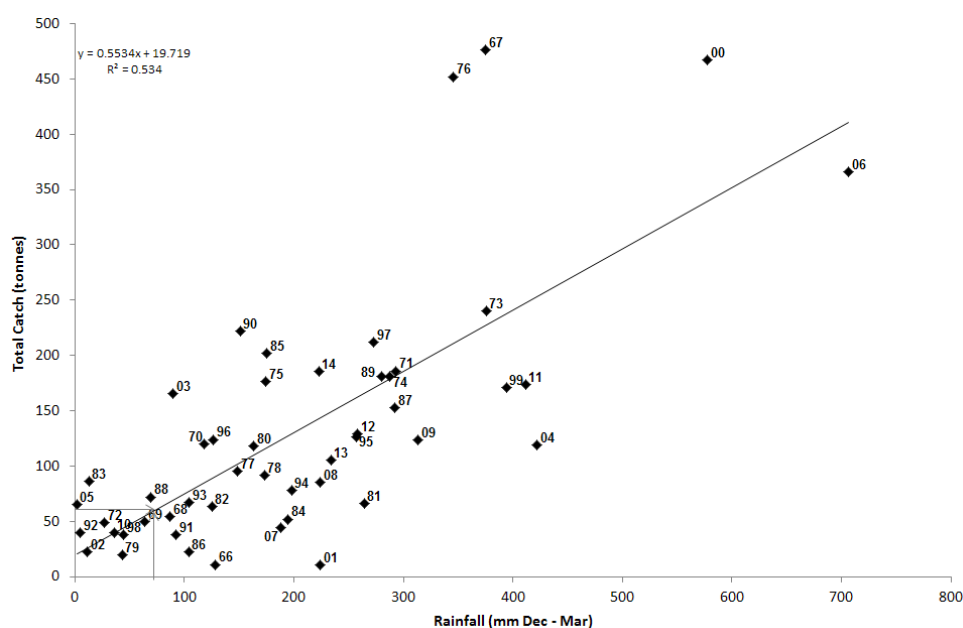
NORTHERN PRAWN FIGURE 7

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1991 – 2014.



NORTHERN PRAWN FIGURE 8

Annual landings and number of boat days (from 1990) for the Kimberley Prawn Managed Fishery, 1980 – 2014.



NORTHERN PRAWN FIGURE 9

Relationship between banana prawn landings in Nickol Bay and rainfall (mm) between December and March for 1966 – 2014 with rainfall level for 2015 indicated by the arrow.

North Coast Nearshore and Estuarine Fishery Status Report

J.I. Brown, S.J. Newman, G. Mitsopoulos, C. Skepper, A. Thomson and D. Wallis

Main Features			
Status		Current Landings	
Stock levels	Acceptable	Total	72.8 t
Fishing Levels	Acceptable	Barramundi	44.2 t
		Threadfin	23.4 t
		Recreational	20% of total (last estimate 2012)
		Charter	< 7 t (barramundi and threadfin)

Fishery Description

Commercial

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) operates in the nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129°E) to the top end of Eighty Mile Beach, south of Broome (19°S). It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi (*Lates calcarifer*) by any means.

Along with barramundi, the other main species taken by the fishery are king threadfin (*Polydactylus macrochir*) and blue threadfin (*Eleutheronema tetradactylum*). The focal 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 and King Sound. In late 2013, Roebuck Bay and

the northern end of Eighty Mile Beach to 19°S were closed to commercial fishing (Kimberley Gillnet Figure 1). This ‘Broome coast’ area historically provided the majority of threadfin catches in the fishery.

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 Management Meetings are now convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

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

Boundaries

Commercial

The waters of the KGBF are defined as 'all Western Australian waters north of 19° south latitude and west of 129° east longitude and within three nautical miles of the high water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47' south latitude' (Kimberley Gillnet Figure 1).

Recreational

The North Coast Bioregion, which encompasses the Pilbara and Kimberley regions, extends from the Ashburton River south of Onslow to the WA/NT border (all land and water north of 21°46'S latitude and east of 114°50'E longitude).

Management arrangements

Commercial

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures and gear restrictions. Access to the KGBF is limited to 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, 123°08.23' E longitude) the closure extends from 1 December to 31 January the following year, while in the northern section of the KGBF (east of Cunningham Point) the closure extends from 1 November to 31 January the following year (see Kimberley Gillnet Figure 1). There are also limits on the length of net and mesh sizes to be used in the fishery.

There are 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.

In addition to the Broome coast (Roebuck Bay) closure, there are commercial fishing area closures around major town sites and recreationally important fishing locations.

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 studied (Pember *et al.* 2005)¹. In addition, the stock structure of both threadfin species was defined by Welch *et al.* (2010)². The results from both of these studies will be considered in future monitoring and assessment programs of threadfin. 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

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.

2011/12 (Ryan *et al.* 2013)¹. A second integrated survey was recently undertaken in 2013/14 and results will be available in 2015.

Retained Species

Commercial landings (season 2014):

All species	72.8 tonnes
Barramundi	44.2 tonnes
Threadfin	23.4 tonnes

The principal species landed in the KGBF are barramundi and two species of threadfin (king threadfin and blue threadfin), comprising around 90% of the total catch by weight (1990-2013). Small quantities of elasmobranchs (sharks and rays), black jewfish (*Protonibea diacanthus*), queenfish (*Scombeoides* spp.) 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.

In 2014, the total reported catch of all species in the KGBF was 72.8 t (Kimberley Gillnet Figure 2). This is the lowest total catch reported for the fishery for the period since 1990 and a decrease of 51.8 t from 2013. This low catch can be attributed to the low effort levels in the fishery following the buyout of the two licensees in the Broome coast (Roebuck Bay) area. The total landings of barramundi from the KGBF were 44.2 t for 2014 (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 3), a decrease on the reported catch of 52.1 t in 2013 but similar to the 10-year average (2004-2013) of 44.4 t. The total landings of threadfin from the KGBF were 23.4 t for 2014 (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 4), and is much lower than the 57.3 t reported in 2013 and the 74.5 t for the 10-year average (2004-2013). The composition of the KGBF catch in 2014 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 the North Coast Bioregion in 2011/12 were estimated to be approximately 8.4 t of barramundi and approximately 7.0 t of threadfin⁵.

The recreational catch in 2011/12 was estimated to be approximately 20% of the total catch (commercial and recreational combined). This 2011/12 catch proportion estimate is likely to be an underestimate for 2014 due to the lower commercial catch as a result of the Broome coast closure. In addition, estimates of the recreational catch were for boat-based fishers only, with shore-based fishers and

boat-based fishers that fished only in freshwater out of scope of the 2011/12 survey.

The reported charter vessel catches for the North Coast Bioregion in 2014 were estimated to be approximately 3.7 t of barramundi and approximately 2.7 t of threadfin.

As such, there is an estimated annual harvest of 12.1 t of barramundi (recreational + charter) reported in the North Coast Bioregion. In addition, there is an estimated annual harvest of 9.7 t of all threadfin (recreational + charter) reported in the North Coast Bioregion.

Noting that these data underestimate the total recreational catch (as explained above), 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 is block days. The effort determination used in the fishery is currently being reviewed but as fishing practices vary across the industry and are not uniform, it is difficult to utilise a more refined determination of effort expenditure for this fishery. 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 2014, the total effort across the fishery was 433 block days, a decrease on the 2013 effort figure of 630 block days. This is the lowest effort level reported for the fishery for the period since 1990 and considerably below the long-term average of 804 days (1990-2013). This substantial decrease in effort is linked to the buyout of two licences at the end of 2013, thus reducing the overall effort in the fishery and in particular the effort expended in the Broome coast (Roebuck Bay) area. There is some latent effort in the KGBF with one licensee not operating in recent years.

Recreational

A summary of the key findings of the 2011/12 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

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.

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 decreased in 2014 from 2013 levels but was similar to the 10 year (2004-2013) average. Whilst the catch of barramundi in 2014 was slightly lower than in 2013, the catch of threadfin was substantially lower than that reported in 2013 and the 10-year average. This decrease can be attributed to the closure of the Broome coast (Roebuck Bay) area, which had historically provided the majority (~80%) of threadfin catches in the fishery.

The commercial catch rates for barramundi in the KGBF increased in 2014 (102.1 kg/block day) to the highest level reported in the period since 1990 (Kimberley Gillnet Figure 3). This continues an increasing trend in the barramundi catch rate for the past three years. The catch rate for threadfin in 2014 (54.1 kg/block day) across the fishery was much lower than that reported in 2013 (90.88 kg/block day) and below the long-term (1990-2013) average (84.7 kg/block day). This decrease in threadfin catch rate can be attributed to the Broome coast closure.

There is the potential for localised depletion risks to barramundi and 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 saltwater 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. Commercial fishers are required to report any interactions with endangered, threatened and protected (ETP) species. In 2014, interactions were reported with two crocodiles and 17 sawfish, with all but one sawfish released alive.

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, and the closure to net fishing in the Fitzroy River and all its creeks and tributaries south of 17° 27' south latitude (a known area for the northern river Shark (Morgan *et al.* 2004)¹), 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 2014, four of the five licensed vessels in the KGBF actively fished, with an average crew level of approximately 2.5 people, with an estimate of at least 10 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.

¹ D.L. Morgan, M.G. Allen, P. Bedford & M. Horstman (2004) Fish fauna of the Fitzroy River in the Kimberley region of Western Australia - including the Bunuba, Gooniyandi, Ngarinyin, Nyikina and Walmajarri Aboriginal names. Records of the Western Australian Museum 22: 147-161.

Recreational

A significant number of recreational and charter anglers also fished across the region.

Economic Effects

Estimated annual value (to fishers) for 2014:

Level 1 - < \$1 Million

The value of the North Coast Nearshore and Estuarine Fishery was reported using the 6 categories defined in Fletcher *et al.* (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 2013-14 financial year.

Historically, the KGBF principally targeted the high-value species, barramundi and threadfin. With the closure of Broome coast (Roebuck Bay), the future catches from the KGBF will primarily consist of barramundi (as observed in 2014), since the majority of the threadfin catches were historically derived from this Broome coast area. The fishery's score value in 2014 was estimated to be 1 (i.e. Risk level – Negligible; Economic value – <\$1 million).

However, the social amenity classification for the KGBF is determined as '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 1990 – 1999, a long-term 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.

The level of barramundi catch was within the target catch range from 2000-2002, 2005-2006 and 2012. The barramundi catch in 2003, 2004, 2008-2010 and 2013 was above the target range, mainly as a result of increased effort levels in different areas of the fishery. The increase in catch in 2013, however, occurred despite a decrease in fishing effort in the Broome and Kimberley Coast areas of the fishery. This resulted in high catch rates which may suggest a recent increase in stock biomass for barramundi. In only two 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 in those years. The barramundi catch in 2014 was 44.2 t, and at the upper end of the target catch range. In 2013, two licences were removed from the Broome area of the fishery (Roebuck Bay closure). This sector of the fishery is now recreational and indigenous fishing only. This effort removal is likely to produce reduced levels of catch in future years. The current fishing level is considered to be acceptable although the reference points will need to be reviewed given the removal of the two licensees and the associated reduced effort in the fishery.

A review of the fishery is planned 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 (2015/16)

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.

An additional related factor to the impact of increasing recreational fishing pressure that requires monitoring is the post-release mortality of barramundi. The 2011/12 boat-based recreational survey identified that the majority (72%) of the catch of barramundi in WA was released or discarded (Ryan *et al.* 2013), however a Northern Territory study observed that the post-release survival rate of barramundi in freshwater systems was high (~90%) (de Lestang *et al.* 2004).

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 2014. Outcomes from the pre-assessment are currently under review.

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

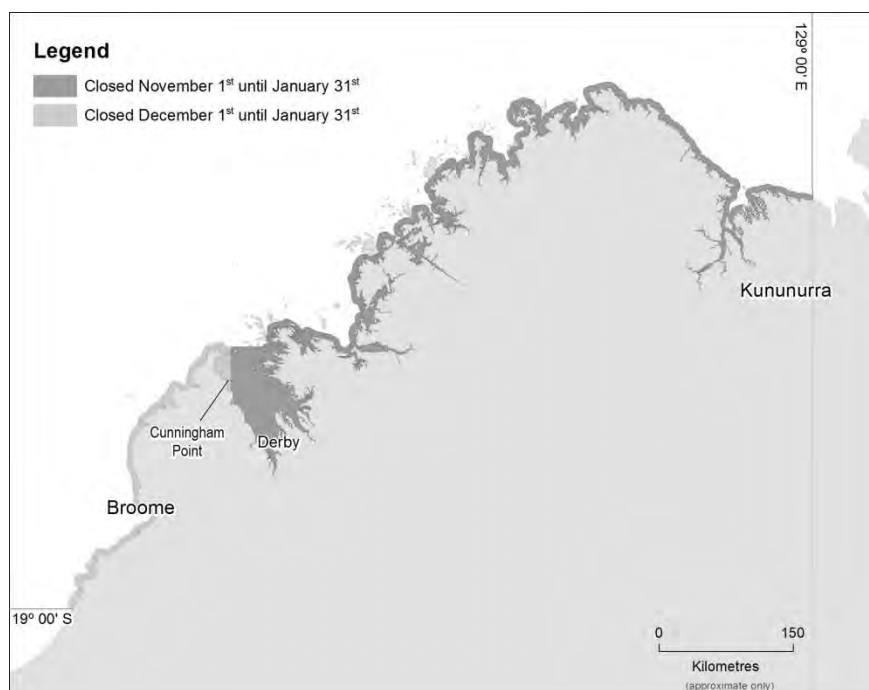
Annual catches of the major target species by the KGBF from 2003-2014.

Species	Kimberley Gillnet Annual Catch (tonnes)											
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Barramundi	45.0	53.5	35.6	36.3	27.2	54.8	59.6	57.1	28.5	39.7	52.1	44.2
Threadfin	94.1	75.8	70.6	67.7	78.5	101.2	89.9	83.3	74.2	46.2	57.3	23.4
Total	148.0	136.1	117.8	109.9	111.4	165.6	167.3	150.9	110.5	91.0	124.6	72.8

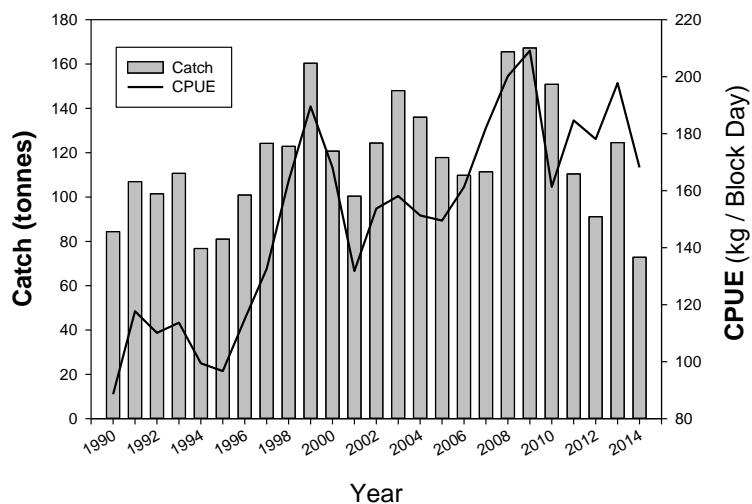
KIMBERLEY GILLNET TABLE 2

Summary of the reported catch (t) in the KGBF in 2014 and the percentage composition of each of the major species retained.

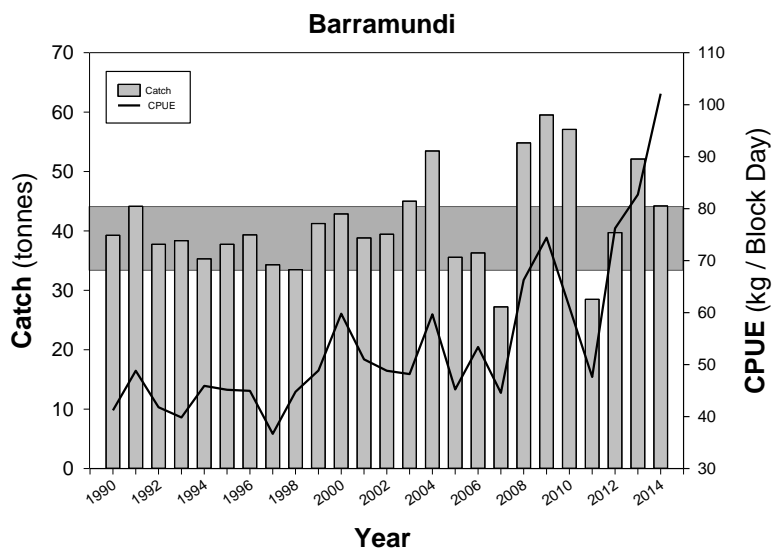
Species	Catch (tonnes)	Composition %
Barramundi	44.2	60.7
Threadfin	23.4	32.1
Black jewfish	1.8	2.5
Tripletail	0.7	1.0
Sharks	0.7	1.0
Other fish	2.0	2.7
Total	72.8	100

**KIMBERLEY GILLNET FIGURE 1**

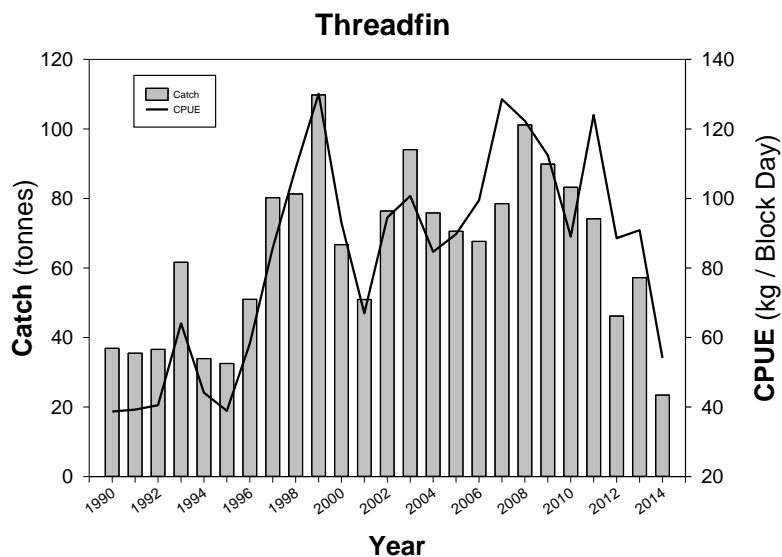
Location and extent of the KGBF within the Kimberley region of Western Australia. Note: this map is indicative only.

**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 2014.

**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 2014. 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 2014.

North Coast Demersal Fisheries Status Report

S.J. Newman, C. Wakefield, C. Skepper, D. Boddington, N. Blay, R. Jones and P. Dobson

Main Features			
Status		Current Landings	
Pilbara:		Total North Coast Demersal landings	2,524 t
Stock level	Adequate	Recreational (top 10 demersal)	48 - 64 t (~3% of total)
Fishing Level		Pilbara:	
Trawl Fishery	Acceptable	Total	1,413 t
Trap Fishery	Acceptable	Red emperor	102 t
Line Fishery	Acceptable	Rankin cod	44 t
Kimberley:		Bluespotted emperor	142 t
Stock level	Adequate	Pilbara Fish Trawl Fishery	1,105 t
Fishing Level	Acceptable	Pilbara Fish Trap	268 t
		Pilbara Line	40 t
		Charter	~18.7 t (1.3% of total)
		Kimberley (NDSF):	
		Total	1,111 t
		Red emperor	132 t
		Goldband snapper	499 t
		Charter	~11.5 t (1.0% 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*), red emperor (*Lutjanus sebae*), crimson snapper (*Lutjanus erythropterus*), bluespotted emperor (*Lethrinus punctulatus*), saddletail snapper (*Lutjanus malabaricus*), brownstripe snapper (*Lutjanus vitta*), Rankin cod (*Epinephelus multinotatus*), rosy threadfin bream (*Nemipterus furcosus*) and spangled emperor (*Lethrinus nebulosus*). 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

NORTH COAST BIOREGION

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 northwest 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 (DoE), 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 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 licence 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. However, the Director General may prohibit further fishing in Zone C if the total amount of fishing in Zone C reaches 550 fishing days.

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 2014, 8 vessels (fishing in zones A, B and 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 m³. While there is no restriction on the number of traps that can be fished per vessel, each licensee is allocated an annual effort quota in 'standard fishing days' based on the use of 20 traps (or 5 lines) per day. 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 and the total retained catch 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 (primarily including 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.

An intense six month independent observer program designed to monitor bycatch and interactions with endangered, threatened and protected species was completed in 2012 in order to meet a specific set of conditions from DotE within the WTO for the Fishery. The outcomes of this 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 (2015) 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 2014):

Pilbara Fish Trawl	1,105 tonnes
Pilbara Fish Trap	268 tonnes
Pilbara Line	40 tonnes
Kimberley (NDSF)	1,111 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 2014 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 1,157 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 eight consecutive years, with 1,105 t landed in 2014 (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 similar or slightly higher in 2014 than the previous year, i.e. crimson snapper 152 t (132 t in 2013), bluespotted emperor 93 t (98 t in 2013), rosy threadfin bream 93 t (76 t in 2013), goldband snapper 86 t (80 t in 2013), brownstripe snapper 71 t (66 t in 2013), saddletail snapper 64 t (53 t in 2013), red emperor 48 t (54 t in 2013), spangled emperor 11 t (11 t in 2013) and Rankin cod 7 t (11 t in 2013). The total retained byproduct was 16 t (8 t in 2013) and included bugs, cuttlefish, and squid (North Coast Table 2).

The total annual catch taken by the Pilbara trap fishery has remained relatively consistent 2004-2013 averaging 440 t per year (North Coast Tables 1 and 2). In 2014, the total catch of 268 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 2014 were red emperor 54 t (49 t in 2013), bluespotted emperor 49 t (41 t in 2013), Rankin cod 37 t (43 t in 2013), goldband snapper 28 t (61 t in 2013), and crimson snapper 22 t (32 t in 2013).

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 2014, the total annual catch for the line fishery was 40 t, which was lower than that taken in 2012 (85 t) and slightly lower than the target catch range of 50-115 t (North Coast Table 2). This lower catch in 2014 was associated with reduced effort in the fishery (North Coast Table 2 and 3). 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 2014, the ruby snapper catch was 11 t (12 t in 2013) and the goldband snapper catch was 15 t (31 t in 2013) (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. This continued in 2014 with total landings of 1,111 t. The Zone B component of the 2014 catch (960 t) is the highest reported. In contrast, the total catch of Zone A in 2014 (145 t) was much reduced

and is the lowest reported since 2009 (135t). The highest reported catch in Zone A of the fishery was 291 t in 2013 (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 2014 is similar to that reported in 2013, with goldband snapper dominating the landed catch. The landed catch of goldband snapper in 2014 (499 t) was similar to that reported in 2013 (493 t). Catch levels of goldband snapper have remained high (> 450 t) 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 2014 was 132 t, which is similar to the red emperor catch levels reported over the past four years (2010–2013). The cods/groupers catch in 2014 (168 t) was less than that reported in 2013 (195 t), although the catch in B Zone (135 t) was the highest reported for that sector. It continues a trend of higher catch levels for the cods/groupers since 2002. Rankin cod dominates the composition of the cod/grouper catch complex. The catch of Rankin cod decreased from 62 t in 2013 to 51 t in 2014 (North Coast Table 7).

The catches reported above represent those derived from all zones of the NDSF. It is noteworthy that the catch of cods/groupers in Zone A has largely driven the overall higher catches of this complex since 2010. The decrease in the overall cods/groupers catch in 2014 is partly a result of the reduction in catch and effort in Zone A. 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 2014, this mix of Zone A species ('other fish') constituted 61t (42%) of the overall catch from Zone A.

The catch rate of red emperor in Zone B in 2014 was slightly above those recorded during the period 2009–13. 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 increased slightly, and remained within the high range reported since 2008. These consistently high catch rates (2009–2014) have been maintained following the sharp increase in catch rates for goldband snapper in the period from 2006–2008 (North Coast Figure 5). The catch rate for the cod/grouper complex in Zone B in 2014 also increased slightly, exceeding the highest catch rate previously reported in 2012. 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 2014 catch of red emperor, goldband snapper and the cods/groupers all within acceptable levels as defined in the Export exemption for this fishery (see 'Fishery Governance' section), with no species or species group exceeding the threshold level (20% increase in average catch of the previous 4 years).

Recreational catch estimate (season 2014):

Pilbara ~3%

Kimberley ~3%

North Coast Bioregion

The most recent state-wide survey of boat-based recreational fishing in WA was conducted during 2013/14 (Ryan *et al.* 2015¹). Estimates from this survey comparable to the state-wide survey of boat-based recreational fishing conducted in 2011/12.

A total of 153 finfish species were taken in the North Coast Bioregion (both Pilbara and Kimberley; Ryan *et al.* 2015). 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 48 – 64 t was reported for the top 10 demersal species in the North Coast Bioregion in 2013/14 (Ryan *et al.* 2015). In terms of estimated harvest, the estimated catch of the top 10 demersal species were grass emperor (12.1 t), barcheek coral trout (7.6 t), red emperor (7.4 t), Rankin cod (6.5 t), spangled emperor (6.3 t), blackspot tuskfish (5.6 t), stripey snapper (3.4 t), crimson snapper (2.7 t), mangrove jack (2.6 t) and golden snapper (2.0 t).

The estimated recreational boat-based catch of the top 10 demersal species in the North Coast Bioregion has decreased from the 76 t (s.e.~12 t) reported in 2011/12 (Ryan *et al.* 2015). The estimated recreational catches were steady between 2011/12 and 2013/14 for: barcheek coral trout, blackspot tuskfish, grass emperor, Rankin cod and red emperor. However, the estimated recreational catches of spangled emperor decreased between 2011/12 and 2013/14 from 15 t (95% confidence intervals from 11–19) to 6 t (95% confidence intervals from 4–9).

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 ~2% of the combined (commercial and recreational) demersal scalefish catch in the North Coast Bioregion in 2014. In addition, the red emperor recreational catch can be estimated to be ~3% of the combined (commercial and recreational) red emperor catch in the North Coast Bioregion in 2014 and the Rankin cod recreational catch can be estimated to be ~6% of the combined (commercial and recreational) Rankin cod catch in the North Coast Bioregion in 2014.

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 degree of spatial separation between the user groups. The recreational and charter sectors do not catch significant quantities of most

¹ Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

species targeted by the commercial Pilbara demersal scalefish fisheries.

The reported charter vessel catch of demersal scalefish in the waters of the Pilbara demersal fisheries in 2014 was estimated to be 18.7 t (spangled emperor – 5.6 t; Rankin cod – 4.4 t; goldband snapper – 1.8 t; crimson snapper – 1.8 t; saddletail snapper – 1.7 t; chinamanfish – 2.1 t; ruby snapper – 0.4 t). The Pilbara charter vessel catch is estimated to be ca. 1.3% of the Pilbara commercial catch of demersal fish.

Kimberley

Historically, there has been little recreational or charter boat fishing effort directed towards the demersal fishes in Area 2 of the NDSF, the species that are targeted by commercial fishers. However, this is now changing with charter vessels moving into the inshore demersal waters of the NDSF.

The reported charter vessel catch of demersal scalefish in the waters of the Kimberley demersal fishery in 2014 was estimated to be 11.5 t (grass emperor – 1.9 t; golden snapper – 3.5 t; goldspotted/blackspotted rockcod – 1.0 t; saddletail snapper – 1.5 t; crimson snapper – 0.8 t). The Kimberley charter vessel catch is estimated to be ca. 1.0% 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.

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 2014/15 season. The percentage of allocated hours used by the trawl fleet during the 2014/15 season were 86% in Area 1, 95% in Area 2, 87% in Area 4 and 54% 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 2014, 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 50% of the units used as calculated from the VMS.

In 2014, line fishers reported operating for 195 days, compared with 358 days in 2013.

Kimberley

The eight fish trap vessels that fished in the NDSF in 2014 reported using between 18 and 36 fish traps per day. Effort across all zones of the fishery in 2014 was 1,058 days (North Coast Table 8).

The total effort allocated in Zone B in 2014 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 897 SFD's (91%). That is, 9% of effort allocated to Zone B in 2014 was not used. A total of

616 standard fishing days was allocated to Zone A. The number of SFDs recorded using VMS data was 153 (233 SFDs in 2013), indicating that ~75% remained unutilised in Zone A at the end of the season. The effort expended in Zone C in 2014 was 8 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 2011)

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 multiple 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 retained catch on an annual basis. Fishing mortality estimates (F) derived from age structure data are used to assess red emperor, Rankin cod and bluespotted emperor relative to internationally recognised biological reference points (BRP) based on ratios of natural mortality¹ on a periodic basis with the last analysis completed using 2011 age structure 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 with the last assessment completed in 2007.

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.

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 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 retained catch increased each year. From 2011-2014 the trends in catch rates for these shorter lived species and the total retained catch have remained stable or increased (North Coast Figure 2). The general trends in catch rates for the longer lived indicator species (red emperor, Rankin cod and goldband snapper) in recent years (i.e. since 2012) have remained stable or decreased (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 or increasing catch rates of the shorter lived indicator species (bluespotted emperor and brownstripe snapper). These species are expected to display positive responses earlier than the longer lived indicator species (red emperor and Rankin cod) considering they are selected by the trap and trawl fisheries at a younger age (i.e. 2-3 vs. 5-6 years) and they have inherently higher population productivity. Since 2008 and following the implementation of effort reductions, the longer lived indicator species (red emperor and Rankin cod) have generally displayed stable catch rates in most management areas. If these longer-lived species are also recovering, it is expected that increases in catch rates will become evident from approximately 2014/15 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 2015.

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 2014, Zone B catch rates for the indicator species were 139 kg/std day for red emperor, 500 kg/std day for goldband snapper and 205 kg/std day for cods/groupers.

Catch rates for red emperor in 2014 are slightly higher than those reported in 2012 and 2013 (125 and 120 kg/std day, respectively), while the catch rate for the cods/groupers is the highest reported, exceeding the 2012 catch rate of 198 kg/std day. The catch rate for goldband snapper in 2014 was similar to that reported in 2012 and 2013.

The 2014 catch of goldband snapper, red emperor and the cods/groupers from all zones were all close to the average of the previous four years, hence none exceeded the ESD trigger point of a 20% increase in catch above the average of the past four 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. Marriott *et al.* 2014 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 significant 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 2014. 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 2014, the catch of both goldband snapper and red emperor were similar to that reported in 2013, and both were below the performance indicator of a 20% increase in catch above the average catch of the preceding four years. The 2014 level of catch of cods/groupers complex was below that landed in 2013, and also did not exceed 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. Overall, 38.1% of megafauna exited through escape hatches in nets during trawling in rapid time (91.2% in < 5 minutes). 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 Pilbara Fish Trawl Interim Managed Fishery was re-accredited a Wildlife Trade Operation (WTO) under the Commonwealth of Australia's Environmental Protection and Biodiversity Conservation (EPBC) Act for three years from mid-2014. This included specific conditions around the observing, reporting and mitigation of endangered, threatened and protected species interactions. As such, an ongoing 12 month independent electronic observer program will be conducted during this accreditation period.

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. 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. Nonetheless, catch rates of dolphins were very rare (5.2 per 1,000 trawls) and had decreased by 20-60% from previous estimates (i.e. 12.6 from observers or 6.5 from logbooks per 1,000 trawls from 2003-2009) despite continued high levels of dolphin attendance and depredation ($> 75\%$ of trawls). 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.

In 2014, the Pilbara trap fishery reported 114 sea snake interactions. 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. One potato cod (*Epinephelus tukula*) was reported in the Kimberley (NDSF) in 2014, and was released alive.

In 2014, the Kimberley trap fishery reported 124 sea snake interactions. Sea snakes are returned to the water alive.

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 2014 fishing season, indicating 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 2013-14:

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
Pilbara Trap Fishery	Acceptable
Pilbara 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 eight seasons. Considering, 1) catch rates of indicator species are stable or increasing for shorter lived species 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 2015 and 2016; current levels 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 and Line Fisheries, the total catch was below the target catch ranges in 2014 due to less effort.

Kimberley

For the 2014 calendar year, the total allowable effort was set at 616 standard fishing days in Zone A, 985.6 fishing days in Zone B and 1,100 fishing days for Zone C. The Zone A and C allocation aims to facilitate the exploration and development of this area of the fishery. 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 2014 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, none were above the average of the previous four years, or exceeded the ESD performance measure. Catches of goldband snapper, red emperor and the cods/groupers complex remained below the trigger level.

New management initiatives (2015)

Pilbara

In 2015, the Department will work with permit holders in the Pilbara Fish Trawl Interim Managed Fishery to adhere to the conditions of the re-accredited Wildlife Trade Operation approval; this will include the development of a logbook validation program, through electronic monitoring.

The Department will continue to review the Pilbara Fish Trawl Interim Management Plan, in 2015.

Kimberley

In 2015, the Department will undertake a Level 5 Stock Assessment of the indicator species in the NDSF. This advice will be used to determine effort allocations for future years in consultation with industry.

The Northern Demersal Scalefish Fishery Operators Guide to the Management Arrangements 2015 (Fisheries Occasional Publication No 120) was published in April 2015, and is a plain English guide to the management arrangements, designed to assist licence holders.

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).

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.

The North Coast demersal fisheries underwent MSC pre-assessment in 2014. Outcomes from the pre-assessment are currently under review.

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 2014 (catches rounded to the nearest tonne, contributions of catches rounded to the nearest %).

Species		Trawl catch		Trap catch		Line catch		Total catch tonnes
		tonnes	%	tonnes	%	tonnes	%	
Bluespotted emperor	<i>Lethrinus punctulatus</i>	93	65%	49	34%	< 0.1	< 1%	142
Crimson snapper	<i>Lutjanus erythropterus</i>	152	87%	22	13%	< 1	< 1%	174
Rosy threadfin bream	<i>Nemipterus furcosus</i>	93	99%	< 1	< 1%	-	-	94
Brownstripe emperor	<i>Lutjanus vitta</i>	71	81%	17	19%	< 0.1	< 1%	88
Goldband snapper	<i>Pristipomoides multidens</i>	86	66%	28	22%	15	12%	129
Red emperor	<i>Lutjanus sebae</i>	48	47%	54	53%	< 1	< 1%	102
Saddletail snapper	<i>Lutjanus malabaricus</i>	64	88%	7	10%	2	2%	73
Spangled emperor	<i>Lethrinus nebulosus</i>	11	56%	5	26%	4	18%	20
Frypan snapper	<i>Argyrops spinifer</i>	28	96%	1	3%	< 1	< 1%	29
Rankin cod	<i>Epinephelus multinotatus</i>	7	16%	37	84%	< 1	< 1%	44
Ruby snapper	<i>Etelis carbunculus</i>	-	-	-	-	12	100%	12
Other demersal scalefish		452	89%	47	9%	7	1%	506
All demersal scalefish		1,105	78%	268	19%	40	3%	1,413

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.

Year	Demersal Scalefish				Byproduct*
	Line	Trap	Trawl	Total	Trawl
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	8
2014	40	268	1,105	1,499	16

* Byproduct in 2014 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)
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	705	10,267
2013	358	357	561	8,221
2014	195	208	591	7,812

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 in 2011. ns = not sampled.

Indicator species	Year	Trawl area (Zone 2)				Trap
		1	2	4	5	
Red emperor	2011	$F > F_{\text{limit}}$	$F > F_{\text{limit}}$	$F_{\text{limit}} > F > F_{\text{threshold}}$	$F = F_{\text{threshold}}$	$F = F_{\text{limit}}$
Rankin cod	2011	$F_{\text{limit}} > F > F_{\text{threshold}}$	$F_{\text{limit}} > F > F_{\text{threshold}}$	$F_{\text{limit}} > F > F_{\text{threshold}}$	$F = F_{\text{threshold}}$	$F_{\text{limit}} > F > F_{\text{threshold}}$
Bluespotted emperor	2011	$F = F_{\text{threshold}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	ns	ns	$F = F_{\text{limit}}$

NORTH COAST TABLE 5

Reported bycatch of listed species by skippers in the Pilbara trawl fishery in 2014.

	Number released Alive	Number deceased*	Total Reported
Bottlenose dolphins	6	19	25
Pipefish	3	21	24
Green sawfish	14	10	24
Narrow sawfish	12	12	24
Seahorses	0	3	3
Sea-snakes	48	27	75
Turtles	6	0	6

*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)							
	2007	2008	2009	2010	2011	2012	2013	2014
Goldband snapper (<i>Pristipomoides</i> spp.)	405	457	485	524	487	487	493	499
Red emperor (<i>Lutjanus sebae</i>)	179	173	156	142	128	135	131	132
Saddletail snapper (<i>Lutjanus malabaricus</i>)	99	104	108	126	87	100	116	89
Spangled emperor (<i>Lethrinus nebulosus</i>)	15	17	23	30	20	25	21	26
Cod/grouper (Epinephelidae)	126	149	142	153	155	170	195	168
Other species	107	102	132	144	161	191	273	196
Total demersal scalefish catch	933	1002	1046	1117	1037	1109	1228	1111

NORTH COAST TABLE 7

Catches of major target and byproduct species or species groups by zone in the NDSF in 2013 and 2014.

Species	NDSF annual catch (tonnes)			
	2013		2014	
	Zone A & C	Zone B	Zone A & C	Zone B
Goldband snapper (<i>Pristipomoides</i> spp.)	25.6	467.5	11.4	488.0
Red emperor (<i>Lutjanus sebae</i>)	43.5	87.1	33.2	99.3
Saddletail snapper (<i>Lutjanus malabaricus</i>)	18.8	97	9.2	80.2
Spangled emperor (<i>Lethrinus nebulosus</i>)	2.7	17.9	2.7	23.0
Rankin cod (<i>Epinephelus multinotatus</i>)	28.4	33.5	10.2	41.2
Other Cods/groupers (Epinephelidae)	42.8	90.6	23.0	93.6
Other species	154	119.1	61.3	135.0
Total demersal scalefish catch	316	913	151	960

NORTH COAST TABLE 8

Total catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF since 2001.

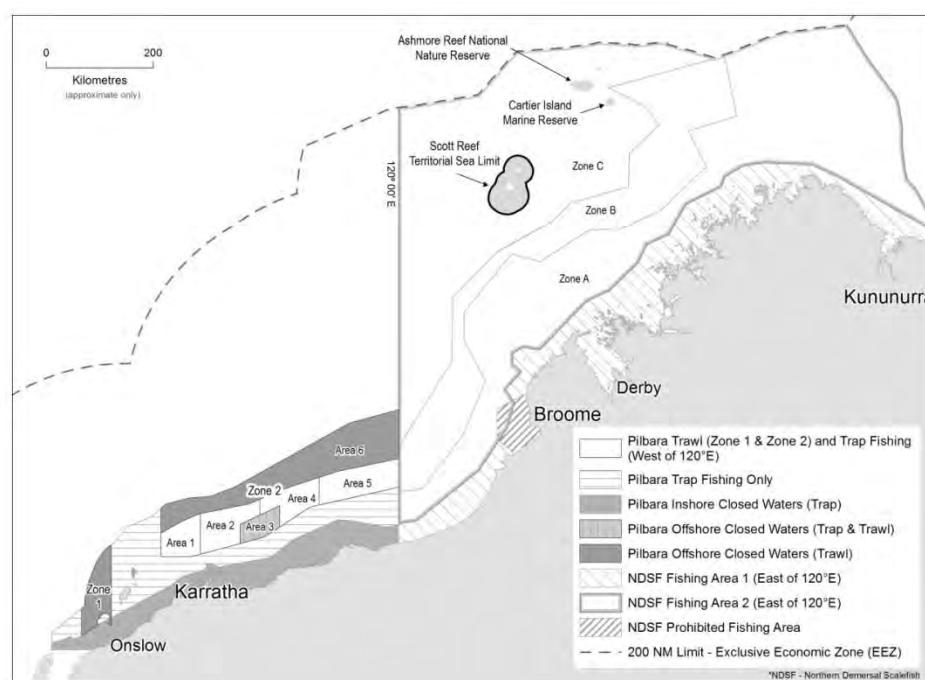
Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	0	0	690	1,300	690
2005	1,760	0	0	922	1,318	922
2006	1,144	0	0	801	1,193	801
2007	1,144*	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
2014	986*	0	0	1,111	1,058#	1,111

(* = TAE is for B Zone only; # = total effort is from all zones; 2014 Estimated Catch: Zone A = 145 t, Zone B = 960 t; 2014 Estimated Effort: Zone A = 153 SFDs, Zone B = 897 SFDs)

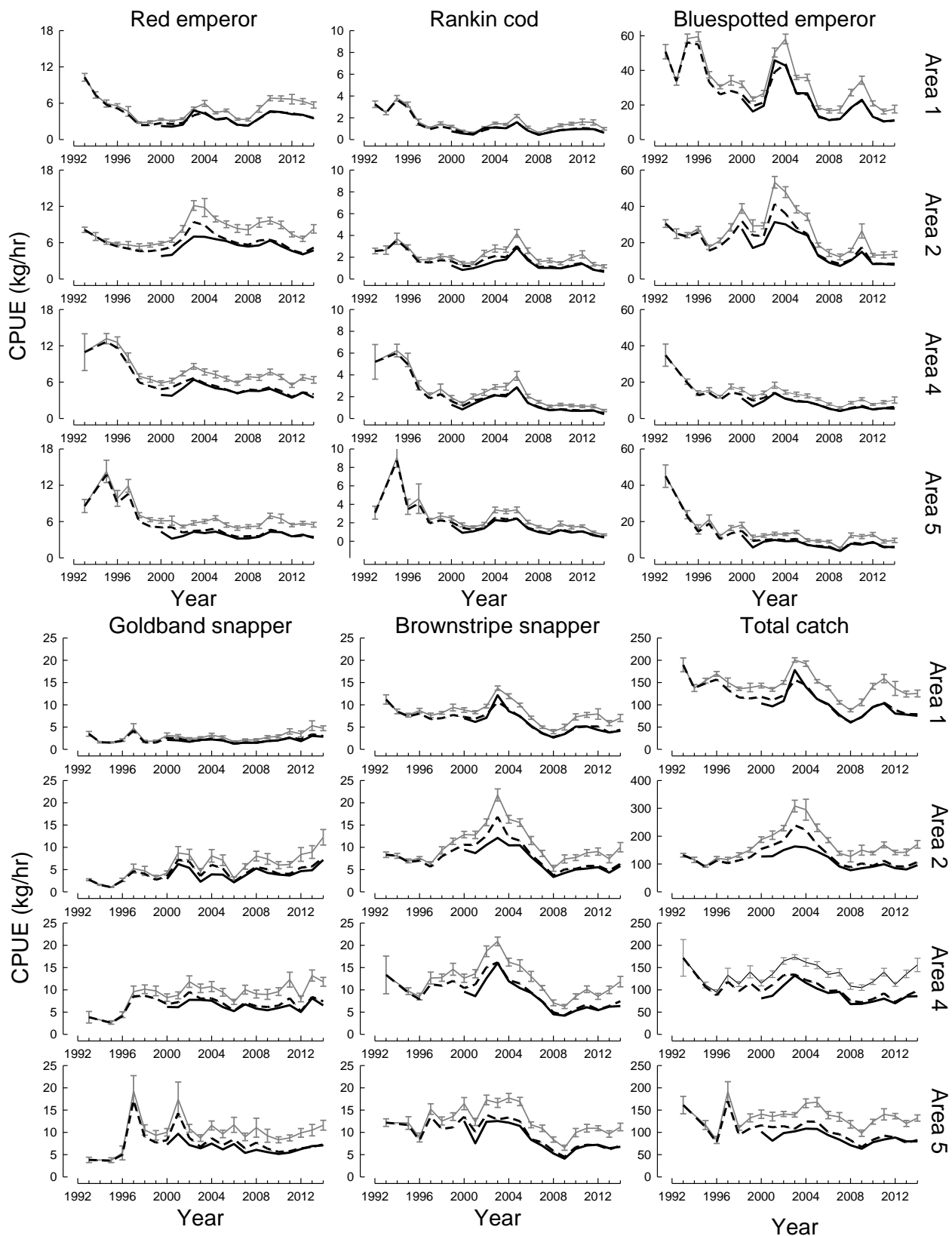
NORTH COAST TABLE 9

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 2014.

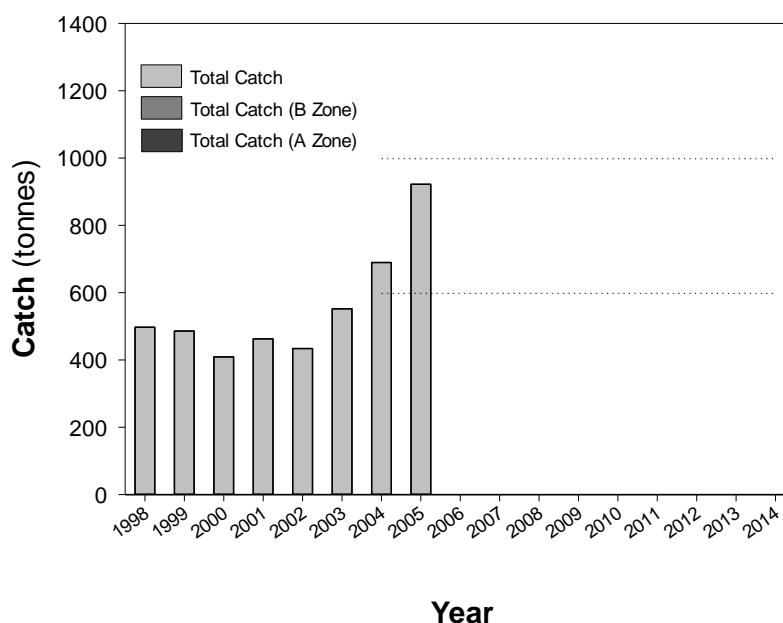
Species	Pilbara catch		Kimberley (NDSF) catch		Total catch tonnes
	tonnes	% total	tonnes	% total	
Red emperor	102	44	132.4	56	234.4
Saddletail snapper	73	45	89.3	55	162.3
Crimson snapper	174	82	37.6	18	211.6
Brownstripe snapper	88	91	8.2	9	96.2
Goldband snapper	129	21	499.4	79	628.4
Spangled emperor	20	44	25.8	56	45.8
Bluespotted emperor	142	72	55.3	28	197.3
Rankin cod	44	46	51.4	54	95.4
Frypan snapper	29	> 99	< 0.1	< 1	29
Rosy threadfin bream	94	> 99	< 0.1	< 1	94
Moses snapper	20	68	9.3	32	29.3
Longnose emperor	5	36	8.8	64	13.8
Mozambique bream	21	71	8.4	29	29.4
Grass emperor	0.1	2	3.7	98	3.8
Barcheek coral trout	7	54	5.9	46	12.9
Other demersal scalefish	465	73	175.7	27	640.7
Total all demersal scalefish	1413	56	1111	44	2524

**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.

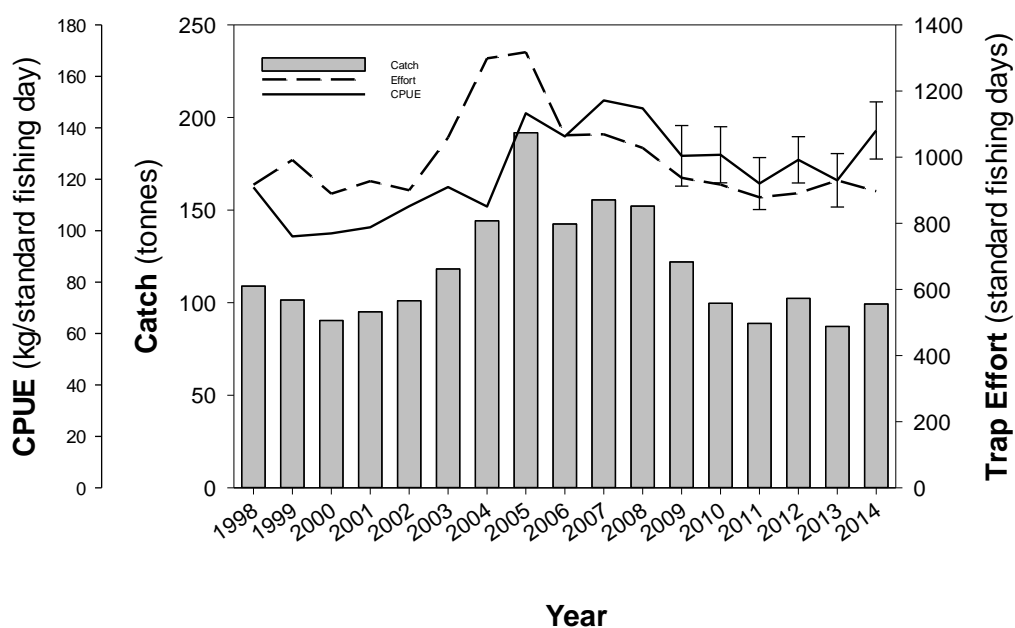
**NORTH COAST FIGURE 2**

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 1993–2014. 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).



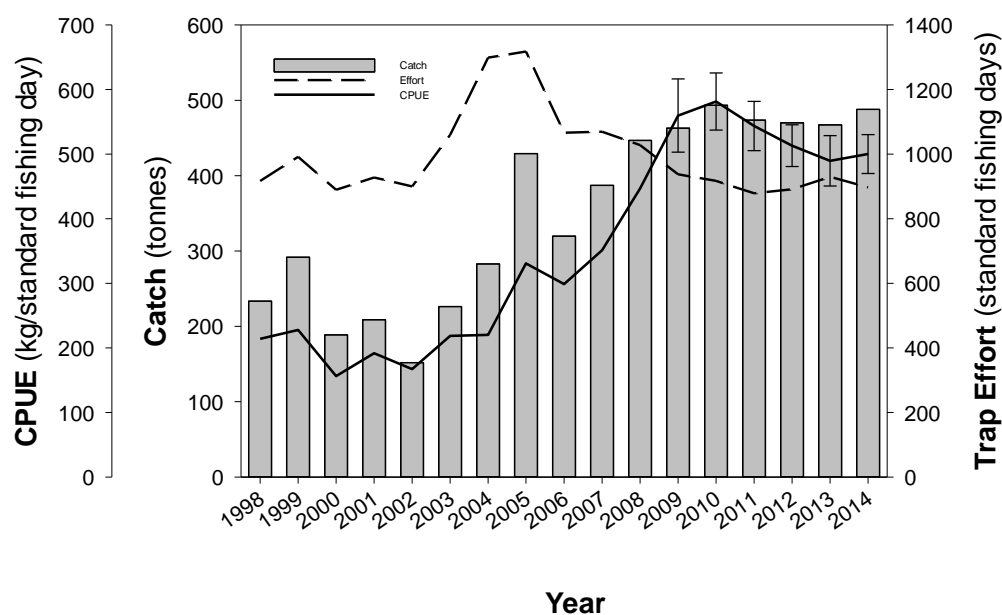
NORTH COAST FIGURE 3

Catch levels of demersal finfish in the NDSF by line and trap from 1998–2014. 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.

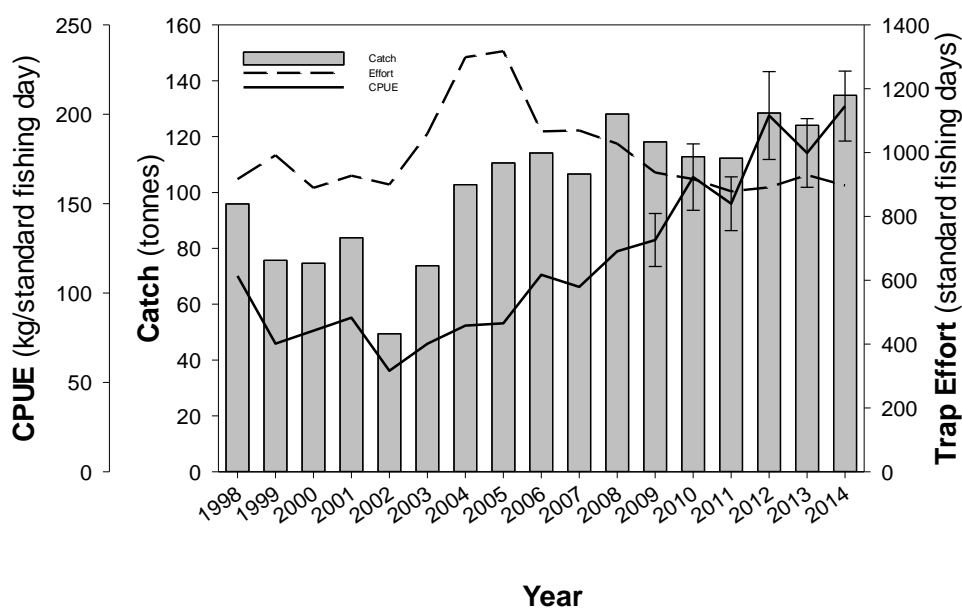


NORTH COAST FIGURE 4

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2014 (2006–2014 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 (2010–14).

**NORTH COAST FIGURE 5**

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998–2014 (2006–2014 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 (2010–14).

**NORTH COAST FIGURE 6**

Catch, effort and catch per unit of effort of the cod/grouper complex in the NDSF by trap, 1998–2014 (2006–2014 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 (2010–14).

Mackerel Managed Fishery Report: Statistics Only

B. Molony, E. Lai and R. Jones

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.

Governing legislation/fishing authority

Commercial

Mackerel Managed Fishery Management Plan 2011

Mackerel Managed Fishery Licence

Recreational

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

Boundaries

Commercial

The Fishery extends from the West Coast Bioregion to the WA/NT border, with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts of the Northern Bioregion. Catches are reported separately for three Areas: Area 1 - Kimberley (121° E to WA/NT border); Area 2 - Pilbara (114° E to 121° E); Area 3 - Gascoyne (27° S to 114° E) and West Coast (Cape Leeuwin to 27° S) (Spanish Mackerel Figure 1).

Recreational

The fishery operates between the West Coast Bioregion and the WA/NT border, with most activity occurring between Perth and Dampier.

Management arrangements

Commercial

The Fishery 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 licence period (1 January to 31 December) is limited to the quantity of mackerel

determined within the Management Plan. The TACC for each Area of the Fishery for 2014 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 48 licences in the Fishery with 14, 16 and 18 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 2014, the Fishery received a one year extension to the 2009 exemption from the export controls of the *Environment Protection and Biodiversity Conservation Act 1999* for a period of five years.

Recreational

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 state-wide database of recreational boat fishers that can be utilised for survey purposes.

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 2014)

Spanish mackerel	322.0 tonnes
Grey mackerel	3.5 tonnes
Other mackerel	1.1 tonnes

Commercial

A total of 11 boats operated in 2014, with three, four and seven vessels operating in the Kimberley, Pilbara and Gascoyne/South Management Areas (Spanish Mackerel Figure 2), noting that some vessels operated in more than one

management area. A total of 673 fishing days of effort were reported targeting Spanish mackerel in 2014, with more than 53% of effort 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 2014 season estimated at 322.0 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 4.6 t of other species of mackerel were landed in the 2014 season, including 3.5 t of grey mackerel. The catch of grey mackerel in 2014 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' (which included grey mackerel until 2006) 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 and 2013/14. Estimates are available at the level of individual Bioregions (Spanish Mackerel Table 1). A total of 59.3 t of Spanish mackerel were landed by recreational boat-based fishers in 2013/14, with most (28.6 t) landed in the Gascoyne Coast Bioregion. An additional 47.3 t were captured and subsequently released. The total landed and released is similar to the estimates from the 2011/12 survey, although higher catches of Spanish mackerel were landed by recreational fishers in the Gascoyne in the 2013/14 survey.

Recreational anglers also reported small 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. The next Statewide integrated survey of boat-based recreational fishing in WA is planned to collect recreational data during 2015/16.

Reported annual catches of Spanish mackerel by recreational charter boats are relatively minor. In 2014, a total of 14.9 t of Spanish mackerel were reported by Charter boat operators with an additional 7.4 t captured and released (Spanish Mackerel Table 1).

Fishery Governance

Target commercial catch range: 46 – 410 tonnes

The total catch in 2014 of 322.0 t was within the acceptable catch range for the Fishery. The reported catch from the Kimberley Area of 193.8 t was within the Area's acceptable catch range (110 – 205 t), and within the range reported since

2005, albeit approaching the TAC for this Area. Catches in the Pilbara Area have been relatively stable since 2006, with the 2014 catch of 94.2 t (acceptable catch range 80 – 126 t). Catches from the Gascoyne/West Coast Area in 2014 were 34.1 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 for this Area since 2007.

As the minimum legal size for Spanish mackerel is 900 mm total length, 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 assessed based on the nominal catch rates for each Area 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 stable or increasing. Additionally, the total catches of Spanish mackerel remain within the target range of the Fishery. 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 2014 have been relatively low and stable, ranging between 10 and 24 t, with catches only reported from a small area within their range. However, the 2014 catch of 3.4 t is the lowest since 2000 and well below the TAC for grey mackerel. As the Fishery is not targeting grey mackerel to a great extent, the low catch in 2014 is not likely a cause for concern. Thus, 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 (2015)

A review of the nomination requirements with the Fishery will occur in 2015/16. Following this an operator's guide will be developed for licence holders and skippers to enhance their understanding of the management arrangements for the fishery.

The Mackerel Managed Fishery underwent pre-assessment for Marine Stewardship Certification in early 2014.

SPANISH MACKEREL TABLE 1

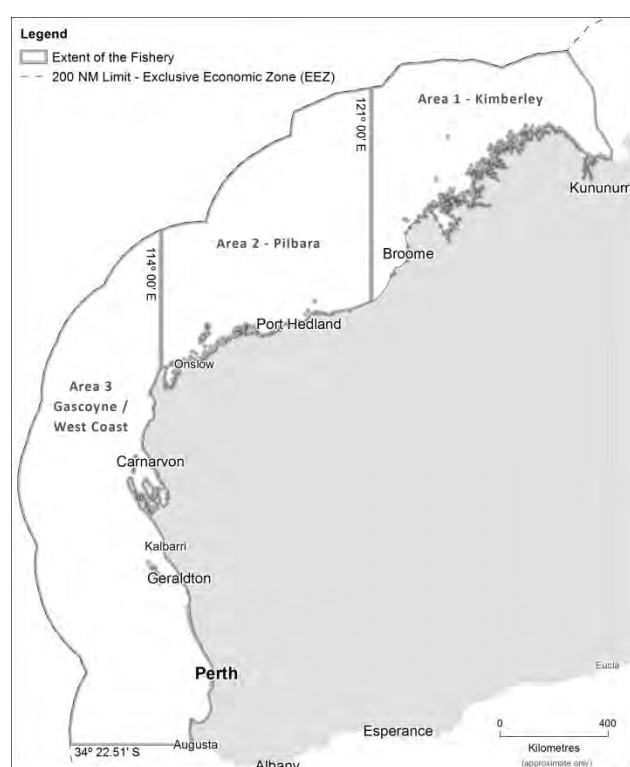
Recreational boat-based catch estimates (in tonnes, t) of Spanish mackerel in Western Australia 2013/14. Estimates are based on an average weight of a Spanish mackerel of 8.2 kg for the North Coast and 6.9 kg for other Bioregions. Too few Spanish mackerel were reported from the South Coast Bioregion during 2013/14 to generate a robust estimate.

Bioregion	Retained catch (std. error)	Released catch (std. error)	Total catch (std. error)
North Coast	20.9 t (3.16 t)	38.4 t (6.09 t)	59.3 t (8.16 t)
Gascoyne Coast	28.6 t (4.13 t)	18.7 t (7.26 t)	47.3 t (9.81 t)
West Coast	16.4 t (2.76 t)	6.7 t (2.22 t)	23.1 t (4.07 t)
Statewide (total)	59.3 t (10.04 t)	47.3 t (15.57 t)	129.7 t (22.04 t)

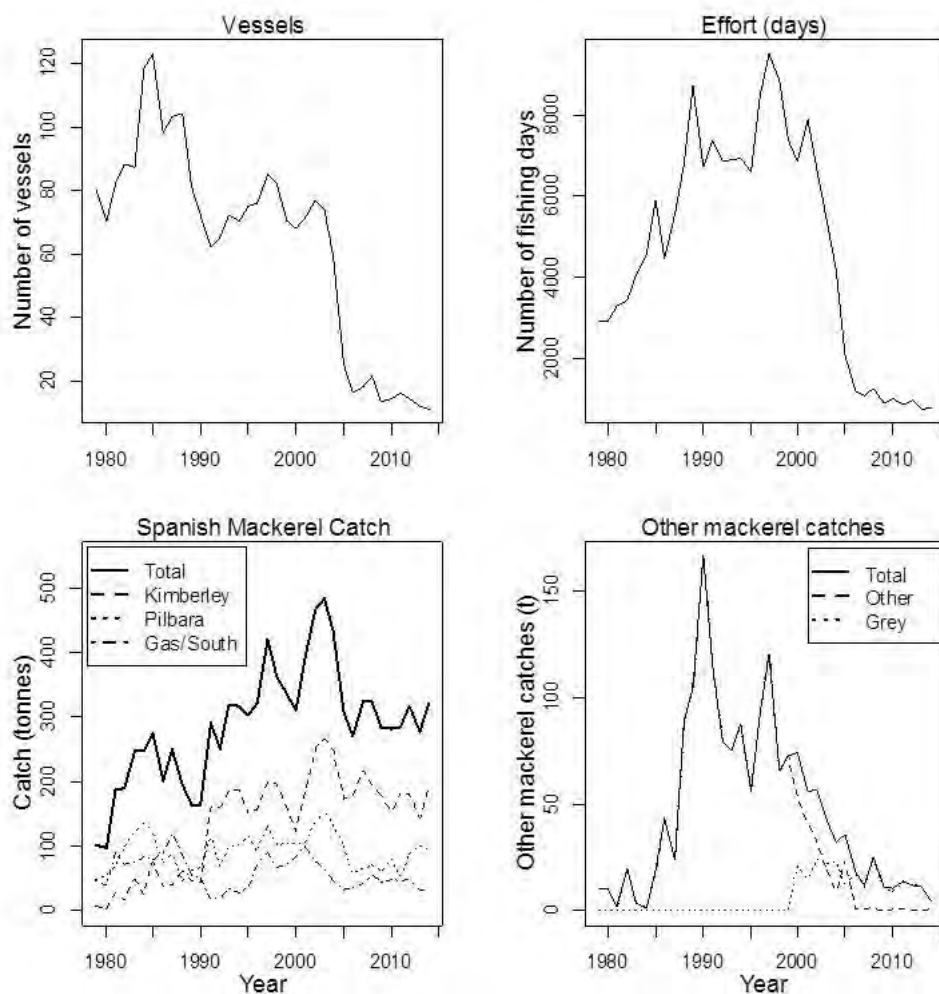
SPANISH MACKEREL TABLE 2

Charter boat catch estimates (in tonnes, t) of Spanish mackerel in Western Australia 2009 - 2014. Estimates are based on an average weight of a Spanish mackerel of 6.9 kg for all regions.

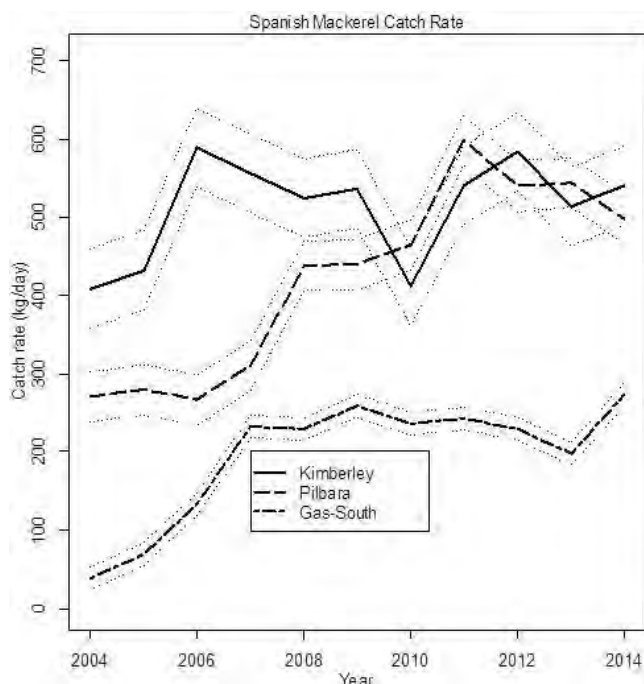
Region	Fate	2009	2010	2011	2012	2013	2014
Kimberley	Retained catch	2.1 t	5.4 t	3.5 t	4.8 t	6.8 t	6.0 t
	Released catch	6.4 t	7.2 t	5.5 t	6.4 t	6.4 t	3.6 t
Pilbara	Retained catch	2.2 t	3.6 t	3.1 t	3.9 t	3.6 t	4.6 t
	Released catch	1.2 t	1.8 t	3.1 t	5.5 t	3.4 t	2.4 t
Gascoyne Coast	Retained catch	1.9 t	2.3 t	2.2 t	3.6 t	3.3 t	1.9 t
	Released catch	0.6 t	1.0 t	1.8 t	2.0 t	1.7 t	0.8 t
West Coast	Retained catch	0.7 t	0.8 t	1.9 t	1.2 t	1.2 t	2.4 t
	Released catch	0.2 t	0.4 t	0.8 t	0.4 t	0.4 t	0.6 t
Statewide (total)	Retained catch	6.9 t	12.2 t	10.6 t	13.4 t	14.8 t	14.9 t
	Released catch	8.5 t	10.5 t	11.1 t	14.3 t	11.8 t	7.4 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, 1979–2014. Note: quota management was introduced in 2006 and the fishery became fully managed in 2012.

**SPANISH MACKEREL FIGURE 3**

Nominal annual catch rates of Spanish mackerel (by management Area) in the Western Australian Mackerel managed Fishery derived from daily logbooks, 2004–2014. 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)	627,634 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 licence 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.

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 access to Zone 2.

Pearl Oyster Zone 4: East of longitude 125°20' E to the Western Australia/Northern Territory border. Although all licensees access this zone currently, 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. These wildstock and hatchery ITQ units are allocated amongst a total of 14 licences.

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 2014 season was 1,100 shell, as a result of stock levels returning from record high levels to normal levels (Pearl Figure 2). In addition, a voluntary quota for 'MOP' only (oysters ≥ 175 mm) of 328 shells per unit was agreed to, resulting in a total unit value of 1,428 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. The trial of the minimum legal size of 100 mm shell length was extended in 2014, to include the 2015-2016 seasons. 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).

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 2014): 627,634 shell

In 2014, catch was taken in Zones 1, 2/3 and the number of wild-caught pearl oyster shell was 627,634 comprising of 486,145 culture shells and 141,489 MOP shells (Pearl Figure 2).

The TAC for the Fishery was 707,566, thus 89% of the TAC was caught. In Zone 2/3 478,101 culture shell were caught (approximately 95% of the culture-shell TAC- 502,700). In comparison, 517,000 culture shells were caught in 2013. The take of 112,917 shells for MOP in Zone 2/3 (75% of the MOP TAC of 149, 896), which are large oysters (>175 mm shell length), was similar to the 135,721 and 129,000 MOP caught in 2013 and 2012 respectively (Pearl Figure 2).

Fishing recommenced in Zone 1, after a hiatus since 2008. In 2014, the number of wild-caught pearl oyster shell was 36,332 comprising of 8,044 culture shells and 28,572 MOP shells (TAC of 54, 970 shells).

Fishing effort/access level

Total effort was 14,011 dive hours (Pearl Figure 2), an increase of 17% from the 2013 effort of 11,993 hours. Of this total effort, 12,651 hours was focused on culture shell fishing, and the remaining 1,360 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 2014 fishing season based on catch and effort statistics, settlement analysis (38,000 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (4,200 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 2015 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 culture-shell 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. A standardised SCPUE index has been developed and provides the best estimate of annual abundance accounting for environmental and efficiency effects as well as the change in minimum size. SCPUE in 2014 was 28 shells per hour, the same as in 2013, which is at the lower end of the target range, but still above the threshold SCPUE (Pearl Figure 3). Raw CPUE was 38 shells per dive hour, a similar level to 2013 and 2012 (35 and 36 shells per dive hour respectively; 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 104 shell per hour in 2014 was similar in 2013 at 112 shell per hour and 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 2015 was maintained at a unit value of 1,100 shells (TAC = 502,700) which is the same as 2014 (Pearl Figure 4). A small increase in CPUE is predicted for the following two years, 2016 and 2017. Fishers were also given an MOP

quota of 240 shell per unit to further explore the potential of the MOP fishery, resulting in a total quota of 109,680 shells per unit.

Zone 1: The Zone 1 fishery was fished for the first time since 2008. Since then, the Zone 1 fishery has been in a state of rebuilding, particularly in the middle sector after some heavy fishing years in the mid-1990s to early 2000s. In 2008, the Zone 1 CPUE was 25 shells per hour, which was a slight increase from the 2007 CPUE of 23 shells per hour. In 2014 all culture shell were fished from one grid in the northern sector (Turtle Island) with a CPUE of 47 shells per hour, indicating 100% increase in the 2008 catch rate, albeit nominal fishing in only one grid. In 2014, MOP was fished from 2 grids in the northern sector (Turtle Island) with a CPUE of 70 shell per diver hour. With a significant change in the culture CPUE, it could indicate that a substantial recovery has taken place and further fishing activity in the years ahead.

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 100 – 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 survive this 'gauntlet' are 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 2014. The area of fishing remains substantially less than 60% of the distribution of oysters within this region. The catch rate in Zone 2 was above performance levels, with a catch rate of 38 oysters/hour. No culture shell were caught in Zone 3.

Non-Retained Species

Bycatch species impact: **Negligible**

Divers have the ability to target pearl oysters of choice (species, sizes and quality of *P. maxima*). Pearl oysters brought to the vessel after hand collection are young and have relatively little epiphytic growth (fouling organisms). A small number of over-sized or under-sized oysters are returned to the substrate.

Protected species interaction: **Negligible**

There is no interaction between the pearl oyster fishing operation and protected species.

Ecosystem Effects

Food chain effects: **Negligible**

The fishery removes only a small proportion of the biomass of pearl oysters on the fishing grounds and is considered to have negligible impact on the food chain in the fishing area.

Habitat effects: **Negligible**

Pearl divers have minimal contact with the habitat during fishing operations. The main habitat contact is by pearl oysters held in mesh panels on holding sites following capture. However, these sites cover a very small proportion of the habitat and the activity concerned is unlikely to cause any lasting effect.

Similarly, the pearl farming operation, which uses longline systems in areas of high tidal flow to culture pearls, has limited impact on the environment. Physical effects are limited to static anchoring systems in typically sand/mud habitats. Environmental management research has demonstrated that pearl farming has negligible impacts on habitat and environment.

Social Effects

Direct

Pearl oyster fishing vessels operate from the Lacepede Islands north of Broome to Exmouth Gulf in the south. The number of vessels in the fishing fleet has been slowly reducing from 16 in 1997 (overall), mostly due to increased fleet efficiency and increased reliance on hatchery-produced shells. In 2009, with the negative impact of the Global Financial Crisis (GFC) on the industry, only two vessels fished. The number of vessels fishing in 2014 was six.

Most vessels presently operate 10 – 14 crew for the fishing of pearl oysters between March and August 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 2014:

Level 5 - > \$20 million (\$67 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 2014 was considered to be approximately \$67

million, which is 10% higher than 2013, in which it was \$61 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 new management initiatives from 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 12,479 dive hours of effort, which was within acceptable effort range.

Zone 2/3 of the pearl oyster fishery achieved its catch at an SCPUE of 28 shells per hour, which was within the target range of SCPUE.

Current effort level: Acceptable

Overall fishery effort level is acceptable.

New management initiatives (2015)

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 has advised that there are no sustainability issues under a fixed TAC.

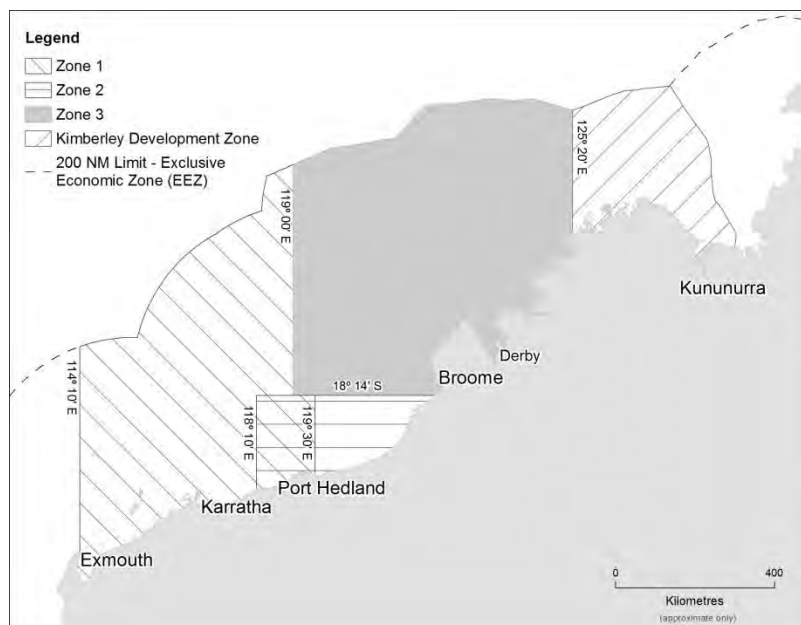
The pre-assessment phase for Marine Stewardship Council (MSC) approval was completed for the Pearl Oyster Fishery in 2014, with the Fishery to undergo full assessment during 2015.

A new State Act of Parliament to ensure the sustainability and management of all WA's aquatic biological resources has been introduced into Parliament in 2015. The new Act (currently *the Aquatic Resource Management Bill 2015*) 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

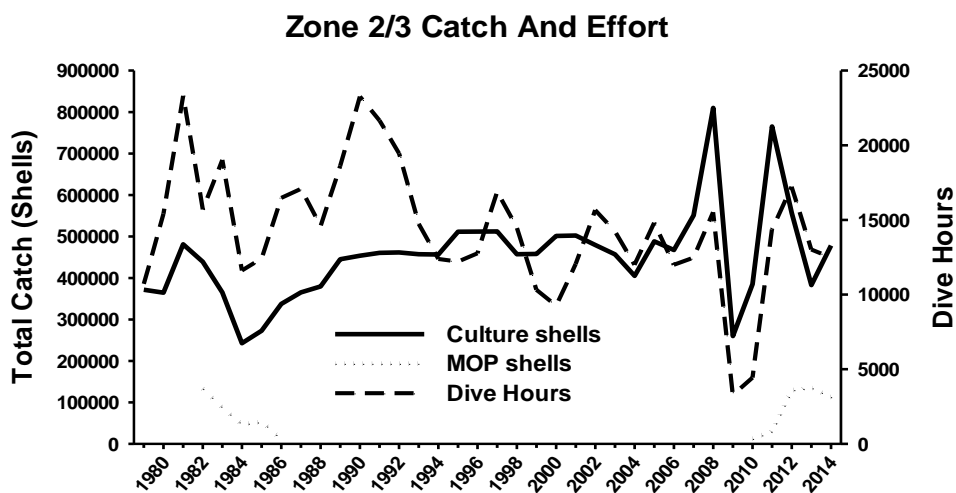
The pearl oyster stocks underpinning the fishery in Zone 2/3 continue to provide a sufficient level of production to support this major Western Australian industry, however preliminary research points to environmental factors being an external driver of the spat settlement in 2005 and high abundance in the fishery in 2008-2011. A risk assessment on the vulnerability of species to climate change ranked pearl oysters as medium-high due to its sensitivity to water temperature and cyclones.

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 2015 suggest a market recovery and a stabilising of 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.



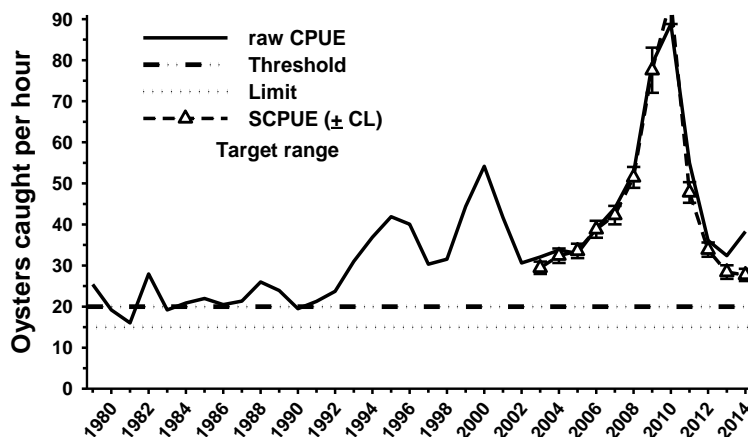
PEARL FIGURE 1

Distribution of pearl oyster stocks and fishing zones in Western Australia.



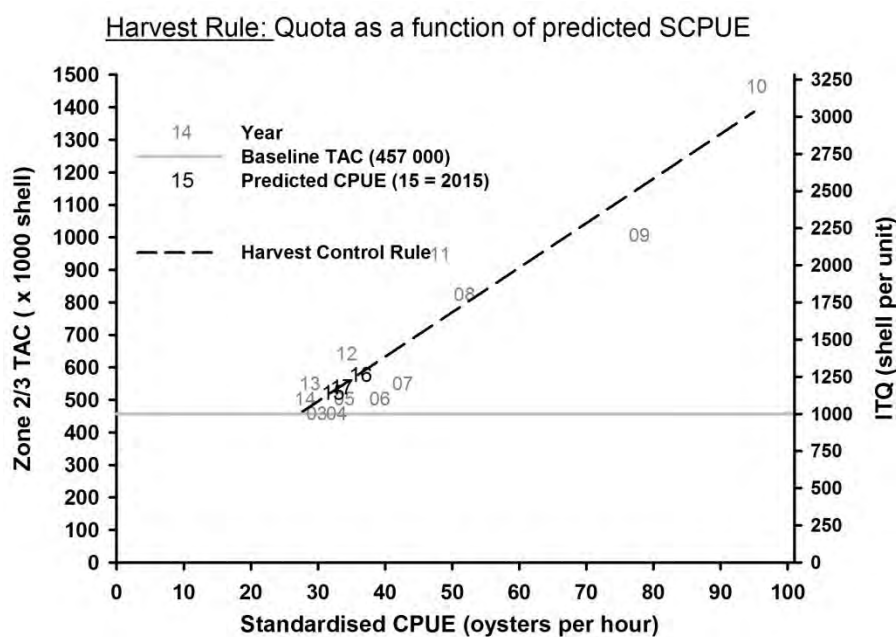
PEARL FIGURE 2

Pearl shell catch and effort – Broome area (Zone 2/3). 'Culture shells' are pearl oysters ≥ 100 and < 175 mm shell length, 'MOP shells' are oysters ≥ 175 mm



PEARL FIGURE 3

Standardized (SCPUE) and nominal (raw CPUE) pearl culture shell catch per unit effort in the Zone 2/3 fishery with threshold and limit reference points and target range indicated.

**PEARL FIGURE 4**

Harvest control rule for the culture shell in Zone 2/3 pearl oyster fishery. The current rule takes the form, $TAC(2015) = 13.7 * SCPUE_{2015} + 85.35$; $r^2 = 0.88$. 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	<i>Actinopyga echinites</i> – Deepwater Redfish	48 t
Fishing level	Acceptable	<i>Holothuria scabra</i> – Sandfish	40 t
		<i>Holothuria whitmaei</i> – Black teatfish	5 t
		Other – Stonefish and Curryfish	0.5 t

Fishery Description

Beche-de-mer, also known as sea cucumbers or trepang, are in the Phylum Echinodermata, Class Holothuroidea. They are soft-bodied, elongated animals that usually live with their ventral surface in contact with the benthic substrate or buried in the substrate.

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 not specifically closed to fishing. 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 and 2014

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 target 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 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 ten 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. A population biomass survey is planned for the *A. echinites* stock in 2015.

Retained Species

Commercial landings (season 2014)

93 tonnes (live weight)

Landings

Industry has advised they are adopting a rotational fishing strategy for both the traditional sandfish *Holothuria scabra* fishery and recently discovered *A. echinites* fishery. Fishing activity within the Western Australian fisheries was in a resting phase during 2013. In 2014 fishing recommenced with a catch of 48 t of *Actinopyga echinites*, 40 t of *Holothuria scabra*, 4.7 t of *Holothuria whitmaei* and 0.5 t of other species being *A. lecanora* (Stonefish), *A. milaris* (Blackfish), and *Stichopus herrmanni* (Curryfish). Current trends of catch and effort within the fisheries are shown in Beche-de-mer Figure 1a and Table 1.

Fishing effort/access level

Two of 6 licensed vessels fished for beche-de-mer in 2014, with 1000 dive hours fishing. From this total, 54 dive hours comprised of exploratory fishing further south into the Gascoyne region targeting other species.

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 2014, catch and catch rates satisfy the performance measures (Beche-de-mer Figure 1b).

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 2014, catch and catch rates satisfy the performance measures (Beche-de-mer Figure 1b).

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 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 2014:

Level 1 - < \$ 1 million

The estimated annual value for 2014 was \$280,500 based on an average product price of \$3.00 per kg live weight and total catch of 93.5 tonnes. This is a farm-gate value and supports a substantial processing and value adding sector.

Fishery Governance

Sandfish catch range: 20 – 100 tonnes

Redfish catch range: 40 – 150 tonnes

New management initiatives (2014/15)

A review of the beche-de-mer fishery is planned for 2014/15. It is anticipated that this review will result in the fishery transitioning from Exemption based to interim managed during 2015/16.

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. Marine park planning has to date restricted this fishery from general use zones of some MPAs. However consideration of removal of this restriction is currently underway as most 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 as a result of the fishery transitioning to interim managed status.

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
2014	93	1000*	40	641	48	255	5

*Includes 54 dive hours of exploratory fishing for negligible catch

BECHE-DE-MER TABLE 2

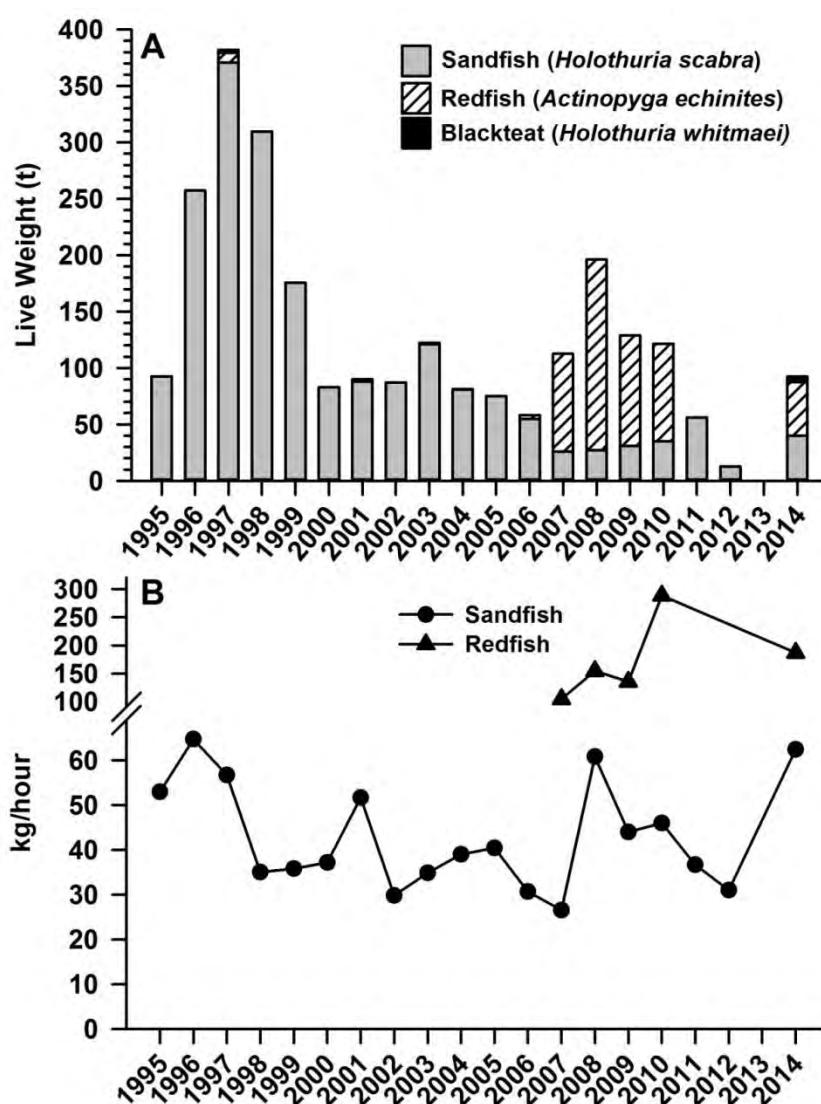
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

Area	MSY (t)	Current average catch (2008-2014) (t)	Parameter estimates*		
			r	K (t)	q
Entire Fishery	142	29	0.84	967	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) for the two main species from the Western Australian beche-de-mer fishery.

North Coast Crab Fishery Status Report

D. Johnston, R. Evans, C. Marsh, N. Blay and D. Wallis

Main Features			
Status		Current Landings	
Stock level		Blue swimmer crab	
Blue swimmer crab	Acceptable	Commercial	45.9 t
Mud crab	Unknown	Recreational (boat-based) (May 13- Apr 14)	
Fishing Level		Mud crab	
Blue swimmer crab	Acceptable	Commercial	12.9 t
Mud crab	Acceptable	Recreational (boat-based) (May 13- Apr 14)	
			5.9 t

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 in Denmark in years of strong southern coastal Leeuwin Current flow (Gopurenko *et al.*, 2003)⁴. The brown mud crab has a more restricted distribution limited to northern embayments, with most catches from King Sound 200 km northwest of Broome. Brown mud crabs are more tolerant of low salinity than green mud crabs, but less tolerant of lower temperatures. They are also considered to exhibit a strong preference for the intertidal zone, while green mud crabs make regular use of both intertidal and subtidal habitats up to 20 m depth offshore (Hill, 1994⁵, Robertson, 1996⁶).

The Kimberley Developing Mud Crab fishery is currently a small developing fishery that targets the green mud crab and the brown 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 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

1 Keenan, C.P., Davie, P.J.F., and Mann, D.L. (1998). A revision of the genus *Scylla* de Hann, 1833 (Crustacea: Decapoda: Brachyura: Portunidae). *Raffles Bulletin of Zoology*. 46(1): 217-245.

2 Lloris, D. (2001). FAO/SIDS species identification sheet: *Scylla serrata*

3 Tongdee, N. (2001). Size distribution, sex ratio and size at maturity of mud crab (*Scylla* spp.) in Rangong Province, Thailand. *Asian Fisheries Science* 14: 113-120.

4 Gopurenko, D., Hughes, J.M., and Bellchambers, L.M. (2003) Colonisation of the south-west Australian coastline by mud crabs: evidence for a recent range expansion or human-induced translocation? *Marine and Freshwater Research*. 54. 833-840.

5 Hill, B.J. (1994) Offshore spawning by the portunid crab *Scylla serrata* (Crustacea: Decapoda). *Marine Biology*. 120:3. 379-384.

6 Robertson, W.D. (2011) Abundance, population structure and size at maturity of *Scylla serrata* (Forsk.) (Decapoda: Portunidae) in Eastern Cape estuaries, South Africa. *South African Journal of Zoology*. 31:4. 177-185.

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 Reefishwest 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 is 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 were permitted to retain bycatch of other *Portunid* crabs for a two year trial period which ended on 30 April 2015. Negligible catches of blue swimmer crabs were retained during this trial. A minimum size limit of 135 mm for blue swimmer crabs was imposed, consistent with the size limit used in the Pilbara Developmental Crab Fishery. No limits were 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 (90-120 mm CW for green and 86-96 mm CW for brown). This was later revised to 131-138 mm CW for green mud

crabs after reclassification of the *Scylla* genus (Knuckey, 1999)¹. These size limits apply to both the commercial and recreational take of the species.

Recreational fishers for mud crabs are restricted to a daily bag limit of 5 mud crabs, with a boat limit of 10 mud crabs.

Research Summary

Blue Swimmer Crab

Data for the assessment of blue swimmer crab stocks in the North Coast Bioregion is obtained from trap fishers' compulsory monthly catch and effort returns and daily research log books, and trawl fishers' daily logbooks.

Baseline information on the biology and ecology of blue swimmer crabs has been generated by a number of Fisheries Research and Development Corporation (FRDC)-funded projects conducted by the Department of Fisheries and Murdoch University over the past decade.

Mud Crab

Data for the assessment of mud crab stocks in the North Coast Bioregion is obtained from trap fishers' compulsory monthly 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 2013/14):

Blue swimmer crabs	45.9 tonnes
Mud crabs	12.9 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 2013/14 was 45.9 t, a 692% increase on the 2012/13 catch of 5.8 t and the highest catch since 2006/07 (North Coast Crab Figure 3). The majority of the 45.9 t recorded catch was taken by the trap fishery, with trawlers retaining only 4.7 t of crab during 2013/14. This Pilbara catch accounted for 8% of the state commercial blue swimmer crab catch of 552 t for 2013/14 (West Coast Blue Swimmer Crab Figure 1).

Mud Crab

The total trap catch of mud crab for the Kimberley Developing Mud Crab Fishery during 2014 was 12.9 t (North

Coast Crab Figure 5). An additional 3 kg was reported from Swan-Canning Estuary. This catch represents a 63% increase on the 7.9 t reported in 2013 and is the highest catch on record; 39% higher than 2006 when the developmental fishery commenced. In 2014 the majority of catch was recorded as green mud crab, while a small proportion was recorded as brown mud crab.

During the 2014 fishing season, mud crab exemption holders were permitted to retain *Portunid* crabs as part of an experimental trial. A total of 263 kg of blue swimmer crabs were landed from Cambridge Gulf with the majority being caught between September and December by one commercial operator.

Recreational catch:

Blue Swimmer Crab (boat-based) (May 13 – Apr 14) **4.2 tonnes**

A statewide survey of boat-based recreational fishing was conducted between 1st May 2013 and 30th April 2014 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 254 g/crab (based on 346 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 72 t (S.E.±4.8 t) (Ryan *et al.*, 2015)⁵. The boat-based catch estimate for the North Coast Bioregion was 4.2 t (S.E.±0.9 t), representing approximately 6% of the state's recreational catch.

Mud Crab

The statewide survey of boat-based recreational fishing was also used to estimate the mud crab catch. Catch data were recorded in numbers of mud crabs, and have been converted to weight for this report using a mean statewide estimate of 649 g/crab (based on 72 mud crabs weighed during the boat ramp surveys). The survey provided a statewide boat-based recreational estimate of retained mud crabs for the 12-month period of 7.3 t (S.E.±0.98 t) (Ryan *et al.*, 2015). The boat-based catch estimate for the North Coast Bioregion was 5.9 t (S.E.±0.89 t), representing approximately 81 % of the state's recreational catch. Of the 5.9 t caught in the North Coast Bioregion, 3.5 t (60%) was caught in the Kimberly and 2.4 t (40%) was caught in the Pilbara.

Fishing effort/access level

Blue Swimmer Crab

Crab trap fishers along the Pilbara coast reported 23, 025 traplifts during 2013/14, which is a 184% increase on the 8,100 traplifts reported for 2012/13 (North Coast Crab Figure 4).

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.

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.

5 Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

Mud Crab

Mud crab fishers along the Kimberley coast reported 21,699 traplifts during 2014, a 136% increase on the 9,190 traplifts reported for 2013 (North Coast Crab Figure 5). There were two commercial fishers operating between April and August 2014, however this increased level of effort is likely due to extensive and prolonged exploratory fishing effort by 1 commercial fisher in the latter part of 2014.

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.*, 2003¹). 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, extreme 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.

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) between 2007/08 and 2012/13.

The Pilbara Developmental Crab Fishery recorded a mean catch rate for 2013/14 of 1.8 kg/trap lift – the highest recorded catch rate and a 156% increase on the catch rate of 0.7 kg/traplift reported during the previous year (North Coast Crab Figure 4).

A preliminary harvest strategy has been determined for this fishery where the primary performance indicator is nominal annual catch rate for the Nickol Bay Region (CAES blocks 2016, 2017), as the majority of fishing has been focused in this area historically. The reference period is between 2005 and 2011 as defined by the commencement of the developing fishery in 2005. As there is no season for this fishery the harvest strategy is based on calendar year. The nominal catch rate of 1.8 kg/traplift for the 2014 calendar year was well above the threshold of 0.6 kg/traplift, so currently the risk to sustainability is low.

Mud Crab

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). Consequently, breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas under normal environmental conditions.

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 5,250 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 18,720 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 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 ~ 8,000 traplifts) but then declined 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 (2010 – 2014) has fluctuated between 0.5 and 0.9 kg/traplift, with a catch rate of 0.6 kg/traplift reported in 2014. Historically, the majority of commercial crabbing has occurred in the areas of Cambridge Gulf, Admiralty Gulf, York Sound and King Sound. During 2014, fishing was reported from Collier Bay and York Sound and the majority of catch was recorded from Cambridge Gulf.

A preliminary harvest strategy has been determined for The Kimberley Developing Mud Crab Fishery where the primary performance indicator is nominal annual catch rate. The reference period is between 2006 and 2011 as defined by the commencement of the developing fishery in 2006. As there is no season for this fishery the harvest strategy is based on calendar year. The nominal catch rate of 0.6 kg /traplift for the 2014 calendar year declined from last year as a result of the increased effort but remained above the threshold of 0.5

1 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.

kg/traplift, so currently the risk to sustainability is low. However, due to the catch rates proximity to the threshold it will be monitored closely in 2015 to ensure that it does not fall below the threshold.

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 is required 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 results in limited habitat disturbance. The large mesh size prevents capture of benthic organisms and only minor dragging of traps on the sea floor occurring in trap retrieval. The sheltered shallow mangrove environment is protected from wind and waves where the majority of traps are deployed, resulting in minimal habitat damage.

Social Effects

Blue Swimmer Crab

During 2013/14, 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.

There were two commercial operators that fished during 2014, with effort concentrated between April and August with one operator fishing through December.

Economic Effects

Estimated annual value (to fishers)

Level 1 - < \$1 million

Blue Swimmer Crab

Average beach price for trap caught blue swimmer crabs across all Western Australian fisheries for 2013/14 was around \$5.24/kg. 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. Based on this beach price, the total commercial blue swimmer crab catch in the North Coast Bioregion for 2013/14 was valued at approximately \$240,754, a 306% increase on the \$53,300

generated in 2012/13. Of this, \$216,360 was reported from the trap sector. The crab catch from the Pilbara region was sold through local and interstate markets.

Based on the WA state beach price the economic value of the total commercial blue swimmer crab catch for the State of Western Australia for the 2013/14 financial year was estimated to be \$2.9 million – a 13% increase on the estimated \$2.6 million generated in 2012/13.

Mud Crab

The average beach price for green (uncooked) mud crabs in the Kimberley for 2014 was around \$23.61/kg (however note this value is based on a small proportion of total catch from an individual processor). 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.

Mud crab landings from the Kimberley mud crab fishery during 2014 were worth approximately \$303,908 a 74% increase on the \$174,572 generated in 2013. 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. Aboriginal corporations may also trade and barter product adding value to the local communities that cannot be estimated.

Fishery Governance

Target catch (or effort) range:

Blue Swimmer Crab Pilbara N/A

Mud Crab N/A

Current fishing (or effort) level:

Blue Swimmer Crab Pilbara - 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

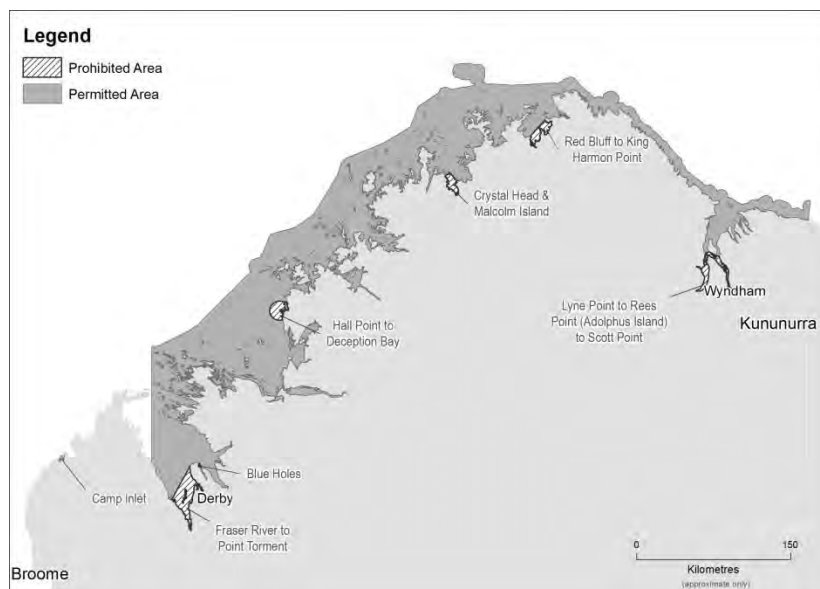
The Department is currently progressing formal management arrangements of the Pilbara Crab DNF through the development of a (Interim) Management Plan for the fishery. This is scheduled to be completed in 2015.

Mud Crab

The Department proposes to bring the Kimberley Developing Mud Crab Fishery under formal management arrangements in 2015.

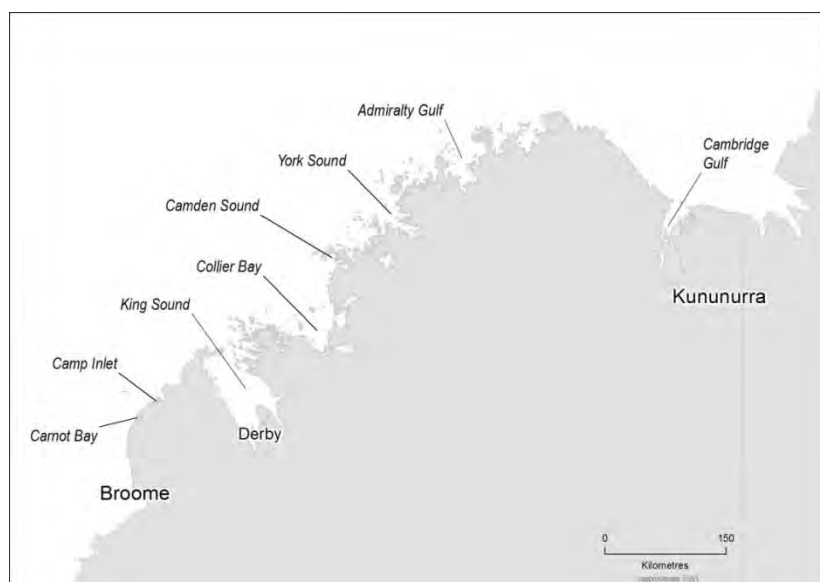
External Factors

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 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. Blue swimmer crabs were rated a high risk to climate change due to their sensitivity to water temperature changes.



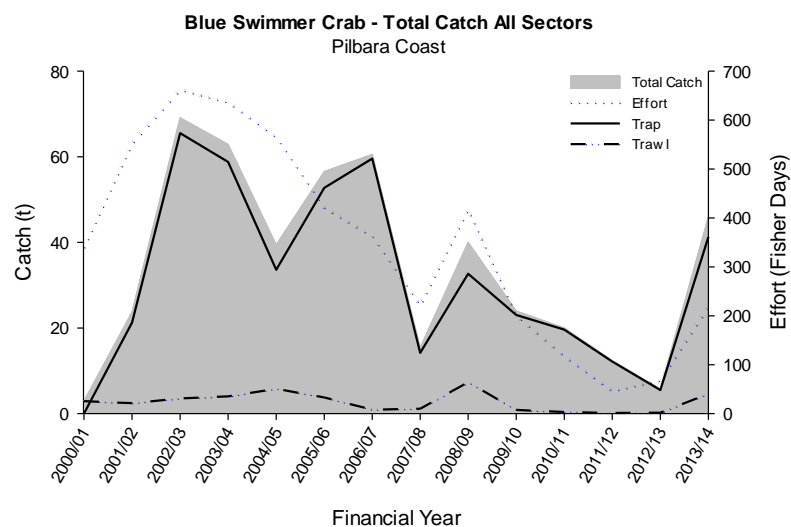
NORTH COAST CRAB FIGURE 1

Areas fished for mud crab along the Kimberley coast of Western Australia.



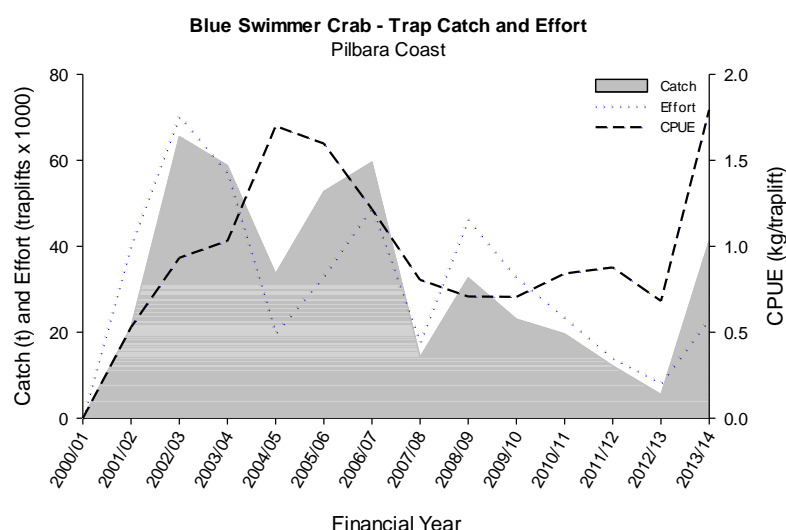
NORTH COAST CRAB FIGURE 2

Key areas fished by exemption holders operating in the Kimberley Developing Mud Crab Fishery in Western Australia.

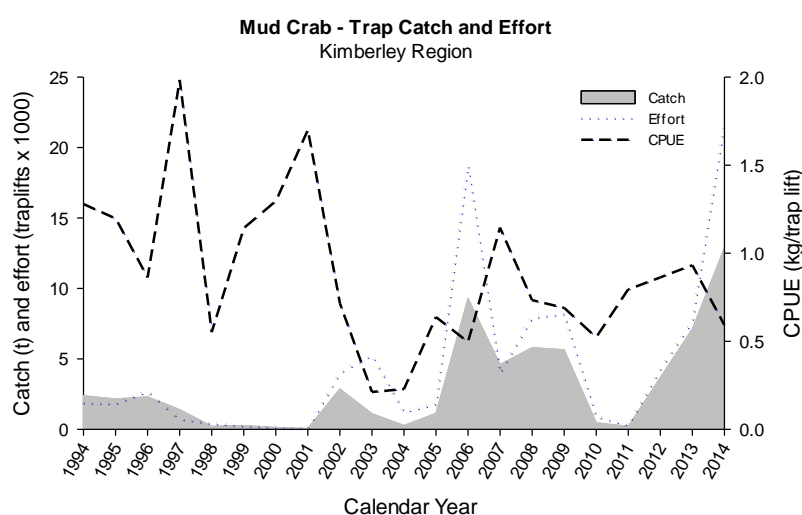


NORTH COAST CRAB FIGURE 3

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 (t), effort (traps x 1000) and catch per unit effort (CPUE) (kg/traplift).

**NORTH COAST CRAB FIGURE 5**

Annual catch (t), effort (traps x 1000) and catch per unit effort (CPUE) (kg/traplift) for mud crab in the Kimberley Region since 1994 when permissive conditions of fishing boat licences 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.

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.

The Minister for Fisheries has now formally declared and gazetted the Kimberley Aquaculture Development Zone, which encompasses approximately 2,000 hectares within Cone Bay, following the Minister for Environment issuing an implementation statement in respect of environmental approval.

The operator of a fish farm producing barramundi (*Lates calcarifer*) in Cone Bay has secured approval to increase production up to 7,000 tonnes per annum, following the declaration of the Kimberley Aquaculture Development Zone. The operator is now planning to gradually increase its production capability.

A company that previously established a demonstration facility near Karratha for the mass production of marine algae is no longer operating at the site and has not renewed its aquaculture licence. The same site is the subject of a new application for an aquaculture licence.

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 bioregion extends from the Ashburton River near Onslow to the Northern Territory border. The bioregion is both expansive and diverse, covering over 2600km and containing a huge range of fish that are targeted by commercial and recreational fishers.

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 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 fly in / fly out is common. Surveys have shown that a large proportion of mining community and tourists take part in fishing while visiting the bioregion.

Within the North Coast Region, creek systems, mangroves, rivers, offshore islands, coral reef systems and continental shelf waters provide for a wide range of shore and boat fishing opportunities.

Three district offices located in Kununurra, Broome and Karratha provide compliance and education across the region with fifteen permanent Fisheries and Marine Officers and one Community Education Officer. An additional two officer Recreational Mobile Patrol operates throughout the North Coast Region. 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 patrol 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.

The Community Education Officer develops programs and coordinates the delivery of educational activities to a range of targeted audiences. They reach a wide range of people

including school aged children and retirees, who come north to escape the cold and throw a line.

FMO's also support community education where possible by supporting the Community Education Officer at a variety of community events and fishing competitions.

Activities during 2013/14

Compliance delivery in the North Coast region requires careful planning due to the vast expanse of coastline, huge tidal variations, the variety of commercial and recreational fisheries and seasonal weather conditions which can often see road closures and flash flooding during the wet.

Fisheries and Marine Officers delivered a total of 7,811 officer hours of active compliance patrol time during 2013/14. FMOs also achieved 19,628 personal compliance contacts with fishers and non-fishers across the commercial and recreational sectors representing an increase on the previous year.

Officers made contact with a total of 203 commercial fishers in the field, across the north coast, again representing an increase on the previous year. This resulted in 18 infringement warnings, 16 infringement notices being issued and 37 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.

Officers made contact with a total of 18,346 recreational fishers in the field, across the north coast.

From this sector 211 infringement warnings and 233 infringement notices were issued and 15 matters resulted in prosecution action.

Education activities for the 2013/14 period included the delivery of school incursions and excursions, school holiday programs, teacher professional learning sessions, community presentations and regional events such as fishing competitions and agricultural shows. A total of 4,655 contacts were recorded across the north coast region. When possible, education initiatives were delivered in partnership

NORTH COAST BIOREGION

with key stakeholders such as; RecFishWest, Department of Parks and Wildlife and local fishing clubs.

Initiatives in 2014/15

Compliance and management staff continue to refine compliance planning to deliver greater outcomes. This has resulted in greater efficiency and ability to deploy resources more effectively.

The North Coast bioregions FMOs will continue to use a risk assessment based approach to fisheries compliance to ensure areas and activities of a high risk of non-compliance are targeted.

The 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 continue 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.

The education program for the north coast will focus on recreational fishers. While school based education is still a very important aspect of the program, the emphasis will decrease for 2014/15. By working more closely with FMO's the program will aim to address some key compliance issues that occur in the region such as the use of illegal traps and species misidentification.

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 2013/14 financial year

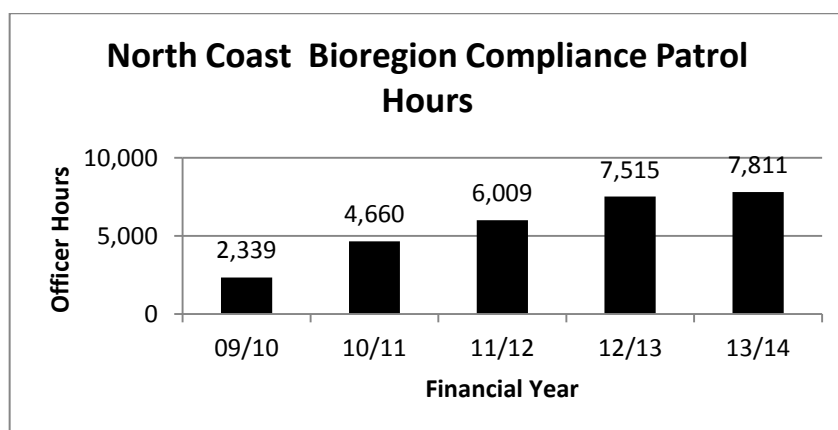
PATROL HOURS DELIVERED TO THE BIOREGION	7,811 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	203
Infringement warnings	18
Infringement notices	16
Prosecutions	37
Fishwatch reports***	3
VMS (Vessel Days)****	6,861
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	18,346
Infringement warnings	211
Infringement notices	233
Prosecutions	15
Fishwatch reports	40
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	1,079
Fishwatch reports	4

* 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 contacts are these contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category. This table includes contacts made by PV 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 five years. The 2013/14 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. (The totals exclude: time delivered by the Department’s large patrol vessels *PV Walcott* *PV Houtman* and *PV Hamelin*; time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.. Time spent in Marine Park sanctuary zones is also excluded because this time may overlap field time outside a sanctuary zone and as a result, the historic data is slightly lowered compared to that reported in previous reports

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 of Fisheries Research Division's Biodiversity and Biosecurity Branch undertakes research and monitoring within the Walpole-Nornalup Marine Park, based on the departments identified risks in conjunction with the marine park management plan priorities. This work includes the support and supervision (in collaboration with Murdoch University) of post-doctoral studies on the finfish community to assess current trends, movement ecology and development of a long term monitoring program for the finfish community within marine park. . 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.

The Marine Biosecurity Research and Monitoring Group implements a range of monitoring and research activities in the Bioregion focussed on detection of introduced marine pests (IMPs) at high risk locations and vessel risk analysis. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. Further details for these projects may be found in the "Introduced Pests Status Report" at the end of this section and also in the Appendix section entitled "Activities of the Marine Biosecurity Research Group during 2014/15".

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 are consistent with 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 km ²	%	Existing MPA km ²	%	Fisheries km ²	%	Existing MPA 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	NEGLECTIBLE	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	NEGLECTIBLE	The stocks of scallops varies annually and fishing only occurs when stocks are abundant

Listed species

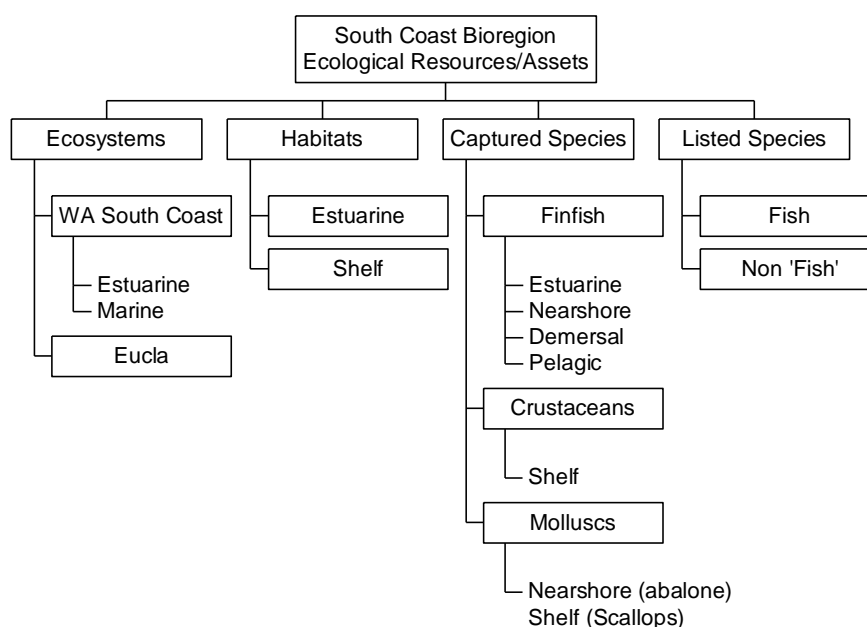
Listed fish species	Species	Risk	Status and Current Activities
Listed non 'Fish' species	Non fish (birds)	MODERATE	The capture of shearwaters in purse seine operations has been addressed by a code of conduct
	Mammals	MODERATE	The potential for the capture of sealions and seals by all fishing operations in this region, but especially gillnets has been the subject of a number of recent studies.
Listed 'Fish' Species	Fish	NEGLECTIBLE	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	NEGLECTIBLE	The shelf region in this bioregion has very little habitat disturbance. Less than 3% of the area is trawled and there are no other activities that would materially impact on the habitats in these areas.

External Drivers (Non Fishing)

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	HIGH	The identification of the pest algae <i>Codium fragile fragile</i> in Albany highlights the issues that now face many ports in Australia
Climate	LOW	This area is unlikely to be impacted by climate change in the near future.



SOUTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

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

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 Group continue to implement a series of biosecurity related projects in the South Coast Bioregion ranging from early detection and control strategies for pests to vessel risk analyses.

The Marine Biosecurity Research Group, with financial and *in-kind* assistance from the Southern Ports Authority and the Department of Transport (Esperance) is running an Early Warning System program using *in-situ* settlement arrays to provide a mechanism for the early detection of marine pests in the ports of Albany and Esperance. Through this surveillance species detected to date in this region are reported in Introduced Pests Table 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. The number of commercial vessels entering the South Coast Bioregion has significantly

increased (~200%) over the past 12 years (2002 to 2014). As a result the group is analysing the change in numbers of commercial vessels as well as their visit and type profiles to better inform management processes of the domestic and international risks to the Bioregion.

The Marine Biosecurity Research Group is also examining the risk recreational vessels pose with respect to introducing, harbouring and translocating IMPs around the State. This project involves surveying marina-based vessel owners about their vessel management practices and their vessel use profiles. The research outputs are designed to be applicable to biosecurity management across the state.

The Marine Biosecurity Research Group is also running an ongoing *in-situ* control program for the management of the invasive alga *Codium fragile* ssp. *fragile*. So far this has involved diver's removing by hand the algae on two occasions, once in 2014 and again 2015. A third visit is planned for mid-late 2015. So far the group has seen a reduction in algae biomass over time, which gives some indication that the program of control is successful.

For further details on the above projects see the Appendix section entitled "Activities of the Marine Biosecurity Research Group during 2014/15".

INTRODUCED PESTS TABLE 1

Introduced marine species detected in this bioregion.

Common name	Scientific name	Type of organism	IMS/IMP listing	Noxious Listing
	<i>Codium fragile</i> ssp. <i>fragile</i>	Algae	Introduced species	Yes
	<i>Didemnum perlucidum</i>	Ascidian	Introduced species – likely pest	Yes
	<i>Botrylloides giganteum</i>	Ascidian	Introduced species	No

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	24 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 (WHARLMF), the Esperance Rock Lobster Managed Fishery (ERLMF), 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 WHARLMF (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

Windy Harbour-Augusta Rock Lobster Managed Fishery Licence

Esperance Rock Lobster Managed Fishery Management Plan 1987

Esperance Rock Lobster Managed Fishery Licence

Southern Rock Lobster Pot Regulation Licence

Condition 105 on a Fishing Boat Licence

Prohibition on Fishing for Rock Lobster Order 2013

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 undertakes consultation directly with licensees on operational issues and processes and is responsible for the statutory management plan consultation. Industry Annual Management 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

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 ERLMF, where crabs may only be taken by licensees in the ERLMF.

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 lobsters across all four south coast crustacean fisheries is 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 that will come into effect on 1 July 2015 and consolidate the four existing fisheries into the South Coast Crustacean Managed Fishery.

Catch statistics for the fisheries are based on the period from 1 November to 31 October inclusive. In 2013/14 there were two licences in the WHARLMF; eight licences in the ERLMF (five vessels reported catch); 28 licences in the Southern Rock Lobster Pot Regulation Fishery (13 vessels reported catch) and 23 holders of Fishing Boat Licence Condition 105 (seven 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, a bag limit of eight lobsters per licence and seasonal closures apply and all recreational fishers are required to hold a current Rock Lobster Recreational Fishing Licence. The recreational rock lobster season has previously been 15 November to 30 June, in line with the commercial rock lobster season. However as of 2014, the recreational season has been extended to 15 October to 30 June to create consistency with the recreational rock lobster fishing season on the west coast, and thereby across the state.

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 2013/14):

Southern rock lobster	46 tonnes
Deep sea crabs	24 tonnes
Western rock lobster	Not reported
due to confidentiality provisions	

In 2013/14, the south coast catch of southern rock lobster of 46.2 t was below the target catch range and slightly lower than last year's catch of 46.5 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 23.8 t, comprising of 1.0 tonne of champagne, 9.9 t of giant, and 12.9 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 227 599 potlifts recorded for all fishing in the south coast crustacean fisheries, with effort spread relatively evenly across the three eastern zones with 62 513, 75 211 and 57 335 potlifts in Albany, Esperance and the Bight areas respectively. Windy Harbour-Augusta recorded 32 540 potlifts in 2013-14

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 8% this season to 113 918 potlifts, while the standardised total effort increased by 5% to 154 428 potlifts (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 was 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 was near its threshold level in 2013/14, though was still within the target region (South Coast Crustacean Figure 2c). In 2013/14 the standardised catch rate for southern rock lobsters was 0.29 kg/potlift.

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 2013/14 season there were no reported interactions with fishing gear of south coast crustacean fisheries.

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 2013/14

Level 2 - \$1 - 5 million (\$3.8 million)

The beach value of the fishery was about \$3.8 million in 2013/14 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 2013/14, the south coast catch of 46.2 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.

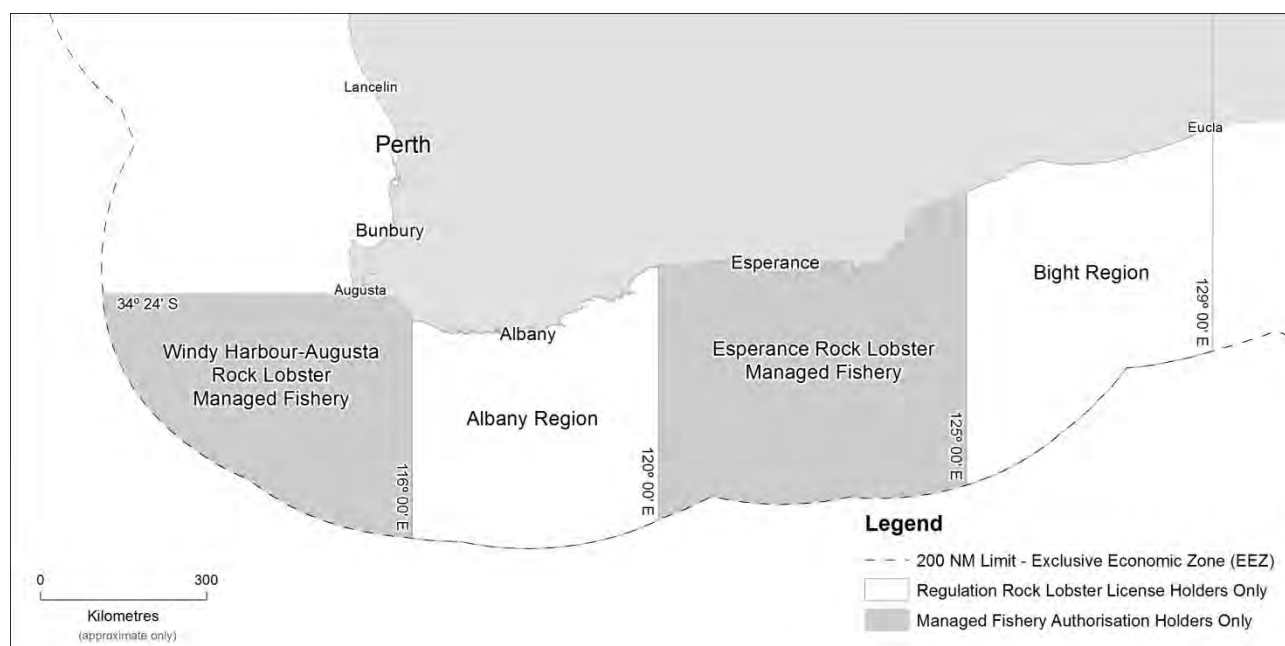
New management initiatives (2015/16)

In 2013, the (then) Minister for Fisheries approved 'in principle' a suite of management proposals and access and allocation criteria for the proposed South Coast Crustacean Managed Fishery (Fishery). This included approval for a single management plan to be developed to amalgamate the management arrangements for the four existing south coast crustacean fisheries. As such, the *South Coast Crustacean Managed Fishery Management Plan 2015* (the Plan) has been developed and will supersede the two existing management plans, regulation licence and licence condition which currently regulate the four fisheries. The Plan will come into effect on 1 July 2015.

Under the Plan, the Fishery will be managed through limited entry, input controls (including limiting the number of pots that can be used), size limits and seasonal and spatial closures. All current authorisation holders will have access to the new Fishery but access will be limited to the zones in which operators currently hold an authorisation.

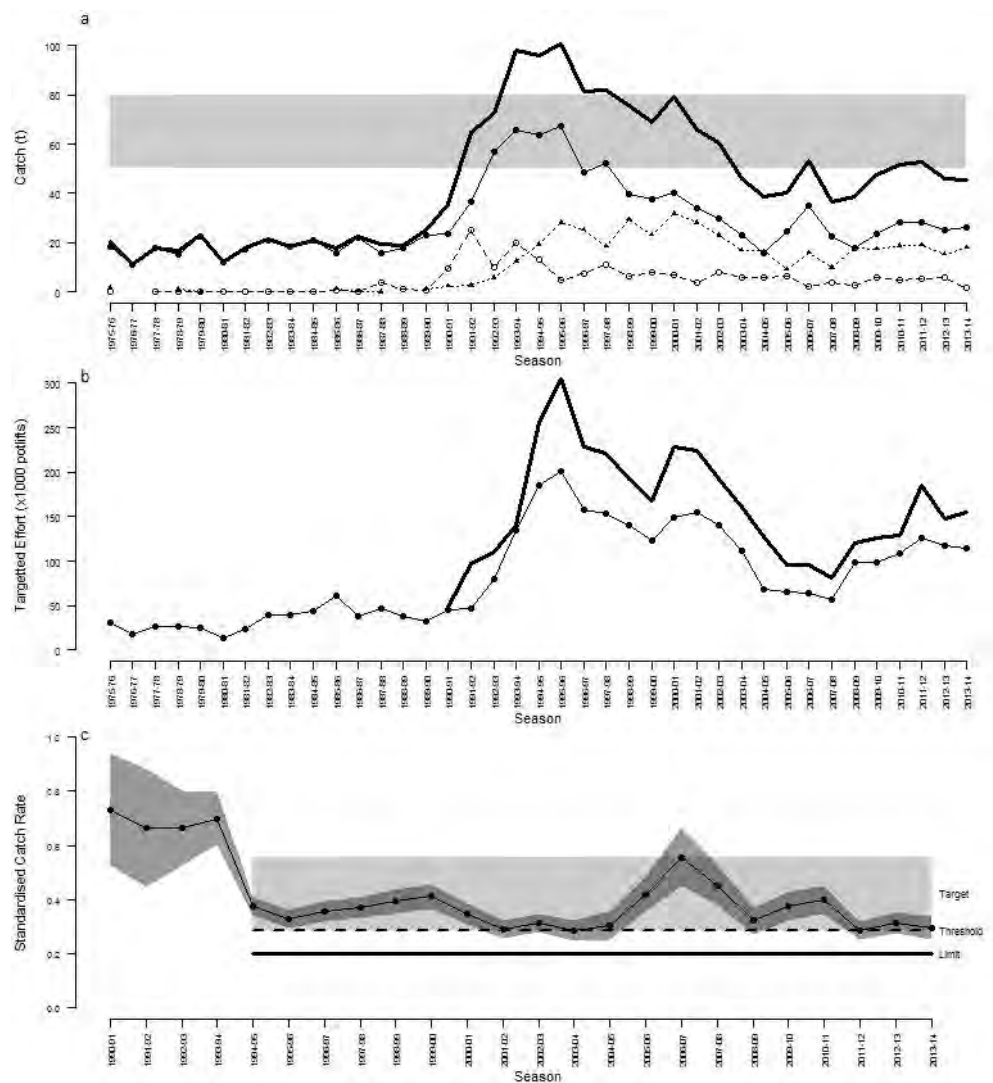
External Factors

Given a large export market, fluctuation in the Australian dollar can have impacts on the economic performance of the fishery. The southern and western rock lobsters are near the edge of their distributional range and hence could be influenced by environmental conditions.



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 (line with solid circles) and standardised total effort (bold line) 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		Not Acceptable	Total 193 t
			Greenlip 159 t
			Brownlip 34 t
		Recreational	3-4% of total catch

Fishery Description

The Western Australian greenlip and brownlip abalone fishery is a dive fishery that operates in the shallow coastal waters off the south-west and south coasts of Western Australia. The fishery targets 2 large species of abalone: greenlip abalone (*Haliotis laevis*), and brownlip abalone (*H. conicopora*), both of which can grow to approximately 200 mm shell length.

Abalone divers operate from small 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 with the Department, 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 2014 was 202 t (whole weight). The TACC is administered through 16,100 ITQ units, with a minimum unit holding of 450 units. The licence 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 harvest strategy 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 licence database. 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 2014/15, 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 2014): 193 tonnes

In 2014 the greenlip/brownlip catch was 193 tonnes whole weight (Greenlip Brownlip Abalone Table 1), which was 4% lower than the 2013 catch. The Area 1 (Nullarbor fishery) exploratory quota of 1.2 t has not been fished since 2010.

The greenlip catch of 158.9 t whole weight which is 96% of the total quota of 165.3 t, was lower than the preceding three years catch of greenlip due to a quota reduction in the Area 3 commercial management area. The brownlip catch of 33.8 t whole weight for the 2014 season was similar to the preceding two years catch and represents 93% of the quota of 36.2 t (Greenlip Brownlip Abalone Table 1).

Recreational catch (2004 - 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). More recent estimates are available from some sectors (e.g. statewide survey of boat-based licences), however are not considered as comprehensive as the telephone diary estimates.

Fishing effort/access level

Commercial

Total fishing effort on the main stocks in 2014 was 1,578 days. This was similar to 2013 (1,558 days).

Recreational

For the 2014 season, 16,315 Abalone Recreational Fishing Licences were issued allowing abalone fishing. This is 2.3% higher than 2013 and similar to the number of licences that have been obtained since the “umbrella” Recreational Fishing Licences, 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 2014 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 review of performance measures¹, the SCPUE for the greenlip fishery is 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 2014, the SCPUE for the combined greenlip stocks was 29 kg whole weight per hour. This was the same as the 2013 value and a decrease from the 2011 and 2012 values of 31 kg per hour (Greenlip Brownlip Abalone Table 1).

The fishing effort in 2014 was 1,578 days (main stocks), which is above the governance range. The range was exceeded due to lowered abundance in both fisheries, 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). As a consequence of lowered abundance, a 30% and 10% TACC reduction were implemented in the Area 2 and Area 3 fisheries, respectively for the 2015 season as the abundance was lower than the limit and threshold levels, respectively, of the harvest strategy for these areas.

Fishing mortality (F): This analysis determines the proportion of the available abalone stock that is being harvested.

Fishing mortality of greenlip abalone in Augusta (West coast) increased from 2012 (no data available for 2013) to 2014 and also increased from 2012 to 2014 (no data available for 2013) for the South Coast of Area 3 (Greenlip Brownlip Abalone Figure 3a). Average F, based on a 2012/2014 was 0.52 (Area 3 Augusta), 0.41 (Area 3 South Coast) and 0.46 (Area 2). Increases in F at Augusta was caused by a combination of lowering of the minimum size of fishing, and a hypothesised slowing of growth due to sub-optimal water temperatures.

Fishing mortality of brownlip abalone in Area 3 increased for 2014 following a stable period between 2011 and 2012, (no data available for 2013). Fishing mortality of brownlip abalone in Area 2 also increased for 2014 from 2011 but no data was available for 2012 and 2013 (Greenlip Brownlip

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.

Abalone Figure 3b). Average F, based on (2012/2014) was 0.35 (Area 3) and 0.37 (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 2014, the average sizes of greenlip and brownlip caught were 175 g and 236 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 243 g in 2011. The TACC was therefore reduced to 36.2 t in 2012 (Greenlip Brownlip Abalone Table 1) and the brownlip average meat weight has stabilised at 238 g and 236 g in 2013 and 2014 respectively.

The main performance measures for the fishery relate to the maintenance of adequate breeding stocks in each area of the fishery. This is assessed using a combination of measures that reflect the average size of breeding individuals and the overall biomass of breeding stock.

In 2014, the average sizes of greenlip and brownlip caught were 175 g and 236 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 (1,578 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).

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 16,315 licences 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 2014:

Level 3 - \$5 - 10 million (\$7.2 million)

The estimated average price received by commercial fishers was \$101/kg meat weight (\$38/kg whole weight) for greenlip and \$83/kg meat weight (\$33/kg whole weight) for brownlip abalone, resulting in a fishery valued at \$7.2 million, similar to \$7.8 million in 2013.

Greenlip prices in 2014 were similar to prices in 2013 (\$105/kg) and are still considerably lower compared to 10 years ago e.g. \$126/kg meat weight in 2004.

Fishery Governance

Target effort range (days): **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 (202 t in 2014) 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 2014 was 1,578 days (main stocks), which is above the governance range. Based on the harvest strategy, a 30% and 10% TACC reduction were implemented in the Area 2 and Area 3 fisheries, respectively for the 2015 season. This change should reduce fishing effort to within the acceptable range and return effort to “acceptable” levels.

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. The fishery is also planning to apply for Marine Stewardship Council (MSC) accreditation.

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 and Brownlip abalone were rated as moderate-high risk to the effects of climate change on these stocks.

GREENLIP/BROWNLIP ABALONE TABLE 1

Greenlip and brownlip abalone catch and effort¹ 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
2014	165,354	158,889	36,150	33,808	192,697	1,578	101 (38)	29

1. Data source: quota returns.

2. Effort (diver days): main stocks are separated from stunted stocks,

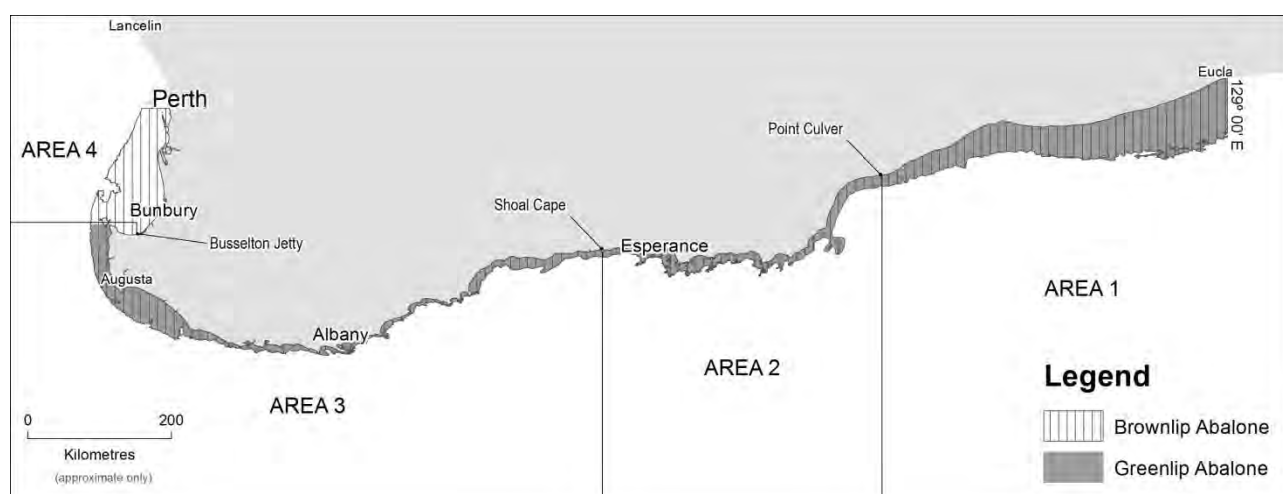
3. The conversion factor for meat weight to whole weight for Greenlip is 2.667 and Brownlip is 2.5.

GREENLIP/BROWNLIP ABALONE TABLE 2

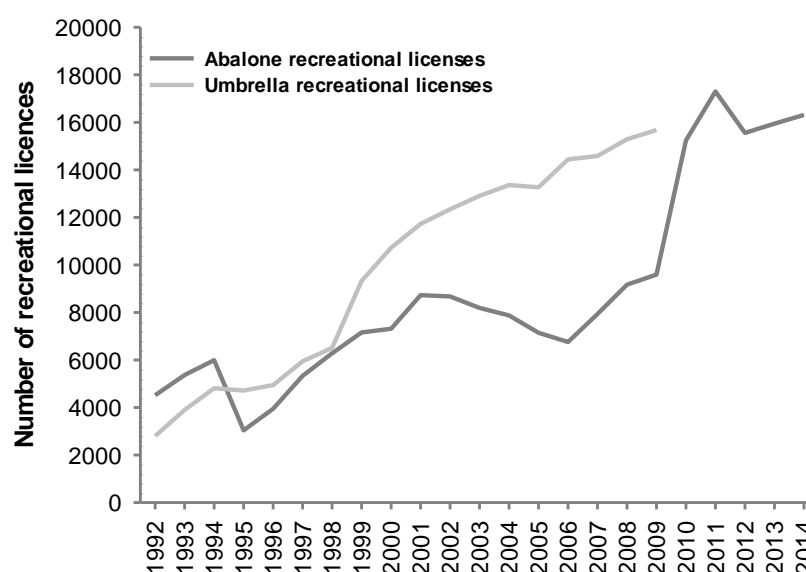
Summary of telephone diary surveys of recreational effort (fisher days), catch rate (abalone per fisher day) and catch (tonnes whole weight) for the greenlip and brownlip abalone fisheries in 2004, 2006, and 2007.

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)

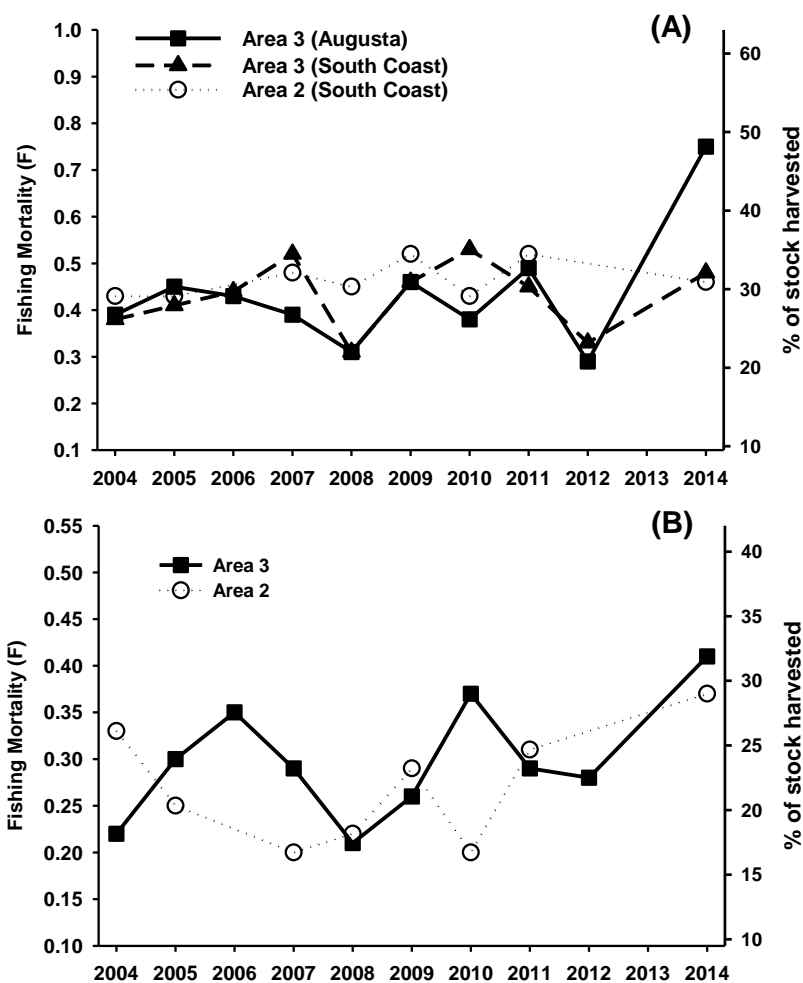
1. Survey area is South Coast Bioregion (i.e. east of Black Point).

**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 licence 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. Augusta 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 E. Smith

Main Features			
Status		Current Landings (2014)	
Stock levels:		Commercial total	588 t (finfish only)
Australian herring	Inadequate	South Coast Salmon Fishery	300 t (salmon only)
Western Australian salmon	Adequate	South Coast herring trap net fishery	82 t (herring only)
Black bream (Stokes Inlet)	Adequate	South Coast Estuarine Fishery	190 t (finfish only)
Black bream (Beaufort Inlet)	Adequate	Other commercial	16 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	(not available for current year)
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 2013/14	290 t (nearshore species only)
Australian herring	Unacceptable		
Other stocks		Acceptable	

Fishery Description

Commercial - Nearshore

Beach-based commercial fishers in nearshore waters of the South Coast Bioregion (SCB) catch various finfish species, mainly using beach seine nets, haul nets, gill nets and trap nets (Australian herring only). The main target species are western Australian salmon (*Arripis truttaceus*) and Australian herring (*Arripis georgianus*), with small quantities of southern 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 SCB) and the South-West Coast Salmon Managed Fishery (located in the West Coast Bioregion (WCB)). 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. Historically, most of the commercial catch of Australian herring in WA has been taken on beaches in the SCB using herring trap nets (also known as ‘G’ trap nets) which are set

from the shore. The remainder of commercial herring catches are taken by various small nearshore and estuarine fisheries in the South Coast and West Coast Bioregions using beach seine nets, gill nets and haul nets.

Commercial - Estuarine

Approximately 25 major estuaries exist in the SCB, extending from Black Point in the west, to the WA/SA border to the east. Thirteen estuaries are conditionally open to commercial fishing as part of the South Coast Estuarine Managed Fishery (SCEMF). This is a multi-species fishery targeting many estuarine finfish species, with the main fishing methods being gill net and seine (haul) net. The main target species are cobbler (*Cnidogobius macrocephalus*), black bream (*Acanthopagrus butcheri*), sea mullet and Australian herring.

Recreational

Most finfish caught recreationally in SCB 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 garfish.

A relatively small amount of recreational net fishing occurs in the SCB, 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 with the Department, although the Department undertakes direct consultation with the community on specific issues.

Boundaries

Commercial - Nearshore

In the SCB, Australian herring can be taken commercially by holders of an unrestricted Fishing Boat Licence (FBL). However, 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. As of 1 March 2015, fishing by means of a herring trap net is prohibited. This prohibition was introduced in response to research indicating a unacceptably high risk to the sustainability of the Australian herring stock.

The South Coast Salmon Managed Fishery covers WA waters from Cape Beaufort (Black Point) to the WA/SA border.

Commercial - Estuarine

The SCEMF encompasses the waters of all estuaries on the south coast of Western Australia between Cape Beaufort and 129° east longitude, including Princess Royal Harbour and Oyster Harbour, and all the rivers, streams and all the tributaries that flow into those estuaries. The areas that are open to commercial fishing are (from west-to-east) Broke Inlet, Irwin Inlet, Wilson Inlet, Princess Royal Harbour, Oyster Harbour, Waychinicup Inlet, Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Culham Inlet, Jerdacuttup Lakes, Oldfield Inlet and Stokes Inlet.

Recreational

Recreational line fishing is permitted in most areas within estuaries and nearshore waters of the SCB. Some spatial closures exist, including closures around dive wrecks.

A limited number of areas within certain estuaries and nearshore waters of the SCB 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 *Prohibition on Herring Trap Nets Order 2015* prohibits the take of herring by means of a herring trap net. However, Australian herring may still 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 SCB 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 SCB¹. Western Australian salmon, black bream and cobbler are indicators for this Bioregion's nearshore and estuarine finfish suites. Australian herring and

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.

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).

Research summary

The status of the fish resources in nearshore and estuarine waters of the SCB 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 the stock. Fish frames collected from commercial and recreational fishers are generally used to determine age structure. When available, archived biological samples are used to estimate historical F levels to provide information on trends in fishing mortality.

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.

Retained Species

Total commercial finfish landings (2014):

398 tonnes in nearshore waters

190 tonnes in estuarine waters

Commercial landings by fishery (2014):

South Coast Salmon 300 tonnes (salmon only)

Herring trap net 82 tonnes (herring only)

South Coast Estuarine 190 tonnes (finfish only)

Commercial finfish catches (South Coast Nearshore and Estuarine Table 1) are taken by estuarine fisheries and beach-based nearshore fisheries using gill nets, haul nets and beach seines.

In 2014, the total commercial catch of finfish by estuarine and beach-based fisheries in the SCB was 588 t and included approximately 47 species. The majority of the catch consisted of western Australian salmon (52% by weight), Australian herring (18%), cobbler (10%) and black bream (5%).

In nearshore waters, the finfish catch in 2014 was comprised predominantly of western Australian salmon (75% by weight) and Australian herring (22%). The estuarine finfish catch was comprised mainly of cobbler (30%), black bream (16%), sea mullet (14%) and Australian herring (9%).

Since 2000, landings by the South Coast Estuarine Managed Fishery have been predominantly finfish, which typically comprise 92-98% of the annual catch (by weight). The non-fish component is dominated by blue swimmer crabs (*Portunus armatus*). Annual crab landings are normally relatively low (<10 t) in this fishery but peaked at 39 t in both

2001 and 2014, and were also relatively high (32 t) in 2013. These peaks in catch appear to be the result of two periods of strong crab recruitment along the south coast. Both occurred during years when the Leeuwin Current flowed strongly and transported crab larvae from the west coast to the south coast. Record high water temperatures along the south coast since 2011 have also created favourable conditions for crabs to survive once recruited. Crabs are mainly taken by gill nets in this fishery.

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 SCB, with the remaining 32% taken in the WCB.

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 2014, the total catch was 364 t. The declining trend since 1995 is mainly driven by the trend in the SCB, 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 2014, the South Coast catch was 303 t. In the WCB, 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 2014, the West Coast catch was 60 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 year¹. A total catch of 61 t was recorded in 2013/14. Trends in SA landings have been attributed¹ to variations in the level of targeted effort but may also partly reflect variations 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 SCB, with most of the remaining 5% taken in estuaries of the WCB. Over this period, 78% of cobbler landings in the SCB were in Wilson Inlet, 11% in Irwin Inlet, 8% in Oyster Harbour and

¹ Fowler, A.J., McGarvey, R., Steer, M.A. & Feenstra, J.E. (2014). The South Australian Marine Scalefish Fishery Status Report - Analysis of Fishery Statistics for 2013/14. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000565-9. SARDI Research Report Series No. 816. 44 pp.

3% in Princess Royal Harbour. Total annual landings in the SCB ranged from 40 t (in 2004) to 95 t (in 2003).

In 2014, 57 t of cobbler was caught in South Coast estuaries. The majority (59%) 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 2014, 98% of commercial landings of black bream in WA were caught in the SCB, with the remaining 2% from the WCB. In the SCB, landings were mainly taken in Beaufort Inlet (49% of landings), Wilson Inlet (17%), Oyster Harbour (14%) and Stokes Inlet (6%). Minor black bream landings were reported in 7 other estuaries.

Since 2000, total landings of black bream in South Coast estuaries have ranged from 30 t (in 2000) to 65 t (in 2010). In 2014, a total of 31 t of black bream was landed.

Historically, Stokes Inlet has contributed the greatest proportion of black bream landings of any single South Coast estuary. From 1980 to 2014, annual landings in Stokes Inlet exhibited a stable (non-directional) trend and averaged 11 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 5 t and 4 t, respectively, in 2014. These catch trends appear to be the result of a strong pulse of recruitment by black bream in each estuary in the mid-1990s.

Recreational catch estimate (2013): NA

Nearshore + estuarine catch (most recent estimate 2000/01): 368 tonnes (key species only)

Estuarine catch only (most recent estimate

2002/03): 50 tonnes (key species only)

Boat-based nearshore + estuarine catch (most recent estimate 2013/14):

315 tonnes (nearshore species only)

Recreational catch levels of finfish in nearshore and estuarine waters of the SCB 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 2003¹). 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 SCB 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 commercial and recreational 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 SCB 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.

State-wide surveys of boat-based recreational fishing were conducted in 2011/12 and 2013/14^{3,4}. During these surveys,

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 West of Western Australia during 2002/03. Fisheries Research Report No. 159. Department of Fisheries, Western Australia. 56pp.

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.

4 Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia.

nearshore and estuarine species (including whiting species, Australian herring, black bream, silver trevally, southern garfish and western Australian salmon) comprised around 75% of all finfish retained by boat-based fishers in the SCB (South Coast Nearshore and Estuarine Table 2). State-wide surveys are scheduled to be repeated at regular intervals in future. It is important to note that these surveys provide 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 estimates from these state-wide surveys underestimate the total recreational catches of nearshore and estuarine species.

The weight of nearshore and estuarine finfish retained by boat-based recreational fishers in the WCB in 2013/14 was estimated to be approximately 315 tonnes¹.

Recreational catch share

The recreational catch share of total finfish landings in nearshore and estuarine waters of the SCB cannot be determined for the current year.

Fishing effort/access level

Commercial

Since 1990, the number of licences in nearshore and estuarine commercial fisheries has been substantially reduced via 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 'method days' i.e. 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 effort peaked at 7,928 method days (all methods) 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. Since 2004 effort has been stable at around 3,500-4,000 method days per year. The majority of effort is spent gill netting, haul netting and seine netting. In 2014, the fishery reported a total of 4,090 method days and an average of 18.6 boats fished per month.

In 2014, 45% of effort (method days) occurred in Wilson Inlet, 23% in Oyster Harbour, 15% in Princess Royal Harbour, 8% in Irwin Inlet and 5% in Beaufort Inlet. The remaining effort occurred in Broke Inlet, Stokes Inlet, Culham Inlet, Oldfield River and Jerdacuttup Lakes. Three

estuaries (Gordon Inlet, Dempster Inlet and Waychinicup Inlet) were not fished during 2014.

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 2014, 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 2014, western Australian salmon landings were reported by 8 of the 18 licensed teams.

Recreational

Current estimates of total recreational effort expended on targeting nearshore or estuarine finfish in the SCB 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 SCB². 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 2002/03³. Total effort during the survey period was estimated at 254,171 fisher hours or 86,482 fisher days. This total included boat-based (202,658 hours), shore-based (47,816 hours) and house boat (3,698 hours) fishing. Recreational netting and charter boat effort was not quantified in this survey, but was considered to have been negligible (less than 2% of total effort). In the 2002/03 survey, recreational fishing effort was estimated to have occurred mainly in Walpole/Nornalup Inlet (33% of total effort), Oyster Harbour (29%), Princess Royal Harbour (12%), Wilson Inlet (12%) and Wellstead Estuary (6%).

State-wide 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 SCB, 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, 49% of total annual boat-based fishing effort (boat days) in the SCB was estimated to have occurred in nearshore habitats (i.e. bottom depth <20m) and 22% in estuaries. In 2013/14, 54% of total boat-based effort was in nearshore habitats and 17% in estuaries.

208pp.Australia.

1 This catch weight includes only those species named in Table 2.

2 See footnote 1, previous page

3 See footnote 2, previous page

Stock Assessment

Assessments complete: Yes

Assessment level and method:

Level 3 - Fishing mortality

Breeding stock levels:

Australian herring¹ Inadequate

Assessment level and method: Level 2 - Catch rates

Breeding stock levels:

West Australian salmon Adequate

Cobbler (Wilson Inlet) Adequate

Cobbler (Oyster Harbour) Adequate

Black bream (Stokes Inlet) Adequate

Black bream (Beaufort Inlet) Adequate

Black bream (Wilson Inlet) Adequate

Black bream (Oyster Harbour) Adequate

Black bream (Walpole-Nornalup Inlet) Not assessed

Indicator species - nearshore

Western Australian salmon: Western Australian salmon form a single breeding stock across southern Australia. Adults undertake a westward migration along the southern coast of Australia to the lower WCB, where they spawn during autumn. The Leeuwin Current disperses eggs and larvae to coastal nurseries distributed from the WCB to Victoria. After spawning, adults migrate back to the SCB (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. In some years, south coast fishers also capture salmon during their 'back run', which occurs around September.

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 SCB, where the majority of the annual catch is traditionally taken. The SCB 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 licensed team) was also the lowest on record. In 2014, the catch was 303 t. The historically low catch SCB levels in recent years are believed to be due to a combination of factors – lack of targeting due to weak market demand and low wholesale prices paid for this species, reduced availability of fish in some years due to low recruitment and low catchability due to environmental factors (e.g. relatively high water temperatures).

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 (level 3) of salmon is underway in order to increase certainty about stock status.

In 2014, a low catch of 60 t was reported in the WCB. Low (0-100 t) catches have occurred periodically (approximately every 11 years) throughout the history of this fishery. However, very low catches have occurred in the past 5 consecutive years (2010-2014), which is atypical. Low catches have previously been restricted to a single year.

Landings of salmon in the WCB 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). For example, the low catch in 2011 was likely due to a 'heatwave' event during the spawning period, when a strong Leeuwin Current and unusually high water temperatures discouraged the northward migration of western Australian salmon (Pearce *et al.* 2011²). This behavioural response, resulting in WCB 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 2011 'heatwave' is also believed to have affected the catchability of salmon and limited the catch in the SCB 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 (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 SCB has mainly occurred in Wilson Inlet and to a lesser extent in the estuaries around Albany (Oyster Harbour, Princess Royal Harbour).

Commercial catch rates suggest a stable long-term trend in the availability of cobbler in Wilson Inlet and Oyster Harbour since 1980 (South Coast Nearshore and Estuarine Figure 4).

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 also occurs in Wilson Inlet. In future, this information may be used to estimate levels of fishing mortality in this stock, which will be used in conjunction with trends in recruitment and catch rates to assess stock status.

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.

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 SCB are taken in four main estuaries - Stokes Inlet, Beaufort Inlet, Wilson Inlet and Oyster Harbour. From 1980 to 2014, commercial catch rates of bream in these estuaries have increased, suggesting an increase in the abundance of each stock (South Coast Nearshore and Estuarine Figure 5). Bream abundance varies in response to environmental factors including river flow, temperature, salinity, oxygen and nutrient loads. These factors determine the condition and productivity of the estuary, which affects growth and reproductive success in bream.

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 SCB. 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 protected listed marine species. New Zealand fur seals and Australian sea lions are occasionally surrounded by beach seine nets used in the South Coast nearshore and estuarine fisheries, but are released immediately by the fishers. This is possible because seine netting is a labour-intensive operation and the fishing team will immediately notice a seal in the net. Fishers are able to release a seal from their seine net without injury to the animal.

The abundance of fur seals on the south coast has steadily increased over the last 15 years, resulting in an increasing level of interaction with fishers, especially in estuaries of the Albany region (R. Campbell, pers. comm.). There have been no reports of incidental mortalities of seals in these fisheries and it is believed that the present level of interaction (direct and indirect) is not a significant threat to the populations of fur seals and sea lions. An assessment of the impact of

interactions is performed on an annual basis and, if required, appropriate management plans will be devised to mitigate these interactions.

Birds such as pelicans, cormorants and shearwaters sometimes interact with commercial fishing nets in estuaries and with recreational line-fishing gear but the risks to bird populations are considered to be low.

Ecosystem Effects

Food chain effects: Low

Excessive removal by commercial and recreational fisheries of certain species, such as Australian herring or western Australian salmon, from the food chain could potentially impact on prey and predator species including larger fish, cetaceans and seabirds. However, commercial fishing effort directed towards these species in recent years has been 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 gill nets and haul nets over predominantly sand and mud bottoms is unlikely to have any impact on these habitats in estuaries and nearshore waters. Similarly, the line fishing methods used by recreational fishers have a negligible impact on the bottom substrates. Anchoring by recreational fishing vessels may have localised impacts on habitats such as seagrass.

Haul nets may be deployed over low or medium density seagrass. This type of net tends to 'roll' over the surface of seagrass beds without removing attached leaves or uprooting plants. At times, haul nets may collect floating vegetation including seagrass leaves or algae.

Social Effects

Commercial

In 2014, there were approximately 37 commercial fishers involved in the South Coast Salmon Fishery and approximately 12 commercial fishers involved in the South Coast herring trap net fishery. In 2014, the South Coast Estuarine Managed Fishery employed an average of 21 fishers per month. Additional employment is created by these fisheries in the processing and distribution networks and retail fish sales sectors.

Australian herring and western Australian salmon fisheries in the SCB 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 SCB^{1,2}. Fish resources in estuaries and nearshore waters of the Bioregion are a focus for recreational fishers and have a high social value in the region.

Within the SCB, approximately 21% of the recreational fishing effort was 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 SCB and therefore has high social value. In 2000/01, Australian herring were estimated to comprise 15% (by number) of all finfish retained by SCB recreational fishers. In 2013/14, a statewide survey of boat-based fishing estimated that herring comprised 20% of all finfish retained by boat-based recreational fishers in the SCB.

Economic Effects

Estimated annual value (to fishers) for 2014:

South Coast Estuarine Fishery

Level 2: \$1 to 5 million (finfish + invertebrates)

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 **Acceptable**

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 2014 South Coast Estuarine Managed Fishery total catch of finfish (190 t) was below the target range of 200-500 t. A high abundance of blue swimmer crabs in south coast estuaries contributed to relatively low finfish landings in 2014. This fishery has reported a steady increase in landings of blue swimmer crabs, from 1 t in 2006 to 14 t in 2012, 32 t in 2013 and 39 t in 2014. In some estuaries, fishers report that the presence of crabs in fishing nets has been inhibiting the capture of finfish. In some estuaries, fishing effort has been redirected toward targeting crabs instead of finfish.

The 2014 South Coast catch of Australian herring (104 t) was well below the target range. The catch has now been below

the target range for 12 consecutive years. Recent research outcomes regarding stock status were used as a basis for new management arrangements introduced in 2014/15 to ensure the sustainability of this iconic species (see 'New management initiatives'). A formal Recovery Strategy for the Australian herring stock is being developed.

The total catch of western Australian salmon (West Coast and South Coast landings combined) in 2014 (364 t) was below the target range. The catch has now been below the target range for 8 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 and low availability of fish due to recruitment variation.

Recreational

Current Fishing (or Effort) Level: **Not available**

Target catch range: **Not developed**

New management initiatives (for 2014/15)

The Wilson and Irwin Inlet Crab Pot Trial commenced on 18 February 2015 by exemption, and allows the commercial take of blue swimmer crabs by nominated South Coast Estuarine Managed Fishery licence holders. There are eight fishers using a combined total of 199 traps across the Wilson and Irwin Inlets, authorised by exemption to use crab traps in a two year trial.

The trial seeks to test a different method of catching blue swimmer crabs, to determine if fishers can more efficiently target the species, resulting in better catch-care and improved market prices. The Department is monitoring the catch rates of blue swimmer crabs through the trial, with fishers required to fill in log-books for research purposes. The exemption period extends until 28 February 2017, with a 12 month review scheduled within this time frame. Following research outcomes surrounding Australian herring which demonstrated an unacceptably high risk to the sustainability of the stock, a number of management initiatives have been introduced in an effort to recover the stock. Daily bag limits for recreational fishers for Australian herring have been reduced from 30 to 12. Commercial fishers are prohibited from using herring trap nets. These measures may be reviewed pending the recovery of Australian herring stock.

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 ecosystems³. 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 WCB and the western SCB. This 'heatwave' event resulted

¹ See footnote 1, page 252

² Barhathah, T. (2006). Department of Fisheries community survey 2005. Fisheries Occasional Paper No. 33. Department of Fisheries, Perth.

³ 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.

in atypical distributions of various species (e.g. tropical species occurring in temperate waters) and unusual fish behaviour.^{1,2} The event altered the distribution and behaviour (eg. spawning activity, migration) of western Australian salmon and Australian herring, which affected recruitment and catch levels of these species in 2011 and subsequent years. Relatively warm coastal ocean temperatures also occurred in 2012 and 2013 in the WCB and the western SCB.

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 SCB estuaries are often driven by environmental factors, independent of fishing. These factors can 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 SCB 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'.

SOUTH COAST NEARSHORE AND ESTUARINE TABLE 1

Total annual catches of finfish from the estuarine and beach-based nearshore commercial fisheries in the South Coast Bioregion, 2010 to 2014.

Species	Scientific name	Catch (tonnes)				
		2010	2011	2012	2013	2014
Western Australian salmon	<i>Arripis truttaceus</i>	291.4	165.2	75.0	139.4	303.4
Australian herring	<i>Arripis georgianus</i>	182.7	110.7	134.4	250.6	103.9
Cobbler	<i>Cnidogobius macrocephalus</i>	69.8	65.5	53.1	67.2	56.9
Black bream	<i>Acanthopagrus butcheri</i>	65.5	43.9	42.7	41.2	31.2
Sea mullet	<i>Mugil cephalus</i>	32.3	29.8	30.7	33.9	27.9
Southern garfish	<i>Hyporhamphus melanochir</i>	13.7	11.1	5.4	14.0	6.7
King George whiting	<i>Sillaginodes punctata</i>	7.0	8.0	9.9	11.5	13.3
Leatherjackets	Monacanthidae	7.3	7.5	10.9	11.0	11.6
Tarwhine	<i>Rhabdosargus sarba</i>	2.8	6.7	3.9	4.6	6.0
Flatheads	Platycephalidae	3.0	4.4	3.2	5.0	3.0
Yelloweye mullet	<i>Aldrichetta forsteri</i>	2.6	3.9	4.9	3.4	5.2
Snook	<i>Sphyraena novaehollandiae</i>	1.3	1.7	1.7	1.9	1.4
Pink snapper	<i>Pagrus auratus</i>	0.9	1.3	2.1	0.6	2.2
Trevally	Carangidae	2.1	2.0	1.5	3.1	1.7
Flounder	Pleuronectidae	1.5	1.3	0.8	2.2	2.2
Trumpeters/Grunters	Teraponidae	0.3	1.6	0.3	0.3	0.5
Yellowtail scad	<i>Trachurus novaezelandiae</i>	0.6	0.8	2.2	0.1	1.8
Tailor	<i>Pomatomus saltatrix</i>	0.4	0.4	0.3	1.8	2.3
Mulloway	<i>Agyrosomus japonicus</i>	0.4	0.7	1.0	0.5	0.5
Scaly mackerel	<i>Sardinella lemura</i>	0.4	0.3	0.3	0.9	0.7
Whiting species	<i>Sillago spp.</i>	0.4	0.6	1.4	0.7	1.7
Other finfish	Teleostei	3.3	3.5	3.7	3.4	4.0
TOTAL		689.6	470.8	389.5	598.2	588.1

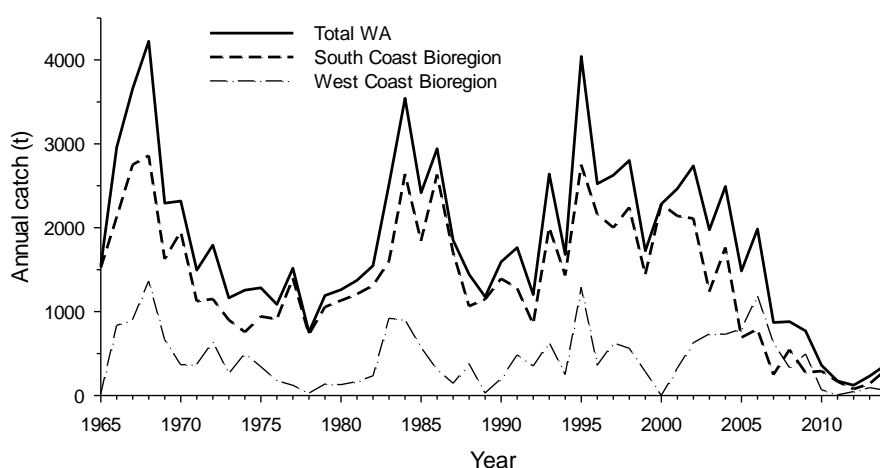
¹ See footnote 2, page 254

² Caputi N., Jackson G. and Pearce A. (2014). The marine heat wave off Western Australia during the summer of 2010/11 – 2 years on. Fisheries Research Report No. 250. Department of Fisheries, Western Australia. 40pp.

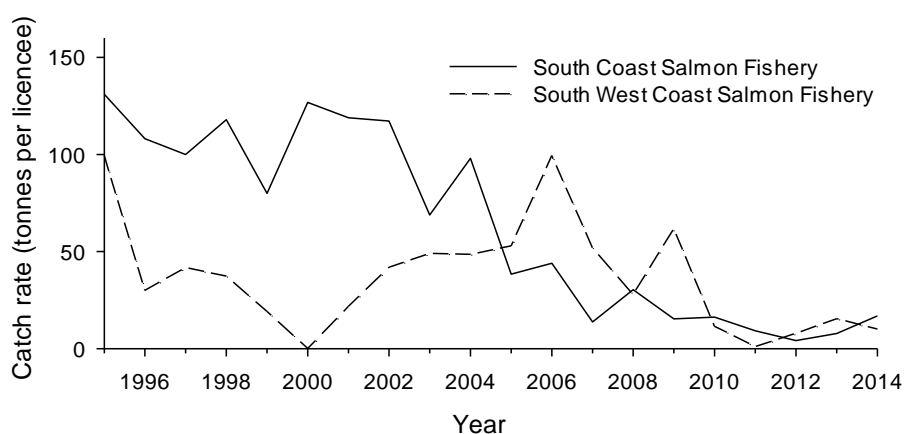
SOUTH COAST NEARSHORE AND ESTUARINE TABLE 2

Estimated annual catch of key nearshore and estuarine finfish species in the South Coast Bioregion by boat-based recreational fishers in 2011/12 and 2013/14. The percentage of the total boat-based finfish catch represented by each species is also shown. (See Ryan *et al.* 2013 and 2015, details above).

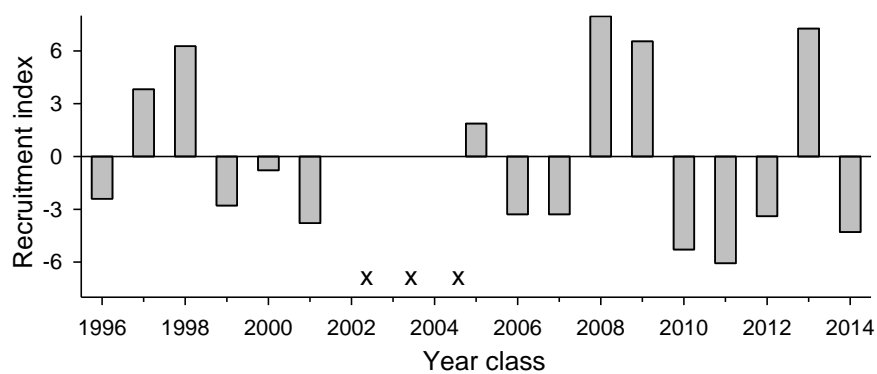
Common name	Species	Catch (number of fish)		% of total finfish catch	
		2011/12	2013/14	2011/12	2013/14
King George whiting	<i>Sillaginodes punctatus</i>	59,011	46,730	29.9	30.7
Australian herring	<i>Arripis georgianus</i>	28,443	30,102	14.4	19.8
Black bream	<i>Acanthopagrus butcheri</i>	22,839	7,160	11.6	4.7
School whiting	<i>Sillago spp.</i>	16,731	21,009	8.5	13.8
Silver trevally	<i>Pseudocaranx spp.</i>	9,797	5,622	5.0	3.7
Southern garfish	<i>Hyporhamphus melanochir</i>	2,375	1,180	1.2	0.8
Western Australian salmon	<i>Arripis truttaceus</i>	2,174	1,576	1.1	1.0
All other finfish		55,813	38,737	28.3	25.5

**SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 1**

Total annual commercial catches of western Australian salmon in the South Coast and West Coast Bioregions, 1965 – 2014.

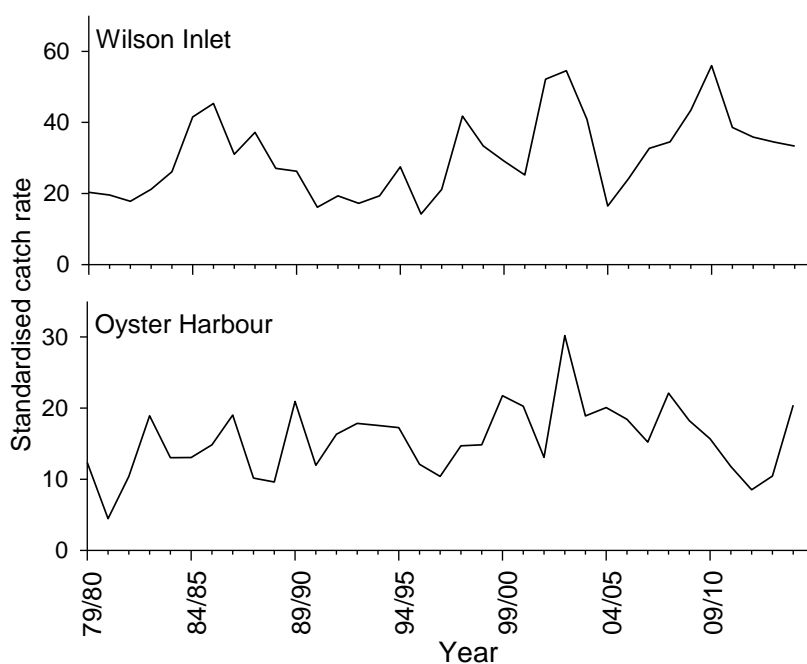
**SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 2**

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 – 2014.



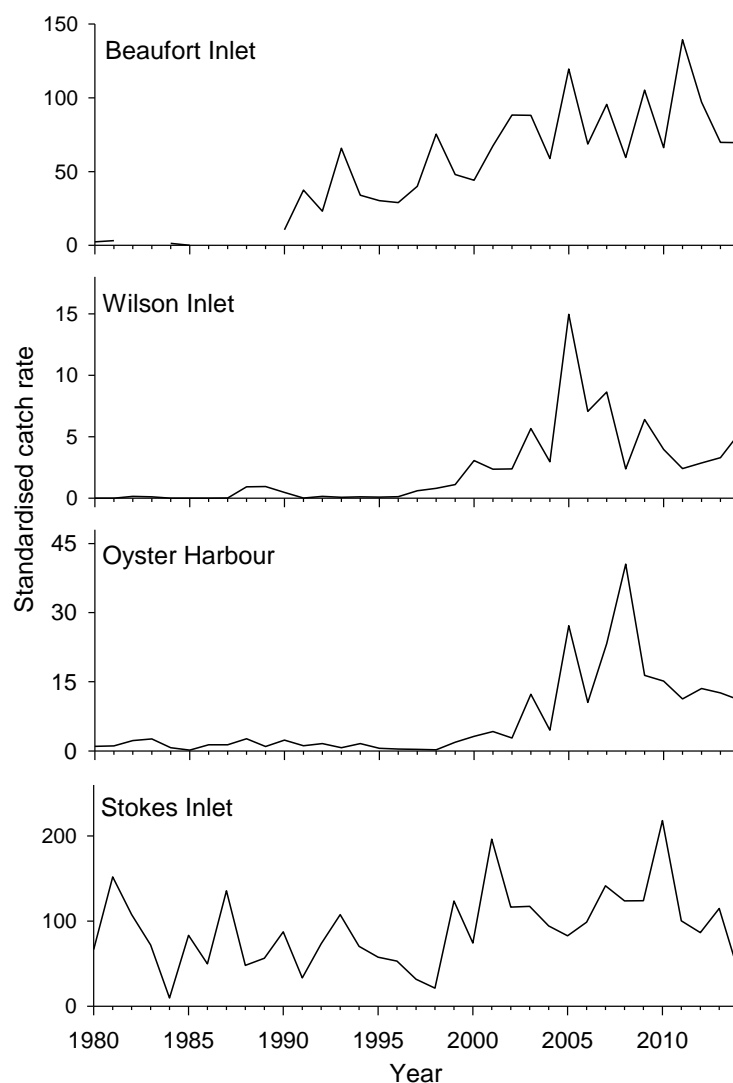
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 3

Annual fishery-independent relative recruitment index for western Australian salmon in the South Coast Bioregion, 1996 – 2014. 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 – 2013/14.



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 – 2014.

South Coast Purse Seine Fishery Report: Statistics Only

G. Jackson, S. Turner and E. Smith

Fishery Description

The South Coast Purse Seine Managed Fishery (SCPSF) is based on the capture of pilchards (*Sardinops sagax*) by purse seine gears 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 (*Sardinella lemuru*), sandy sprat (*Hyperlophus vittatus*) blue sprat (*Spratelloides robustus*) and maray (*Etrumeus teres*).

Boundaries

The SCPSF consists of five Management Zones (South Coast Purse Seine Fishery Figure 1) as follows:

- 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;
- Zone 3 - Bremer Bay Zone, extends from Cape Knob to longitude 120°E;
- Zone 4 - Esperance Zone, extends from 120°E to the WA/SA border.
- Zone 5 - between Cape Leeuwin and Point D'Entrecasteaux (not significantly fished)

These zones are broken down into finer spatial scale blocks for reporting of catch and effort in the statutory daily/trip catch and effort returns and the catch disposal records. However, 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 the statutory catch and effort returns.

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, the value of which is determined by dividing the Total Allowable Catch (TAC) for a 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. The total number of units allocated across each of the four zones in the fishery amount to 890 and has 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 2013/14

Bremer Bay and Esperance: **Not reported**
due to confidentiality provisions

Albany **885 tonnes**

Effort in the SCPSF was again lower than in recent years with a total of 843 days fished in 2013/14 (2009/10: 1,450 days; 2010/11: 1,290 days, 2011/12: 1,359 days, 2012/13: 1,175 days).

The 2013/14 pilchard catch in the SCPSF was 1,501 tonnes, the lowest since 2003 and continued the downturn since the trend of slowly increasing catches since the late 1990s (South Coast Purse Seine Figure 2). As with last season, the lower

effort levels do not suggest a decline in biomass as nominal daily catch rate continues to show an overall increasing trend (South Coast Purse Seine Figure 2). Most of the commercial catches were reported from the Albany zone (885 t). Less than 15 t of other pelagic species were also landed, again mostly yellowtail scad.

While effort and catches overall 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 2013/14 season, the total pilchard catch (1,501 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 fleshy-footed 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.

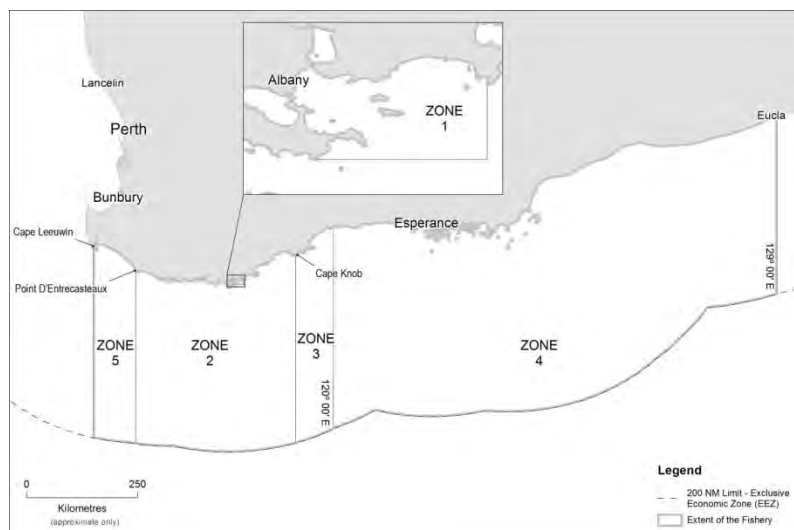
There are no significant legislative management changes planned for this fishery.

In 2014, the fishery underwent pre-assessment for Marine Stewardship Certification.

SOUTH COAST PURSE SEINE FISHERY TABLE 1

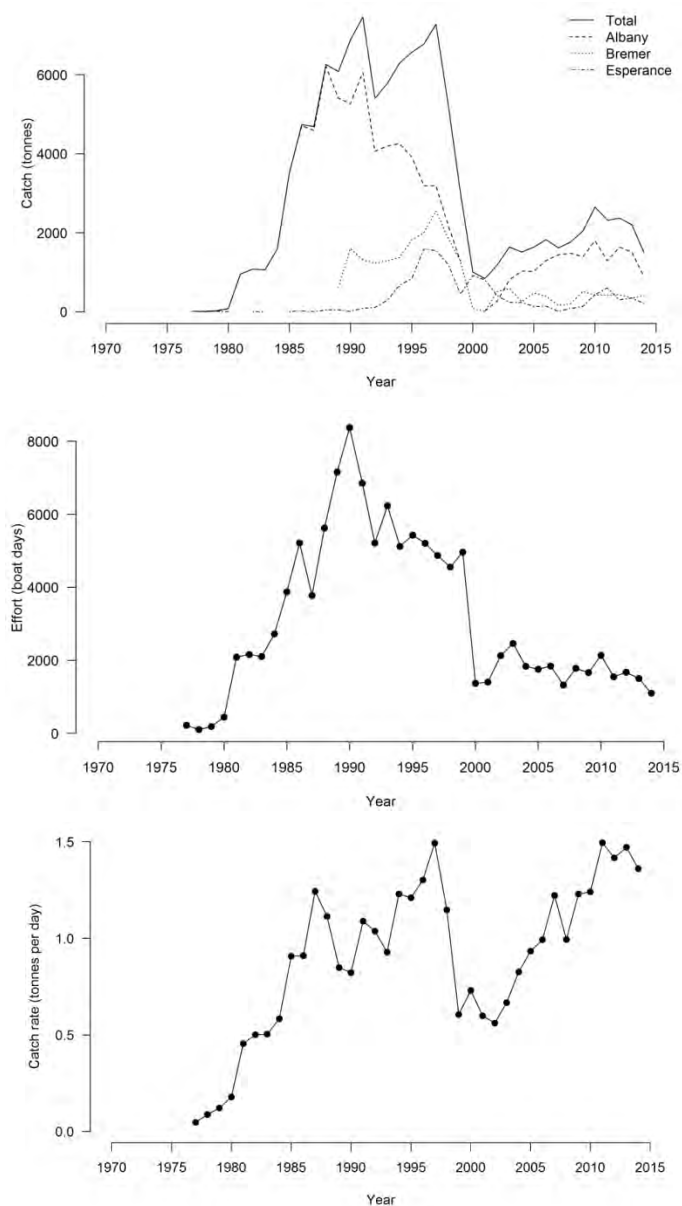
2013/14 pilchard catches and TACs in tonnes (t) for each of the major Management Zones. * Three or less vessels operated in each of these zones in 2013/14 and cannot be reported.

Management Zone	TAC (t)	2013/14 catch (t)	2013/14 catch as per cent of TAC
Albany (Zones 1 and 2)	2,683	885	33.0%
Bremer Bay (Zone 3)	1,500	*	-
Esperance (Zone 4)	1,500	*	-
Total for Fishery	5,683	1,501	26.4%



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

Total annual catch of pilchards (*Sardinops*) for main zones (Albany, Bremer, Esperance) (upper panel), total effort (boat days fished) (middle panel) and nominal catch rate (tonnes per day) (lower panel) in the South Coast Purse Seine Fishery, 1970–2014.

Temperate Demersal Gillnet and Demersal Longline Fisheries Status Report

R. McAuley, M. Braccini, S.J. Newman & J.O'Malley

Main Features

Status		Current Landings (2013/14)	
Stock level		Demersal Gillnet and Demersal Longline Fishery	
Gummy shark	Adequate	Total sharks and rays	994 t
Dusky shark	Recovering	Total scalefish	192 t
Sandbar shark	Recovering	Indicator species	
Whiskery shark	Adequate	Gummy shark	445 t
Fishing Level		Dusky shark	190 t
JASDGLF Zone 1	Acceptable	Sandbar shark	45 t
JASDGLF Zone 2	Acceptable	Whiskery shark	161 t
WCDGLF	Acceptable	Sharks and rays by other commercial fisheries	4 t
		Recreational catch (2013/14)	<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 (JASDGLF) and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGLF). 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 Bioregions, 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 JASDGLF 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 a management plan introduced in 1997.

Both fisheries are managed via input controls in the form of transferable time/gear effort units, with additional restrictions on mesh and hook sizes, net height ('drop') and maximum net length. Historically, each unit has permitted the use of 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 in Zones 1 and 3 of the JASDGDLF and 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 length) 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 Area 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 the period of its currency. The current WTO expires on 28 August 2015.

In addition to the renewal of the WTO, the fishery was re-accredited for the purposes of Part 13 of the EPBC Act which provides protection for operators who may interact with 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 was 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 2013/14)¹:

All sharks (and rays):	994 tonnes
Indicator shark species:	841 tonnes
Gummy:	445 tonnes
Dusky²:	190 tonnes
Whiskery:	161 tonnes
Sandbar:	45 tonnes

Other finfish (i.e. non shark) catch: In addition to their primary catch of sharks, the JASDGLF and WCDGLF land a variety of scalefish species, which totalled 192 t in 2013/14 (Demersal Gillnet and Longline Figure 3). This catch included 96.5 t of demersal scalefish species taken in the West Coast Bioregion and 95.1 t of demersal scalefish taken in the South Coast Bioregion and a total of 13.8 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 (4 t in 2013/14).

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 less than 15 t.

Two integrated survey of boat-based recreational fishing in WA during 2011/12 and 2013/14 estimated the recreational catch of a range of species of sharks (Ryan *et al.* 2015³). In 2013/14, for the West Coast and South Coast Bioregions, less than 11,000 sharks ($\pm \sim 4,150$) were estimated as being caught by the boat based recreational sector, with more than 82% released. Most catches were reported from the West Coast Bioregion and were dominated by Port Jackson, gummy and dusky sharks.

Fishing effort/access level

There are 57 licences in the JASDGLF (24 in Zone 1 and 33 in Zone 2) and 20 WCDGLF permits, which can be used collectively in conjunction with a Fishing Boat Licence. Only 5 Zone 1, 15 Zone 2 and 6 WCDGLF vessels reported active fishing returns during 2013/14, 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 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

1 All reported weights are live weight

2 Dusky shark catches include catches of bronze whaler (*Carcharhinus brachyurus*), which cannot be accurately separated in catch returns data prior to 2006/07.

3 Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

fished in each management zone. These (daily) effort limits are considered likely to deliver sustainable catches of target, byproduct and bycatch species and acceptably low risks to ETP species. Effort limits were subsequently re-defined and legislated as hourly units of entitlement using conversion rates of 24 hours day⁻¹ in Zones 1 and 3 of the JASDGLF, 20 hours day⁻¹ in Zone 2 and 24 hours day⁻¹ in the WCDGLF. Thus, specified fishing effort limits for each management zone of the fishery are:

JASDGLF Zones 1 and 3:	84,075 km gn.hr ⁻¹ (3,503 km gn.d ⁻¹)
JASDGLF Zone 2:	144,102 km gn.hr ⁻¹ (7,205 km gn.d ⁻¹)
WCDGLF ¹ :	67,692 km gn.hr ⁻¹ (2,832 km gn.d ⁻¹)

Expended effort in 2013/14 was 46,200 km gn.hr (2,822 km gn.d⁻¹) in Zone 1; 114,600 km gn.hr (6,305 km gn.d⁻¹) in Zone 2 and 14,200 km gn.hr (679 km gn.d⁻¹) in the WCDGLF (Demersal Gillnet and Longline Table 1). The effort decline in the WCDGLF is consistent with the gradual declining trend observed in recent years explained by the combination of a reduction of fishing units due to the VFAS, area closures and new effort management regimes. When measured in km gn.hr⁻¹, 59% of the fisheries' effort capacity was utilised in 2013/14 (55% in Zone 1, 80% in Zone 2 and 21% in the WCDGLF). When measured in km gn.d⁻¹, 72% of the fisheries' effort capacity was utilised in 2013/14 (81% in Zone 1, 88% in Zone 2 and 24% in the WCDGLF). Zone 1 and 2 km gn.d⁻¹ effort is high (noting Zone 1 effort in 2012/13 was also 100%) and is 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 being developed.

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

¹ The WCDGLF limit is adjusted to 64% of the 2001/02 effort level to account for the reduction in entitlement units arising from the 2008 Voluntary Fishery Adjustment Scheme.

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 2006¹, the current management arrangements are considered suitably precautionary to ensure that fishing mortality is now at a level such that recovery of this stock is occurring.

Whiskery shark: Previous age structured modelling of the whiskery shark stock (based on hourly CPUE data) 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 during the years that were subject to an annual whiskery shark pupping closure (see management arrangements above) begin recruiting to the fishery (around 2012/13 and beyond).

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 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

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.

minimum acceptable limit (40% of virgin biomass), the WCDGDLF will need to be carefully monitored over coming years to ensure that catch levels of sandbar sharks are maintained consistent with continued stock recovery.

Other sharks: The four indicator species of the temperate shark 'suite' account for approximately 80% of the fisheries' and Bioregional shark catch and represent the range of life history strategies of other shark species caught by the fisheries. Thus, the status of indicator stocks is believed to generally reflect the status of other sharks in the South and West Coast Bioregion.

Non-Retained Species

Bycatch species impact: **Low**

The catch composition of the fishery was examined in detail for the period 1994 to 1999. There is some discarded bycatch of unsaleable species of sharks, rays and scalefish. During ESD risk assessment of these fisheries in 2002, all impacts on stocks of bycatch species were determined to be low risk. As maximum potential fishing effort is now explicitly capped at less than 70% of the mid to late 1990s levels, bycatch in all management zones is expected to have been proportionally reduced. Recent multi-fisheries bycatch risk assessment has identified the Port Jackson shark among the higher risk bycatch species in the West Coast Bioregion. Although this species is one of the largest components of the demersal gillnet and demersal longline fisheries bycatch and is recorded as bycatch in other commercial fisheries, cumulative risks were assessed as low-moderate due to its very high post-capture survival from gillnet fisheries (Braccini *et al.* 2012¹).

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 69 crew were employed in the JASDGDLF and between 21 and 28 were employed in the WCDGDLF during 2013/14. As sharks are generally not targeted by recreational fishers in Western Australia, their direct social importance to this group is negligible.

Indirect: The capture of sharks generates a high level of community interest and debate.

Economic Effects

Estimated annual value (to fishers) for 2013/14:

JASDGDLF: Level 3 - \$5 - 10 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.

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

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.

Current Fishing Level

JASDGLF Zone 1	Acceptable
JASDGLF Zone 2	Acceptable
WCDGLF	Acceptable

The total catch for 2013/14 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 2000/04/05, 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 2013/14 were similar to previous years. It is worth noting that the fishery has not utilised its full entitlement during 2013/14 and as such the Department will continue to closely 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 102 t 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 2013/14 catch of 161 t is only 14 t below the minimum level. The low catches of recent years mostly reflect the outcomes of management measures to recover this stock, in particular, the introduction of the seasonal whiskery 'pupping' closure. As these measures are intended to increase catch rates in coming years the acceptable catch range may need to be reviewed as the magnitude and rate of stock recovery can be determined.

Sandbar shark catches exceeded their maximum acceptable level until effort declined dramatically in the WCDGLF in 2008/09 when catches declined to more sustainable levels of 81 t in 2008/09, 107 t in 2009/10, 71 t in 2010/11, 34 t in 2011/12, 49 t in 2012/13 and 45 t in 2013/14. The historically

low catch of sandbar sharks is likely to reflect the low level of fishing effort and other fleet dynamics in the WCDGLF. At these levels, recruitment to the breeding stock should improve in coming years and gradually allow the mature biomass to recover from more than a decade of excessive catches in the northern shark fisheries.

New management initiatives (2014/15)

Given recent modelling indicates that total and mature female biomass trends of whiskery sharks are increasing, and the status of the stock is now considered to be acceptable, a decision was made not to implement a whiskery pupping closure 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 from the TDGDLF to assist in evaluating management options to ensure interactions with Australian sea lions are maintained with acceptable levels.

The WTO for the TDGDLF was renewed on 31 May 2012 and expires on 28 August 2015. In addition, the Part 13 accreditation of the management plans for the fisheries were re-accredited. The accreditation carries a condition associated with addressing interactions between the fishery and Australian sea lions. The Department convened an Australian sea lion Working Group (the Working Group) that consists of Departmental staff, 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 pre-assessment for Marine Stewardship Certification in 2014.

External Factors

As the TDGDLF key target species span multiple Bioregions 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

SOUTH COAST BIOREGION

Zone 2 of the JASDGLF (although the fishery is tightly managed via quota controls) and incidental catches of dusky and gummy sharks in other State and Commonwealth Government-managed fisheries. While the risks associated with these outside influences are largely unqualified they

must be taken into account in the stock assessment for individual species (and the TDGDLF 'suite') to ensure appropriate management strategies are implemented that address the long-term sustainability of the shark stocks.

DEMERSAL GILLNET AND LONGLINE TABLE 1

Summary of the 2013/14 catch (t live wt.) by the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Data are given by management zone and also by Bioregion (italicised). Indicator species and catches are highlighted in bold.

Name	Species or taxon	JASDGLF		WCDGLF	Bioregion		Total
		Zone 1	Zone 2		South Coast	West Coast	
Sharks and rays							
Gummy	<i>Mustelus antarcticus</i>	20.9	423.4	0.4	429.4	15.3	444.7
Dusky whaler	<i>Carcharhinus obscurus</i>	96.8	84.4	9.1	98.5	91.8	190.3
Whiskery	<i>Furgaleus macki</i>	33.1	120.2	7.4	129.5	31.3	160.8
Sandbar	<i>Carcharhinus plumbeus</i>	12.6	6.4	26.1	10.1	35.1	45.2
Hammerheads	Sphyrnidae	21.7	34.9	0.6	37.7	19.5	57.1
Spinner (long nose grey)	<i>Carcharhinus brevipinna</i>	20.9	8.1	4.7	9.5	24.1	33.6
Wobbegongs	Orectolobidae	13.9	10.8	3.2	15	12.9	28
Rays	Batoidea	1.8	4.6	2.9	4.8	4.5	9.3
Common saw shark	<i>Pristiophorus cirratus</i>	0.3	7.9		7.9	0.3	8.2
School	<i>Galeorhinus galeus</i>		1.9	<0.1	1.9	<0.1	1.9
Other elasmobranchs		5	5.9	4.1	6.9	8.2	15.1
Total elasmobranchs		227.1	708.6	58.5	751.2	242.9	994.2
Scalefish							
Blue Morwong	<i>Nemadactylus valenciennesi</i>	8.5	27.4	0.7	31.6	4.9	36.6
Blue Groper	<i>Achoerodus gouldii</i>	17	21.3	0.9	27	12.2	39.2
West Australian dhufish	<i>Glaucosoma hebraicum</i>	6.2	0.6	8	1.3	13.5	14.8
Pink snapper	<i>Chrysophrys auratus</i>	7.7	10.5	38.6	12.3	44.5	56.8
Boarfishes	Pentacerotidae	1.1	5.2		5.4	0.9	6.3
Samsonfish	<i>Seriola hippos</i>	2.6	4.6	2.7	5	5	10
Redfishes	<i>Centroberyx</i> spp.	0.1	5.8	<0.1	5.9	<0.1	5.9
Mulloway	<i>Argyrosomus japonicus</i>	1.5	2.4	0.6	2.5	2.1	4.6
Sweetlips	Haemulidae			0.5		0.5	0.5
Baldchin groper	<i>Choerodon rubescens</i>	<0.1		3.1		3.1	3.1
Other scalefish		4.6	2.9	6.4	4.0	11	15
Total scalefish		49.3	80.8	61.5	95.1	96.5	191.6
'Demersal scalefish suite' component		40.6	71.4	57.5	84.1	85.4	169.5
Fishing effort (km gn d)		2,822 (81) ¹	6,305 (87) ¹	679 (24) ²			9,806 (72) ²
Fishing effort (1000 km gn hr)		46 (55) ³	115 (80) ³	14 (21) ³			175 (59) ³

1 Percentage of respective 2001/02 levels

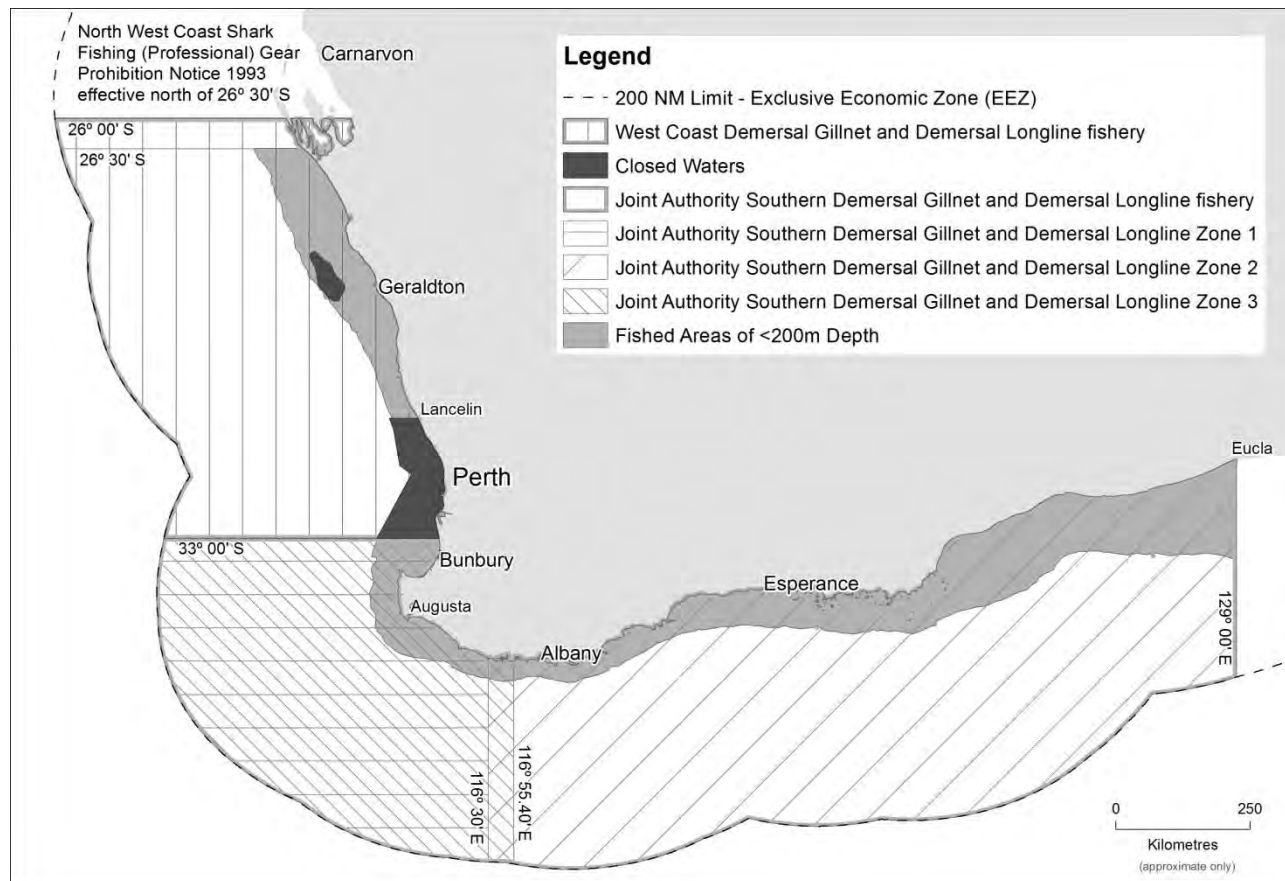
2 Percentage of VFAS adjusted 2001/02 levels

3 Values in parentheses are percentages of each management zone's maximum hourly effort capacity

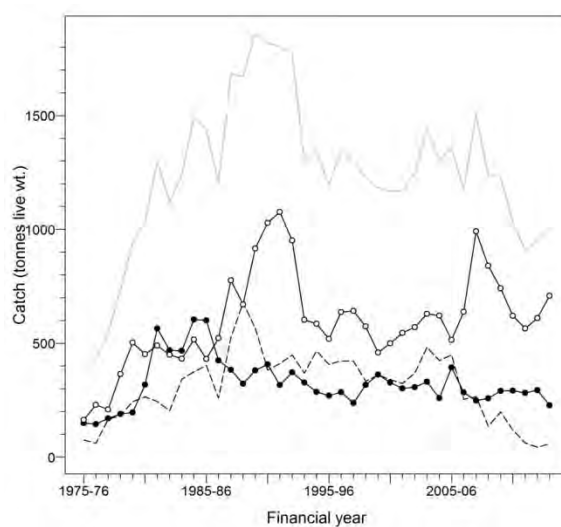
DEMERSAL GILLNET AND LONGLINE TABLE 2

Recorded interactions with Endangered, Threatened, Protected (ETP) species.

ETP SPECIES	2007/08		2008/09		2009/10		2010/11		2011/12		2012/13		2013/14	
Alive(A)/Dead(D)	A	D	A	D	A	D	A	D	A	D	A	D	A	D
Dolphins	1		1	2		2		3						
Manta Rays							2				1			
Muttonbird, General					7		4							
Sawfish, General	1						1							
Sea Birds		2	2	1										
Sea Lions				2					3		1		1	
Seal, NZ Fur		2	1	5		7		1		3				
Shark, Grey Nurse	38	16	63	18	59	27	53	19	69	18	68	19	48	18
Shearwater, Fleshfooted						2								
Snake, Sea		2												
Turtle, General	5		2	2	2	1	1		3		3		1	
Whales			1											
White Shark	10	3	14	2	2	1	3	5	19	3	17	1	17	3

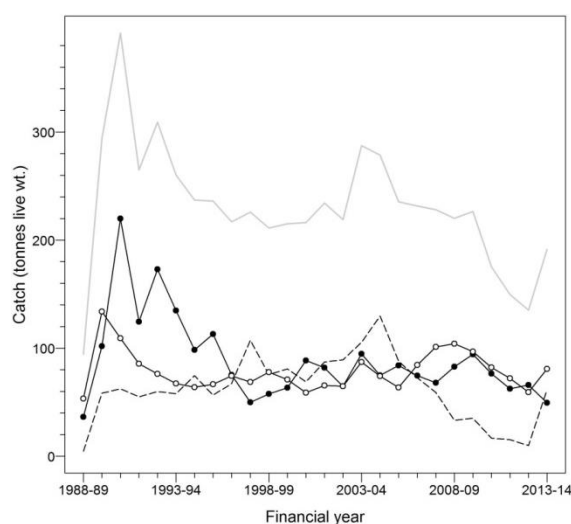
**DEMERSAL GILLNET AND LONGLINE FIGURE 1**

Management boundaries of the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Grey shading represents fished areas of less than 200m depth.



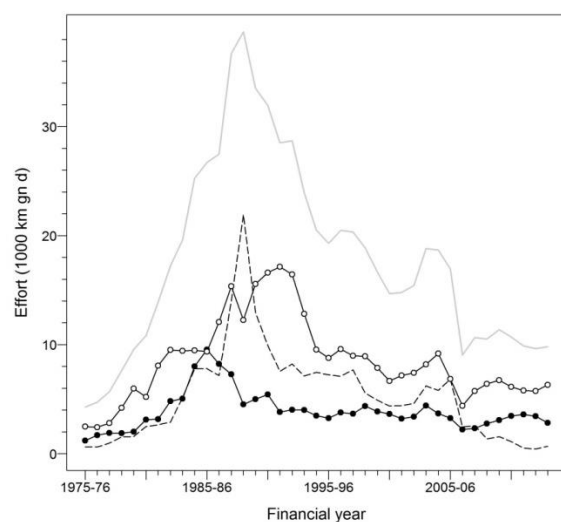
DEMERSAL GILLNET AND LONGLINE FIGURE 2

Total elasmobranch catches. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; dashed black line = WCDGLF; plain grey line = total from the three management zones.



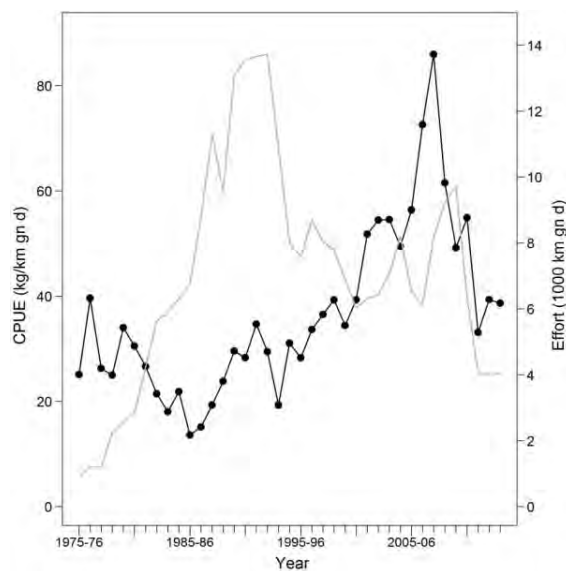
DEMERSAL GILLNET AND LONGLINE FIGURE 3

Total scalefish catch. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; dashed black line = WCDGLF; plain grey line = total from the three management zones. Catches prior to 1988/89 cannot be distinguished from other fisheries' gillnet and longline catches and are omitted.



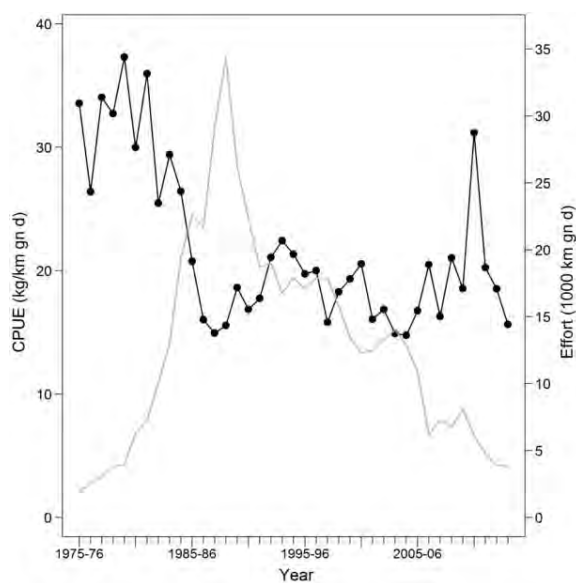
DEMERSAL GILLNET AND LONGLINE FIGURE 4

Standardised demersal gillnet and demersal longline effort. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; dashed black line = WCDGLF; plain grey line = total from the three management zones.



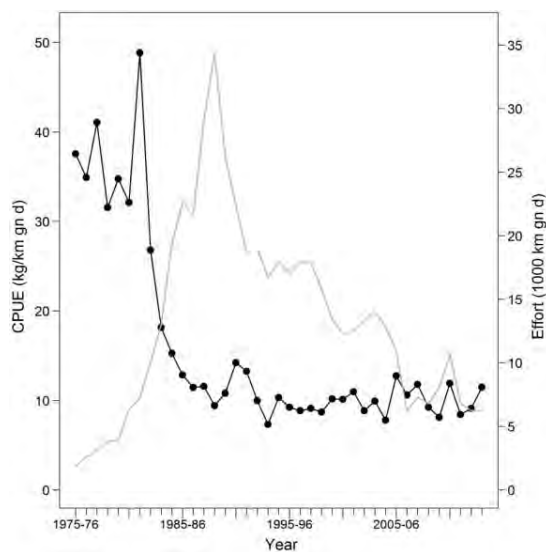
DEMERSAL GILLNET AND LONGLINE FIGURE 5

Gummy shark effective effort (grey line) and CPUE (black circles).



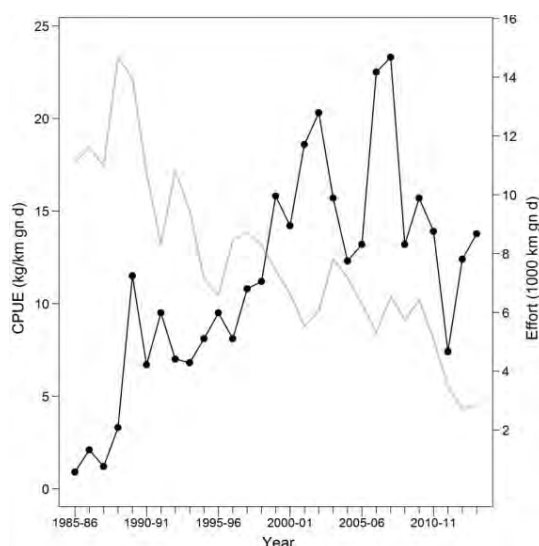
DEMERSAL GILLNET AND LONGLINE FIGURE 6

Dusky shark effective effort (grey line) and CPUE (black circles).



DEMERSAL GILLNET AND LONGLINE FIGURE 7

Whiskery shark effective effort (grey line) and CPUE (black circles),

**DEMERSAL GILLNET AND LONGLINE FIGURE 8**

Sandbar shark effective effort (grey line) and CPUE (black circles).

South Coast Demersal Scalefish Resource Report: Statistics Only

J. Norriss 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 (SCB), 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, particularly leatherjackets.

The take of scalefish by trawl methods, salmon by line and beach netting, estuarine netting and pilchards by purse seine in the SCB 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’ and as such is accessible to the holder of a Commercial Fishing Licence (for the fisher) fishing from an unrestricted Fishing Boat Licence (for the boat) .

Recreational

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

Total Landings (Season 2014):

79.0 tonnes demersal scalefish

42.0 tonnes non-demersal scalefish

Commercial

Commercial catches (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 more catch statistics are included in this chapter as they are unreported elsewhere: samson fish, one of the indicator species for the SCB pelagic suite; and leatherjackets not caught by the South Coast Estuarine Managed Fishery and taken in oceanic waters mostly by trap. A high leatherjacket catch in 2011 was due to a concerted attempt to develop that fishery at the time.

The catch of 79.0 t of demersal scalefish during 2014 is the second lowest annual catch since at least 2000, with only the 2013 catch lower. Catches in earlier years ranged from 104 to 147 tonne (South Coast Demersal Scalefish Resource Figure 2). Pink snapper, Bight redfish and hapuku catches were at their second lowest since 2000, and blue morwong at its lowest. The recent low catches may be due to reduced fishing effort, although the reason is currently not well understood given the difficulty of quantifying effort in this “open access” fishery. In addition, 42.0 t of non-demersal scalefish catch was reported in 2014, comprising mainly of samson fish, leatherjacket species and bonito.

Recreational

Two surveys of boat based recreational fishing for the 12 months to 29 February 2012, and to 30 April 2014, provided the following respective SCB catch point estimates: pink snapper 9.4 and 5.3 t, Bight redfish 11.8 and 9.9 t, blue morwong 12.0 and 7.8 t. The recreational catch of Samson fish was estimated to be 670 and 748 fish kept, respectively.

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 Office (WANRM) 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 WANRM-funded research project commenced in 2013, with the objectives 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 2015. Through this review, the Department intends to implement more formal management arrangements for these fisheries to provide an improved framework for the sustainable management of commercial line, net and trap fisheries into the future.

External Factors

Bight redfish are an important component of the catch of the Great Australia Bight Trawl Sector (GABTS), part of a Commonwealth (Australian Fisheries Management Authority [AFMA]) managed fishery operating across southern Australia as far west as Cape Leeuwin. Off the Western Australia coast (i.e. west of 129 ° E) it operates outside State fishery shelf waters (depth less than 200 metres), except for east of 125° E (approximately 250 km east of Esperance) where shelf waters are also able to be fished. In the 2013-14 fishing season, 196 t of Bight redfish were taken by the GABTS, although mostly from waters off South Australia. Thus the South Coast Demersal Scalefish resource is also exploited by the GABTS and is affected by management arrangements in that fishery. The WANRM-funded research project has collaborated with AFMA in an attempt to elucidate Bight redfish stock connectivity. A report is due in 2015.

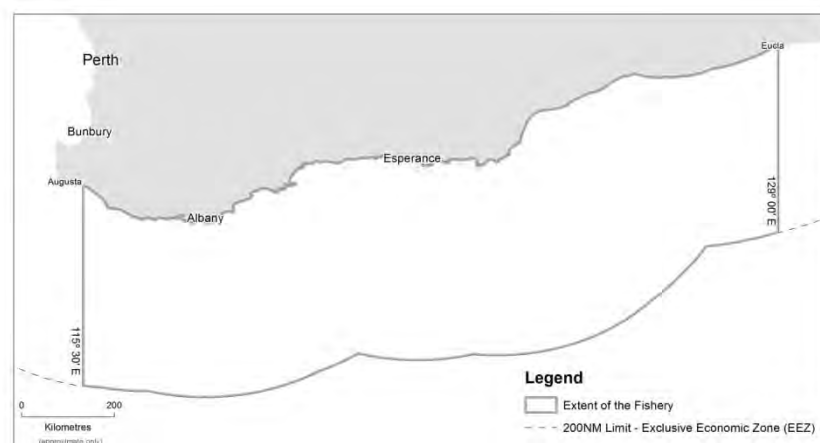
SOUTH COAST DEMERSAL SCALEFISH RESOURCE TABLE 1

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, 2010–2014.

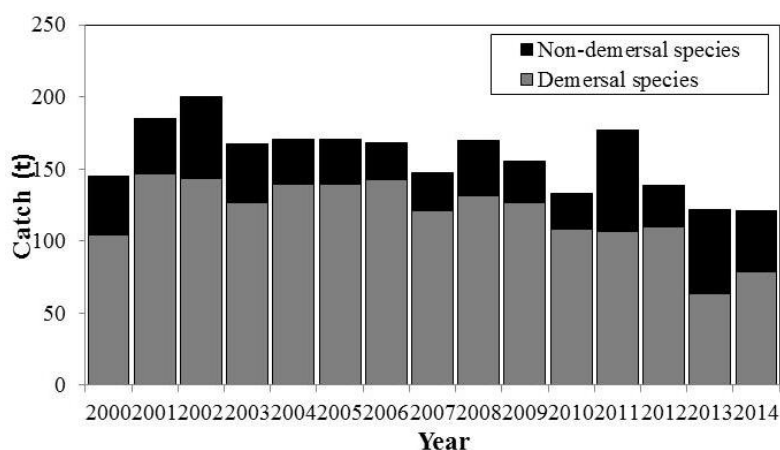
Species	2010	2011	2012	2013	2014
Bight Redfish*	31.2	36.4	45.8	22.1	26.6
Blue groper	0.7	1.4	0.4	0.9	0.5
Blue Morwong	5.0	5.2	4.4	4.0	4.0
Pink Snapper	40.7	30.2	27.4	17.9	21.3
Hapuku	12.8	16.8	14.5	7.5	11.3
Blue-eye trevalla	2.2	3.4	3.1	0.6	0.6
Eightbar grouper	0.6	1.7	3.4	1.5	2.9
Other demersal scalefish	14.8	11.8	10.3	9.0	11.9
Total demersal scalefish	108.0	106.8	109.4	63.4	79.0
Samson fish (pelagic)	15.4	19.4	13.5	14.0	14.8
Leatherjackets (nearshore)	4.9	39.1	6.3	11.5	6.0
Total other non-demersal scalefish**	4.6	11.5	9.4	32.5	21.2
Total Scalefish	133.0	176.8	138.6	121.5	120.9

* Estimates of Bight redfish catches include fishes reported as 'Bight redfish', 'yelloweye redfish' and 'redfish', confirmed by recent catch sampling to be > 99% Bight redfish (add genus species name).

** Includes catches of pelagic and nearshore species, excluding samson fish and leatherjackets which are given separately.

**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, 2000–2014.

AQUACULTURE

Regional Research and Development Overview

Greenlip abalone (*Haliotis laevis*) is considered a key species for aquaculture development on the south coast of WA.

An abalone farm and associated hatchery near Bremer Bay have been upgraded and modified to cater for planned growth in production and to accommodate biosecurity requirements. The land-based farm and hatchery are being operated according to a Management and Environmental Monitoring Plan (MEMP), which includes provisions for biosecurity. Independent audits are undertaken to ensure compliance with biosecurity measures.

The licence holder for a marine-based greenlip abalone farm near Augusta has been granted a variation to include an additional two areas in Flinders Bay for abalone aquaculture

and is currently increasing production. The marine-based abalone farm is also operating under a MEMP and the Department of Fisheries has a compliance plan in place.

The Department of Fisheries is currently assessing an application for exemption to conduct trials on the suitability of areas in Wylie Bay, near Esperance, for abalone aquaculture.

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) from: Busselton, Albany and Esperance District Offices as well as utilising a recreational mobile patrol vehicle based at Bunbury. Compliance strategies include both overt and covert operations. Inspections of fishing activities are conducted on land, at-sea, at commercial fish processing establishments, wholesale/retail outlets and aquaculture sites. FMOs inspect vessels, catches, fishing gear, marine safety equipment and commercial and recreational licences. Marine Education Officers deliver a community education program.

Activities during 2013/2014

Due to the variety of commercial and recreational fisheries, expanse of coastline and the variable and seasonal weather conditions, FMOs use risk assessments to prioritise and plan compliance activities.

Overall, FMOs delivered a total of 2,562 'on-patrol' officer hours to the bioregion, which is a reduction from the previous year. Reduction in patrol hours can be attributed to a reduced number of available staff due to shark mitigation projects and time associated with delivering training to relevant FMOs (South Coast Compliance Figure 1).

FMOs made contact with a total of 150 commercial fishers in the field, across the south coast. Offences detected included licence 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.

During the year, 20 infringement warnings and eight infringement notices were issued with a further five cases resulting in prosecution action being taken against

commercial fishers (or those offending against commercial gear).

Recreational compliance activities concentrated mainly on checking shore and vessel based anglers, abalone fishers and shellfish collectors. FMOs contacted a total of 6,498 recreational fishers. During 2013/14, there were 73 infringement warnings and 57 infringement notices issued and six 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 seasonal restrictions that apply in the recreational abalone fishery.

The fisheries of highest risk of non-compliance with 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.

Community and school education programs in the South Coast Bioregion were conducted by the Marine Education Officers. Activities included the delivery of school incursions and excursions to 825 primary and secondary students across the region in 28 structured sessions. A further 470 people took part in structured community education activities such as school holiday programs and presentations to interest groups. Two agricultural shows were attended and a number of information displays to engage directly with recreational fishers at key locations such as boat ramps and caravan parks were held, with a total of 1,382 contacts made. A new initiative for 2013/14 included the delivery of presentations to migrant groups on recreational fishing rules and regulations. A session was held in Katanning and Albany, with the aid of a translator.

Where possible, education initiatives were delivered in collaboration with other environmental education providers. Partnerships included Reefishwest, the Department of Parks

and Wildlife, South Coast Natural Resource Management, the WA Museum, the Fishers with Disabilities Association, the Albany Migrant Resource Centre, the Katanning Community Resource Centre and the Oyster Harbour Catchment Group.

Initiatives in 2014/2015

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 will result 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.

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. A compliance plan

will be developed for abalone aquaculture operations in Flinders Bay. The objective of the plan is to create a regulatory environment which promotes, encourages and ensures compliance by the holders of the licence and their staff. The plan will be based on risk assessments and provide for regular inspections of the operations at that location. A similar plan will also be developed for abalone aquaculture operations at Bremer Bay.

The education program will aim to strengthen direct engagement with the community, including commercial and recreational fishers. This will be done through providing face to face engagement opportunities for the community at boat ramps and caravan parks, as well as regional events and fishing competitions. Indirect engagement to address local issues will continue to include articles in newspapers and community newsletters, as well as information mail-outs to strategic locations such as visitor centres, tackle and bait outlets and service stations.

Education staff will continue the delivery of community activities such as school holiday programs and workshops, in partnership with other agencies where possible.

The education program will continue to deliver school incursions and 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, Redmap and Biosecurity Watch.

An emerging issue for 2014/15 is to address the issue of waste management and rock fishing safety at Salmon Holes Beach in Albany. The Marine Education Officers plan to develop partnerships with key stakeholders such as the Department of Parks and Wildlife, South Coast Natural Resource Management, Recfishwest and the City of Albany to address these issues.

SOUTH COAST COMPLIANCE TABLE 1

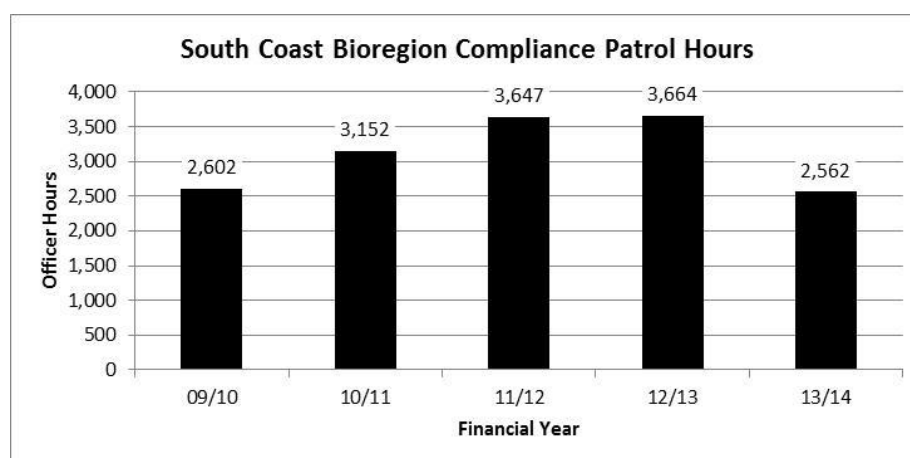
Summary of compliance and educative contacts and detected offences within the South Coast bioregion during the 2013/14 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,562 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	150
Infringement warnings	20
Infringement notices	8
Prosecutions	5
Fishwatch reports**	11
VMS (Vessel Days)***	3,128
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	6,498
Infringement warnings	73
Infringement notices	57
Prosecutions	6
Fishwatch reports	40
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	107
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 five years. The 2013/14 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. (The totals exclude: time delivered by the Department's large patrol vessels PV Walcott PV Houtman and PV Hamelin; time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.. Time spent in Marine Park sanctuary zones is also excluded because this time may overlap field time outside a sanctuary zone and as a result, the historic data is slightly lowered compared to that reported in previous reports).

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

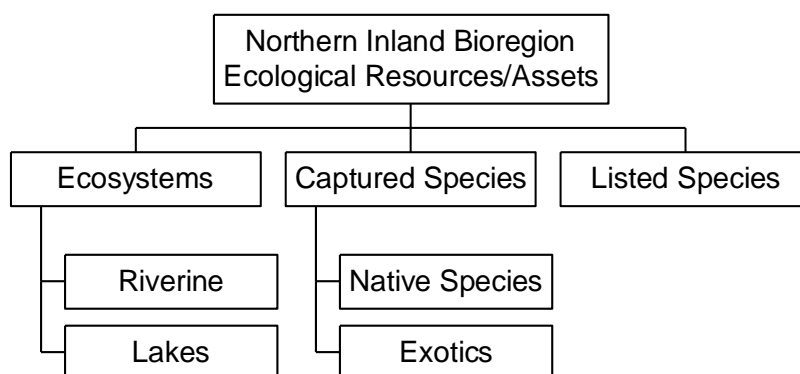
Ecosystem	Risk	Status and Current Activities
Ecosystems	LOW (non fishing)	Minimal threats and these would be due to non-fishing activities

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

J.I. Brown, 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 the artificially created Lake Argyle in the north-eastern Kimberley. This gillnet fishery specifically targets silver cobbler (*Neoarius midgleyi*), with catches of barramundi (*Lates calcarifer*) not permitted.

Recreational

A small recreational and charter boat fishery exists in Lake Argyle and surrounding waters for silver cobbler and barramundi 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 permitted to use no more than 1,500 m of set nets at any one time and these nets must have a minimum mesh size of 159 mm 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. The new notice retains the management arrangements that were in place under the previous notice. Under this Order the six Fishing Boat Licences listed are still 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. Additionally, at this time of the year water temperatures in the lake are high and would cause spoilage of fish in the nets. Commercial operators in the LASCF are not permitted to take barramundi at any time and all nets used by LASCF fishers must be suitably marked with licence identification.

In 2001, a voluntary industry Code of Practice was introduced to the LASCF, to enhance 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.

Furthermore, a Bycatch Action Plan has also been developed for the LASCF which aims to minimise the incidental capture of other species in Lake Argyle (including freshwater crocodiles, freshwater turtles, and birds) during commercial gillnetting operations. The Lake Argyle Silver Cobbler Fishery Bycatch Action Plan and Code of Practice were revised in 2010.

Landings and Effort

Commercial (season 2014):	Not reported due to confidentiality provisions
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Following the damming of the Ord River in 1971 and the creation of Lake Argyle, the commercial fishery first developed in 1979 with annual catches of silver cobbler landed up to 1984 being less than 41 t. From 1984 catches increased to reach an historical peak of 231 t in 2000 and then following reductions in effort, catches steadily declined to a low of <50 t in 2009. Catches from 2010 to 2013 then fluctuated between 67 t to 118 t (Lake Argyle Silver Cobbler Figure 1). In 2014, the catch of silver cobbler declined to be the second lowest level reported for the fishery since 1984 (actual figures cannot be reported due to confidentiality limitations).

The effort used in the fishery to assess stock status is currently being reviewed. Presently, nominal effort in this gillnet fishery is determined using block days fished with effort calculated as the effort associated with any catch of silver cobbler in the LASCF block. A more refined determination of targeted effort is difficult as fishing practices vary across the vessels in the fishery and are therefore not uniform. Additionally, reporting practices of effort and net lengths by some fishers are inconsistent across time. As such, block day is the only current reliable effort measure available.

During 2014, only one vessel was active in the fishery. The level of effort reported is the lowest level reported for the fishery since 1983. There is considerable latent effort available in the LASCF with 5 licences choosing not to operate in the fishery in 2014. 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.

The overall catch in 2014 was lower than 2013 and the second lowest since 1984. The historically low catch level can be attributed to the lower effort expended in the fishery, with only one licensee actively fishing in 2014. In recent years (2004 to 2013), two to four licensees have actively fished Lake Argyle each year. The level of catch in the fishery at present is a reflection of the variable level of effort expended.

Since 2000, the catch per unit effort (CPUE) has been fairly constant indicating a long-term stable trend in the biomass of

silver cobbler in Lake Argyle (Lake Argyle Silver Cobbler Figure 1).

This fishery requires further monitoring of the population dynamics (growth, longevity and mortality) of silver cobbler to confirm stock status.

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 2014 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, although, fishers are restricted to a mixed species bag limit of four 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 2014 is below the acceptable catch range. This level of catch is, however, considered acceptable as the effort in the fishery is historically low. In addition, the catch rate since 2000 has been at a relatively high and stable level. The lower levels of catch in the fishery in recent years are likely to have allowed the stock to increase in size, thus resulting in the observed high catch rates. A review of the catch reference points will need to be undertaken if effort in the fishery continues to remain at low levels.

New management initiatives (2014/15)

The next management review for the Fishery is scheduled for 2016/2017.

The LASCFC underwent MSC pre-assessment in 2014. Outcomes from the pre-assessment are currently under review.

External Factors

A number of external factors may impact on silver cobbler biomass.

The introduced cane toad (*Rhinella marina*) was first observed in Lake Argyle in 2009 (Somaweera *et al.* 2011). This pest species is highly toxic to a number of native species, although a recent study determined the likely impact to the silver cobbler population in Lake Argyle to be minimal due to the ability of the fish to learn avoidance behaviour of egg and tadpole consumption in a laboratory study (Somaweera *et al.* 2011). However, the impact of cane toad consumption by prey and predators of silver cobbler may still influence their biomass.

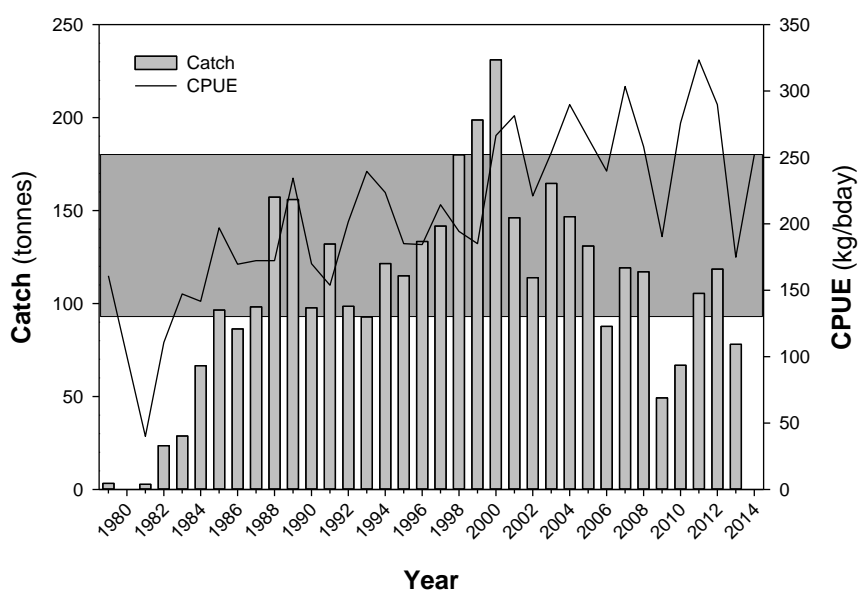
Since the creation of Lake Argyle, the population of the freshwater crocodile (*Crocodylus johnsoni*) has increased to more than 30,000 (Webb Pty Ltd 1989; WMI 2005, 2009). The population status of freshwater crocodiles is also likely to impact silver cobbler biomass in the form of predation levels as well as competition for food.

In Lake Argyle, stratification resulting in low oxygen levels typically occurs during the silver cobbler spawning period, possibly impacting recruitment levels particularly given the species low fecundity and high parental care.

There may also be a risk to the silver cobbler stock by the disease caused by the bacterium *Edwardsiella ictaluri*. This bacterium has impacted freshwater catfish aquaculture industries in the USA and Asia. In Australia, this disease has been detected in captive native catfish species but has yet to be detected in wild populations.

Barramundi aquaculture in Lake Argyle is likely to indirectly provide some additional (waste) food utilized by the silver cobbler and its prey species. Although there may be some negative impacts on environmental conditions due to the decomposition of food waste and excrement.

Lake Argyle Silver Cobbler Fishery



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 2014. Note, the 2014 catch is not reported due to confidentiality limitations. 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

There is one current licence to produce barramundi in Lake Argyle; the licence holder has secured tenure over a land based area to support its proposed aquaculture activities and has started operations.

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.

The compliance effort for this area primarily focuses on the commercial Silver Cobbler fishery in Lake Argyle, as well as aquaculture lease inspections and licence compliance.

The Ord and Fitzroy rivers are two of the State's largest river systems. They are highly valued by visiting and local fishers. Both river systems are relatively easy to access and are focal points for fishers pursuing barramundi. A large number of campers also access the northern inland rivers during the peak tourism period of May to October. Compliance and education for the freshwater systems in the Northern Inland bioregion therefore continues to focus on these river systems.

Officers pay particular attention to the catch of any protected sawfish species, rules regarding barramundi, illegal fishing gear and localised impacts of fishers.

Given the presence of red claw in Lake Kununurra, time is also dedicated to translocation inspections of non-endemic freshwater species and continued monitoring of these and other introduced fish species in northern inland waters.

The Community Education Officer develops programs and coordinates the delivery of educational activities to a range of targeted audiences. They reach a wide range of people including school aged children and retirees, who come north to escape the cold and throw a line.

Activities during 2013/14

During 2013/14, Fisheries and Marine Officers (FMOs) recorded 1,026 hours of active compliance patrol time in the Northern Inland bioregion (Northern Inland Compliance Figure 1).

Across the Northern Inland bioregion, personal contact was made with 3312 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 localised complaints regarding illegal fishing activities.

Compliance and education was also undertaken in the Lake Argyle area, where FMOs inspected commercial silver cobbler fishers to ensure that compliance with management, protected species interaction and environmental objectives were being met. These inspections resulted in 4 infringement warnings being issued.

Education activities for the 2013/14 period included the delivery of school incursions and excursions, school holiday programs, community presentations and regional events such as fishing competitions and agricultural shows. 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 Department's 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.

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.

District FMOs will continue to work closely with other government agencies to facilitate the transfer of intelligence information and respond to compliance situations.

Given the large expanse of these inland waters the community education program will focus on other methods of delivery rather than direct contact. Initiatives such as local media releases, advertising in fishing magazines and websites and signage are planned for these areas. Presentations on the recreational fishing rules will also be delivered to target audiences such as interstate tourists where recreational fishing rules for barramundi and legal/illegal gear differs between the states.

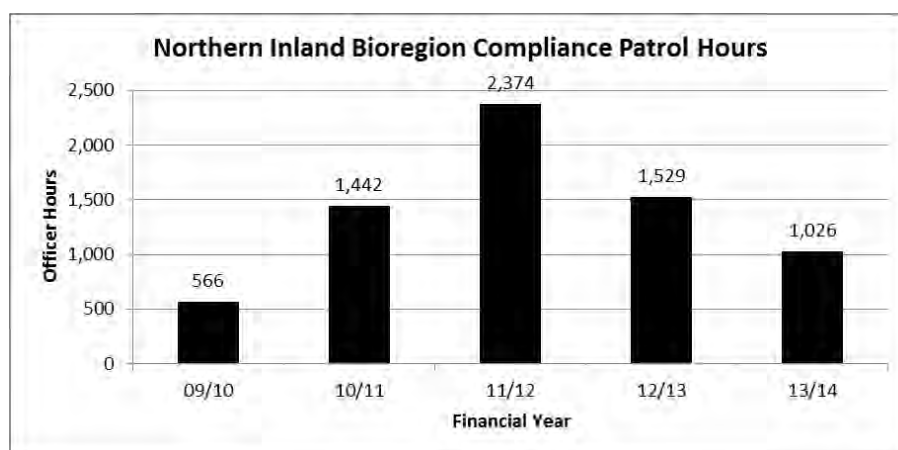
NORTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Northern Inland bioregion during the 2013/14 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION		1,026 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY¹		
Field contacts by Fisheries & Marine Officers		10
Infringement warnings		4
Infringement notices		0
Prosecutions		0
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY		
Field contacts by Fisheries & Marine Officers		2,277
Infringement warnings		4
Infringement notices		8
Prosecutions		0
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY		
Field contacts by Fisheries & Marine Officers		1,025
Fishwatch reports ²		N/A

¹Contacts 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, Gascoyne Coast and West 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 2013/14 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.

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 dams 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 native fish and crustaceans 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 11 species of obligate 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 climate change, 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
Freshwater 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

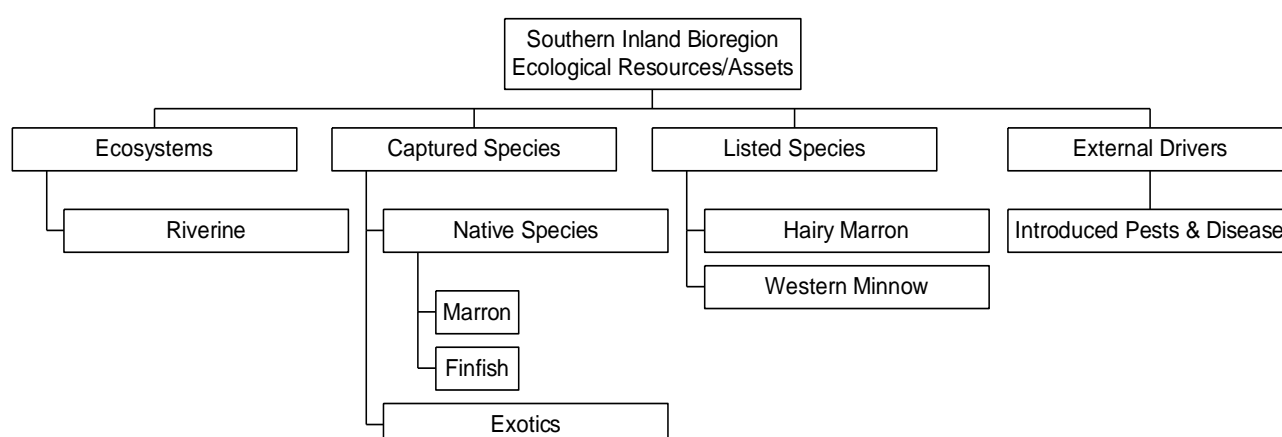
Fish species	Risk	Status and Current Activities
Finfish Native (not listed)	HIGH (non-fishing)	The abundance and distribution of most native fish have been severely impacted due to reduced rainfall and land management practices. This has led to widespread fragmentation of native fish populations (i.e. regional extinctions, which without restocking will be permanent as there is no migration between lakes or catchments).
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. Research activities are aimed at Improving growth rate by increasing the volume of spawnless fish produced at the hatchery.

Listed species

Species	Risk	Status and Current Activities
Hairy Marron	SIGNIFICANT (fishing)	Poaching of hairy marron from the upper reaches of Margaret River has been observed despite a ban on all marron fishing.
	SIGNIFICANT (non-fishing)	A new recovery plan has been developed to guide hairy marron recovery activities. This includes population monitoring, control of threatening processes, a captive breeding program, and Increased community awareness through a zoo display and collaborating with regional NRM groups.
Western Minnow (non fishing)	SIGNIFICANT (non-fishing)	Western minnow were successfully bred in captivity by the department.

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, E. Smith

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*). Native freshwater cobbler (*Tandanus bostocki*) are also taken by anglers in smaller numbers. 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-sustaining 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, Department of Water, Water Corporation, 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° 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 freshwater fish species.

To protect newly released trout from over exploitation, 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, which are open to angling all year.

A combined daily bag limit of 4 applies to rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and 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 actively predated 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 are present since the 1930s. The Department's trout stocking processes are conducted in accordance with the Department's *Five-Year Management Strategy for the Recreational Trout Fishery: Fisheries Management Paper 250* (FMP250). 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 changes to the management arrangements between 2013 and 2014, however the five year management term of FMP 250 expires in September 2016 and as such, a review of the document and stocking strategy will be undertaken in 2015/16.

Landings and Effort

Commercial catch estimate (season 2015)

Not applicable

Recreational catch estimate (season 2015)

53,160 retained fish

At the end of the 2015 season, a phone recall survey was undertaken of 371 metro and 400 country respondents (7.2% of licence holders in that season).

The estimated total effort for 2015 was 34,196 days (standard error $\pm 1,631$), which was the same as the previous year (Freshwater Angling Table 1, Freshwater Angling Figure 1a). The estimated total number of licensed fishers was 10,759 in 2015, which was a very slight increase on the previous year. Overall purchase of licences has been increasing, with 2015 year having the highest number of licences purchased since changes to licensing in 2012 (Freshwater Angling Table 1). The estimated total number of licensed fishers that participated in freshwater angling was 5,638 in 2015; a slight increase from 5,357 in 2014. The average number of days fished per fisher was stable at 6.05 days in 2015 (Freshwater Angling Table 1).

Fishing effort amongst dams was stable, and Harvey Dam continued to receive the highest fishing effort (43% of all effort) (Freshwater Angling Table 2). Fishing effort in rivers is evenly distributed amongst three main rivers; the Blackwood, Collie and Warren Rivers (13%, 16% and 17%

respectively). Total fishing effort across “other” rivers has increased to 37%, a substantial proportion of all effort. The cause of the increase in 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 2015 was 106,611 (by number) (Freshwater Angling Table 3 and Freshwater Angling Figure 2b) of which 53,160 were kept and 53,451, were released, similar to the previous season but substantially higher than 2012 and 2013 (Freshwater Angling Table 3).

The estimated catch per unit effort (CPUE) for all species combined in 2015 (3.12 fish per fisher day) was similar, but slightly higher than that estimated for 2014 (3.03) (Freshwater Angling Figure 1a). Overall, catches of each species were similar to previous years. A large proportion of trout (rainbow and brown) are released by fishers (approximately 70%). From the available data, it is not possible to accurately determine if the fish are released because they are undersize, or if catch and release forms a large social component of the fishery. Most captured redfin perch are retained by fishers (97%), as encouraged by the Department.

FRESHWATER ANGLING TABLE 1

Summary of survey respondent effort and total effort extrapolated to all licence holders for seasons (2012 to 2014).

Season	Licences	Total fishers	Mean days	Total effort	
				Total effort days	Std error (Total effort)
2012	8541	4167	4.94	20594	1979
2013	9718	4787	4.94	23646	2302
2014	10370	5357	6.35	34021	2368
2015	10759	5638	6.07	34196	1631

FRESHWATER ANGLING TABLE 2

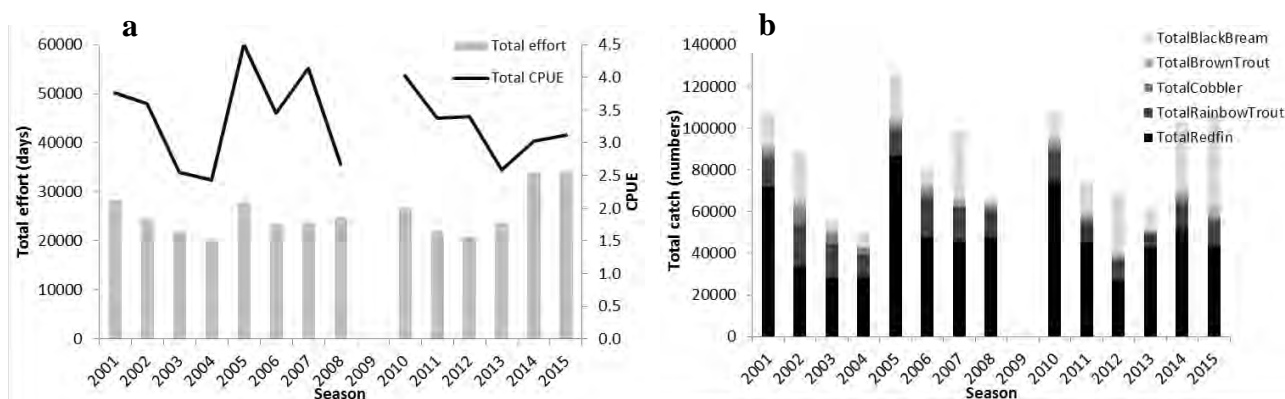
Summary of proportion of effort (days) for individual dams and rivers for seasons (2012 to 2014).

Waterbody	Watercourse	Proportion of effort %			
		Season			
		2012	2013	2014	2015
Dams	Big Brook	6	4	4	9
	Drakes Brook	2	4	4	6
	Harvey	50	49	45	43
	Logue Brook	12	17	15	10
	Waroona	14	13	14	13
	Wellington	9	6	16	16
	Other	7	6	3	4
	Total	100	100	100	100
Rivers	Blackwood	19	18	14	13
	Collie	12	19	14	16
	Donnelly	6	10	8	5
	Hutt	0.4	0	0	0.5
	Margaret	0.1	1	2	1
	Murray	15	11	11	9
	Preston	3	1	4	2
	Warren	24	19	17	17
	Other	20	21	30	37
	Total	100	100	100	100

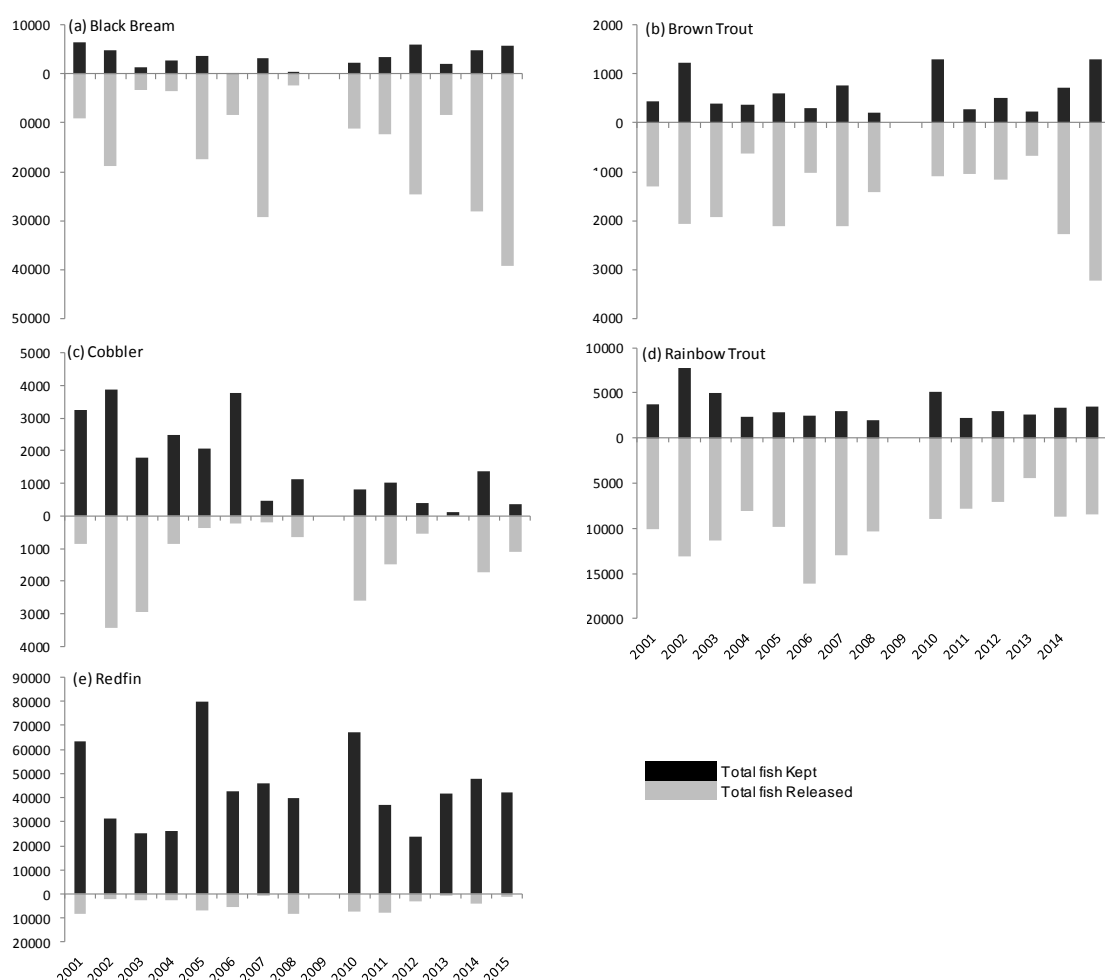
FRESHWATER ANGLING TABLE 3

Summary of survey estimates for the main freshwater species targeted for seasons (2012 to 2014). Release rate = (Released /Total)

Season	Species	Total (numbers)		Total	Release rate %
		Kept	Released		
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
2015	Black Bream	5694	39348	45042	87
	Brown Trout	1307	3237	4544	71
	Cobbler	371	1104	1475	75
	Rainbow Trout	3475	8487	11962	71
	Redfin	42313	1275	43588	3
	Total	53160	53451	106611	50

**FRESHWATER ANGLING FIGURE 1**

Estimated total effort, CPUE (a) and total number of fish caught (b) for 2001 to 2015 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 perch (e) for 2001 to 2015 seasons.

Licensed Recreational Marron Fishery Report

R. Duffy, F. Trinnie, K. Ryan, E. Smith.

Main Features

Status	Current Landings		
Stock level	Acceptable	Commercial	nil
Fishing level	Acceptable	Recreational catch estimate 2015 70, 807 ± 5650 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, Freshwater Fisheries Reference Group 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 2015 season, licensed fishers were permitted to fish for marron from midday 8th January to midday 5th February 2015. 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 changes to the management arrangements between 2014 and 2015.

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.

A modified 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 four dams and eight rivers. This survey was modified slightly in 2014. The survey trialled the inclusion of a drinking water dam where fishing is banned, to act as a control site.

Historical phone surveys revealed that up to 30% of fishing effort in rivers occurs in systems that were not included in the fishery-independent stock assessment. The 2014 fishery-independent stock assessment trialled sampling in three additional river systems, that, along with six other rivers, represent the majority of this effort. These additional rivers will be surveyed on a three year rotation.

Retained Species

Recreational catch estimate (season 2015)

70,807 marron ± 5650 marron

At the end of the 2015 season (8 January 2015 to 5 February 2015), a phone-recall survey was undertaken, sampling 458 metro residents and 376 country residents (5.8% of licence holders for this season). The total number of licensed fishers available to fish at least one day in the 2015 season was 14,357.

The estimated recreational catch for marron was 70,807 (by number, with ±5,650 s.e.) (Recreational Marron Figure 1a) of which 21,480 (±3,581 s.e.) were taken in dams (Figure 2a) and 49,327 (±4,791 s.e.) in rivers (Recreational Marron Figure 2b). This was similar to the estimated catch of marron in 2014 of 71,268.

Total effort was estimated at 20,609 (by days, with ±1,182 s.e.) in 2015 which was higher than the 18,287 days in 2014 (Figure 1). The total number of active fishers was estimated at 7,161 in 2015 which was an increase from 6,232 active fishers in 2014. The average number of fishing days per fisher was 2.88 days (±0.17 s.e.) in 2015.

The catch per unit effort (CPUE) (3.44 marron per fisher day) in 2015 was lower than the CPUE observed (3.90) in 2014 (Recreational Marron Figure 1b) due to the higher amount of effort in 2015. The CPUE observed in dams (3.39 marron per fisher day) was similar to rivers (3.46) in 2015 (Recreational Marron Figure 1b).

The proportion of total effort was 6,340 days (31%) in dams compared to 14,269 days (69%) in rivers in 2015 (Table 1). 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 1).

Wellington Dam and Harvey Dam have always received the highest proportion of fishing effort since surveys began in 2000. From 200 to 2004, Wellington received the majority fishing effort between the two dams. However, since 2005, with the exception of 2007 and 2015, Harvey Dam has consistently received the most fishing effort (Recreational Marron Figure 2a). The change in effort in 2007 is most likely due to an extremely low minimum water level that year, however this is not the cause for the change in effort in 2015. Therefore, while patterns of fishing remain constant between years, it appears that many fishers actively choose their fishing location.

Effort in rivers is spread over a greater number of sites, with approximately 70% of effort being spread amongst seven systems (Recreational Marron Figure 2b). In 2015, the majority of this effort occurred in the Blackwood River (15%), Collie and Warren Rivers (14%), and the Preston River (11%) (Recreational Marron Figure 2b), this is similar to previous years, although effort in the Blackwood river appears to have decreased by 5 to 10% from historical levels. Effort in other rivers is variable and is only occasionally above 5%. Of note, however, is a consistent decline in effort in the Murray River from around 10% in the early 2000s to less than 6% since 2010.

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 in 2006 (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 marron abundance varies greatly among the surveyed rivers and dams (Recreational Marron Figure 3) and is highly variable between years. Size however, is relatively stable at all sites, although there has been a slight decrease in mean size of marron in Harvey Dam. Harvey Dam, in conjunction with Wellington Dam, are the most heavily fished dams. Therefore, the decrease in mean size in Harvey dam will be monitored carefully in 2015 to determine if the trend continues.

Marron abundance in most dams were similar to previous years (Recreational Marron Figure 3); however, both Wellington Dam and Waroona Dam have shown gradual increases in abundance from lows in 2012 due to favourable rainfall conditions. River CPUE was stable in Preston River, Collie River and Murray River, and increased in Warren River. Analysis of data for the Collie River is annually confounded by tampering and theft of sampling equipment. Stocks in the Blackwood River and Donnelly River, while stable over the last three years are low and will be reassessed based on the results of the 2015 stock assessment.

Overall marron stocks are considered adequate, although under pressure. Recreational CPUE has remained correlated, indicating fishers are not having to work harder for their catch. However, the stock assessment is detecting a decrease in marron stocks. The decrease in stocks is across the entire size range, therefore it is not considered to be a result of fishing effort, in addition marron fishers are considered to generally comply with legal catch and bag limits. The decrease in abundance witnessed in some systems, has also occurred in the Shannon River which has been closed to all marron fishing since 2007. Whist poaching is known to occur in the Shannon River, the effort is not considered to be high enough to cause this decline. Therefore the changes in marron abundance and size appear largely to be a result of environmental variables.

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 recreational marron fishers.

Listed species interaction: Negligible

A second species of marron, the critically endangered hairy marron, *Cherax tenuimanus*, occurs only in Margaret River. It is threatened mainly by smooth marron, *Cherax cainii*, following the introduction of this species into Margaret River in the early 1980's. 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 Parks and Wildlife, and other stakeholders is nearly complete and will guide recovery actions for the next 5 years. These actions include the removal of smooth marron from habitat shared with hairy marron, a captive breeding program to increase the numbers of hairy marron, and the creation of new populations of hairy marron using the captive bred stock.

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 in 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 is collected. In the past, this data was collected as part of a marron logbook program, however, this program ceased operation in 2008. The estimated 20,000 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. This level of catch has rarely been achieved, with the exception of 2010, a year of extremely low rainfall.

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, limited growth in the fishery is permissible 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. However, external factors such as rainfall, dam levels and river flow are likely to be the main factors that drive marron abundance (see External Factors below).

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 2015 was 20,609 ($\pm 5,650$) fishing days with a 28 day season. Catch and effort in 2015 are still strongly correlated and show the same relationship as previous seasons. Should effort change and catch does not change proportionately, management changes may be required to reduce the impact of fishing on marron stocks.

New management initiatives (2014/15)

For 2015 the marron season started at midday on 8th January and ran for a 28 day period until midday 5th February. Fisheries managers and scientists continue to monitor the impact of changing rainfall patterns in the South-West on marron populations.

External Factors

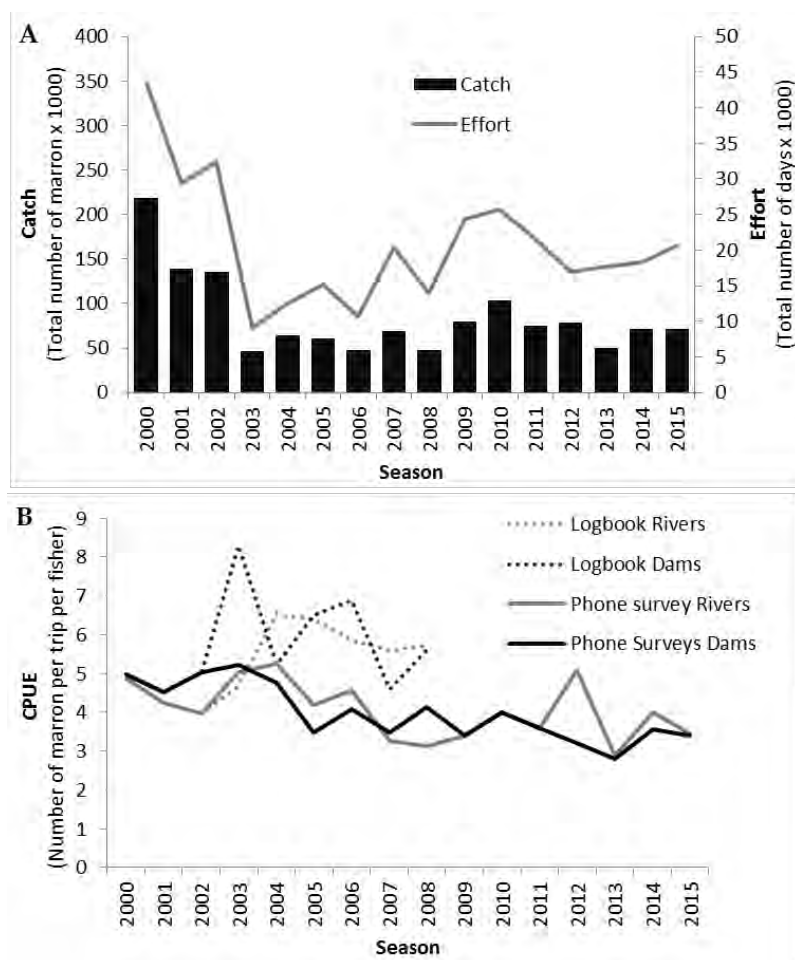
In 2014, the Department of Fisheries received a report of marron from Grimwade Dam containing an infection of numerous white cysts. A sample of marron was collected and analysed. The cysts were determined to contain the second life stage of a previously undescribed species of trematode, belonging to the genus *Choanocotyle*. The final host for the trematode is a turtle, so there was no risk to humans consuming the infected marron. A similar species has previously been described in turtles in WA and this new species of trematode is believed to be a native species. To investigate this further, the Department of Fisheries, in conjunction with the Department of Parks and Wildlife will complete a joint investigation into the life cycle of the trematode. In addition, the 2015 stock assessment will collect samples of marron from river systems throughout the south-west, to confirm the distribution of the trematode.

Rainfall in the south-west of Western Australia has declined by 10-15% since 1975 according to CSIRO models. The decline has been most noticeable in autumn and early winter rains. 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. CSIRO models predict an additional 7% decrease in rainfall by 2030. Managing the marron fishery in the face of these external changes will be a major challenge.

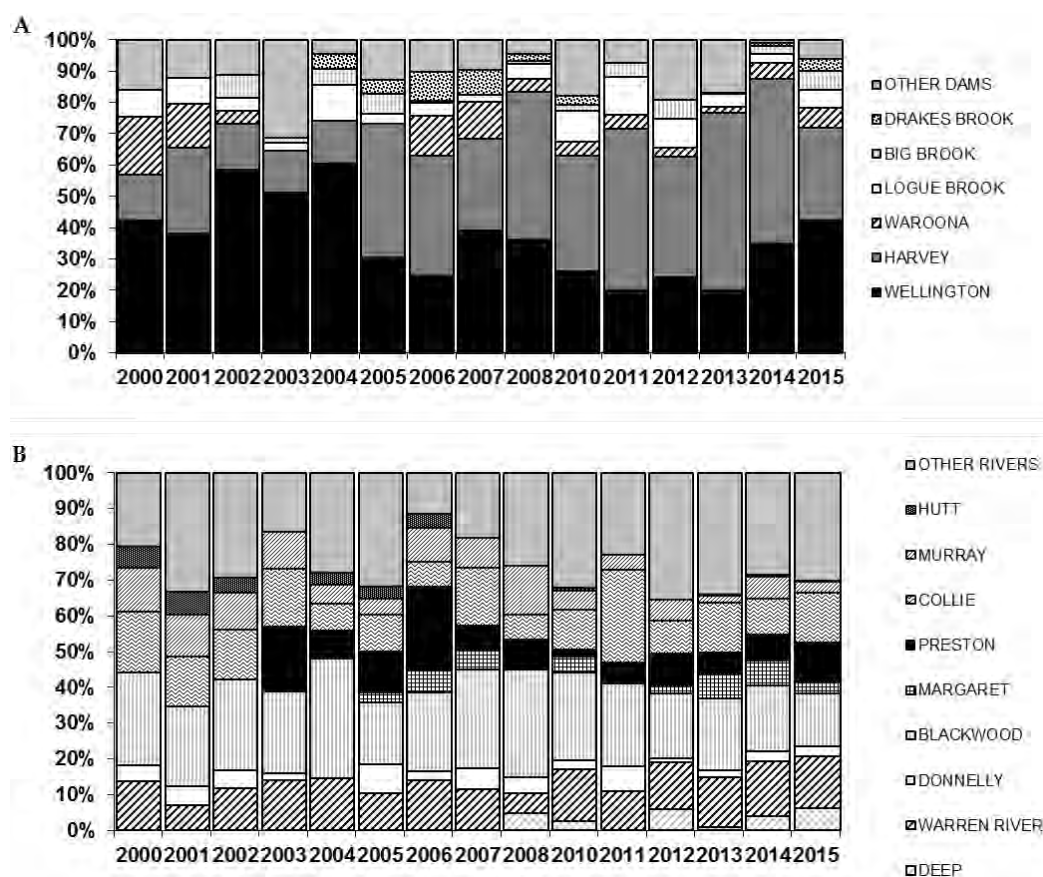
RECREATIONAL MARRON TABLE 1

Proportion of total effort between river and dams from 2000 to 2015.

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
2015	0.69	0.31

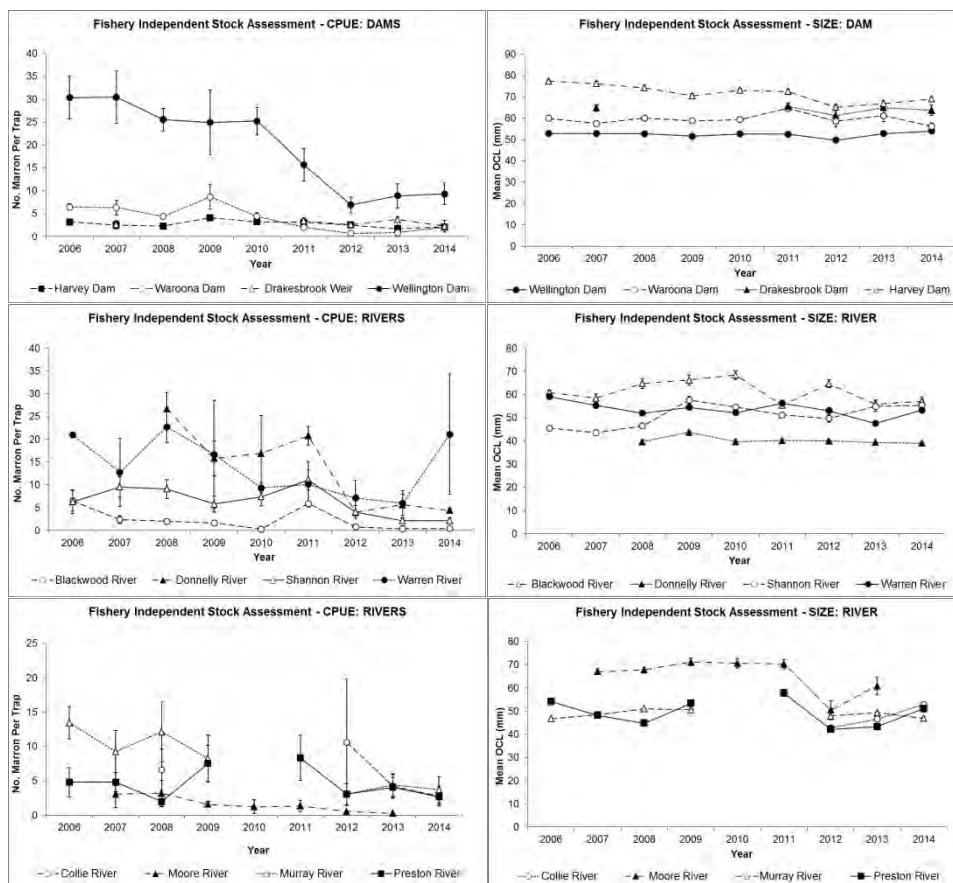
**RECREATIONAL MARRON FIGURE 1**

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 2015.



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 2015.



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 collaborative

project with the University of British Columbia was recently completed which sought 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.

Marron aquaculture in the south west of the State continues to perform well and annual production remains relatively stable. There is some interest among the marron growers in increasing production by undertaking research on marron nutrition and diets.

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 effective compliance program. Activities undertaken by FMOs include educating the public, inspecting licences, size and bag limits and patrolling waterways to ensure no illegal gear is being used to take marron.

FMOs engage in joint patrol/operation initiatives with police to investigate the theft of marron from private properties and licensed aquaculture sites as well as with Water Corporation Rangers to target State waters in and around catchment areas.

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 authorised as honorary FMOs to assist with the compliance of illegal fishing in Water Corporation dams. Some Department of Parks and Wildlife officers have also been authorised as honorary FMOs and play an important role in marron compliance throughout the South West.

The other main recreational fishing activities for the Southern Inland bioregion is freshwater angling and netting. Compliance effort in these fisheries primarily focuses on fish

size and bag limits, licences, gear specifications, closed area and seasonal restrictions. Inspections of fish wholesale and retail premises form part of the compliance activities conducted by FMOs in the Southern Inland bioregion.

Commercial fishing activity occurs in some rivers in the Southern Inland Bioregion and 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, licensing and inspecting consignments of fish for minimum legal sizes.

Activities during 2013/14

During 2013/14 FMOs delivered 2,809 'on-patrol' officer hours to the Southern Inland bioregion, an increase of 323 hours on the previous year (Southern Inland Compliance Figure 1).

Officers conduct patrols throughout the bioregion in vehicles, motorbikes, vessels and canoes. There were 5,266 field contacts with recreational fishers, an increase of 1190 from the previous year, and 32 contacts with commercial operators a decrease of 26 from the previous year (Southern Inland Compliance Table 1)

There were 69 infringement warnings and 86 infringement notices issued with a further 61 prosecutions for recreational offences.

The marron fishery was a major focus for the compliance and education program in this bioregion especially in the South West corner. 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) were also a focus in the Southern Inland Bioregion. Activities mainly involved targeted inspections of aquaculture facilities, to ensure that licences were held and there was compliance with the conditions of those licences. FMOs continue to work closely with police and industry to investigate any reports of illegal interference with lawful aquaculture establishments.

Community education staff addressed three key issues in the education strategy for the 2013/14 marron season. These included a lack of awareness of legal versus illegal gear for marron fishing, lack of awareness of the noon to noon daily bag limits, and lack of education material being accessed by the community when purchasing marron licences, particularly when paid online.

A mail-out to target peak tourist locations was distributed to 25 stakeholders including campgrounds and visitor centres within key marron fishing areas, and caravan parks from Albany through to Dwellingup. The aim of the mail out was to circulate the 'Don't get caught in a trap' poster and the Recreational marron fishing guide. Additionally, several articles on the issues associated with using traps, and advertisements to promote the 'Don't get caught in a trap' campaign were run prior to and during marron season in Albany, Walpole, Busselton and Margaret River.

Initiatives for 2014/15

Compliance operations will continue to cover all fisheries within the Bioregion with each District setting their own

priorities for their particular fisheries. There however will be particular compliance effort concentrated towards targeting 'out of season' marron fishing with both covert and overt patrols. A high-profile compliance presence is again planned for the marron season focussing on key areas known for high activity as well as areas identified as experiencing pressure through the use of illegal methods.

FMOs are committed to maintaining joint patrols and partnerships with external stakeholders. The unlawful removal of marron from dams on private property and aquaculture facilities remains an important focus for joint agency collaboration in the sharing of intelligence and resource sharing.

FMO's will remain an integral part of the Departments ability to liaise with and educate stakeholders from all sectors.

Community education activities will again include a mail out to stakeholders in key marron fishing areas, with the aim to increase our stakeholder list. Other strategies will include articles and advertisements in newspapers, and displays at relevant community events to target recreational fishers prior to, and during the marron fishing season. 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.

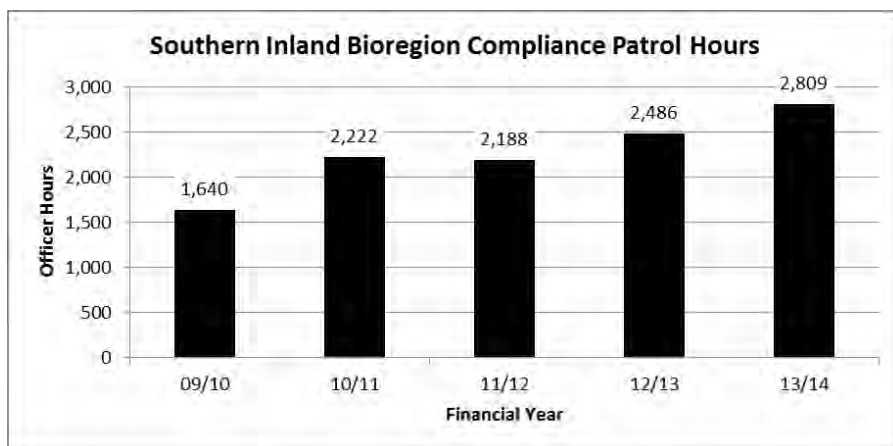
SOUTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Southern Inland bioregion during the 2013/14 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,809 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	32
Infringement warnings	3
Infringement notices	5
Prosecutions	6
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	5,266
Infringement warnings	69
Infringement notices	86
Prosecutions	61
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	617
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

“On Patrol” Officer Hours showing the level of compliance patrol activity delivered to the Southern Inland Bioregion over the previous five years. The 2013/14 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.).

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 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’s risk based approach to research and monitoring (under its EBFM framework) in conjunction with marine park management plans drives research and monitoring activities within marine parks.

STATEWIDE ECOSYSTEM MANAGEMENT TABLE 1 - RISK LEVELS FOR EACH ASSET.

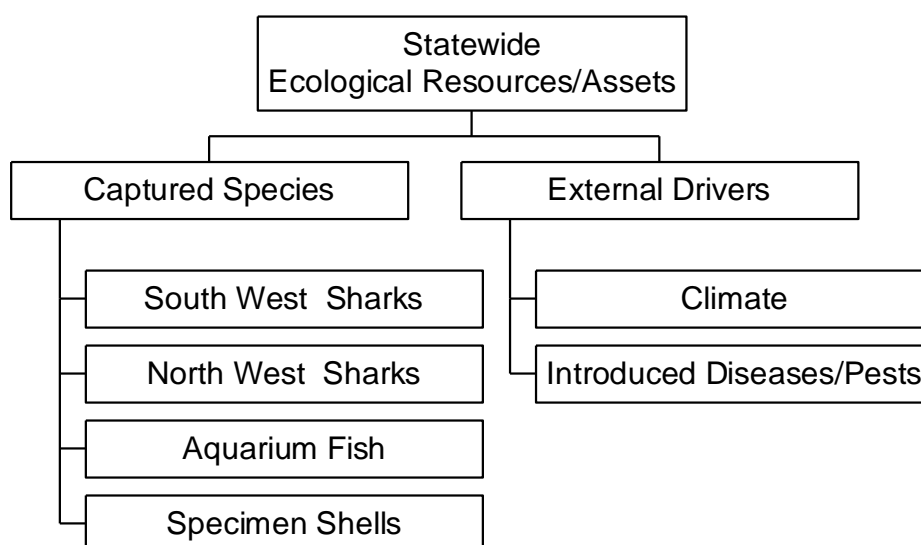
Low and Medium values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required.

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.
Specimen Shells	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	The predictions for impacts of climate change affecting the Statewide ecosystems and process are moderate in the short term. The risk escalates to a higher level in the medium term.
	HIGH in Medium term	

**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, K. Crowe, C. Bruce, C. Syers and K. Green

Fishery Description

Commercial

The Marine Aquarium Fish Managed Fishery (MAFMF) 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, moray 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 2014 the number of marine aquarium fish species landed ranged from 183 to 288; 170 marine aquarium fish species

were recorded in 2014). Operators in the MAFMF 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 2014, a total of over 321 species or species groups were reported in the landed catch of the MAFMF. The reported catch includes groups that were reported at the level of Order, Family, Genus or species. The MAFMF is primarily a dive-based fishery that uses hand-held nets to capture the desired target species. While the MAFMF 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

STATEWIDE

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 MAFMF operates in Western Australia's state waters spanning the coastline from the Northern Territory border in the north to the South Australian border in the south. The effort is spread over a total gazetted area of 20,781 km². During the past three years the fishery has been active in waters from Esperance to Broome with popular areas being around the Capes region, Perth, Geraldton, Exmouth and Dampier.

Management arrangements

This fishery is managed primarily through input controls in the form of limited entry to the fishery and permanent closed areas. There are 12 licences in the fishery; 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 2014, 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-fish species covered by other specific commercial management arrangements or management plans.

The MAFMF 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*). There is currently an upper limit of 2,000 individual syngnathids across the State, if this limit is exceeded, 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 MAFMF 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 20,052 fish (excluding syngnathids) were landed in 2014. 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 2014 was higher than that reported in 2013 (19,302), but lower than that reported in 2012 (22,780). The level of catch of aquarium fish reported over the last 5 years is all somewhat similar.

The main fish (excluding syngnathids) species landed in 2014 were damselfish of the *Chromis* genus and the *Neopomacentrus* genus, followed by the spotted blenny (*Istiblennius meleagris*) and the scribbled angelfish (*Chaetodontoplus duboulayi*) (Marine Aquarium Fish Table 2). Likewise, the main coral species landed in 2014 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). The syngnathid catches in 2011 (1,138), 2012 (1,232) and 2013 (1,635) were higher in comparison and were similar to the catch levels reported in 2008 (1,218). In 2014, the syngnathid catch was again low, similar to the 2009-2010 level (359 individuals).

In 2014, 10 licences reported some level of activity (effort). Effort in the fishery has decreased from 981 fishing days (2007) to 479 fishing days in 2014. 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.

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 were no reported listed species interactions for the fishery in 2014.

The performance measures for the fishery relate to the catch of the syngnathids. The MAFMF 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 2014, the catch of syngnathids from all species and areas was 359, well below the target commercial catch range level of 2,000 individuals per year. The catch level of syngnathids has decreased from that reported in 2013 (1,635), 2012 (1,232) and 2011 (1,138). Note, that there is a prohibition on the take of leafy seadragons (Phycodurus eques) in the MAFMF.

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 (2015/16)

The MAFMF 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 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 MAFMF 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.

The MAFMF is scheduled to undergo MSC pre-assessment in 2015.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Fish Managed Fishery and associated endorsements in 2014 (Note: the catch of hermit crabs is now reported in the Hermit Crab Fishery Status Report).

Common Name	Quantity (numbers)	Weight (kg)	Volume (litres)
Fish	20,052		
Syngnathidae (not included in Fish)	359		
Invertebrates (not including Corals)	41,587		
Hard coral		3,707.55	
Soft coral ¹		5,851	
Living rock		12,313	
Sponges	2,580		
Algae/Seagrasses			345
Live Feed (mainly shrimps/prawns)			21

¹ The soft coral category includes 2,765 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 (number of individuals) of the main fish (excluding Syngnathids) species landed from the Marine Aquarium Fish Managed Fishery for 2014, with catch for the previous six years. Note the species reported in this table vary from year to year.

Species	Common Name	Year					
		2009	2010	2011	2012	2013	2014
<i>Chromis atripectoralis</i>	Black-axil Chromis	50	1,350	1,550	1,010	1,200	2,778
<i>Neopomacentrus cyanomos</i>	Regal Demoiselle	0	0	0	0	0	2,365
<i>Istiblennius meleagris</i>	Spotted Blenny	2,846	1,040	2,081	1,468	1,075	1,669
<i>Chaetodontoplus duboulayi</i>	Scribbled Angelfish	492	1,333	2,275	2,527	1,938	1,333
<i>Chromis</i>	Chromis	2,849	2,650	2,320	400	2,039	1,213
<i>Chelmon marginalis</i>	Margined Coralfish	682	1,266	1,506	1,048	1,429	1,082
Apogonidae/Dinolestidae Undifferentiated	Cardinalfishes	1,766	94	54	0	500	950
<i>Chromis cinerascens</i>	Green Chromis	790	2,998	1,941	2,203	1,052	760
<i>Centropyge jocular</i>	Yellowhead Angelfish	633	554	584	594	494	657
<i>Valenciennesa puellaris</i>	Orange-dashed Goby	26	440	1,559	1,250	562	513
<i>Heterodontus portusjacksoni</i>	Shark, Port Jackson	389	197	664	489	270	487
Chaetodontidae/Pomacanthidae	Angelfishes	14	18	28	0	2	440
<i>Trachinops noarlungae</i>	Yellow-headed Hulafish	420	670	1,525	580	230	380
<i>Istiblennius edentulus</i>	Rippled Blenny	0	0	0	0	0	350
<i>Chromis klunzingeri</i>	Black-headed Puller	220	480	575	421	150	310

MARINE AQUARIUM FISH TABLE 3

Summary of the reported catch (kg) of the main coral species landed from the Marine Aquarium Fish Managed Fishery for 2014, with catch for the previous six years.

Species	Common Name	Year					
		2009	2010	2011	2012	2013	2014
<i>Corallimorphus</i>	Corallimorphus	0	0	45	72.5	1,869	2,318
Zoanthidae Undifferentiated	Zoanthid anemones	2,184	1,606	799	527.5	1,712	1,576
Zoanthidea Undifferentiated	Anemones & Corals	56	105	35	736.6	404	632
<i>Sarcophyton</i>	Toadstool coral	166.2	174.1	203.4	118.8	314.6	448
Corallimorpharia Undifferentiated	Coral-like anemones	1,899	2,233	2,932	3,725	1,009	418
<i>Lobophyllia</i>	<i>Lobophyllia</i>	4,662.8	430.2	438.5	293.2	555.9	333.5
<i>Euphyllia ancora</i>	Anchor coral	414.8	605.6	599.7	491.8	344.8	330.9
<i>Euphyllia paraancora</i>	Branching hammer coral	0	0	0	29	269	330
<i>Duncanopsammia axifuga</i>	stony coral (Duncan coral)	548	877.4	407.3	456.4	326.5	318.8
<i>Symphyllia</i>	Symphyllia	169.4	289.8	225.6	189.9	74.8	296
Scleractinia Undifferentiated	Hard corals(kg)	16	4	16.4	18.15	222.4	290
<i>Euphyllia glabrescens</i>	Torch coral	149.8	374.1	402	504.6	246.6	277.5
<i>Goniopora</i>	<i>Goniopora</i>	102.5	68.4	156.1	145.1	235.9	225.8
Alcyonacea	Soft coral & Sea fans - undifferentiated	6	0.4	0.6	10.8	243	197
<i>Trachyphyllia geoffroyi</i>	stony coral (Trachyphyllia brain coral)	503.5	640.4	470.9	266.3	230	180.15
<i>Acropora</i>	<i>Acropora</i> (corals)	333.3	193.5	285.6	186.2	98.4	163.6
<i>Plerogyra sinuosa</i>	stony coral (green bubble)	0	22	380	30	60	155
<i>Catalaphyllia jardinei</i>	Elegant coral	11	23.15	16	265.2	0	129.5
<i>Zoanthus</i>	<i>Zoanthus</i> (colony polyps)	744	669	558	513	395	109
<i>Echinophyllia</i>	<i>Echinophyllia</i> (chalice corals)	511	293	222.4	197.3	109.3	90.9
<i>Acanthastrea</i>	<i>Acanthastrea</i> (large polyp stony corals)	100.3	72.4	102.2	129.5	174.5	90.7
<i>Cynarina</i>	<i>Cynarina</i>	10.4	83.85	118.6	34.9	7	58.8
<i>Euphyllia</i>	<i>Euphyllia</i>	31	46.2	150	0	10	54
<i>Favia</i>	<i>Favia</i> coral (brain coral)	481	267.1	243.8	140.6	136.4	44
<i>Turbinaria</i>	<i>Turbinaria</i> (cup corals)	165.3	271.3	169	94.2	149.1	41

Specimen Shell Managed Fishery Status Report

A. Hart, K. Crowe

Main Features

Status		Current Landings
Stock level	Adequate	Specimen Shell Catch Total
Fishing level	Acceptable	Shell numbers 37,371 shells

Fishery Description

The Specimen Shell Managed Fishery (SSMF) 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 2014, 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 licence at any one time and specimens may only be collected by hand.

There are a number of closed areas where the SSMF 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 SSMF 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 SSMF 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 2014): 31,371 shells

Recreational catch estimate (season 2014):

Unknown

Commercial Landings

In 2014, the total number of specimen shells collected was 31,371 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. 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 in 2014 was 644 days, a decrease from 745 days in 2013. Over the past 5 years, there was an average of around 800 days fished.

Recreational component:

Not assessed

Shell collecting is a popular recreational pastime, and members of the public are permitted to collect shells for their private collections. The recreational catch, while unknown, is considered to be declining, as evidenced by declining membership in shell collecting associations.

Stock Assessment

Assessment complete:

Yes

Breeding stock levels:

Adequate

During the 2014 season the catch rate was approximately 49 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 47 % of the shells sighted were not harvested in 2014. 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. 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 2014 season has seen 11 licensees report the smaller spatial resolution grid blocks rather than reporting the 60 x 60 nm 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 2014, the catch level of approximately 31,300 shells is above the range set, i.e. 10,000 – 25,000 shells and the catch rate of 49 shells/day was also above 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 2014. 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 2014 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 2014:

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. Catch in 2014 was above the range, due principally to increased activity of one licence holder.

New management initiatives (2015/16)

The Specimen Shell Managed Fishery is currently under review with changes to the management arrangements expected to be introduced in 2016. 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.

Hermit Crab Fishery Report: Statistics Only

S.J. Newman, K. Crowe, C. Bruce, C. Syers and K. Green

Fishery Description

Commercial

The Hermit Crab Fishery (HCF) specifically targets the Australian land hermit crab (*Coenobita variabilis*) for the domestic and international live pet trade. The fishery operates throughout the year and is the only land-based commercial fishery in Western Australia.

Collectors use four-wheel drive vehicles to access remote beaches predominantly in the states north. Collection usually occurs on foot and at night when hermit crabs are most active.

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 a recreational daily bag limit of 10 (for “unlisted” crustaceans).

Boundaries

The HCF is currently permitted to fish Western Australian waters (as defined in Section 5, Part 1 FRMA 1994) north of Exmouth Gulf (22°30'S).

Management arrangements

This fishery is managed primarily through input controls in the form of limited entry to the fishery, nominated operators, species restrictions, gear restrictions and permanent closed areas. Access to the fishery is limited to the 5 Commercial Fishing Licence (CFL) holders (or persons acting on their

behalf) listed in the Instrument of Exemption enabling the take of land hermit crabs (*C. variabilis*) by hand collection only.

The Fishery has been managed by way of an exemption authorisation since 2008. Prior to 2008 the fishery was managed by CFL conditions.

Landings and Effort

Data for assessing the status of the HCF 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 77,675 hermit crabs were landed in 2014. The reported landings of hermit crabs for 2014 were lower than those reported in 2013 (88,443), 2012 (90,364) and in 2010 (105,774) and 2009 (110,250), but were at level similar to that reported in 2011 (75,667; see Hermit Crab Fishery Table 1).

In 2014, 3 of the 5 collectors reported some level of activity in this fishery. Effort in the fishery is variable and does not appear related to catch. A total of 219 effort days were reported in the HCF in 2014. Effort in the fishery is spread over large areas along the Western Australian coastline.

Hermit crabs are collected for a live market, licencees are restricted in terms of the quantities that they can safely handle and transport.

Land hermit crabs inhabit dead mollusc shells which have no attached biota. There is no bycatch associated with this fishery.

There are no reported listed species interactions for this fishery. The HCF is highly selective and land based. It is highly unlikely that this fishery has any interactions with endangered, threatened or protected species (ETPs). The main opportunity for interaction maybe through four-wheel drive vehicles on beaches and whilst walking to collect the crabs, however, if ETPs are sighted they can be easily avoided. The potential for ETP interactions is further limited due to the low fishing effort and restricted areas of collection.

Fishery Governance

Target commercial catch range:

Not Applicable

Current Fishing (or Effort) Level:

Acceptable

The current effort level in the fishery has been relatively constant over the last 4 years and the operating extent of the fishery is low relative to the widespread distribution of the target species. There is limited potential for any impact on the breeding stock. Therefore the current level of fishing activity is considered acceptable.

New management initiatives (2015/16)

The Department of Fisheries is currently reviewing the management of the Western Australian Hermit Crab fishery with a view to transitioning the fishery to Interim Managed Fishery status through the drafting of a (Interim) Fishery Management Plan.

The development of the (Interim) Management Plan will be in accordance with Part 6 of the FRMA 1994. Management arrangements under the management plan will be consistent with, and guided by stock assessment data in accordance with Ecosystem Based Fisheries Management requirements, Commonwealth Wildlife Trade Operation export accreditation requirements, Ecological Risk Assessment outcomes, and minimum effective regulation principles.

There is currently no Wildlife Trade Operation (WTO) approval for the whole fishery under the provisions of the EPBC Act (Department of the Environment (DotE)). However, one operator has received WTO approval to export land hermit crabs. This WTO is in force until November 2015 and is subject to conditions. The primary condition is the export limitation of *C. variabilis* under the EPBC Act is not to exceed 10,000 specimens per year.

External factors

Terrestrial hermit crabs such as *C. variabilis* have large gill chambers which are kept moist acting as a type of lung. This facilitates their terrestrial life stage, however females must move to the ocean to release eggs which hatch as planktonic larvae. Larvae settle as small juveniles, find a tiny shell and move onshore.

In order for *C. variabilis* individuals to grow, they must exchange their shell for a larger sized one. There is frequently strong competition for any available shells, with *C. variabilis* individuals fighting over shells as intact gastropod shells are not an unlimited resource. The availability of empty shells is dependent not only on the abundance of *C. variabilis* and the gastropods whose shells they seek, but importantly on the occurrence of predators that prey on gastropods yet leave the shells intact.

C. variabilis is endemic to northern Australia including northern Western Australia, the Northern Territory and northern Queensland. Given the warming climate of Australia and the moving of moist air southwards, the distribution of this species may extend further south in future years.

HERMIT CRAB FISHERY TABLE 1

Summary of the reported catch of Hermit Crabs landed from the Hermit Crab Fishery for 2014, with catch for the previous six years.

Common Name	Year					
	2009	2010	2011	2012	2013	2014
Land Hermit Crabs	110250	105774	75667	90364	88443	77675

APPENDICES

APPENDIX 1

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APPENDIX 2

Table of catches from fishers' statutory monthly returns for 2013/14

This table contains the landed¹ and estimated live weight² of species recorded in the compulsory catch and fishing effort returns provided by commercial fishers each month. These data include the catch taken as by-product as well as the targeted catch.

These catch data may differ slightly from some of the catch estimates presented for specific fisheries as the latter may include additional data from other sources, such as research log books and processors. The figures may also differ slightly from previously reported figures, as additional data may have been received by the Department of Fisheries. The table represents the latest year for which a complete set of data is available.

While scientific names have been included wherever possible, it should be noted that many fish recorded under a common name cannot be identified as belonging to a particular single species and therefore must be reported as being part of a commercial grouping of several species. For example, the common name '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.

Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH			
Carcharhinidae			
Bronze Whaler	<i>Carcharhinus brachyurus</i>	29	45
Dusky Whaler	<i>Carcharhinus obscurus</i>	88	140
Sandbar Shark	<i>Carcharhinus plumbeus</i>	29	46
Spinner Shark	<i>Carcharhinus brevipinna</i>	22	35
Tiger Shark	<i>Galeocerdo cuvier</i>	3	5
Lamnidae			
Shortfin Mako	<i>Isurus oxyrinchus</i>	2	3
Orectolobidae			
Wobbegong Sharks	Orectolobidae	18	28
Pristiophoridae			
Common Sawshark	<i>Pristiophorus cirratus</i>	4	8
Rajidae			
Skates	Rajidae	5	13
Sphyrnidae			
Hammerhead Sharks	Sphyrnidae	36	57
Triakidae			
Gummy Shark	<i>Mustelus antarcticus</i>	286	455
Pencil Shark	<i>Hypogaleus hyugaensis</i>	1	2
Whiskery Shark	<i>Furgaleus macki</i>	106	159
Shovelnose/Fiddler Rays	Rhinobatidae & Rhynchobatidae	0	1
Shark, Other		9	19
Ariidae			
Catfishes	Ariidae	11	11
Berycidae			
Bight Redfish	<i>Centroberyx gerrardi</i>	31	32
Redfish	<i>Centroberyx</i> spp.	7	7
Yelloweye Redfish	<i>Centroberyx australis</i>	2	2

Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)			
Clupeidae			
Australian Sardine (Pilchard)	<i>Sardinops sagax</i>	1516	1516
Maray	<i>Etrumeus teres</i>	2	2
Perth Herring	<i>Nematalosa vlaminghi</i>	1	1
Sandy Sprat (Whitebait)	<i>Hyperlophus vittatus</i>	12	12
Hemiramphidae			
Southern Garfish	<i>Hyporhamphus melanochir</i>	18	18
Platycephalidae			
Flatheads	Platycephalidae	8	8
Plotosidae			
Estuary Cobbler	<i>Cnidoglanis macrocephalus</i>	51	71
Latidae			
Barramundi	<i>Lates calcarifer</i>	35	57
Polyprionidae			
Bass Groper	<i>Polyprion americanus</i>	1	1
Hapuku	<i>Polyprion oxygeneios</i>	8	8
Epinephelidae			
Barcheek Coral Trout	<i>Plectropomus maculatus</i>	12	12
Birdwire Rockcod	<i>Epinephelus merra</i>	2	2
Blackspotted Rockcod	<i>Epinephelus malabaricus</i>	25	25
Breaksea Cod	<i>Epinephelides armatus</i>	5	5
Chinaman Rockcod	<i>Epinephelus rivulatus</i>	2	2
Common Coral Trout	<i>Plectropomus leopardus</i>	2	2
Duskytail Grouper	<i>Epinephelus bleekeri</i>	4	4
Eightbar Grouper	<i>Hyporthodus octofasciatus</i>	13	13
Flowery Rockcod	<i>Epinephelus fuscoguttatus</i>	43	43
Goldspotted Rockcod	<i>Epinephelus coioides</i>	33	33
Rankin Cod	<i>Epinephelus multinotatus</i>	108	108
Tomato Rockcod	<i>Cephalopholis sonnerati</i>	1	1
Cods	<i>Epinephelus/Cephalopholis</i>	57	57
Glaucosomatidae			
Northern Pearl Perch	<i>Glaucosoma buergeri</i>	20	20
West Australian Dhufish	<i>Glaucosoma hebraicum</i>	66	67
Priacanthidae			
Bigeyes	Priacanthidae	20	20
Terapontidae			
Trumpeters	Terapontidae	3	3
Yellowtail Grunter	<i>Amniataba caudavittata</i>	1	1
Sillaginidae			
King George Whiting	<i>Sillaginodes punctatus</i>	14	14
Whittings	Sillaginidae	92	92
Yellowfin Whiting	<i>Sillago schomburgkii</i>	65	65
Pomatomidae			
Tailor	<i>Pomatomus saltatrix</i>	24	24

Common Name		Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)				
Rachycentridae				
	Cobia	<i>Rachycentron canadum</i>	13	13
Carangidae				
	Amberjack	<i>Seriola dumerili</i>	14	14
	Black Pomfret	<i>Parastromateus niger</i>	2	2
	Golden Trevally	<i>Gnathanodon speciosus</i>	3	3
	Queenfish	<i>Scomberoides commersonnianus</i>	0	2
	Samson Fish	<i>Seriola hippos</i>	35	37
	Silver Trevally	<i>Pseudocaranx</i> spp.	5	5
	Trevallies	Carangidae	130	130
	Yellowtail Kingfish	<i>Seriola lalandi</i>	2	2
	Yellowtail Scad	<i>Trachurus novaezelandiae</i>	16	16
Arripidae				
	Australian Herring	<i>Arripis georgianus</i>	154	154
	Western Australian Salmon	<i>Arripis truttaceus</i>	327	328
Lutjanidae				
	Brownstripe Snapper	<i>Lutjanus vitta</i>	64	64
	Chinaman Fish	<i>Symphorus nematophorus</i>	9	9
	Crimson Snapper	<i>Lutjanus erythropterus</i>	259	259
	Darktail Snapper	<i>Lutjanus lemniscatus</i>	14	14
	Flagfish/Spanish Flag	<i>Lutjanus vitta/quinquelineatus/carponotatus/lutjan</i>	26	26
	Goldband Snapper	<i>Pristipomoides multidens</i>	648	648
	Mangrove Jack	<i>Lutjanus argentimaculatus</i>	11	11
	Moses Snapper	<i>Lutjanus russelli</i>	34	34
	Red Emperor	<i>Lutjanus sebae</i>	232	232
	Rosy Snapper	<i>Pristipomoides filamentosus</i>	7	7
	Ruby Snapper	<i>Etelis carbunculus</i>	16	16
	Saddletail Snapper	<i>Lutjanus malabaricus</i>	167	167
	Sharptooth Snapper	<i>Pristipomoides typus</i>	1	1
	Stripey Snapper	<i>Lutjanus carponotatus</i>	1	1
	Tropical Snappers	Lutjanidae	8	8
Nemipteridae				
	Monocle Bream	<i>Scolopsis</i> spp.	5	5
	Threadfin Breams	Nemipteridae	75	75
Lobotidae				
	Tripletail	<i>Lobotes surinamensis</i>	1	1
Haemulidae				
	Javelin Fish	<i>Pomadasys</i> spp.	44	44
	Painted Sweetlips	<i>Diagramma labiosum</i>	12	12
	Sweetlips	Haemulidae	43	43
Lethrinidae				
	Bluespotted Emperor	<i>Lethrinus punctulatus</i>	201	201
	Drab Emperor	<i>Lethrinus ravus</i>	4	4
	Emperors	Lethrinidae	1	1

Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)			
Grass Emperor	<i>Lethrinus laticaudis</i>	5	5
Longnose Emperor	<i>Lethrinus olivaceus</i>	15	15
Mozambique Seabream	<i>Wattsia mossambica</i>	8	8
Redspot Emperor	<i>Lethrinus lentjan</i>	20	20
Redthroat Emperor	<i>Lethrinus miniatus</i>	55	55
Robinson's Seabream	<i>Gymnocranius grandoculis</i>	21	21
Spangled Emperor	<i>Lethrinus nebulosus</i>	60	60
Sparidae			
Black Bream	<i>Acanthopagrus butcheri</i>	38	38
Frypan Bream	<i>Argyrops spinifer</i>	31	31
Snapper (Pink Snapper)	<i>Chrysophrys auratus</i>	484	487
Tarwhine	<i>Rhabdosargus sarba</i>	4	4
Western Yellowfin Bream	<i>Acanthopagrus morrisoni</i>	18	18
Sciaenidae			
Black Jewfish	<i>Protonibea diacanthus</i>	2	3
Mulloway	<i>Argyrosomus japonicus</i>	17	18
Mullidae			
Red Mullet	Mullidae	15	15
Clupeidae			
Scaly Mackerel	<i>Sardinella lemuru</i>	974	974
Kyphosidae			
Sea Sweep	<i>Scorpiis aequipinnis</i>	1	1
Pentacerotidae			
Boarfish	Pentacerotidae	6	6
Oplegnathidae			
Knifejaw	<i>Oplegnathus woodwardi</i>	1	1
Cheilodactylidae			
Blue Morwong	<i>Nemadactylus valenciennesi</i>	37	41
Mugilidae			
Mullets	Mugilidae	2	2
Sea Mullet	<i>Mugil cephalus</i>	198	198
Yellow-Eye Mullet	<i>Aldrichetta forsteri</i>	22	22
Sphyraenidae			
Pikes	Sphyraenidae	3	3
Snook	<i>Sphyraena novaehollandiae</i>	2	2
Polynemidae			
King Threadfin	<i>Polydactulus macrochir</i>	31	42
Threadfin	Polynemidae	2	2
Labridae			
Baldchin Groper	<i>Choerodon rubescens</i>	12	12
Blue Groper	<i>Achoerodus gouldii</i>	33	40
Bluespotted Tuskfish	<i>Choerodon cauteroma</i>	3	3
Parrotfishes	Scarinae	2	2
Pigfish	<i>Bodianus</i> spp.	1	1

Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (Continued)			
Tuskfishes	<i>Choerodon spp.</i>	2	2
Wrasses	Labrinae	1	1
Scombridae			
Bonito	<i>Sarda australis</i>	14	14
Grey Mackerel	<i>Scomberomorus semifasciatus</i>	5	5
Mackerel, Other	Scombridae	0	0
Spanish Mackerel (Narrow-barred)	<i>Scomberomorus commerson</i>	213	294
Tuna, Other	Scombridae	1	1
Centrolophidae			
Blue-Eye Trevalla	<i>Hyperoglyphe antarctica</i>	1	1
Bothidae			
Flounder	Bothidae	2	3
Monacanthidae			
Leather Jacket	Monacanthidae	12	22
Fish, other			
		131	153
TOTAL FISH		8043	8612
CRABS			
Crystal Crab	<i>Chaceon albus</i>	152	152
Champagne Crab	<i>Hypothalassia acerba</i>	1	1
Giant Crab	<i>Pseudocarcinus gigas</i>	10	10
Blue swimmer Crab	<i>Portunus armatus</i>	549	549
Mud Crab	<i>Scylla spp.</i>	10	10
TOTAL CRABS		723	723
PRAWNS			
Banana Prawn	<i>Penaeus merguensis</i>	425	425
Brown Tiger Prawn	<i>Penaeus esculentus</i>	724	724
Coral Prawn	<i>Metapenaeopsis spp.</i>	141	141
Endeavour Prawn	<i>Metapenaeus endeavouri</i>	110	110
Western King Prawn	<i>Penaeus latisulcatus</i>	1538	1538
Prawns, Other	Penaeidae	1	1
TOTAL PRAWNS		2939	2939
LOBSTERS			
Southern Rock Lobster	<i>Jasus edwardsii</i>	46	46
Western Rock Lobster	<i>Panulirus cygnus</i>	5811	5811
Bugs/ Slipper lobster	Scyllaridae	7	7
TOTAL LOBSTERS		5863	5863
MOLLUSCS			
Squid	<i>Sepioteuthis spp./Loligo spp.</i>	40	40
Octopus	<i>Octopus (cf.) tetricus</i>	161	209

Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
MOLLUSCS (Continued)			
Cuttlefish	Sepiidae	35	35
Saucer scallop	<i>Amusium balloti</i>	56	280
Brownlip Abalone	<i>Haliotis conicopora</i>	11	28
Greenlip Abalone	<i>Haliotis laevigata</i>	54	145
Roe's Abalone	<i>Haliotis roei</i>	66	66
Molluscs, Other		0	0
TOTAL MOLLUSCS		424	803
OTHER INVERTEBRATES		19	56
GRAND TOTAL		18010	18995

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 2013/14

Highlights for 2013/14

There were 453 licensed aquaculture producers

The farm gate value of aquaculture production in WA (excluding marine algae and pearl oysters) was just under \$14.68 million

The most valuable industry sector was barramundi (\$7.8 million), followed by marron (\$1.41 million), mussels (\$0.79 million) and yabbies (\$0.30 million)

The industry sector with the most participants was marron with 184 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 2013/14. 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 2015.

Note that all production reported in tonnes throughout this document refers to whole weight and the farm gate value refers to the value of product at the first point of recorded sale.

The Industry in 2013/14

A total of 453 aquaculture licence holders were required to submit quarterly returns for one or more quarters in the 2013/14 financial year. Of the 453 licences, 218 i.e. 48 per cent recorded production on their returns. Marron had the

largest number of producers with 184 licences recording production (Table 1).

Estimated aquaculture production decreased from 1663 tonnes produced in 2012/13 to 1015 tonnes in 2013/14 (excludes algae, pearl oysters, and ornamental species) (Table 2).

The estimated value of Western Australian aquaculture (excluding algae and pearl oysters) decreased from \$16.85 million to \$14.68 million in 2013/14 (Table 3). Finfish aquaculture made up 55 per cent of the total value for 2013/14.

AQUACULTURE PRODUCTION TABLE 1.

Growth production for the Western Australian aquaculture industry in 2013/14

Common name	Productive licences	Quantity	Units*	Average price (\$)/kg or individual	Value (\$)
Barramundi	5	699	tonnes	11.18	7,814,198
Marron	184	47	tonnes	29.62	140,551
Mussels	5	188	tonnes	4.19	785,364
Yabbies	7	15	tonnes	20.36	303,572
Silver perch	10	14	tonnes	19.61	280,338
Koi carp	6	52,015	No.	3.40	177,083
Ornamental fish	5	15,388	No.	n/a	67,511
Goldfish		25,902	No.	1.83	47,287
Rainbow trout	7	3	tonnes	11.66	31,642
Ornamental crustaceans	5	4,736	No.	n/a	26,759
Other species with <5 producers**	<5			n/a	3,736,299
Algae	<5	**			**
Total (not including algae or pearls)					14,675,554

* 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 2007/08-2013/14

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Barramundi	tonnes	365.9	455.2	433	862.5	1 127.0	1 190.0	699
Mussels	tonnes	481.2	433.5	506.5	364.9	349.8	242.6	188
Marron	tonnes	51.1	52.8	53.9	51.1	51.3	51.9	47
Yabbies	tonnes	60.8	44.1	46.7	19.7	18.8	19.4	15
Silver perch	tonnes	16.9	28.5	27.2	18	14.1	12.9	14
Rainbow trout	tonnes	13.3	11.7	7.5	11	4.2	4.3	3
Ornamental fish & crustaceans	No.	55 047	50 598	46 425	21 167	26 538	22 796	20124
Koi carp	No.	35 620	34 270	44 787	39 944	41 366	50 210	52015
Goldfish	No.	33 918	36 199	15 785	11 448	8 624	12 975	25902
Other species with < 5 producers	tonnes	97.2	94.9	94.2	75	97.4	43.6	48.3

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Barramundi	3 870 071	4 793 106	4 512 123	8 391 579	11 143 391	12 510 851	7 814 198
Marron	1 298 672	1 434 494	1 445 252	1 418 951	1 471 608	1 508 755	1 405 501
Mussels	1 531 849	1 618 594	1 870 531	1 357 009	1 367 470	1 017 041	785 364
Yabbies	1 059 532	810 608	760 595	389 920	376 830	415 581	303 572
Silver perch	245 157	405 506	435 624	310 977	254 883	254 561	280 338
Koi carp	160 597	168 279	184 708	173 928	148 751	185 094	177 083
Rainbow trout	135 007	140 422	101 681	133 257	61 012	63 956	31 642
Ornamental fish & crustaceans	237 408	276 986	230 856	108 023	68 468	76 972	94 270
Goldfish	80 732	73 992	52 139	32 771	25 759	36 793	47 287
Other	1 554 289	1 715 130	1 018 211	1 024 396	1 337 601	775 734	3 736 299
Total (not including algae & pearls)	10 173 312	11 437 116	10 611 720	13 304 811	16 255 773	16 845 338	14 675 554

APPENDIX 3

Research Division - Other Activities

Activities of the Pemberton Freshwater Research Centre and the Aquaculture & Native Fish Breeding Laboratory 2014/15

C. Lawrence and T. Church

The Department of Fisheries Pemberton Freshwater Research Centre (PFRC) is the largest freshwater hatchery and research facility in Western Australia. Located on the Lefroy Brook in Pemberton it consists of two neighbouring sites, the original PFRC hatchery and the Dr Noel Morrissey 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 Morrissey Research Ponds on Thomson's Flat feature 25 earthen ponds, ranging in size from 150m² breeding ponds to 1000m² commercial growout-scale ponds, 28 tanks and a post-harvest handling facility. This site also includes an area that is leased to Forest Fresh Marron for processing and marketing the product from over 60 local marron growers.

PFRC staff are responsible for the maintenance and production of native fish, crayfish and trout at the facility. They are also responsible for stocking trout into public waters and packing trout and marron for sale to commercial farmers. Efficient management and operation of a large production and research facility for fish and crayfish such as PFRC requires a high level of expertise. As a result PFRC staff provide a key regional extension service to aquaculture, recreational fishing and biodiversity client groups. In 2010/11 as part of the NRM funded hatchery infrastructure modifications a front office has been allocated for public enquiries, community education material and the recommencement of tours of the facility by the public. The community education material on the Department's activities in the region will be developed when resources permit. Once complete it will enable the PFRC hatchery to recommence public education tours.

PFRC provides facilities, expertise and stock to support research and industry development in the four key areas of i) conserving and recovering biodiversity, ii) recreational fishing, iii) aquaculture and iv) freshwater fisheries.

The Aquaculture and Native Fish Breeding Laboratory is located at the UWA Field Station, Shenton Park. It is the result of a long term collaborative research partnership between UWA and Department of Fisheries. For the past 20 years this partnership has successfully addressed strategic state government aquatic research priorities and trained postgraduate students. The laboratory is the largest recirculating freshwater aquaculture research facility in Australia, consisting of over 2 million litres including; 30 x 20,000 L tanks, 9 x 5,000 L tanks, 10 x 2,000 L tanks, 24 x 150 L tanks, 8 x 500 L tanks, 2 x 1000 L broodstock conditioning tanks, hatchery troughs, 3 x 220,000 L artificial lakes, 12 x 1000 L aquaponics tanks, 100 x 100 L aquariums and a 12 x 310 L quarantine facility. It is the only hatchery producing disease free genotyped native and endangered fish species in the state. At this facility both UWA and Department of Fisheries staff and post-graduate students

undertake advanced and technically challenging leading edge research into aquatic biology and aquaculture across a broad field including reproduction, larval rearing, nutrition, strain selection, translocation, experimental design, conservation biology, production systems, husbandry, selective breeding, biological control and species variation.

Key PFRC and Aquaculture and Native Fish Breeding Laboratory projects in 2014/15 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 2014/15 the PFRC produced 666,500 fry. These consisted of 664,000 rainbow trout fry and 2,500 brown trout fry, representing an decrease in production of 4% and a decrease of 82% respectively, compared with 2013/14. The majority of production (71%) consisting of 471,000 rainbow trout fry and 1,500 brown trout yearlings (fry held over summer) was stocked into public waterways to support recreational fishing. A further 158,000 rainbow trout (24%) 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 17% decrease in sales from PFRC in 2014/15 to 158,000 down from 190,000 in 2013/14.

76,000 sterile triploid rainbow trout were produced at PFRC in 2014/15 of which 45,000 were released to a public waterway with the balance supplied to licensed aquaculture producers and fishing associations. The remaining 35,000 diploid trout produced (5%) were retained for future brood stock for PFRC, yearling stocking, and research.

In the winter-spring months of 2014 and May-June 2015 16,250 (27,600 in 2013/14) rainbow yearlings and 2,600 brown yearlings as well as 2,400 rainbow and 345 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

Rainbow trout brood stock selection

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 confirming the unique thermal tolerance of PFRC trout and was published in 2015.

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, UWA 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. Prior to the 2015 spawning season the stock were then relocated from Shenton Park back to PFRC to enable comparison between the heat challenged and PFRC stocks and to establish a genetic line selected for heat tolerance.

Native and endangered fish conservation and biodiversity research

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 and Native Fish Breeding Laboratory for restocking the Swan Coastal Plain; and a southern genetic line at PFRC.

The aim of this research is to develop large-scale production techniques for native fish species to 1) enable stocking of public and private water bodies, 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).

Broodstock populations of Pygmy perch (*Nannoperca vittata*), Western minnows (*Galaxias occidentalis*), Western trout minnow (*Galaxias truttaceus* - Critically endangered) and Balstons perch (*Nannatherina balstoni* - Vulnerable to extinction) were established at the UWA Aquaculture and Native Fish Breeding Laboratory in Shenton Park. In a world first, intensive hatchery production of Pygmy perch, Western minnow and the critically endangered Western trout minnow were achieved at the Aquaculture and Native Fish Breeding Laboratory in 2014/15. Disease free, genotyped Pygmy perch and Western minnows produced at the Aquaculture and Native Fish Breeding Laboratory were used to restock Lake

Marmion Myaree, after the eradication of feral catfish, in 2015.

Broodstock populations of Pygmy perch (*Nannoperca vittata*), Western minnows (*Galaxias occidentalis*) were established at PFRC and spawned in research ponds at the facility.

Mosquito predation

While it has been widely accepted that native fish consume more mosquito larvae than the introduced mosquito fish (*Gambusia holbrooki*) this has not been previously scientifically verified. In a series of experiments Department of Fisheries' researchers quantified the mosquito larvae consumption of key native fish and *Gambusia holbrooki*. These results show that native fish, particularly *Galaxias*, consume more mosquito larvae than *Gambusia holbrooki*.

For mosquito control, endemic fish species offer potential to supplement larviciding efforts as part of an integrated vector control programme. This research, which has been submitted for peer review and publication, will also determine which species is the most suitable for stocking artificial water bodies in which control of mosquito borne viruses, 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 UWA Aquaculture and Native Fish Breeding Laboratory. This research investigated the relationship between size of trout and rates of consumption. Data is being prepared for publication, however early results suggest that presence of trout in water bodies will have a significant impact on reducing feral *Gambusia* 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 UWA 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.

Summary

In early 2015 the Department was required to reduce expenditure. Consequently in May 2015 the Freshwater section vacated the Aquaculture and Native Fish Breeding Laboratory, Shenton Park. The outcome of this was the cessation of research into i) Control of mosquito born viruses by endemic fish species, ii) Large scale hatchery production of native fish for restocking, iii) Captive breeding of

endangered fish species for conservation, iv) Selection for high temperature tolerance of rainbow trout, v) Feral fish (*Gambusia*) control methods. It also required the cessation of maintaining a repository of i) The valuable PFRC trout line to reduce the risk of loss of trout with the highest known temperature tolerance of any stock worldwide, ii) Captive populations of endangered native fish species to reduce their risk of extinction, which due to their limited distribution could occur from a single bushfire or waterway pollution event

Core activities for recreational and aquaculture stakeholders, including trout production and monitoring of recreational marron fishery, will continue to be delivered from PFRC.

Activities of the Fish Health Unit during 2014/15

The Fish Health Laboratory 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 research scientist, one full time and one part-time fish pathologist, one senior research scientist, one laboratory manager, and two part-time technical officers.

The laboratory is accredited to ISO 17025 and provides a diagnostic service and advice to the seafood industries in Western Australia, undertakes disease surveillance for key fisheries, investigates 'fish kills', contributes to policy advice developed by the Department, and carries out research on diseases of aquatic organisms. In addition, protocols for high health hatchery status have been developed and adopted by key industries. Key activities and achievements of the unit during 2014/15 were as follows:

The Fish Health Laboratory received a total of 133 diagnostic cases during 2014/15.

The provision of pearling translocation certificates increased from 6 to 9 in this reporting period. Two hatcheries are currently operating in the state: Cygnet Bay Pearls and Clipper Pearls. Paspaley has relocated its pearl oyster hatchery to Darwin.

There were 9 cases of notifiable diseases reported in 2014/15. All notifications related to records of Megalocytivirus in ornamental fish in quarantine facilities at the border following importation from overseas.

In January and February 2015, the Fish Health Laboratory investigated the presence of cysts in the flesh of marron obtained from Grimwade dam (Manjimup shire) and found that the marron were infected by a trematode parasite belonging to the *Choanocotyle* genus. This parasite has since been reported in various locations within the south-west. The laboratory will continue to investigate the life cycle of this worm which likely represents a native species and does not pose a risk to human health

The Fish Health Laboratory has provided support to the invertebrate team of the Research division during the period

2014/15 through the investigation of diseases/ parasites in wild-caught scallop and crab populations sampled at different locations within the state.

The Fish health Laboratory has provided health certification for restocking projects for several species: brown and rainbow trout released in the south west, Roe's abalone released in the mid-west, Western School Prawns released in the Swan and Canning Rivers and barramundi released in the north of the state.

In collaboration with the staff from the Department of Water, 2 reports of 'fish kills' throughout the State were investigated. These '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. Fish kill training was provided by members of the Fish Health Laboratory for personnel who may need to respond to fish kill incidents. In 2014/15, the training occurred within the metropolitan area and in several regional centres. The laboratory is developing a new fish kill training program, including an online training element that will be hosted by the Department of Agriculture and planning Perth-based training in the second half of the year.

A project funded by the FRDC (2013/002) aimed at investigating the cause of diseases in pearl oysters (*Pinctada maxima*) was progressed. The project is in collaboration with Macquarie University and the Pearling industry and exploits 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 2 year FRDC project 2014/002 to develop control material for molecular tests for detection of important endemic and exotic pathogens has progressed. This project is in collaboration with the national reference laboratory for animal diseases: CSIRO Australian Animal Laboratory.

The Fish Health Laboratory is also involved in the FRDC project 2014/001 that aims to develop strategic approaches to identifying pathogens of quarantine concern associated with

the importation of ornamental fish. This project started in 2014/15.

A range of national committees including: the national SCAAH (Subcommittee for Aquatic Animal Health); the AqCCEAD (aquatic Consultative Committee on Emergency Animal Disease); 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 Fish Health Laboratory has also engaged in the national program of proficiency testing through the LEADDR

(Laboratories for Emergency Animal Disease Diagnosis and Response) and ANQAP (Australian National Quality Assurance Program) programs. These programs allow laboratories to verify that they provide a reliable diagnostic service and allow the comparison of results between participating Australian laboratories.

The laboratory continued its role as one of the 7 regional resource centres for aquatic animal health within the Network of Aquaculture Centres (NACA) in the Asia-Pacific.

Indian Ocean Territories Fishery Status Report

S.J. Newman, L. Bellchambers, C. Skepper, S. Evans and P. Dobson

Main Features

Status		Current Landings	
Stock level	Some species at risk	Total	Not assessed
Fishing Level	Not Assessed	Main Commercial Fishery	Not reported

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 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 jocularis*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*).

Recreational

Large amounts of recreational fishing are undertaken around the Cocos (Keeling) and Christmas Islands targeting both finfish and invertebrate species. The Cocos (Keeling) Islands consist of a diverse range of fishable environments that include a sheltered lagoon, fringing reefs and offshore 'blue water'. These environments support a range of demersal and pelagic finfish species, as well as various crustaceans (e.g. lobsters, crabs) and molluscs (e.g. gong gong, clams) that are highly sought after by fishers for both individual and community purposes. Christmas Island, on the other hand, has a limited environments available for fishing with no lagoon present, fringing reef surrounding the island and offshore 'blue water' are the only environments and support primarily pelagic fish species and a limited range of demersal finfish 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 Licences 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 three licences in the fishery, of which two operated during 2014. 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 finfish assemblages at the Indian Ocean Territories. 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). A report is currently in preparation.

Retained Species

Commercial landings (season 2014) Not reported due to confidentiality provisions

Pelagic species dominate the catch of the CILF, comprising 94% of the total reported catch. Wahoo (*Acanthocybium solandri*) is the main target species of the CILF, comprising 80% 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 6% of the total reported catch in 2014. The commercial catch for Christmas Island usually consists of catch data from only two 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 eight years.

There is no commercial line fishery at the Cocos (Keeling) Islands.

The CKIMAFF targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge jocularis*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*). As there is only one licence in the CKIMAFF the catch data is not reportable due to confidentiality provisions.

Recreational catch estimate (season 2014)

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 had been increasing steadily over the previous five years; however in 2014 effort was lower than in previous years. Effort in the fishery is weather dependent and is limited by access to the water through the principal boat ramp at Flying Fish Cove, and to a lesser extent the Ethel Beach boat ramp.

Effort in the CKIMAFF has been similar over the last few years providing a similar level of catch.

Recreational

Effort by recreational anglers at both the Cocos (Keeling) Islands and Christmas Island is weather dependent. At the Cocos (Keeling) Islands the prevailing weather conditions determine what part of the Island complex is subject to fishing activities. Access to the water at Christmas Island is limited to the principal boat ramp at Flying Fish Cove, and to a lesser extent the Ethel Beach boat ramp.

Stock Assessment

Assessment complete: Yes

Assessment method: Risk Assessment

Breeding stock level: Some species at risk

Invertebrates:

Holothurians: In 2006 a large-scale assessment of the holothurian communities inhabiting the lagoon and outer reef at the Cocos (Keeling) Islands was undertaken to determine the status of key holothurian species and enable recommendations to be made regarding the feasibility of a commercial holothurian fishery being developed in the region. Analysis of abundance and distribution data found that the holothurian community is strongly influenced by habitat and although some species are wide-ranging and found in relatively high densities, they tend to be of low economic value. In contrast, species of moderate to high value were recorded at densities too low to support commercial fisheries and typically had very restricted distributions. The holothurian community found at the Cocos (Keeling) Islands is near to pristine, due to a lack of historical fishing pressure. Holothurian stocks are very sensitive to fishing pressure and have been heavily overexploited in other areas of the Indian and Pacific Oceans.

Gong Gong: The common spider conch or gong gong (*Lambis lambis*) is a heavily recreationally-targeted gastropod inhabiting shallow waters of the lagoon. This species is vulnerable to over-fishing as it is highly accessible and presumably shares biological traits with other exploited conch species, including slow growth and late maturity. Monitoring data collected between 2007 and 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 risk assessments undertaken for the marine resources of the Cocos (Keeling) Islands by the Department of Fisheries. To address these concerns, a stock abundance and distribution assessment of giant clams was undertaken in 2011/12. In addition, an on-going reef monitoring program has been established to monitor natural and anthropogenic impacts on the reef and lagoon communities at Cocos (Keeling) Islands.

The implementation and ongoing monitoring of these initiatives will enable the Department of Fisheries to assess the health of the invertebrate stocks and 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 advised that recreational fishers in the waters of the lagoon targeted these species using lines. This species was extremely low in abundance at the Cocos (Keeling) Islands (Hobbs, Choat pers. comm.), suggesting local depletion and/or overexploitation of the stock. However, recent large recruitment events appear to have led to a stock recovery for this species.

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 jocular* and to a lesser extent *Centropyge flavissima*. *Centropyge jocular* is endemic to the Cocos and Christmas Islands and inhabits fringing reefs from 15 to 70 m.

¹ Lincoln-Smith, M.P., Skilleter, G.A., Underwood, A.J., Stark, J., Smith, A.K., Hawes, P.M.H., Howitt, L., White, G.A. and Chapman, M.G. 1995. Cocos (Keeling) Islands: Quantitative baseline surveys for core marine reserves and biosphere reserve in the South Keeling lagoon (prepared for Australian Nature Conservation Agency Project 153). The Institute of Marine Ecology, University of Sydney and The Ecology Lab Pty. Ltd., Sydney, Australia.

Little is known about the biology of *C. jocularis* although Allen *et al.* (2007)¹ describe this species as being abundant on Christmas Island.

Non-Retained Species

Bycatch species impact: Negligible

Fishing in the CILF for pelagic species such as wahoo uses specialised trolling gear to target the fish and involves limited discarding. Species occasionally caught and sometimes retained but generally discarded include billfish, barracuda, shark 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 three people were employed in the CILF around Christmas Island during 2014. This estimate is based on the number of vessels reporting catches and the average number of crew on each boat.

At least two people were employed in the CKIMAFF around Cocos (Keeling) Islands during 2014.

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 2014:

Not assessed

The value of the CILF is not known. The value of the CKIMAFF is also unknown, although *C. jocularis* commands a high price on the international market (reported in excess of AU\$700.00 each).

Fishery Governance

Commercial

Target commercial catch range: Not available

Current Fishing (or Effort) Level: Not assessed

The potential recreational fishing effort for both pelagic and demersal fish species at both the Cocos (Keeling) Islands and at Christmas Island is high with a capacity to operate over the entire extent of the fishable area at each island group. Given the restricted amount of habitat and fishing area available it is expected that fishing pressure on some species at Cocos (Keeling) Islands or Christmas Island is above sustainable levels.

The catch of the CKIMAFF has been small since its inception in 1993. There is little incentive for the single licensee to increase catch or effort since market viability and high prices are maintained by only having small numbers of fish available for sale.

New management initiatives (2015)

A new, multiple year Service Delivery Arrangement with the Commonwealth is being negotiated and is expected to commence on 1 July 2015.

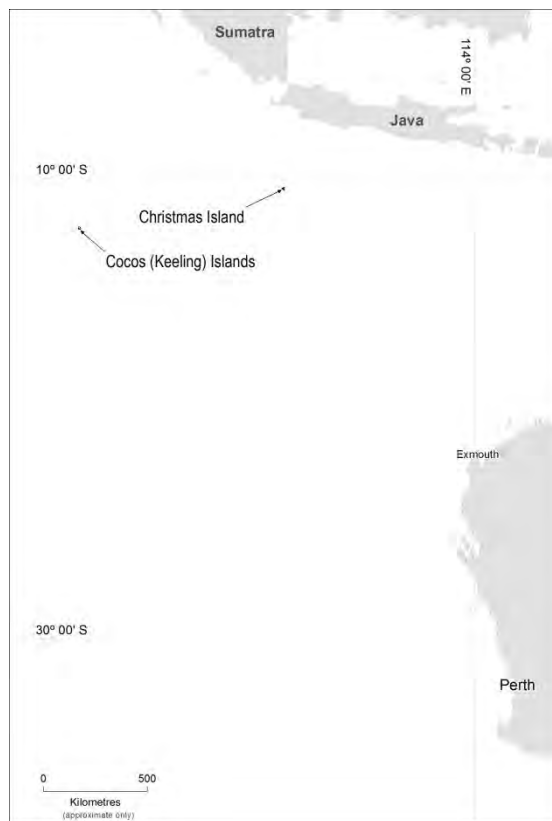
Subject to a new Service Delivery Arrangement being entered into, the island-specific recreational fisheries management arrangements for the Indian Ocean Territories will be progressed to legislation.

The effective implementation of any future recreational fisheries management legislation at the Indian Ocean Territories will require ongoing research, community education and compliance programs.

¹ Allen, G.R., Steene, R.C. and Orchard, M. 2007. Fishes of Christmas Island (Second Edition). Christmas Island Natural History Association, Christmas Island, Indian Ocean, Australia. 284 pp.

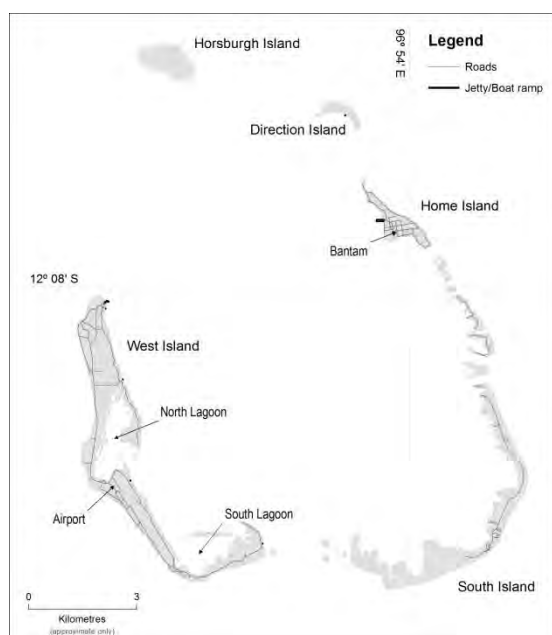
External Factors

The demersal fish and invertebrate populations of Cocos (Keeling) Islands and Christmas Island are likely to consist of small, isolated populations that are expected to experience highly variable recruitment due to environmental fluctuations.



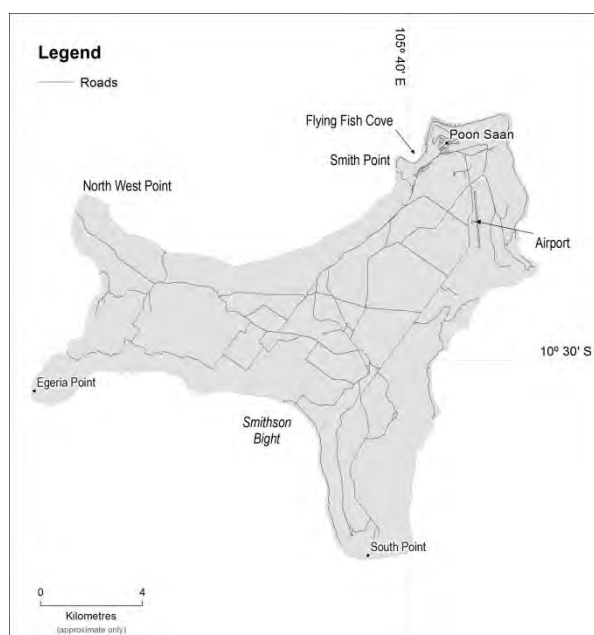
INDIAN OCEAN TERRITORIES FIGURE 1

Location of the Cocos (Keeling) Islands and Christmas Island comprising the Indian Ocean Territories within the Indian Ocean and illustrating their proximity to the Western Australian coast.



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 2014 the FAL processed and aged 15,543 fish (Finfish Ageing Laboratory Table 1). This was about 14% fewer than

2013, due to a temporary reduction in staff. The priority species were from the Inshore Demersal Suite of the West Coast Bioregion, representing approximately 52% of fish aged. This group has steadily come to dominate the output of the FAL since reporting commenced in 2010, constituting 25%, 25%, 35%, 42% and 52% of output in 2010, 2011, 2012, 2013 and 2014 respectively, a reflection of the priorities of the of the Finfish Research Branch. While this proportion is expected to decline in 2015, the West Coast Demersal Suite is set to remain a high priority in the future.

Demersal species from the South Coast Bioregion were also a high priority, supporting an age-based stock assessment project. State-wide, demersal species again dominated, representing 89% of the total FAL output.

A guide to methods for ageing key finfish species from the West Coast and South Coast Bioregions is currently being drafted by the Department of Fisheries. Chapters on Australian herring and blue morwong have been completed, forming a template for chapters on other species in various stages of completion. A northern guide will follow (for species in the North Coast and Gascoyne Coast Bioregions).

FINFISH AGEING LABORATORY TABLE 1.

The number of fish processed and aged by the Finfish Ageing Laboratory in 2014, by Bioregion, species, ecological suite and whether it is an indicator species for that suite.

West Coast Bioregion	Number processed	Ecological suite	Indicator species
<i>Australian herring</i> <i>Arripis georgianus</i>	918	Nearshore	Yes
<i>West Australian Dhufish</i> <i>Glaucosoma hebraicum</i>	2,118	Inshore demersal	Yes
<i>Pink Snapper</i> <i>Pagrus auratus</i>	2,124	Inshore demersal	Yes
<i>Baldchin Grouper</i> <i>Choerodon rubescens</i>	1,089	Inshore demersal	Yes
<i>Redthroat emperor</i> <i>Lethrinus miniatus</i>	1,515	Inshore demersal	Yes
<i>Bight Redfish</i> <i>Centroberyx gerrardi</i>	1,201	Inshore demersal	Yes
Total	8,965		
Gascoyne Bioregion	Number processed	Ecological suite	Indicator species
<i>Pink snapper</i> <i>Chrysophrys auratus</i>	173	Inshore demersal	Yes
<i>Yellowfin whiting</i> <i>Sillago schomburgkii</i>	728	Nearshore	Yes
Total	901		

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

North Coast Bioregion	Number processed	Ecological suite	Indicator species
<i>Rankin cod Epinephelus multinotatus</i>	14	Inshore demersal	Yes
<i>Goldband jobfish Pristipomoides multidens</i>	32	Inshore demersal	Yes
<i>Red bass Lutjanus bohar</i>	122	Inshore demersal	No
Total	168		
South Coast Bioregion	Number processed	Ecological suite	Indicator species
<i>Pink Snapper Pagrus auratus</i>	781	Inshore demersal	Yes
<i>Bight Redfish Centroberyx gerrardi</i>	2,309	Inshore demersal	Yes
<i>Blue morwong Nemadactylus valenciennesi</i>	1,843	Inshore demersal	Yes
Total	4,933		
Statewide	Number processed	Ecological suite	Indicator species
<i>Hapuku Polyprion oxygenios</i>	25	Offshore demersal	Yes
<i>Blue Eye Trevalla Hyperoglyphe antarctica</i>	36	Offshore demersal	Yes
<i>Ruby snapper Etelis carbunculus</i>	515	Offshore demersal	Yes
Total	576		
GRAND TOTAL	15,543		

Activities of the Marine Biosecurity Research Group during 2014/15

Marine Unit

The Marine Biosecurity Research Group currently monitors high risk sites 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, certain species 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 and between Australian jurisdictions, 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 ocean going vessels that transport these goods represent one of the largest vectors of introduced species. In 2014 alone there were over 28 000 visits to Western Australian ports from commercial ships. For these reasons of propagule pressure alone our ports and marinas are regarded as high risk areas for the potential introduction of a marine pest. The Commonwealth Government, together with the states and territory has 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 Group are 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 at HMAS Stirling (Garden Island, Defence Services Group) in late 2014 and in Fremantle and Dampier Ports in early 2015. The Marine Biosecurity Research and Monitoring Group have also developed more risk-based targeted monitoring programs, to complement the above, which occur in the off years.

The Marine Biosecurity Research Group have developed 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 for marine pest monitoring in Broome, Port Hedland, Cape Lambert, Dampier, Cape Preston, Fremantle, Albany, Esperance and at HMAS Stirling (Introduced Pests Figure 1). 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. In December 2014 another specimen of *C. japonica* was caught by a recreational fisher in the Swan River Estuary and handed in to the Department. A further week of surveillance trapping was conducted, totalling more than 8,000 trap hours. No further specimens were detected during the surveillance trapping, nor were there any more handed in by members of the 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 Group who have since detected the species 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 expansions 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 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 Group has developed identification capabilities for this species based on characterisation of its DNA. Samples of *D. perlucidum* from around the world were analysed to investigate the native and introduced range of this species. We identified that populations of *D. perlucidum* elsewhere had multiple genetic COI haplotypes where as in Australia we consistently find

only a single COI haplotype. Native populations of a species typically have the highest genetic diversity. The low diversity present in Australian samples suggests these populations are introduced. Finer scale microsatellite analyses of these Australian samples revealed several populations to be distinctly different from others indicating multiple introductions of this species to 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 has been prolific elsewhere and once established readily spreads throughout its new location. In 2014 the Marine Biosecurity Research Group undertook a delimiting survey of this species in and around the vicinity of the Albany tug pen where it had previously been reported. The algae was confined to the same area it originally occupied in 2008 (approximately 4m wide by 80 m long) and was extremely patchy in its distribution. As this species did not appear to be displaying the invasive traits we may have expected based on the literature a control program was initiated to try and reduce the biomass. Divers removed all visible plants, taking care to capture all visible material to avoid spread. *Codium fragile* ssp *fragile* is known to be able to regrow from remnant tissue therefore every effort was made to remove as much visible material as possible. In early 2015 the team returned to Albany to ascertain if there was any regrowth after the removal. Although the alga was still present, biomass was significantly reduced despite the field period being during peak growth time for this species. It is believed that remnant cells from the holdfast may have regrown to produce the existing plants. New trials will be undertaken to test removal and spot treatment (using chemo-mechanical treatments) of holdfast scars underwater. The learnings from this study are not limited to *Codium* but broadly applicable to the control of any sessile pest species. It is hoped that with sufficient attention we may be able to remove this species from WA waters.

Research programs

Temporal likelihood analysis

The Marine Biosecurity Research Group is undertaking a large spatial and temporal analysis of vessels entering WA ports and how vessel activity and risk has changed over time from 2002 to 2014. This research examines the types and number of commercial vessels that visit our ports from domestic and international last port of calls, duration of the vessels stay, duration of the voyage, the 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 will provide an analysis of the changing patterns in trade to better manage domestic and international biosecurity risks to Western Australia

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 Group has commenced a study of recreational vessels from marinas all over the State. This has three main components. Firstly a state-wide survey of vessel owners examining vessel use and maintenance practices. Then in the West Coast Bioregion 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 thirdly 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.

Wrapping structures

Preventative measures such as maintenance of a clean vessel hull are widely acknowledged as more effective in curtailing invasions of marine pests than are eradication or control measures. The Marine Biosecurity Research Group completed a trial in collaboration with South Australian researchers to ascertain the efficacy of wrapping a recreational vessels hull in eliminating/killing biofouling. Results were very promising for these small vessels. Further successful trials were completed on the efficacy of wrapping structures such as pylons to kill fouling which are currently being written up for publication. The group are now undertaking a project that will provide accurate data correlating length of time a structure is wrapped with biofouling breakdown and mortality under different seasonal environmental conditions. By providing more comprehensive timeframes associated with wrapping efficacy this will increase the level of confidence when using this method to deal with marine pest emergencies.

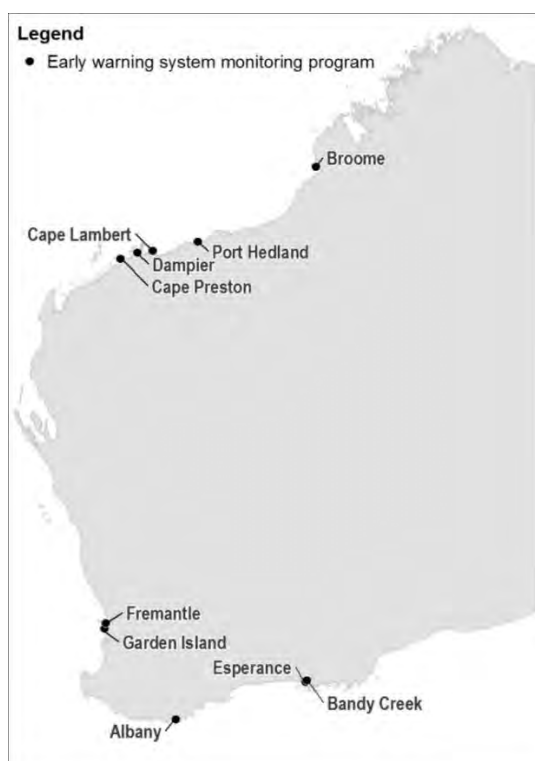
Crab traps and crab behaviour

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 using underwater cameras to examine 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 2013/14

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 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 surveillance project the Marine Biosecurity Research Group completed a large-scale marine pest monitoring program in Christmas Island port in early 2015.



INTRODUCED PESTS FIGURE 1.

Map showing the locations of the early warning system monitoring program around Western Australia.

Activities of the Freshwater Biosecurity Research Program 2014

Prepared by: C. Bird, A. Harris & R. Duffy

Background

In 2010, an NRM funded project surveyed 114 of over 4000 permanent wetlands of the Swan Coastal Plain between Geraldton and Busselton. This project found that fish abundance in the majority of wetlands surveyed was dominated by introduced species. The survey detected two new introduced fish species and a new location for a previously detected introduced species. Findings from this survey identified the need for a more comprehensive survey program.

As a result, a detailed survey of pest fish in metropolitan water bodies commenced in 2012. The 2012 and 2013 results have been reported previous annual reports. Prior to 2014 there were three introduced crustacean species and 19 introduced finfish species recorded in freshwater in Western Australia (WA) (excluding species stocked for recreational angling (Freshwater Biosecurity Table 1). Most of these species show evidence of successful reproduction through the presence of multiple year classes and are therefore considered established pests. Murray cod, golden perch, silver perch and the convict cichlid do not appear to have established self-sustaining populations, however, this does not necessarily imply they are unable to breed in WA.

Freshwater fishes are one of the most commonly introduced vertebrate species. Ornamental fish in particular account for the 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. Many of these species can negatively impact both native species and the ecosystem as a whole.

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 aquaponics) and the aquarium trade. Many species are approved for translocation within the state, these are recorded in industry specific "White List". Species not on a "White List", need to be assessed for risk. If the assessment determines that the translocation of that species into or within WA is acceptable, translocation approval is granted with a set of conditions that must be followed. Applications are refused when the risk is assessed as being too high.

Community Engagement

The Department has continued to have a strong focus on community engagement. The 'don't dump that fish' program launched in 2013 has continued with the distribution of posters, brochures and fish bag stickers that alert aquarium owners to the environmental dangers of dumping unwanted fish into open waterways, toilets, drains or the ocean. In 2014, WA PestWatch, a free smart phone and tablet application ('app') that allows members of the public to report sightings of pests in the field, was upgraded. The new upgrade includes more photos of marine and freshwater pests that are currently in WA, or have a potential to be a pest here. This allows users to more easily recognise pest species and report them via the app.

The Department has attended several community events in the metropolitan and regional areas, as well as visiting aquarium shops and other relevant outlets to distribute freshwater biosecurity materials. Compliance officers have continued to conduct random inspections at the Perth airport in an attempt to prevent any species entering WA that are not listed on the allowable import list, or are seen as a high biosecurity threat.

The Department's research staff, policy staff and enforcement staff involved in biosecurity have received formal training in incident management so that there is a readiness 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.

Pest Reporting and Response

In addition to the ongoing survey work conducted throughout the Perth-metro region (Swan/Canning coastal plain) in 2014, the Freshwater Biosecurity Research Unit also responded to several 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 perceived risk and previous known distribution of the reported species. From the 45 reports received in 2014, eight were responded to 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.

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 2014, a continuation from the 2012 and 2013 monitoring, was concentrated in the Perth metropolitan region of the Swan/Canning coastal plain. This area has been identified as high risk due to previous pest fish detections, the high population density and the extensive lake and drainage systems connected to the Swan and Canning Rivers.

There are approximately 1300 permanent wetlands listed in the Perth-metro region, comprised of natural lakes and swamps, man-made or highly modified lakes, water compensation basins as part of drainage management, and

permanent pools in ephemeral systems. A review of recent late summer aerial photos indicated that only approximately half of the listed permanent wetlands currently retain water all-year-round.

Sampling for this survey was commenced by the Freshwater Biosecurity Research Unit in 2012. Sampling priority was given to wetlands closest to previously reported pest species populations. Occasionally, site visits revealed the location was not able to be sampled as it was either 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 wetlands were sampled.

Sampling methodology

The majority of sampling in the Perth area in 2014 was undertaken using fyke nets – a fish trap that has a wing attached to the bank, which guides fish into a series of hoops and funnels from which they are unable to escape. These nets were generally unbaited. It is accepted that not all fish species are susceptible to capture by fyke nets, however, it was considered the most appropriate, cost effective method for sampling the large number of locations in this survey. Fyke nets can also be used in locations where other methods such as seine netting, electrofishing, gill nets and opera house traps are unable to be deployed due to habitat type, by-catch and staff safety. However, on occasions, these 'other' methods were utilised where required. The fyke nets used by the Department were fitted with a float ring to ensure any air-breathing animals captured in the nets could access the air above the water surface.

Survey Results

A total of 157 sampling events were conducted during the 2014 survey, at 114 locations (Table 2). In October 2014, a report from the public was received through Fishwatch alleging that Murray cod, *Maccullochella peelii peelii* were breeding in a lake adjacent to Alexandria Boulevard, Canningvale. A follow up visual survey conducted by the Department confirmed the Fishwatch report, with the sighting of one Murray cod in the lake, however, there was no evidence at that time of breeding. The Department then unsuccessfully deployed fyke nets in an attempt to catch the Murray cod. Boat based electrofishing was subsequently undertaken by staff from Murdoch University, where they captured one Murray cod and sighted, but were unable to land, a second Murray cod.

Murray cod have been stocked into many public and private waters outside its natural range, including at a number of localities in south-western Australia in the late 1800s (i.e. the Swan-Avon River and Lake Powell - formally known as Lake Grassmere, Albany). However, there is no information to indicate these populations still exist.

In a separate incident, the Freshwater Biosecurity Research Unit received an email from the Turtle Oblonga Rescue Network in August 2014, reporting the freshwater eel-tailed catfish *Tandanus tandanus* to be present at a water-filled clay pit in Kalamunda National Park, Gooseberry Hill. This report came as the third location the eel-tailed catfish was recorded in the Perth-metro region. Initial sampling of the clay-pit lake captured three catfish which were later confirmed to be *Tandanus tandanus*. Further sampling of the location removed an additional 47 of the catfish. The clay-pit lake overflows into a creek line which feeds into Helena Valley

Pipehead Dam. Sampling of the Helena River above this dam and the dam itself was conducted by the Department, but failed to capture any *T. tandanus*. The native freshwater cobbler *Tandanus bostocki* was, however, captured during this sampling occasion. The connectivity of the clay-pit lake to the Pipehead Dam is of particular concern. For instance, if *T. tandanus* enters the dam it would likely follow overflow linkages directly into the Swan River.

Control and Containment Activities

The Freshwater Biosecurity Research Unit continued with control measures in 2014 for the population of *T. tandanus* in Marmion Reserve Lake, Myaree. A final fish-down effort was conducted in January 2014, which removed over 460 Catfish from the lake prior to undertaking the poisoning of any remaining *T. tandanus* with the fish poison rotenone in mid-February 2014. Four post-poisoning surveys were undertaken that captured a total of 14 young-of-the-year *T. tandanus*, and so a second round of rotenone poisoning was undertaken in November 2014. The Freshwater Biosecurity Research Unit has continued to undertake follow-up sampling on *T. tandanus* at Ollie Worrell Reserve, and over six sampling occasions throughout 2014 has captured only one additional *T. tandanus*. This site will continue to undergo monitoring.

The capture of Pearl Cichlids, *Geophagus brasiliensis*, in wetlands adjacent to the Southern River led to concerns about the potential of this species to cross into the Serpentine Catchment via the Berriga Drain located on the Wungong Brook. During 2014 the Department of Fisheries worked with the Department of Water, Water Corporation, Swan River Trust, Serpentine – Jarrahdale Shire and the land owner through which the drain flowed to close this connection and prevent the spread of this pest species into the Serpentine and Peel-Harvey systems.

New Discoveries

Two of the eight reports (excluding the introduced catfish and Murray cod above) which were attended to in the Perth-metro region were of particular importance to the Freshwater Biosecurity Research Unit.

A report of an unidentified dead fish found on the banks of a lake in Kingsbridge Boulevard Lake, Butler, was received by the Department via phone. The species was identified to be an Oscar, *Astronotus ocellatus* or *crassispinis*, which is the

first record of this species in WA. Sampling of the lake failed to catch any further Oscar specimens.

The second report of particular importance to the Department was of an eel-like species, which had allegedly been observed in a lake at Sir James McCusker Park. Sampling was conducted twice at the site of the report, but failed to capture any eel-like species. However, the ongoing survey captured one Marbled Eel, *Anguilla reinhardtii*, in a small lake in Hillarys which was the first capture of this east coast species in WA.

Impact on non-target species

The use of fyke nets for sampling can unintentionally capture non-target species. The most commonly caught non-target species was oblong turtles *Chelodina oblonga*. A total of 1,581 oblong turtles were caught in the 5,702 fyke nets set during the 157 sampling occasions conducted in 2014. All of these animals were returned alive to the water. Water birds were also captured in shallow wetlands sampled, where the entrance to fyke nets was not completely submerged under water. A total of 16 water birds were captured at eight sites, and all but two were released unharmed. A musk duck became entangled in the rope structure inside the fyke and a second musk duck was captured in a gill net set.

Native fish abundance

Native fish abundance recorded from the 2014 sampling displayed a similar trend to that observed during the 2012 and 2013 survey. Of the 114 wetlands sampled, native species were found to be present in only 39 sites (34%). Far less wetlands were found to contain *only* native freshwater species (1%). The majority of the sites surveyed contained introduced *and* native species or *only* introduced species. There is little historical information on native fish distribution in the wetlands of the Perth metropolitan region. Low frequency and abundance of native species may be the result of reduced water levels from decreased rainfall and/ or increased groundwater extraction, poor water quality (i.e. acidification, eutrophication, salinisation, sedimentation as well as pollution by industrial, residential and agricultural waste), destruction of riparian vegetation, channelisation of streams in irrigation areas, or introduced species which can compete with and prey on native fish.

FRESHWATER BIOSECURITY TABLE 1

Freshwater species introduced to Western Australia, recorded during the Freshwater Biosecurity Survey (2010-2014)

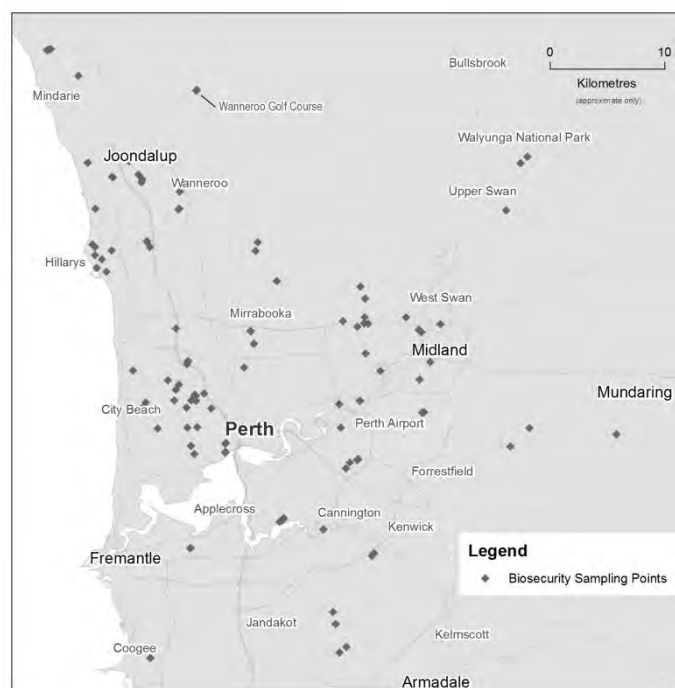
Common Name	Scientific Name	Origin	Year of Introduction (Detection)
Finfish			
Carp (Koi)	<i>Cyprinus carpio</i>	Eurasia	1947
Convict Cichlid	<i>Amatitania nigrofasciata</i>	Central America	(2011)
Freshwater Eel-tailed Catfish	<i>Tandanus tandanus</i>	Eastern Australia	(2010)
Gambusia/ Mosquito Fish	<i>Gambusia holbrooki</i>	Sth America	1934
Golden Perch	<i>Macqaria ambigua</i>	Eastern Australia	1897
Goldfish	<i>Carassius auratus</i>	Eurasia	1893
Guppy	<i>Poecilia reticulata</i>	Sth America	(2001)
Murray Cod	<i>Maccullochella peelii peelii</i>	Eastern Australia	1894
Pearl Cichlid	<i>Geophagus brasiliensis</i>	Sth America	(2006)
Redfin Perch	<i>Perca fluviatilis</i>	Europe	1903
Rosy Barb	<i>Puntius conchoni</i>	SE Asia	(2007)
Silver Perch	<i>Bidyanus bidyanus</i>	Eastern Australia	1897
Southern Platyfish	<i>Xiphophorus maculatus</i>	North and Central America	(2013)
Spangled Perch	<i>Leiopotherapon unicolor</i>	Gascoyne	(2009)
Speckled Mosquito Fish	<i>Phallocheros caudimaculatus</i>	Sth America	(1972)
Swordtail	<i>Xiphophorus helleri</i>	Sth America	(2001)
Tilapia	<i>Oreochromis mossambicus</i>	Africa	(1978)
Marbled Eel	<i>Anguilla reinhardtii</i>	Eastern Australia	(2014)
Oscar	<i>Astronotus ocellatus or crassispinis</i>	Sth America	(2014)
Crustaceans			
Redclaw Crayfish	<i>Cherax quadricarinatus</i>	Eastern Australia	(2000)
Yabby	<i>Cherax destructor albidus</i>	Eastern Australia	1932
Indistinct River Shrimp	<i>Caridina indistincta (B1)</i>	Eastern Australia	(2013)
Molluscs			
Snail sp.	<i>Planorbella sp</i>	Unknown	(2013)

FRESHWATER BIOSECURITY TABLE 2

Freshwater Biosecurity Sampling Results from the Perth-metro Region

Year of Sampling	2014		2013		2012	
	Total	%	Total	%	Total	%
Finfish						
Number of locations visited	114	-	176	-	140	-
Number of locations by visit dry or too shallow	2	2	8	5	9	6
Number of locations sampled	105	92	164	93	124	95
Number of locations containing finfish	92	81	134	76	119	96
Number of locations containing Estuarine fish	28	25	33	19	42	34
Number of locations containing native freshwater finfish	39	34	17	10	8	6
Number of locations containing only native freshwater finfish	2	2	0	-	3	2
Number of locations containing feral freshwater fish	89	78	126	72	99	80
Number of locations containing only feral freshwater finfish	74	65	49	29	71	57
Number of new introduced finfish species detected	2	2	2	1	1	<1
<i>Number of new locations introduced Tandanus tandanus detected</i>	1	<1	1	<1	0	-
<i>Number of new locations introduced Leiopotherapon unicolor detected</i>	0	-	1	<1	8	6
<i>Number of new locations introduced Xiphophorus helleri detected</i>	6	5	3	2	NA	NA
Crustaceans						
Number of locations containing crustaceans	63	55	85	48	66	53
Number of locations containing native crustaceans	38	33	63	36	51	41
Number of locations containing only native crustaceans	30	26	3	2	29	23
Number of locations containing feral crustaceans	33	29	45	26	37	30
Number of locations containing only feral crustaceans	24	21	4	2	14	24
Number of new introduced crustacean species detected	NA	NA	1	<1	NA	NA

NA not applicable for this year of sampling



FRESHWATER BIOSECURITY FIGURE 1

2014 Freshwater Biosecurity Sampling Locations in Perth-metro region.

Monitoring of the Southwest artificial reef trial in 2013 & 2014

P. Lewis & M. Pagano

The Department of Fisheries (Department) first trial of purpose built artificial reefs in Western Australia began in March 2013 with the deployment of 60 artificial reef modules at two locations in Geographe Bay. 30 of the reinforced concrete modules (SW Artificial Reef Trial Figure 1) are located at each reef site off the Bunbury and Dunsborough (SW Artificial Reef Trial Figure 2). The \$2.38 million Southwest artificial reef trial (Artificial Reef Trial) was funded by Royalties for Regions and Recreational Fishing Initiatives Fund which is funded through Recreational Fishing Licences. The funding included provisions for 4 years of monitoring of the trial. A monitoring plan for the Artificial Reef Trial was designed and overseen by a Scientific Reference Group (made up of members from the Department, Recfishwest and other Research Institutes in WA) and meets the requirements for the Commonwealth Department of the Environment (DOE) approvals. Full details of the monitoring are covered in the Long Term Management and Monitoring Plan for the Artificial Reef Trial, available on the Department website. The monitoring conducted each year and results are summarised in an annual report produced in July each year for the DOE.

Monitoring Objectives

The monitoring objectives are divided into four broad groups (see below). The Department is responsible for the first three of these and provides input to the monitoring of the fourth by Recfishwest.

The monitoring objectives are:

Biological

- Document the use/colonisation of artificial reefs by recreationally important fish species, noting concentration and production effects. How and why are fish using these structures?
- Document the presence of any protected species in proximity with the artificial reefs,
- Document the presence of any introduced species in proximity with the artificial reefs.

Ecological

- Describe the extent of the influence of the artificial reefs on recreationally important fish species in the area.
- Assess the impacts of artificial reefs on proximal reef communities with comparisons to (potentially) HMAS Swan, MV Lena, natural reefs and Busselton Jetty (NB – existing data for the HMAS Swan and Busselton Jetty already exist).

Artificial Reef Structures

- Document changes to the artificial reef modules post-installation including movement, integrity (e.g. cracking, rusting).
- Document changes to areas immediately around the artificial reefs post-installation including scouring, sedimentation, and benthic habitat types etc.

- Document any other anthropogenic changes such as fouling of fishing gears and anchors, and remove to reduce risks.

Social/ Economic (conducted by Reefishwest)

- Document the use of the artificial reef areas by recreational fishers.
- Document fishing activities (effort and catch) on artificial reefs. Compare to available data to identify changes in recreational angler behaviour (catch, effort etc).
- Document reasons why fishers use the artificial reefs.

Biological, Ecological and Structural monitoring methods

The Department monitoring surveys are conducted using a combination of baited remote underwater video (BRUVs), diver operated video (DOV), towed underwater video (TUV) and sidescan sonar to assess the monitoring objectives at:

- Artificial reef sites,
- Control sites (close <1 km and distant >5 km natural reef sites),
- Surrounding natural reef sites (areas of natural reef at intervals of approximately every kilometre up to 6 km from the artificial reefs).

The monitoring plan includes:

- An annual major survey in February of all sites above; and
- Additional minor seasonal surveys (May and September/October) of the artificial reef and control sites for the first 2 years using methods appropriate at the time, accounting for weather and water visibility restrictions.

The stereo video systems used allow the lengths of the target species and other recreationally important species to be estimated from the footage.

Monitoring conducted

Seven surveys of the Artificial Reef Trial and surrounding natural sites were conducted during 2013 & 2014 (SW Artificial Reef Trial Table 1).

On each survey it was possible to achieve the minimum BRUV drops and sidescan sonar surveys required (SW Artificial Reef Trial Table 1). However, it was not always possible to dive at the Bunbury Reef due to limited visibility (< 1 metre) at times.

The shift in timing of the major annual survey from May to the February period should coincide with better visibility at both Reefs and allow diver surveys at Bunbury to be undertaken. This will allow the structural integrity and debris monitoring required to be achieved.

Biological and Ecological monitoring

Fish species recorded on the artificial reef sites

The pre-deployment BRUV surveys at the artificial reef sites recorded a diversity of 10 and 12 species at the Bunbury and Dunsborough sites, respectively. Of the target species Samsonfish (*Seriola hippos*), Snapper (*Chrysophrys auratus*) and silver trevally (*Pseudocaranx georgianus*) only Snapper were recorded at the Dunsborough site and silver trevally at Bunbury site on these surveys, both in low numbers (n=1 to 3).

The Bunbury and Dunsborough Reefs show signs they are still establishing with the diversity and relative abundance of fish on both reefs generally increasing over the first 18 months,

with slightly lower values at 6 and 13 months due to the influence of low visibility, see Figures 3 and 4. The post deployment BRUV surveys have recorded total cumulative diversity of 38 and 44 fish species at the Bunbury and Dunsborough Reefs, respectively. These include all three target species on both Reefs, albeit in low abundance apart from Samsonfish on the Dunsborough Reef which occurred as a consistent school of 30-50 fish.

No protected or introduced species have been recorded on or in the vicinity of the Bunbury and Dunsborough Reefs.

Fish species recorded on surrounding natural reef sites

The post deployment BRUV surveys recorded a total of 105 and 110 fish species on the surrounding natural sites in the vicinity of the Dunsborough and Bunbury Reefs, respectively. The surveys have recorded baseline and seasonal data on the abundance and size of the three target species (snapper, Samsonfish and silver trevally) and other recreationally caught finfish species in these surrounding areas.

Structural monitoring

The sidescan sonar survey conducted at deployment confirmed that all of the modules at both the Bunbury and Dunsborough Reefs had been placed within the site boundaries specified to DOTE. All post deployment sidescan sonar surveys have indicated no movement of the modules.

During 2013 a significant storm event occurred with a maximum wave condition of significant wave height (Hs) = 9.47 m (with 9.2 m swell and 2.3 m sea) and wave period (Tp) = 16.67s recorded at the Cape Naturaliste waverider buoy on the 1st of September 2013 (Dept. of Transport *pers comm*). This storm event was approaching the intensity of the 1/100 yr storm calculated as Hs = 10-11 m, Tp = 16-20 s for a location offshore of Busselton (50 m water depth), based on extreme analyses of NOAA Wave Watch 3 model. It also exceeds the maximum Hs = 8.2 m recorded in the period from 2007-2011 at Cape Naturaliste. Thus the modules at the Bunbury and Dunsborough Reefs have withstood a significant storm event in their first six months with no signs of movement or damage.

The diver surveys detected some bedding down of the modules into the sediment at the Bunbury and Dunsborough Reefs. Some small scale scouring and deposition of sediment in the vicinity of modules was also evident but not to any significant distance, less than 2 m.

The diver surveys removed three and two lengths of fishing line with hooks, sinkers or lures that were wrapped around modules at Bunbury and Dunsborough Reefs respectively. An anchor with 10 m of rope was also removed from the Bunbury Reef.

Extension activities

The project has produced a number of seminars and articles for recreational fishers. The Long Term Management and Monitoring Plan, plus data, pictures, video footage and other information collected during the Artificial Reef Trial has been incorporated into the artificial reef information page on the Department website (<http://www.fish.wa.gov.au/Fishing-and-Aquaculture/Recreational-Fishing/Pages/Artificial-Reefs.aspx>). The project has assisted with ministerial media releases and associated pictures and video for the official opening in April 2013 and at the 12 month anniversary. These resulted in numerous articles on the Artificial Reef Trial in the media, particularly in the south west of Western Australia.

APPENDICES

Additional activities included meeting with Recfishwest and the Mandurah Offshore Fishing Club to provide advice on the approvals process for the proposed Mandurah artificial reef, meeting with honours students (on socio-economic assessment of the artificial reefs and citizen science monitoring), involvement in a collaborative FRDC proposal and subsequent FRDC project (2014/005) with Recfishwest on habitat enhancement structures in WA involving two PhD students.

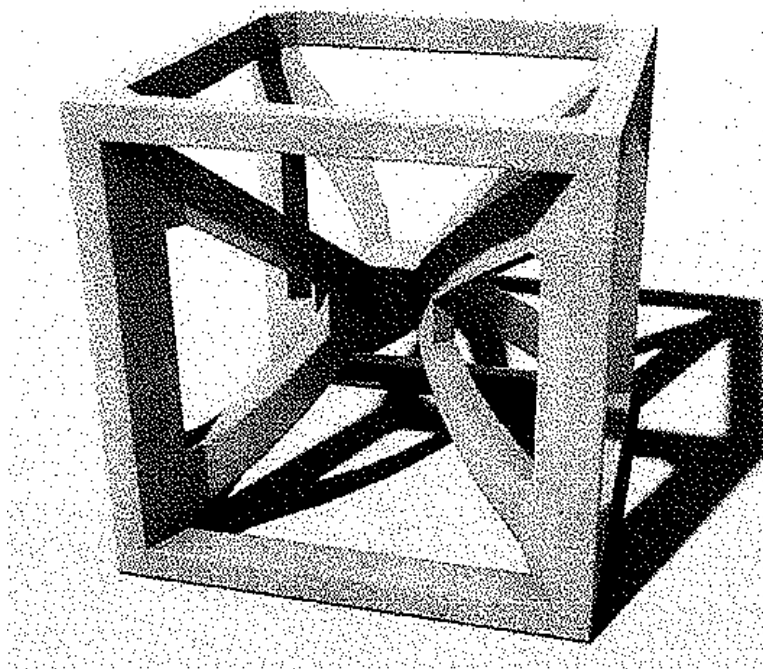
Ongoing monitoring

The funding for the monitoring of the Artificial Reef Trial allows for further major surveys to be conducted until 2017. At the end of this monitoring period a full report on the monitoring objectives will be produced for the Artificial Reef Trial.

SW ARTIFICIAL REEF TRIAL TABLE 1.

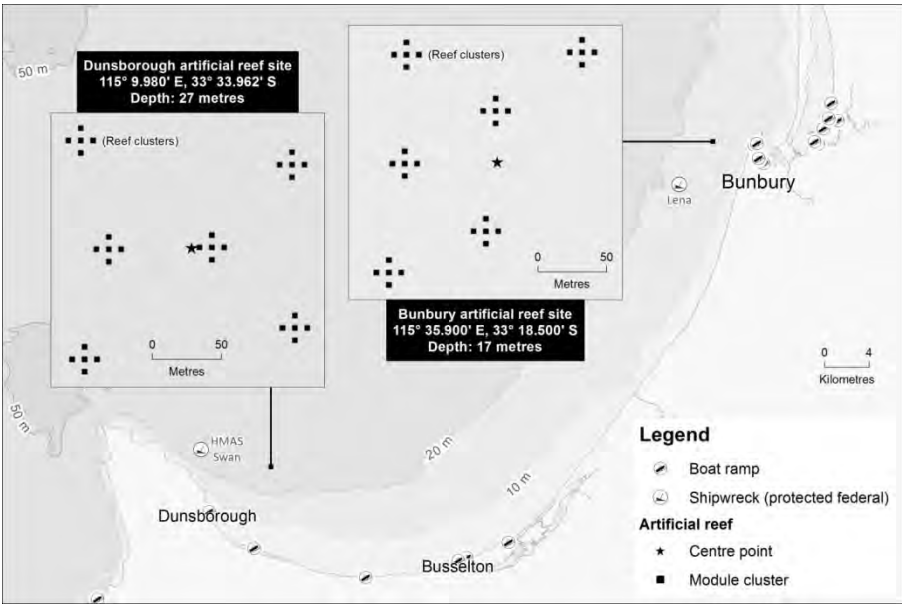
Details of date, reef age and type for each survey conducted in the SWART, giving monitoring conducted for each method (number of drops or transects) at each artificial reef. (BRUV – baited video and TUV – towed video).

Date	Reef age	Survey	Bunbury				Dunsborough			
			BRUV	Dive	Sonar	TUV	BRUV	Dive	Sonar	TUV
Jan 2013	Pre	Minor	9	-	4	6	9	-	4	6
Apr 2013	0	AR only	-	-	2	2	-	-	2	2
May 2013	1	Major	58	-	2	-	55	4	2	-
Sep 2013	6	Minor	9	-	2	-	9	4	2	-
Jan 2014	10	Major	50	9	2	-	50	4	2	-
May 2014	13	Minor	9	-	-	-	9	4	-	-
Oct 2014	18	Minor	9	-	2	8	9	-	2	8



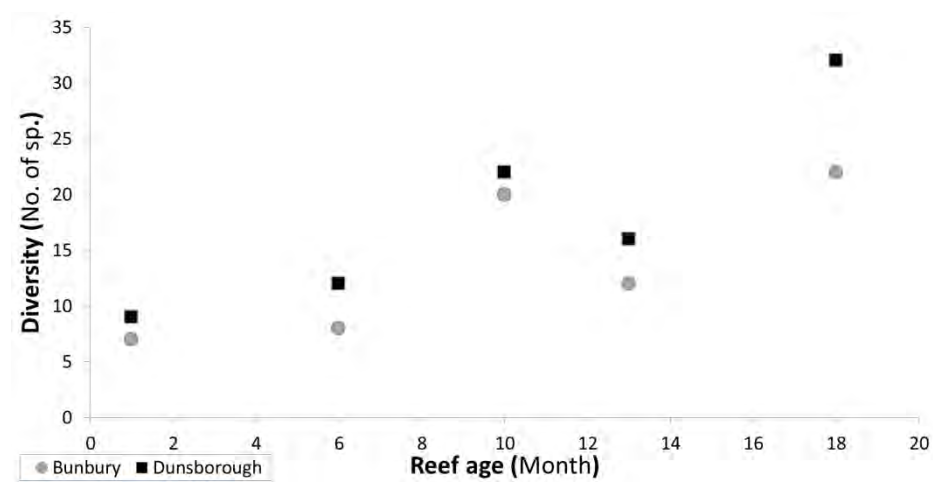
SW ARTIFICIAL REEF TRIAL FIGURE 1.

Reinforced concrete fish box module used in the Artificial Reef Trial. Each side is approximately 3 m. Each unit weights approximately 10 t.



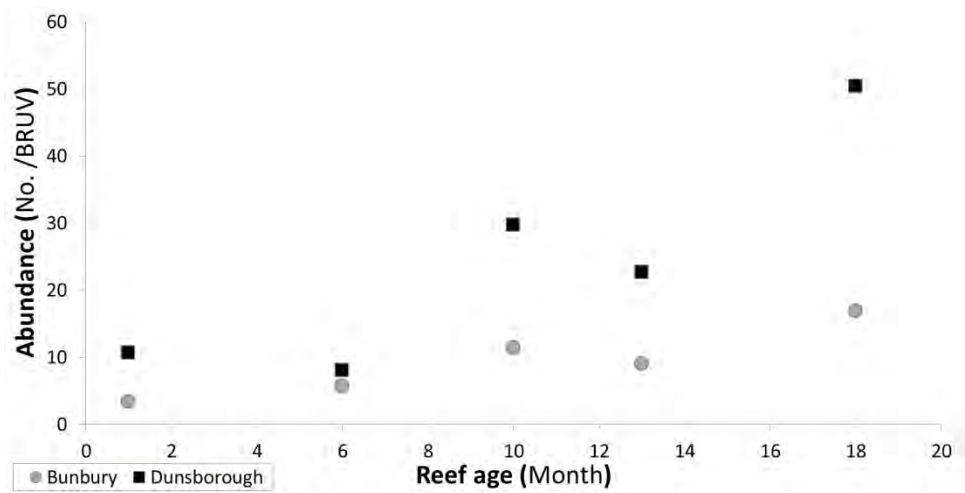
SW ARTIFICIAL REEF TRIAL FIGURE 2.

Map of Geographe Bay in southwestern WA showing artificial reef trial sites with coordinates and showing layout of modules at each site.



SW ARTIFICIAL REEF TRIAL FIGURE 3.

Diversity of fish species (No. of species) recorded on each survey of the Bunbury and Dunsborough Reefs over the first 18 months.



SW ARTIFICIAL REEF TRIAL FIGURE 4.

Relative abundance of fish (Average No. of fish/BRUV) recorded on each survey of the Bunbury and Dunsborough Reefs over the first 18 months.

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 2013/14 season or the calendar year 2014 for fisheries data but up to June 2015 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 2013/14 or 2014	Comment
Fishery: Abalone Approval type: Accredited Export Exempt Fishery Initial accreditation: August 2004 Current accreditation: August 2015 Expiry date: August 2025	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: August 2015 Expiry date: August 2025	Scallops (spawning stock)	The survey stock abundance index determines a predicted catch that sets the length of the next season and the fishing season ceases at a catch rate threshold level,	Environmentally Limited	The survey catch prediction was below the target range therefore the fishery did not open in 2014 due to low stock levels

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2013/14 or 2014	Comment
<i>Fishery:</i> Beche-de-mer <i>Approval type:</i> Wildlife Trade Operation <i>Exemption</i> <i>Initial accreditation:</i> December 2004 <i>Current accreditation:</i> August 2011 <i>Expiry date:</i> August 2016	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	
<i>Fishery:</i> Broome Prawn <i>Approval type:</i> Accredited Export Exempt Fishery <i>Initial accreditation:</i> August 2004 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2025	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any one year	Acceptable	No fishing in 2014.
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–90 t (7-year catch range)	Acceptable	As above
	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 above target level.
	King prawn (spawning stock)	Total catch within acceptable range of 350–500 t	Acceptable	Below range but the catch prediction was low and landings were just above the prediction range with a conservative fishing strategy
<i>Fishery:</i> Exmouth Gulf Prawn <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Initial accreditation:</i> March 2003 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2025	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	
<i>Fishery:</i> Gascoyne Demersal Scalefish Managed Fishery <i>Approval type:</i> Wildlife Trade Operation <i>Exemption</i> <i>Initial accreditation:</i> June 2004 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2025	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 details	Issue/species	Performance measure/Condition	Current performance in 2013/14 or 2014	Comment
Fishery: Kimberley Prawn Approval Type: Accredited Export Exempt Fishery Initial accreditation: November 2004 Current accreditation: August 2015 Expiry date: August 2025	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: August 2015 Expiry date: August 2025	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: Northern Demersal Scalefish Approval type: Accredited Export Exempt Fishery Initial accreditation: November 2004 Current accreditation: August 2015 Expiry date: August 2025	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 details	Issue/species	Performance measure/Condition	Current performance in 2013/14 or 2014	Comment
Fishery: Onslow and Nickol Bay Prawn Approval Type: Accredited Export Exempt Fishery Initial accreditation: November 2004 Current accreditation: August 2015 Expiry date: August 2025	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	Limited fishing by one boat in 2014.
	Brown tiger prawn (spawning stock)	Acceptable catch ranges of Nickol Bay 2–40 t and Onslow 10–120 t	Acceptable	As above for Onslow.
	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. Limited fishing in Onslow.
	Endeavour prawn (spawning stock)	Total catch within acceptable ranges; Nickol Bay 1–10 t and Onslow 5–20 t.	Acceptable	As above
	Coral prawns (spawning stock)	Total catch within acceptable range of Nickol Bay 1–15 t (10-year catch range) and Onslow 4–20 t	Acceptable	As above
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–2 t	Acceptable	
Fishery: Pearl Oyster Approval type: Accredited Export Exempt Fishery Initial accreditation: September 2003 Current accreditation: August 2015 Expiry date: August 2025	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: 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	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2013/14 or 2014	Comment
	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
	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	
<i>Fishery:</i> Salmon <i>Approval type:</i> Accredited Export Exempt Fishery <i>Initial accreditation:</i> November 2004 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2025	Western Australian salmon (spawning stock)	Expected catch range under the current management regime is 1,200–2,800 t	Acceptable	2014 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 details	Issue/species	Performance measure/Condition	Current performance in 2013/14 or 2014	Comment
<i>Fishery:</i> Shark Bay Crab <i>Interim Managed Fishery</i> <i>Approval type:</i> Wildlife Trade Operation Exemption <i>Initial accreditation:</i> November 2004 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2025	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Acceptable	Partial recovery of the stock during 2013 provided confidence to resume commercial fishing with a conservative TACC of 400 tonnes of which 93% was achieved. Ongoing stock monitoring surveys indicates increasing levels of recruitment and spawning biomass during 2014.
	Tiger prawn (spawning stock)	Level of spawning stock present based on fishery independent surveys during the spawning season at a target of 25 kg/hr (5.5 fathom quad gear)	Acceptable	The spawning stock was within the target. An additional area is being assessed as a spawning area and a combined Index will be used in future.
	King prawn (spawning stock)	Total catch within historical acceptable range of 1,100–1,600 t, given no change in effort	Acceptable	
<i>Fishery:</i> Shark Bay Prawn <i>Approval type:</i> Accredited Export Exempt Fishery <i>Initial accreditation:</i> February 2003 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2025	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 2014 season, 27 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	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2013/14 or 2014	Comment
	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.
<i>Fishery:</i> Shark Bay Scallop <i>Approval type:</i> Accredited Export Exempt Fishery <i>Initial accreditation:</i> February 2003 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2025	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	Environmentally Limited	Catch prediction below target level due to poor environmental conditions and the fishery did not open in 2014.
	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	As for Shark Bay prawn although no fishing effort in 2014.
<i>Fishery:</i> South Coast Crustacean <i>Approval type:</i> Wildlife Trade Operation Exemption <i>Initial accreditation:</i> September 2004 <i>Current accreditation:</i> November 2015 <i>Expiry date:</i> November 2016	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.
<i>Fishery:</i> Specimen Shell <i>Approval type:</i> Accredited Export Exempt Fishery <i>Initial accreditation:</i> 25 May 2005 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2025	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
<i>Fishery:</i> Temperate Demersal Gillnet and Demersal Longline (Shark) Fisheries <i>Approval type:</i> Accredited Export Exempt Fishery <i>Initial accreditation:</i> February 2006 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2018	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 at the end of 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

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2013/14 or 2014	Comment
<i>Fishery:</i> West Coast Rock Lobster <i>Approval Type:</i> Wildlife Trade Operation Exemption <i>Initial accreditation:</i> August 2002 <i>Current accreditation:</i> May 2013 <i>Expiry date:</i> May 2018	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.
	Western rock lobster (spawning stock)	Spawning biomass at Abrolhos Islands and coastal regions to remain above respective levels during the early 1980s with 75% certainty	Acceptable	
	Octopus (spawning stock)	Catch rate not to drop outside of historic range by > 10%	Acceptable	The catch rate of octopus (incidental landings) is an indicator for this fishery. Currently the catch rate is based on a different measure to those in the past and cannot therefore be compared. This comparison will be reinstated once a new time series of landed octopus is developed
	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	Unacceptable	There were 6 confirmed whale entanglements in WRL gear during the 2014 humpback whale migration season. Mitigation measures have been implemented to reduce whale entanglements.

APPENDICES

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2013/14 or 2014	Comment
<i>Fishery:</i> West Coast Deep Sea Crustacean Managed Fishery <i>Approval type:</i> Wildlife Trade Operation Exemption <i>Initial accreditation:</i> March 2004 <i>Current accreditation:</i> August 2015 <i>Expiry date:</i> August 2025	Champagne and Giant crab (spawning stock) Crystal 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 The fishery is quota based with catches limited to 140t of crystal crab per season	Acceptable 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.
Matias Braccini	PhD co-supervision, Universidad de Mar del Plata, Argentina, supervises Marcelo Perez – 'Patrones de desplazamiento del gatuzo (<i>Mustelus schmitti</i>) en el Ecosistema Costero Bonaerense a partir de la técnica de marcación con marcas convencionales. Implicancias para el manejo y explotación del recurso' (in Spanish).
	Masters supervision, University of Western Australia, supervises Kelly Rensing - " Spatial and Temporal Movement Dynamics of Four Commercially Important Shark Species in Western Australia "
	Honours co-supervision, Murdoch University, supervises Carissa King - " Investigating the movement patterns of sharks and the significance of potential shark predation attempts on bottlenose dolphins (<i>Tursiops aduncus</i>) in the waters of south-western Australia "
Samantha Bridgwood	Technical Advisor for IMarEST Biofouling Expert Management Group.
Cécile Dang	Adjunct Lecturer Associate, Faculty of Science and Engineering, School of Science, Department of Environment and Agriculture, Curtin University.
Simon de Lestang	PhD co- supervision, University of Western Australia, supervises Jean Dumas - 'Investigating sperm limitation in the Western Rock Lobster Fishery'.
	Honours co- supervision, University of Western Australia, supervises Michael Brooker - An examination of the fish assemblages found in the west coast bioregion of Western Australia'.
David Fairclough	Adjunct Senior Lecturer. School of Veterinary and Life Sciences, Murdoch University.
	Adjunct Senior Lecturer. Department of Environment and Agriculture, Faculty of Science and Engineering. Curtin University.
	Honours co-supervision, Natasha Prokop, Murdoch University, Genetic implications of a novel technique for culturing Australasian snapper (<i>Chrysophrys auratus</i>) from wild-caught eggs collected from Cockburn Sound, Western Australia.
	Honours co-supervision, Megan Cundy, Curtin University, A comparison of reef fish assemblages in different management zones in the Jurien Bay Marine Park
Rick Fletcher	Member, NSW Marine Estate Expert Knowledge Panel.
	Co-supervision Jenny Shaw. Knowledge and adaptation in coastal fishing communities. PhD, Curtin University.
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 <i>Acanthopagrus butcheri</i> in south-western Australia. PhD, Murdoch University.
	Supervision, Eloise Ashworth - Influence of environmental variables on the growth and reproductive biology of Black Bream, <i>Acanthopagrus butcheri</i> .
	Supervision, Daniel Yeoh – Gillnet selectivity of Black Bream <i>Acanthopagrus butcheri</i> , Honours, Murdoch University.

Staff Member	Position
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 <i>Acanthopagrus butcheri</i> in south-western Australia. PhD, Murdoch University.
Craig Lawrence	Adjunct Associate Professor, The University of Western Australia.
	PhD supervision Miriam Sullivan- Fishing for Answers: How can we improve welfare for aquarium fish? The University of Western Australia.
	PhD supervision Kelly Mills: Effects of oestrogens and wastewater treatment plant effluent on the Western Pygmy Perch. The University of Western Australia.
	Honours Supervision Ruyu Wang: Genetic Diversity of Western Minnow (<i>Galaxias occidentalis</i>) along the Swan and Canning river systems. The University of Western Australia.
Rod Lenanton	Adjunct Associate Professor, Faculty of Sustainability, Environmental and Life Sciences, School of Biological Sciences and Technology, Murdoch University.
Justin McDonald	Adjunct 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.
Terry Miller	Associate Editor Management of Biological Invasions – International Journal.
	Adjunct Senior Lecturer, Centre for Sustainable Tropical Fisheries and Aquaculture, College of Marine and Environmental Sciences, James Cook University.
Brett Molony	Member of Marine and Freshwater Course Consultative Committee, Edith Cowan University.
	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.
Karina Ryan	Adjunct Supervisor, Eric Aidoo “Spatial Modelling of Recreational Boat-Based Fishing in Western Australia”. PhD, Edith Cowan University.
	Adjunct Supervisor, Eva Lai “Integrating multiple sources of data to construct a time series of recreational catch/effort for the West Coast Bioregion of Western Australia”. PhD, Edith Cowan 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.

Staff Member	Position
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'.
Brent Wise	Masters co-supervision, Victorian University of Wellington New Zealand, supervises Natalie Stewart – 'The population structure of Polyprionidae from Australia and New Zealand'.
	Adjunct Associate Professor, School of engineering, Faculty of Health, Engineering and Science, Edith Cowan University.

